METODOLOGIA PARA DECLARACIONES DE IMPACTO AMBIENTAL
MARZO 6-10, 1 9 7 8

SESION (Hora)	LUNES	MARTES	MIERCOLES	JUEVES	VIERNES
1 (10-12)	Reid Panorama. Evaluación Tecnológica de la Planeación Ambiental	Reid Sistemas Ambientales. Enfoque de Sistemas	Canter Metodologías de Declaraciones sobre Impacto Ambiental.	Canter Detalles para preparación de Declaraciones. Desechos Sólidos	Canter Detalles para preparación de Declaraciones. Aire.
2 (12-13) (15-16)	Canter Declaraciones sobre Impacto Ambiental.	Reid Criterios para Predicciones	Murphy Evaluación. Reglamentación para la efectividad de DIA. Participación Gubernamental.	Reid Detalles de preparación. Agua	Murphy Detalles de Preparación.
3 (16-18)	Murphy Aspectos Reglamentarios. (DIA)	Murphy E S T U D I O S D E C A S O S Caso "A"	Murphy Caso "B"	Canter Caso "C"	Reid Revisión. Nuevas ideas.

SCHEDULE (March 6-10)

DAY

Sessions	I	II	III	IV	V
1	Reid (1) Overview Environmental Planning Technology Assessment	Reid (4) Environmental Systems, System Approach	Canter (6) Statement Methodologies	Canter (8) Preparation Details (Solid Waste)	Canter (10) Preparation Details (~~energy~~ air)
2	Canter (2) Environmental Impact Statements	Reid (5) Forecasting Criteria, etc.	Murphy (7) Regulatory Assessment of Effectiveness of EIS program (government role)	Reid (9) Preparation Details (water)	Murphy (11) Preparation Details
3	Murphy (3) Regulatory Aspects of Environmental Impact Statements	Case Histories A Murphy	B Murphy	C Canter	Review New Ideas Reid

Sessions

Reid 5

Canter 5

Murphy 5

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   Director General
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   Tel. 566.96.26

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METODOLOGIA PARA DECLARACIONES DE IMPACTO AMBIENTAL

TEMA: PANORAMA. IMPACTOS. EVALUACION.

Prof. Dr. George W. Reid.

Marzo 6-10,1978.

Lecture 1

by G. W. Reid

Overview, Impacts, Assessment

1 - Concepts of the Environment and Concerns

(a) Individual Preception - Lawyer, Ecologist, Engr. Econ.

(b) Firms Preception - Engr., Oil, Energy

(c) Natures Preception - Snow, Aquatic, etc.

(d) Public Needs, today - tomorrow

2- Environmental System - Ecological System

(a) Interactions, Equilibriums

(b) Basic Law- Energy Balances, Returned Resources

(c) Time - sec, hrs, years, eons, etc.

(d) Space - spots, rivers, basins, global, etc.

(e) Inbedment - in time, in space

3 - Basic Concerns

(a) Understanding the system - models

(b) Establishing goals - alternatives - for whom?

(c) Understanding costs and benefits - processes contrasted to profits and losses-economics

(d) Human venture organization - rule making, etc. - laws

4 - System Approach - the engineer's tool.

(a) Model-

(b) Metrics - measures of effectiveness - Economics, Life style, Environmental Enhancement

(c) Again for Whom, Where, When, etc., Goals,alternatives.

(d) Calibration, Validations, etc. - Experimentalism, inpacts, sensitivity

5. Pollution

(a) A resource out of place, for some one.

(b) Residuals of energy

X 6.0 Areas of Conflict

Production and Conversion of resources to useful products, creates residuals, use nature, consumes natural resources

-verses-

Disruption of the intricate web of relationships between living organisms

-such as-

Aswan - Power-reduces fish in Mediterranean - reduce fertility of Nile - Increase snails

St. Laurence - Transport sea lamprey predatory on trout, kill lamprey add Salmon, Salmon, Salmon contains DDT.

Santa Barbara Channel - Oil blow out erupted.

-so-

Growth, energy 18%/year, population, 1½%/year, residuals 27%/year agriculture - 3-4 fold, economics - scale, energetics, 8%, etc.

7.0 Industry and Government

Misplaced economic incentives - price fails to account for environment damage.

Social Damages

Failing to or underpricing spawns pollution

Property tax leads to rapid amortization - through quality degradation.

Poor land use, facor industry, high density housing costs, more in public service, produce less taxes.

High premimum on consumer goods
Federal subsidies, catchup,
Private enterprise verses
Collective Return

Neighborhood Effect

Public works, defense, roads, etc,. but uncoordinated decisions of individual destruction.

x

6.0 Legal Basis

National Environmental Policy Act (NEPA)
Clear Air Act (CAA)
Federal Water Pollution Act (FWPCA)

EPA Statutes
Section 309 - 110 Clean Air
CAA Section 112 - 307 Impacts

FWPCA Hazardous
Section 301, 302, 304, 306

A. INTRODUCTION

1. Project description
   a. Purpose of action
   b. Description of action
      (1) Location and setting of the activity
      (2) Summary of activities
2. Environmental setting
   a. Environment prior to proposed action
   b. Other related Federal activities

B. LAND-USE RELATIONSHIPS

a. Conformity or conflict with other land-use plans, policies and controls
   (1) Federal, state, and local
   (2) Clean Air Act and Federal Water Pollution Control Act Amendents of 1972
b. Conflicts and/or inconsistent land-use plans
   (1) Extent of reconciliation
   (2) Reasons for proceeding with action

C. PROBABLY IMPACT OF THE PROPOSED ACTION ON THE ENVIRONMENT

a. Positive and negative effects
   (1) Regional environmental and national/international environment where applicable
   (2) Environmental factors to be considered
   (3) Impact of proposed action
b. Direct and indirect consequences
   (1) Primary effects
   (2) Secondary effects

D. ALTERNATIVES TO THE PROPOSED ACTION

a. Reasonable alternative actions
   (1) Those that might enhance environmental quality
   (2) Those that might avoid some or all adverse effects
b. Analysis of alternatives
   (1) Benefits
   (2) Risks

E. PROBABLY ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

a. Adverse and unavoidable impacts
b. How avoidable adverse impacts will be mitigated

F. RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

a. Trade-off between short-term environmental gains at expense of long-term losses
b. Trade-off between long-term environmental gains at expense of short-term losses
c. Extent to which proposed action forecloses future options

G. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

a. Unavoidable impacts irreversibly curtailing the range of potential uses of the environment
   (1) Materials
   (2) Natural
   (3) Cultural

H. NATIONAL DEFENSE CONSIDERATIONS THAT MUST BE BALANCED AGAINST THE ADVERSE ENVIRONMENTAL EFFECTS OF THE PROPOSED ACTION

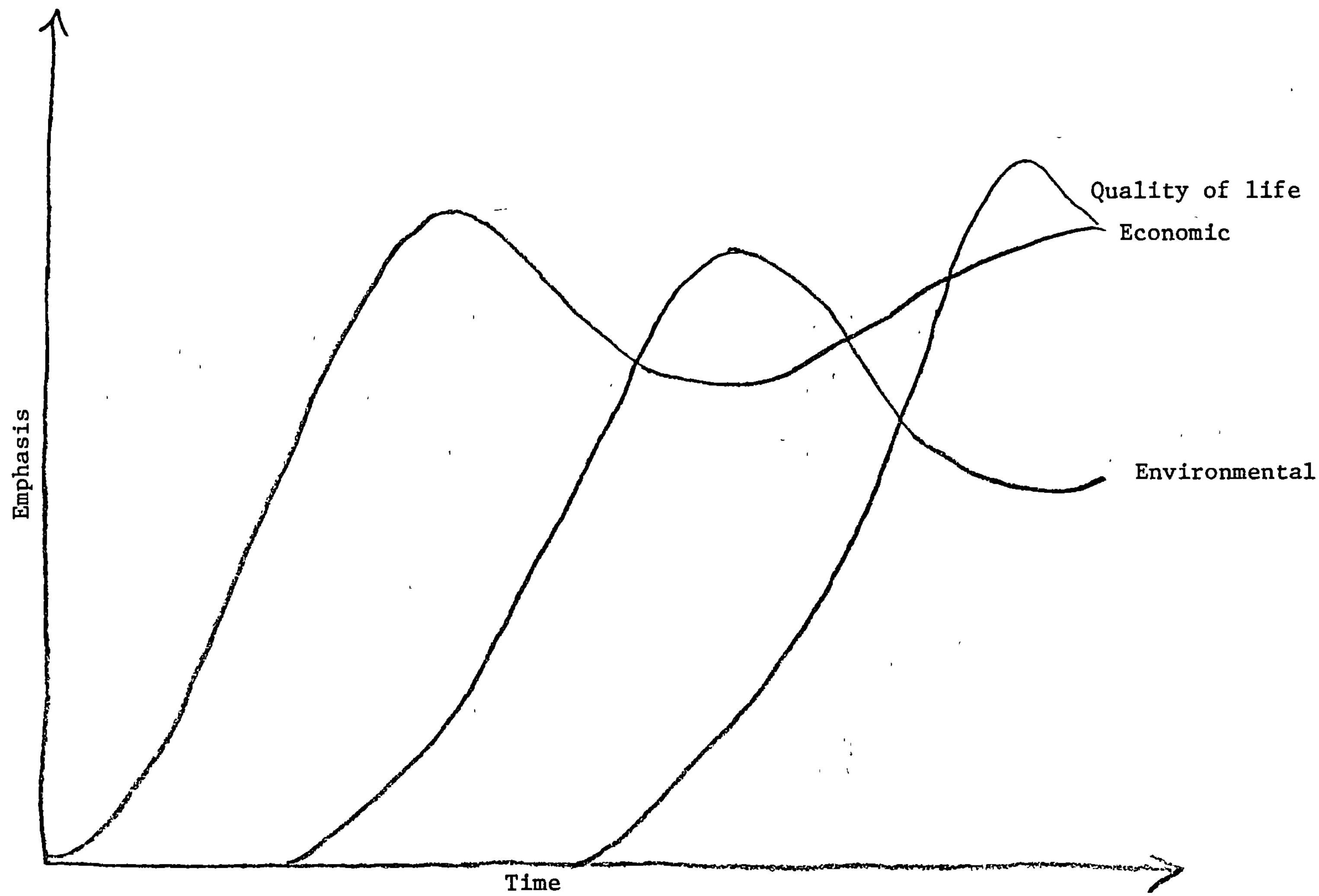
a. Benefits of proposed action
b. Benefits of alternatives

12 Current Status

At present we are planning projects on the basin of economic efficiency and then testing them for environmental impact. The process of running the impact study is exhorbitant and delaying.* I don't think that this should be done this way, but I think we should internalize this rather than using consultants the impact assessment along with the economic efficiency planning and work toward the multiple objective (economic efficiency and environmental enhancement) rather than the single objective to be tested. By integrating these two efforts together it makes a much more sensible approach to planning. So in the development of the planning objectives for water projects, I think we should use multiple objectives rather than single objectives and the two objectives certainly at the present could be environmental enhancement and economic efficiency.
I would add a third objective and this would deal with the emergine problem of consumer acceptance or preception. For many reasons of which I don't have time to go into, it appears that the consumer isn't altogether happy with what the professionals and the federal and state establishments do for him and this is a very difficult thing to come to grips with when you talk about water resources. At the same time we have the problem of doing somethin effective for the tax payer effected not only those that realize immediate utility. So I would suggest a third category which might be called the consumer preceived quality of life. This should accommodate the problems that we have at the present time with consumer acceptance.
In conclusion, I would stress that I would hope that the establishment could have a better integrated and planned research program directed toward the needs of emerging problems associated with resource allocation development.

* From Testimony before WRC, September 1, Dallas.

This does require careful planning and the planning that I would envision should be multiple objective rather than single eliminating the need for very expensive environmental impact statement by integrating environmental enhancement as a goal along with the economic justification and perhaps the gradual inclusion of third goal, which one would call the quality of life.


Quality of life
Economic
Environmental
Emphasis
Time

METODOLOGIA PARA DECLARACIONES DE IMPACTO AMBIENTAL

TEMA: INFORMES SOBRE IMPACTOS AMBIENTALES.

Prf. Larry W. Canter.

Marzo 6-10,1978.

Lecture 2

ENVIRONMENTAL IMPACT STATEMENTS

by
L. W. Canter*

The past several years have been characterized by considerable Federal legislation dealing with the environment. Perhaps the most significant single piece of legislation is the National Environmental Policy Act (PL 91-190), which had an effective date of January 1, 1970. The thrust of this Act, as well as subsequent Executive Orders, Council on Environmental Quality Guidelines, and numerous specific Federal agency procedures, is to insure that "balanced decision making occurs in the total public interest." Project planning and decision making is to include the integrated consideration of technical, economic, environmental, social and other factors. Prior to NEPA, technical and economic factors dominated the decision making process.

I. Terminology

A. Environmental Inventory

1. Inventory of environmental descriptors.

2. Checklist of items to describe the physical, biological and cultural environment.

3. Used as basis for considering impact.

B. Environmental Assessment

1. Methodology whereby the environmental impacts of a proposed action are evaluated.

2. This involves a detailed compilation of the projected impacts; prediction of changes; determination of magnitude or scale; consideration of significance or importance.

3. Should be interdisciplinary, systematic and reproducible.

* Director and Professoor, School of Civil Engineering and Environmental Science, University of Oklahoma, Norman, Oklahoma.

C. Environmental Impact Statement

1. Statement written in format as specified by NEPA, CEQ Guidelines and specific agency guidelines.

2. Represents summary of environmental inventory and environmental assessment.

3. Draft statement is prepared for review and comment, final statement is filed with CEQ.

4. Concept of negative declaration.

II. NEPA (1)

A. Two Parts

1. Title I -- Declaration of National Environmental Policy

2. Title II -- Creation of Council on Environmental Quality

B. Section 102

1. Part A -- utilize systematic, interdisiplinary approach.

2. Part B -- identify and develop methods and procedures which will insure that presently unquantified environmental amenities and values may be given consideration in decision making.

3. Part C -- include for legislative proposals and major actions significantly affecting the quality of the human environment (MASAQHE), a detailed statement on:

a) the environmental impact of the proposed action.

(1) beneficial and detrimental

(2) primary and secondary (direct and indirect)

(3) site and regional

b) any adverse environmental effects which cannot be avoided should the proposal be implemented -- abstracted from the environmental impact section.

c) alternatives to the proposed action.

(1) retroactivity

(2) no action

(3) alternatives outside realm of responsibility

(4) compare based on environmental impact.

d) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity.

e) any irreversible and irretreivable commitments of resources which would be involved in the proposed action should it be implemented.

(1) land resources

(2) mineral resources

(3) historical/archeological/cultural/ecological resources

(4) materials of construction; costs; labor.

(5) threatened and endangered species (plant or animal)

(6) energy

(7) aesthetics

III. CEQ Guidelines (2)

A. First Issuance (April 23, 1971)

1. Added "description of proposed action."

2. Added "discussion of problems and objections raised by reviewers."

a) public hearings

b) comment/response

c) unreconciled conflicts

3. List of agencies to be consulted

B. Second Issuance (August 1, 1973)

1. Content of EIS D / A

a) Description of Proposed Action and Existing Environment.

b) Relation to Land Use Plans, Policies and Controls.

c) Probable Impact of Proposed Action.

(1) Positive and negative

(2) Direct and indirect

d) Alternatives

e) Probable Adverse Effects Which Cannot Be Avoided

f) Short-Term vs. Long-Term

g) Irreversible and Irretrievable

h) Other Decision Factors Which Offset Adverse Environmental Effects

2. Environmental considerations should be included early in the planning process.

3. Economic, technical and other factors to be included along with environmental factors.

4. Program statements are encouraged.

5. Public participation is encouraged.

C. Comments From 7th CEQ Report (3)

1. Overall, EIS process has strengthened agency planning and decision-making. However, greater incorporation is still needed.

2. EIS's are causing lesser delays in project planning than in early 1970's.

3. Court cases related to NEPA --- 654 (1/1/70 to 6/30/76).

a) 332 completed
DOT (26%)
HUD (14%)
Agriculture (10%)
Corps (10%)

b) 322 pending
DOD (21%)
Interior (19%)
HUD (15%)
Agriculture (9%)
Corps (9%)

4. ~ 30,000 assessments in FY 1975

~ 1,200 EIS's in FY 1975

5. Program statements are increasing.

   a) Example
      Emergency Watershed Protection Program (SCS)

   b) 17 agencies have used.

   c) Need more guidelines.

6. Environmental assessments of U.S. actions in other countries are just starting. AID is doing this.

IV. State and City Environmental Policy Acts (4)

A. States With Comprehensive Statutory Requirements
1. California
2. Connecticut
3. Hawaii
4. Indiana
5. Maryland
6. Massachusetts
7. Minnesota
8. Montana
9. New York
10. North Carolina
11. South Dakota
12. Virginia
13. Washington
14. Wisconsin
15. Puerto Rico

B. States With Comprehensive Executive or Administrative Orders
1. Michigan
2. New Jersey
3. Texas

C. States With Special or Limited EIS Requirements
1. Arizona
2. Delaware
3. Georgia
4. Nebraska
5. Nevada
6. New Jersey (coastal)

D. Cities
1. Bowie, Maryland
2. New York City

V. The Future

A. More court cases.

B. More Guidelines (CEQ and Agency).

C. More public involvement.

D. EIS from private sector.

E. EIA in planning.

Selected References

1. "National Environmental Policy Act," PL 91-190, 91st. Congress, S. 1075, January 1, 1970.

2. Council on Environmental Quality, "Preparation of Environmental Impact Statements: Guidelines," Federal Register, Vol. 38, No. 147, pp. 20550-20562, August 1, 1973.

3. Council on Environmental Quality, "Environmental Quality, the Seventh Annual Report of the Council on Environmental Quality," U.S.G.P.O., Washington, D.C., December, 1976, pp. 122-143.

4. "102 Monitor," U.S. Government Printing Office, Washington, D.C., Vol. 7, No. 4, May, 1977.

METODOLOGIA PARA DECLARACIONES DE IMPACTO AMBIENTAL

TEMA: RECLAMENTOS EN RELACION CON INFORMES AMBIENTALES.

Prof. Dr. Robert Jerry Murphy.

Marzo 6-10,1978.

REGULATORY ASPECTS OF ENVIRONMENTAL IMPACT PROCESS

OUTLINE

I. GENERAL BACKGROUND

A. BASIC LAWS/EXECUTIVE ORDERS/REGULATIONS

1. NEPA - REQUIRES ALL FEDERAL AGENCIES TO CONSIDER ENVIRONMENTAL EFFECT OF ANY PROPOSED MAJOR PROJECT OR PROGRAM. MUST ALSO COMMENT ON ENVIRONMENTAL IMPACT STATEMENT PREPARED BY OTHER FEDERAL AGENCIES.

2. ESSENTIAL ELEMENTS TO BE INCLUDED IN AN EIS: ENVIRONMENTAL IMPACTS OF PROPOSED ACTION; ADVERSE AFFECTS UNAVOIDABLE; ALTERNATIVES; IRREVERSIBLE OR IRRETRIEVABLE RESOURCE COMMITTMENTS; SHORT TERM/LONG TERM CONSIDERATIONS.

3. EXECUTIVE ORDERS - PRESIDENT DIRECTION TO FEDERAL AGENCY WHICH IMPLEMENTS NEPA & DIRECTS COUNCIL OF ENVIRONMENTAL QUALITY (CEQ) TO ISSUE GUIDELINES TO FEDERAL AGENCIES.

4. CEQ GUIDELINES - 2 SETS ISSUED. ESTABLISH PROCEDURES & GUIDANCE ON COORDINATION/CONTENTS (BROAD IN SCOPE) ON IMPACT STATEMENTS.

5. AGENCY REGULATIONS. - FEDERAL AGENCIES' POLICY & PROCEDURES TO IMPLEMENT NEPA IN THEIR PROPOSED PROGRAM DEVELOPMENT.

B. ROLES OF VARIOUS GROUPS IN NEPA (CEQ, FEDERAL AGENCIES, EPA, STATE/LOCAL/CITIZENS/PRIVATE INDUSTRY)

1. CEQ - WRITE GUIDELINES - REVIEW FEDERAL AGENCIES NEPA PROCEDURES - MEDIATE DISPUTES & MONITOR ADEQUACY OF DOCUMENTATION.

2. EPA - PREPARE EIS'S AS OTHER FEDERAL AGENCIES ARE REQUIRED & ARE REQUIRED TO REVIEW ALL OTHER FEDERAL AGENCIES' EIS'S AND COMMENT ON THE QUALITY OF EIS AS WELL AS THE ENVIRONMENTAL SIGNIFICANCE OF THE PROPOSED ACTION.

3. STATE/LOCAL AGENCIES, PUBLIC CITIZENS, PRIVATE INDUSTRY — OBLIGATIONS ARE DISCRETIONARY, BY COMMENTING ON ANALYSIS OF PROPOSED ACTION.

INTERPRETIVE ROLE.

4. COURTS - ADDRESS DETAIL AS TO REQUIRED ANALYSIS OF ALTERNATIVES — EXTENT AGENCY'S REGULATION CONFORM TO NEPA - WHETHER FEDERAL AGENCY ON SPECIFIC ACTION COMPILE WITH NEPA.

II BASIC STAGES IN EIS PROCESS

4 MAJOR STAGES

A. DOES ACTION OR PROJECT REQUIRE IMPACT STATEMENT? IS ACTION FEDERAL, A MAJOR ACTION OR WILL IT HAVE SIGNIFICANT EFFECT ON ENVIRONMENT?

B. IF NO, DOCUMENT BASIS FOR DECISION; IF YES, PREPARE EIS. (WHO decides?)

C. CIRCULATE DRAFT EIS & PREPARE FINAL EIS.

D. DECISION MUST BE BASED ON ANALYSIS OF EIS & other factors.

III WRITING DRAFT IMPACT STATEMENTS

A. WHO WRITES IMPACT STATEMENT?

B. WHO PAYS FOR PREPARATION?

C. WHAT ~~IS~~ CONTENT REQUIRED? 5 STEPS INVOLVED - 1. PROPER SCOPE RELATIVE TO PROJECT 2 RANGE OF CONSIDERATIONS THAT SHOULD BE ANALYZED 3 DATA & ANALYSIS REQUIRED TO INVESTIGATE EFFECTS 4 CRITICAL ASSESSMENT OF ANALYSIS/ASSESSMENT IN CONCLUSIONS 5. WHAT ALTERATIVES SHOULD BE ANALYZED?

IV CIRCULATING & RESPONDING TO COMMENTS OF DRAFT EIS

A. CIRCULATING DRAFT - FOLLOW CEQ GUIDELINES WHEN IN DOUBT SEND FOR COMMENT.

B. RESPONSE TO COMMENTS. FINAL EIS MUST INCLUDE COMMENTS & RESPONSE.

C. Writing Final Statement - Changes required in response to comments dictate degree of revision required to draft

V EPA Review of Impact Statements

A. Review ALL Federal Agencies' EIS's.

B. Rank quality of EIS, 1-2-3. 1- Adequate, 2- Insufficient information to assess environmental effects, 3- Inadequate needs substantial revision.

C. Rank expected impact of project on environment (3 rankings; LO, ER, EU) LO - No objections, ER- Reservations on some environmental aspect & reassessment of aspect needed; EU- Proposed action environmentally unsatisfactory

VI. EIS's Influence on Decisions

A. Must not be regarded as just another additional procedural requirement.

B. Must reflect a balancing of environmental costs & benefits against other relevant considerations.

VII. Historical Perspective of Impact Statement Process

A. Statistical Interpretations. (6 year history)

1. ~~B.~~ Number prepared - New each year approximately 100

2. Time required for preparation - In 1975 average for 28 agencies was 11 months

3. Ave time between circulating draft & filing final impact statement was 8 months for 21 agencies.

4. Costs - Difficult to assess. Estimates for 1975 was $27 million for 273 projects for Corps of Engineers.

5. Court Actions - over 5½ years 332 cases of litigation - 1/3 were dismissed, 60 resulted in temporary injunction & 4 permanent injunctions.

B. Framework for Analysis - Concept is to develop charts + tables giving average levels of environmental parameters, related to various level of projects - by project type.

Table 5

Time Required for Draft EIS Preparation, Fiscal Year 1975
(in months)

	Minimum	Maximum	Average
Agriculture			
Forest Service	1	24	13
Soil Conservation Service[1]	36	60	48
Commerce	1	5	3
Defense	2	24	5
Air Force	3	12	4
Army	5	15	6
Navy	2	24	4
Corps of Engineers	2	24	9
Health, Education, and Welfare	1	6	4
Housing and Urban Development	3	6	3
Interior	1	18	10
Bureau of Indian Affairs	4	6	5
Bureau of Land Management	2	38	20
Bureau of Outdoor Recreation	4	12	7
Bureau of Reclamation	8	28	19
Fish and Wildlife Service	3	12	8
National Park Service	12	24	14
Geological Survey	12	24	15
Justice			
Law Enforcement Assistance Administration	3	9	7
Labor	5	12	5-6
State	NA		
Transportation			
Federal Aviation Administration	1	9	7
Federal Highway Administration	5	16	10
Treasury			
Energy Research and Development Administration	9	13	11
Environmental Protection Agency	1	13	9
Federal Energy Administration	2	5	3
Federal Power Commission	9	30	15
General Services Administration	4	11	5
Nuclear Regulatory Commission	3	26	10

NA = Not available
1 Includes project planning, not just EIS preparation.

Table 6

Average Time Between Filing of Draft and Final EISs, Calendar Year 1974
(in months)

Agriculture	
Forest Service	9.1
Soil Conservation Service	12.7
Commerce	4.4
Defense	NA
Air Force	
Army	
Corps of Engineers	10.5
Navy	
Health, Education, and Welfare	NA
Housing and Urban Development	5.2
Interior	NA
Bureau of Indian Affairs	3.6
Bureau of Land Management	5.7
Bureau of Outdoor Recreation	6.1
Bureau of Reclamation	11.7
Fish and Wildlife Service	19.8
National Park Service	13
Geological Survey	6.7
Justice	
Law Enforcement Assistance Administration	4.0
Labor	2.5
State	14.4
Transportation	
Federal Aviation Administration	8.9
Federal Highway Administration	11.9
Treasury	NA
Energy Research and Development Administration	6.1
Environmental Protection Agency	7.4
Federal Energy Administration	NA
Federal Power Commission	5.3
General Services Administration	6.5
Nuclear Regulatory Commission	NA

NA = Not available

Table 11 [1/]
Estimated EIS Preparation and Review and Comment Costs

Agency	Formal process for determining NEPA costs	Preparation FY 1974	Review and comment FY 1974	Total FY 1974	Total as percentage of operating budget FY 1974[2/]	Preparation FY 1975
COE[3]	Yes	$21.933.832	$ 76,000	$22,009,832	1.2%	$27,057,447
USDA						
FS[4]	No, estimate	27,000,000	225,000	27,225,000	2.7%	27,000,000
SCS[5]	No-use estimates	3,500,000	360,200	3,860,200	1.0%	3,500,000
APHIS[4]	No-use estimates	125,000	NA	125,000	NA	85,000
REA[5]	No-use estimates	117,190	11,295	128,485	.73%	161,630
DOC[4]	No-use estimates	430,000	3,174,000	3,604,000	.24%	526,680
DOD[6]	No-use estimates	5,200,000	NA	NA	NA	4,200,000
DOI[7,8]	No-use estimates	15,200,000	5,500,000	20,700,000	.1%	23,400,000
BLM[9]	Yes	3,544,243	305,000	3,849,243	1.3%	NA
BOR[5]	Yes	575,000	995,400	1,570,400	1.4%	600,000
BuRec[4]	No-use estimates	3,796,000	390,000	4,186,000	.63%	4,050,000
FWS[5]	No-use estimates	NA	1,849,000	NA	NA	NA
NPS[5]	No-use estimates	1,900,900	545,000	2,445,900	.54%	2,013,600
USGS[10]	No-use estimates	2,400,000	800,000	3,200,000	1.85%	5,000,000
DOT[4]	No-use estimates	31,746,000	250,000	31,996,000	.18%	36,500,000
ERDA[4,8,11]	No-use estimates	NA	NA	NA	NA	3,400,000
EPA[4]	Yes	1,280,000	1,600,000	2,880,000	.048%	6,300,000
FEA[12]	No-use estimates	NA	NA	NA	NA	330,000
FPC[4]	Yes	1,481,419	70,000	1,551,419	5.4%	1,333,000
GSA[4]	No-use estimates	1,600,000	10,000	1,610,000	.18%	2,235,000
HEW[5]	No-use estimates	40,000	100,000	140,000	.0001%	80,000
HUD[5]	No-use estimates	6,000,000	275,000	6,275,000	.07%	NA
NRC[4,11]	Yes	NA	NA	NA	NA	14,900,000

NA = Not available

1 From responses to a NEPA questionnaire distributed by CEQ to all federal agencies in November 1974.

2 From federal budget figures for fiscal year 1976.

3 Costs include inhouse and contractor staff, inventories, impact assessments, EISs, supplements, and public meetings.

4 Costs include inhouse and contractor staff only.

5 Costs include inhouse staff only.

6 Costs include inhouse and contractor staff, travel, research, administration, and public hearings but do not include environmental assessments.

7 Total for department.

8 Costs include preparation of all environmental assessments as well as EISs.

9 Costs include inhouse staff, program services, leave, and other indirect costs for all environmental assessments and EISs.

10 Fiscal year 1974 costs include inhouse staff and obtaining other agencies' expertise, fiscal year 1975 also includes contractor staff.

11 Not established until 1975.

12 Costs include consultant fees, NEPA training, and preparation of a NEPA manual.

Table 7
NEPA-Related Cases Completed, as of June 30, 1975[1]

Agency	Total cases	No EIS alleged	Dismissed by trial court	Dismissed where no EIS alleged	Dismissed where inadequate EIS alleged	Injunctions where no EIS alleged	Injunctions where inadequate EIS alleged	Total permanent injunctions
USDA	31	23 (74)	10 (33)	8 (26)	1 (3)	4	1	0
DOC	4	3 (75)	2 (50)	1 (0)	0 (0)	0	0	0
CPSC	1	1(100)	0 (0)	0 (0)	0 (0)	0	0	0
USAF	1	0 (0)	0 (0)	0 (0)	0 (0)	0	0	0
COE	34	15 (44)	1 (3)	1 (3)	0 (0)	3	5	2
USN	11	9 (82)	10 (91)	8 (73)	2 (18)	0	0	0
EPA	12	6 (50)	2 (17)	1 (9)	1 (9)	1	2	0
FCC	1	0 (0)	0 (0)	0 (0)	0 (0)	0	0	0
FEA	2	2(100)	0 (0)	0 (0)	0 (0)	0	0	0
FPC	10	7 (70)	0 (0)	0 (0)	0 (0)	0	0	0
GSA	6	4 (71)	1 (14)	1 (14)	0 (0)	0	0	0
HEW	5	3 (60)	2 (40)	1 (20)	1 (20)	1	0	0
HUD	46	32 (70)	22 (48)	17 (37)	5 (11)	6	1	0
ICC	7	3 (43)	0 (0)	0 (0)	0 (0)	0	1	0
DOI	22	10 (45)	3 (14)	1 (5)	2 (9)	0	3	0
DJUS	6	5 (84)	4 (67)	3 (50)	1 (17)	1	0	0
NASA	1	1(100)	0 (0)	0 (0)	0 (0)	0	0	0
NCPC	8	7 (88)	1 (13)	1 (13)	0 (0)	2	0	0
NRC	17	4 (23)	5 (29)	1 (6)	2 (12)	1	0	0
SEC	4	0 (0)	3 (75)	0 (0)	0 (0)	0	0	0
DOT	88	49 (56)	38 (43)	20 (23)	16 (18)	8	9	1
Treas	7	6 (86)	3 (43)	3 (43)	0 (0)	0	0	1
TVA	5	2 (20)	0 (0)	0 (0)	0 (0)	0	1	0
WRC	3	1 (33)	2 (67)	1 (33)	1 (33)	0	0	0
Total	332	193 (58)	109 (33)	68 (20)	32 (9)	27[2]	23[2]	4[2]

1 A number in parentheses is the percentage of the total number of cases.
2 Other NEPA-related "injunctions": 10; other non-NEPA-related injunctions: 1.

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METODOLOGIAS PARA DECLARACIONES DE IMPACTO AMBIENTAL

TEMA IV: SISTEMAS DEL MEDIO AMBIENTE

Dr. George W. Reid
Marzo, 1978

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Lecture #4 Reid

Environmental Systems, System Approach

SYSTEMS APPROACH

The systems approach has developed from operations research and systems engineering with initial development stemming from military applications and expanding to industrial applications, and finally applications to the public sector. It has evolved into a comprehensive look at all the interactants at one time using inductive followed by deductive reasoning or feedback. It provides a look at the whole system as an entity rather than one part at a time as has been done in the past. This approach has been made possible by the development of new concepts and tools enabling the management of large amounts of data and many variables.

Basic to the systems approach is a model. The model is used to understand, design and predict or evaluate, and forecast. The model is, of course, a symbolic representation of a real life situation. Single purpose open loop models have been used by engineers for years, but the systems approach inputs simultaneous investigation of numerous controlled and uncontrolled variables and time frames. Thus, one must progress to multistaged, multivariant models. Water and sewerage problems can now be appraised in terms of alternate decisions and ranked in relation to other public sector programs. Consequences of various public actions over time can be compared in advance of actual program development. Thus, a team will participate in the planning process from start to finish. The model, or leader concept, will designate the dominant role.

Present day public expenditures such as those on water in a river basin are too large, far too far in the future to be gambled with and too expensive to experiment with, especially in the developing countries. Modelling is essential. The Systems Approach to water problems can be looked at from several levels, levels that can be characterized as strategical, logistical, or tactical, or macro, micro and micro-micro. The comparison is shown as follows on Figure 1.0

Figure 1.0: System Level Assignment

Coarse ↑ General ↑ Fine ↓ Substantive ↓

System	Military	Planning
Macro	Strategic	Comprehensive Developmental
Micro	Tactical	Comprehensive Functional
Micro-Micro	Logistic	Program Development

Aggregrate ↑ Disaggregrate ↓ Increased Discipline Spectra ↑ Increase Specialty ↓

In the systems formulation, there is a reciprocity between detail and variables, or fineness and scope. The macro level is of course detailed, but of a wide variety of variables. As details of fineness are increased, variables must be reduced, thus the micro system deals with water as opposed to general committments to all public expenditures. Another view might well be one of going from a skeleton to several Modules or Components. Finally, relative location of the parts in detail is structured in the micro-micro model. Basically, the fineness can be increased or decreased as the model is arranged over time, closer to t=0 the finer the detail, the further in the future the coarser or more general, actually working from physical elements to globe.

It is in these areas that the analyst will study water problems. So, basic to the analytical capability:

Complexities = (detail) X (variables)

or

Capability = (fineness) X (time)

So the concepts of <u>scale</u>, <u>time</u>, and <u>detail</u> are involved.

As has been previously stated herein, historically, operations research (OR) means many things to many people, say, system analyses or management science. Operations research proceeds by analyzing qualitative aspects of human activity and not merely associated with tools and techniques, but is a basic philosophical approach. It is not, for example, the application of statistics and common sense, not specific industrial engineering tools, nor computerization of data. But, it is research on operations, a process that provides combinations of all elements, gear, morale, output, and is an economic process. Operations research varies from simple problems that require math and science to complex ones requiring the addition of economics, psychology, ecology, etc., ot the team; OR is based on the scientific method with faith in the rationale of nature and that observed phenomena has cause, or pattern or a system that can be explained.

Thus professionally, we find ourselves responsive to the interdependency of disciplines; after all, disciplines emerged from problem identity, and mixes of disciplines are needed to solve new problems.

Regional analysis may be viewed as consisting of two distinct, yet interrelated approaches. First, a vast amount of effort has been devoted to microanalysis, that is, the study of particular segments or problem areas of a region. Second, there is a more recent interest in macroanalysis of regions. This category of study typically involves looking at the intra- and inter-regional interdependencies, as contrasted to the more or less isolated question areas involved in the microanalytic approach.

It is clear that a given regional research project might utilize both the micro and macro approach. In fact, underlying the macroanalytic method are various microanalytic tools, techniques, and methodologies. A summary of various tools of regional analysis is contained in Table 1.

TABLE 1.

Tools of Regional Analysis

Microanalytic	Macroanalytic
Economic Base Studies	Simulation
Coefficient Analysis	Input/output analysis
Factor Analysis	Linear programming
Regression Analysis	Regional Multiplies analysis
Commodity Flow Studies	Industrial Complex analysis
Money Flow Studies	Gravity Models
Comparative Cost Analysis	Operational Simulation
Regional Income Accounting	
Balance of Payments Studies	

Typical microanalytic research includes the use of such tools as coefficient analysis, flow studies, economic base studies, factor analysis, and regression analysis. In the realm of macroanalytic research, illustrative tools include input-output analysis, regional multiplier analysis, linear programming and simulation. These tools, representative of methodologies used in regional studies and in regional modeling are discussed below in more detail.

Coefficient Analysis essentially amounts to a practical shortcut method of depicting salient features or characteristics of a region. The coefficient of localization, for example, measures the concentration of an industry in a region in relation to the same industry's concentration in the nation as a whole, with a zero to one range.

The models outlined below are:

1. California Development Model*
2. Hawaii Planning Model*
3. Lehigh Basin Model*
4. New York Metropolitan Region Study*
5. Ohio River Basin Study*
6. Oklahoma Water Plan*
7. Susquehana Model*
8. Upper Midwest Economic Study*
9. West Virginia Model*
10. A Multistructural Demand Model For Water Requirement Forecasting*
11. Aggregate Modeling of Water Demands For Developing Countries Utilizing Socio-Economic Growth Patterns.

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*Reid, G.W., A Multistructural Demand Model for Water Requirement Forecasting (Final Report), Office of Water Resources Research, Department of Interior, Washington, D.C., January, 1970.

Formally the approach is:

Data
Model
Alternatives
Validation

Models
- dynamic, static
- multi structured, multi staged, multivariable
- taylor made, off the shelf
- etc.
- stochastic, deterministic, probabilistic
- simple, complex
- numerical or analytical
- demensional
- analog
- iconic

Solutions
- calcalus
- L.P. D.P.
- Lagrangen
- Simulation

Appropriate Technology Model, Process Selection

Sample format for Process Selection, Example

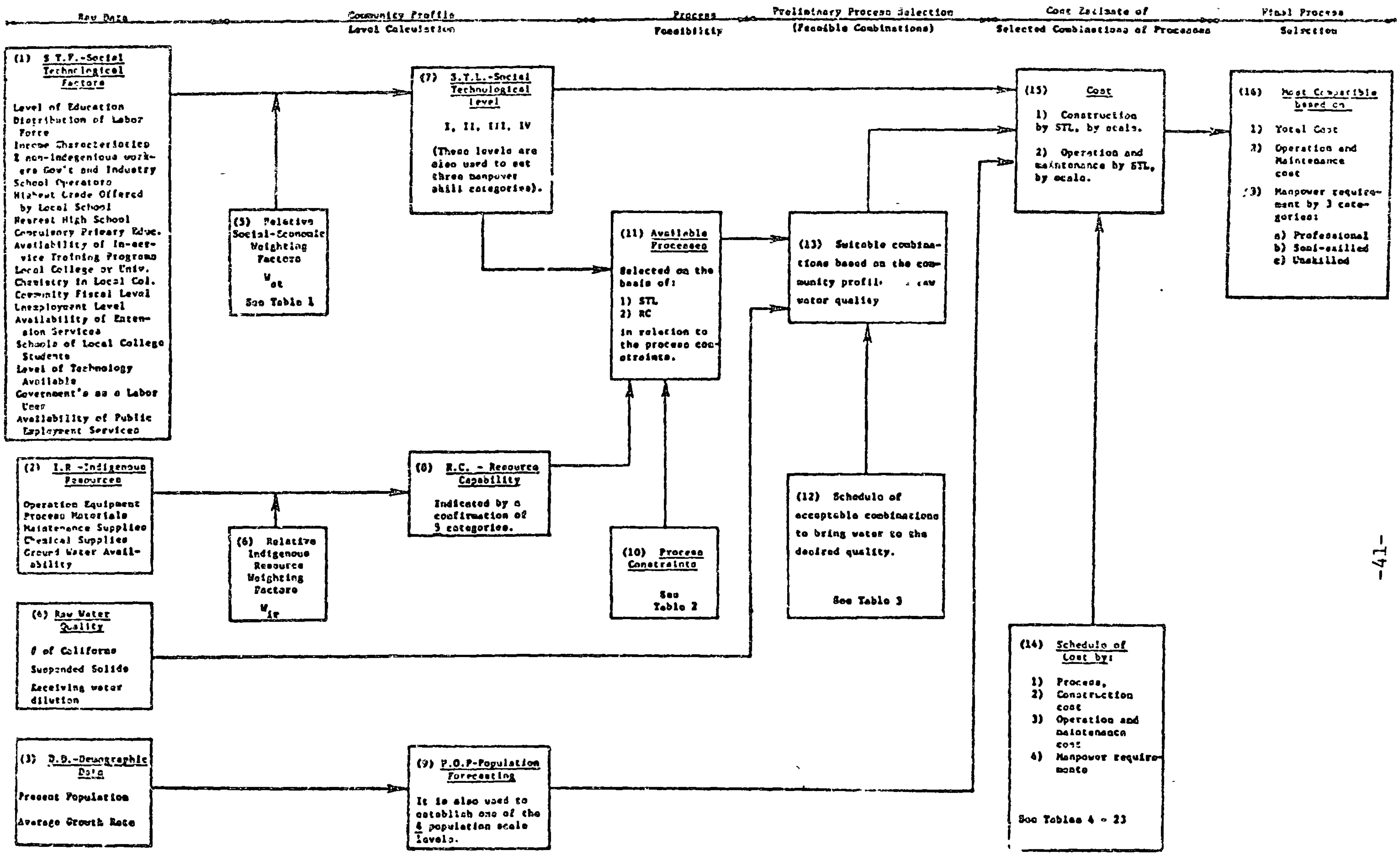

Figure 1. The Complete Information Flow for the Water & Waste Water Treatment Process Selection Model

	Treatment Methods \ Process Requirements	Process Number	Manpower Operation			Resources Required				
			Unskilled	Skilled	Professional	Operation Equipment	Process Materials	Maintenance Supplies	Chemical Supplies	Groundwater Availability
WATER PROCESSES	No Treatment	PW1	●				●			●
	Pre-Treatment	PW2	●					●		
	Slow Sand Filtration	PW3	●					●		
	Rapid Sand Filter-Conv.	PW4		●	●	●	●	●	●	
	Rapid Sand Filter-Adv.	PW5		●	●	●	●	●	●	
	Softening	PW6		●	●	●	●	●	●	
	Disinfection	PW7		●		●	●	●	●	
	Taste-Odor - Fe, Mn	PW8		●		●	●	●	●	
	Desalting-Salt	PW9		●	●	●	●	●	●	
	Desalting-Brackish	PW10		●	●	●	●	●	●	
	Containment Filter	PW11	●					●		
WASTE PROCESSES	Primary-Conventional	PS1	●							
	Primary-Stab. Pond	PS2	●							
	Sludge-Conventional	PS3	●	●			●	●	●	
	Sludge-Advanced	PS4	●	●		●	●	●	●	
	Sludge-Combined (Imhoff)	PS5	●			●		●		
	Secondary - Standard Filter	PS6	●	●		●		●		
	Secondary - High Rate Filter	PS7	●	●	●	●	●	●	●	
	Secondary - Activated Sludge	PS8	●	●	●	●	●	●		
	Secondary - Extended Aeration	PS9	●	●		●		●		
	Disinfection	PS10		●		●	●			
	Aqua Culture	PS11	●							
	Dilution	PS12	●							
	Individual	PS13	●							●
	Individual (adv)	PS14		●		●		●		●

Table 3. eptable Combination of Treatment Processes for Potable Water.

	Combination CODE	PROCESS COMBINATIONS	CRITERIA LEVEL: Raw Water Concentration — Coli MPN/100 ml	Solids mg/l — Turb	Solids mg/l — Other	Receiving Water: Receiving Water Volume (7-day Low Flow Level)/Waste Volume
WATER TREATMENT	W1	PW1	1 - 2	10		
	W2	PW1 + PW7	100	10		
	W3	PW3	100	100		
	W4	PW2 + PW3	300	800		
	W5	PW11	300	800		
	W6	PW4 + PW7	2,000	100		
	W7	PW2 + PW4 + + PW7	3,000	1,000		
	W8	PW5 + PW7	2,000	100		
	W9	PW2 + PW5 + PW7	3,000	1,000		
	W10	(any one of W1 to W8) + PW6			300 Hardness	
	W11	(any one of W1 to W8) + PW8			1-3 Fe & Mn	
	W12	PW7 + PW9			> 3000 TDS	
	W13	PW7 + PW10			> 2000 TDS	
SEWAGE TREATMENT	S1	PS1 + PS5				20 (or 3-4 CFS/1000 PE*)
	S2	PS1 + PS3				20 (")
	S3	PS2				10 (or 1.5-2 ")
	S4	S1 + PS6				6 (or 0.9-1.2 ")
	S5	PS1 + PS9				3 (or 0.45-0.6 ")
	S6	S2 + PS6				6 (or 0.9-1.2 ")
	S7	S2 + PS7				5 (or 0.75-1 ")
	S8	S2 + PS8				4 (or 0.6-0.8 ")
	S9	(any one of S1 to S7) + PS10	250			2 (or 0.3-0.4 ")
	S10	PS3 (Without water carriage)				- NA
	S11	PS11				10 (or 1.5-2 ")
	S12	PS12				40 (or 6-8 ")
	S13	PS2 + PS12				8 (or 1.2-1.6 ")

*The unit is defined as cubic feet per second of receiving water flow rate/1000 population equivalent. A population equivalent is a waste equivalent to one person per day, normally taken as 0.17 lb. BOD/day.

Table 4. Water and Wastewater Treatment Process Subcharacterization.

WATER

Processes		Constraints
PW1	No-Treatment	
	a. Groundwater (not construction, etc.)	Usually limited by size to less than Level IV.
	b. Catchment Control	
PW2	Pre-Treatment	
	a. Turbidity/Sand - Plain Sedimentation	Level I
	b. Algal Control - Thermocline Control**	Level IV
	c. Copper Sulfate ($CuSO_4$)**	Level III
	d. Microscreen**	Level IV
PW3	Slow Sand Filtration	
	a. Conventional, manually cleaned	Usually limited by size to less than Level IV.
	b. Upflow**	
	c. Crossflow (dynamic)**	
	d. Dual media**	
PW4	Rapid Sand Filter-Conventional*	
	a. Conventional	Level III
	b. Surface Aggitation (air, water, mechanical)	Level III
	c. Dual media (sand and artificial)	Level III
	d. Upflow	Level IV
PW5	Rapid Sand Filter - Advanced	
	a. Multi-media (sand, garnet, coal)	Level IV
	b. Plate or tube settling	Level III
	c. Polelectrolytes (ionic and anionic)	Level IV
	d. Biflow**	
	e. Dynamic **	
	f. Valve-less**	
PW6	Softening	
	a. Lime soda	Level III
	b. Zeolite	Level IV
PW7	Disinfection	
	a. Disinfection-chlorine	Level III
	b. Iodine	Level IV

*Includes Fe, CaO, and/or Al for coagulation, mixing, and settling.

**Requires more field evaluation at present.

Table 4 (Continued)

Processes	Constraints
PS 4 Sludge - Advanced	Level IV
a. Zimpro-Pyrolysis	
b. Incineration	
c. Fertilizer	
PS5 Sludge Combined - Imhoff	Level I
PS6 Secondary - Standard Filter	Level II
PS7 Secondary - High Rate Filter	Level III
a. Bio-filter	
b. Accelo-filter	
c. Aero-filter	
d. Biosorption-filter	
PS8 Secondary - Activated Sludge	
a. Min. solids	Level IV
b. Conventional	Level III
PS9 Secondary Extended Aeration (Oxidation Pond)	Level III
a. Dutch ditch	
b. INKA	
c. Aerated lagoon	
PS10 Disinfection - Chlorine	Level II
PS11 Aqua - Culture	Level I
a. Fish, culture-milkfish, tilapia, bass	
b. Vascular plants - Hyacinth, Kang Kung	
c. Ecological	
d. Irrigation	
PS12 Dilution	Level III
a. Coarse screens	
b. Fine screens	
c. Chemical Precipitation, Guggenheim	
PS13 Individual	Level I
a. Septic tank	
b. Clivus multrum	
c. Sanitary pit privy	

Table 4 (Continued)

Processes		Constraints
	c. Ozone	Level IV
	d. Ultra violite	Level IV
	e. Lime, $CuSO_4$	Level I
	f. Energy** (Pasteurization)	Level II
PW8	Taste Odor - Fe, Mn	
	a. Aeration	Level II
	b. Zeolite	Level IV
	c. Chlorine	Level III
	d. Adsorbent - Char.	Level III
PW9	Desalting - Salt	Level IV
	a. Multiple effect	
	b. Freezing out	
	c. Pressure	
PW10	Desalting-Brackish	Level IV
	a. Electrodialysis (ED)	
	b. Reverse Osmosis (RO)	
	c. Chemical	
PW11	Containment Filters	
	a. Dunbar **	
	b. Coconut fiber/charred rice**	
	c. Asbestos/charred pine needle**	
	WASTEWATER	
PS1	Primary - Conventional	Level I
	a. Separate	
	b. Combined	
PS2	Primary Stabilization Pond	Level I
	a. Single Cell	
	b. Multiple Cell	
PS3	Sludge - Conventional	
	a. Conventional	Level III
	b. Heated	Level III
	c. Thickened	Level IV
	d. Staged, including mixing	Level IV

Table 4 (Continued)

Processes	Constraints
PS14 Individual (Advanced) a. Chemical b. Thermal	Level III

TABLE D-3 . Per Capita Cost Parameters in U.S. Dollars & Operation & Maintenance Manpower Requirements
Process: Slow Sand Filter (PW3)

Population Scale		Socio-Technological Levels*				MANPOWER (# of workers)		
Level	Type of Cost	I	II	III	IV	Unskilled	Skilled	Professional
1 (500-2,499)	Construction	12.65	16.50	16.00	20.00			
	Operation & Maintenance	1.33	2.00	2.33	5.00	1		
2 (2,500-14999)	Construction	9.03	11.72	11.85	14.28			
	Operation & Maintenance	0.60	0.90	1.05	2.25	2		
3 (15000-49999)	Construction	6.33	7.18	7.68	10.01			
	Operation & Maintenance	0.33	0.58	0.73	1.25	5		
4 (50000-100000)	Construction	3.95	6.98	5.21	6.25			
	Operation & Maintenance	0.20	0.35	0.44	0.75	8		

* For a complete description of these levels see Appendix A.

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METODOLOGIAS PARA DECLARACIONES DE IMPACTO AMBIENTAL

TEMA V: PREDICCION DE LAS DEMANDAS

Dr. George W. Reid
Marzo, 1978

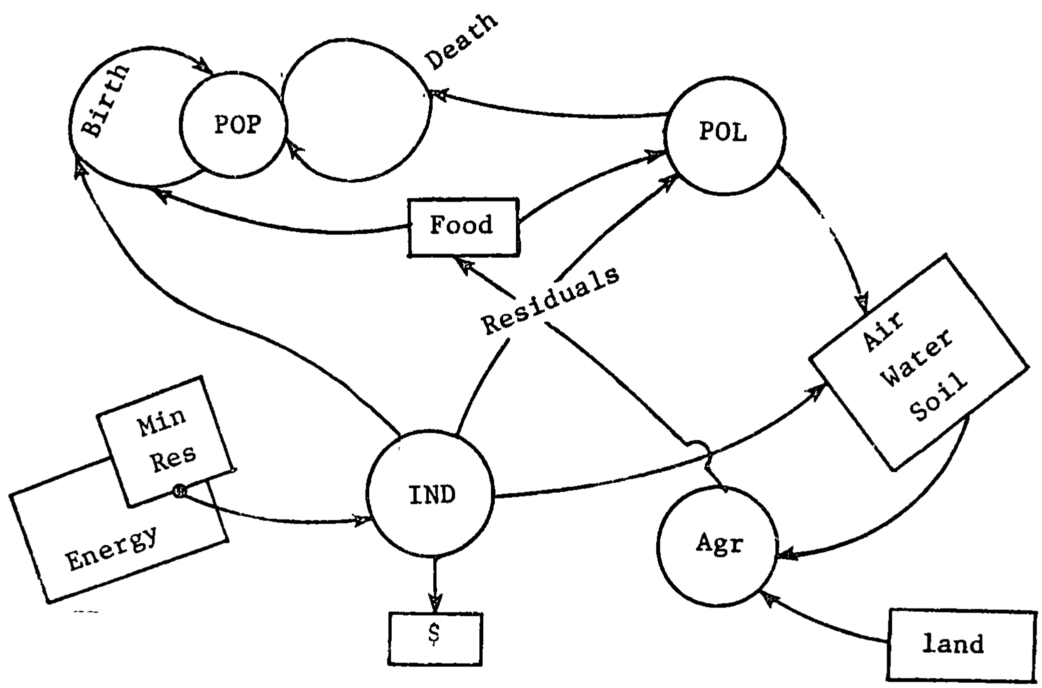
Lecture #5, Reid

Forecasting, etc,

(1) The analysis require alternative strategies at some future time.

(2) The Environmental Systems driving force is people, people needs, energy, water, food, air all are interrelated.

(3) Generally forecasting involves, pop, thru multithesis.



(4) More formally:

MULTISTRUCTURED MUNICIPAL WATER DEMAND MODEL[1]

George W. Reid[2]

ABSTRACT. Any system, such as an urban cluster, is always embedded in a larger system either in space or time, and each subsystem is affected by both its subscriptions and the large system of which it is a part. Central to this system model is the development of the interactions of these systems with particular regard to resources. This model provides forecasts of the urban cluster as a result of its interactions with other systems and the realization of alternative goals.

The Demand Model is composed of an economic, population, reconciliation and life style submodel. The population is forecast for the large system (nation) and disaggregated to the subsystems (regions, state, counties, urban, etc.) based on resource concepts both probable and possible. Transducers are used to describe the life style of urban areas. Again the transducers are goal oriented. Technical coefficients which are also alternative goal oriented are then used to produce individual or total water needs.

As a result a demand model which is goal oriented and also applicable to a wide range of supply-demand studies has been developed.
(KEY WORDS: demand model; people needs; multistructural; population; life style; demand alternatives; stochastic)

INTRODUCTION

The population explosion and the expected rapid development of urban areas require new insites into, among other things, the requirement for municipal water. A system, such as urban cluster, is always embedded in a larger system; in space such as the county, region, or state; and in time, year 1980, 2000, etc. Also, a subsystem, or technical system, such as the municipal water system is embedded in time, layered water systems, and in other urban systems. The municipal water system in turn has an array of subsystems–distribution, pumping, treatment, etc. So urban water systems relate to and are influenced by a great many other systems or variables.

A second, and equally important consideration is that the population concentration and growth rates are causing urban replication in less than twenty years, providing very short lag time, and no longer permitting the adoption of a leisure reactive mode, but make an acting mode essential. The finally constructed works associated with projected water demands, literally fixed in concrete are too dear to experiment with. So, a multivariant, multistaged system involving a "short fuse" and a high degree of uncertainty call for innovative approaches.

[1] Paper No. 71109 of the *Water Resources Bulletin* (Journal of the American Water Resources Association). Discussions are open until June 1, 1972.
[2] Director, School of Civil Engineering and Environmental Science, University of Oklahoma, Norman, Oklahoma 73069.

THE SYSTEMS APPROACH

The systems approach provides an ideal technique to have looks into the future, looks that are essential to the management for beneficial use of critical resources. The systems approach must consider long-range objectives. It shifts emphasis from inputs to goals. These goals must be developed as "people needs" and in terms understandable to the model builders (Engineer-Analyst) and the consumer (the affected recipient and/or his political representative). The resultant model must provide alternative policies to these goals, a reasonable set of metrics, and verifier. Conceptually, this model will be responsive to alterable "people needs" (goals) over time as incremental violations enroute are exposed. The author feels strongly that the consumer should have presented to him the alternatives, benefits, and cost in terms he can understand, so that he can participate in the decision process. That is the basic charge to the model builder. The model provides guides and it is essential that in addition to the analytical mode provided by the model, a judgmental mode must be exercised by experienced engineers. So, to study long-range problems of the demand for water requires macro level, multistructural, multistages, multivaried models, articulated over time toward consumer understandable "goals."

The point is that one can no longer look at water but must now look at its interaction with other elements. Now one must consider the whole system. It is not enough to simply design pipes and pumps to convey a projected flow requirement for water. The systems approach will allow one to look at the future and to bring all of the interactants over time into play. The tools and concepts have arisen from new computer capabilities and econometric and operational record techniques. To this must be added an environmental (ecological) appraisal. These concepts and tools have made it possible to *build models*, reasonable replicas of the real world and play the game to see the consequences of one's actions.

Historically, the engineer based his estimates on eye projection; then he formalized these projections mathematically by relating to arithmatic progressions for small towns and farming areas and geometric progressions for vigorous cities and old dying ones, and so it went. All were based on the past projected into the future. Then the economist entered the act using macro-economic forecast procedures and then relating to people and water. At this point the engineer "sublet" this responsibility. In the late 1960's, the engineer is broadening his base and again concerning himself with inputs (projections) and using the systems approach.

This is shown briefly in Figures 1 and 2, and studies of particular significance include Reid [1970], Hittman [1968], West Virginia [1969], and AVCO/ESC [1969]. Reid's study is the subject of this paper, the Hittman models disaggregate to very great detail, gallons per barber chair for example, etc., demands arising by counting detail sector projections and multiplying by technical coefficients. The West Virginia and AVCO/ESC studies are regression analysis, the former national models, the latter state or regional models.

THE DEMAND MODELS

The demand models consist of population (or demographic model), an economic (or employment forecast model), a reconciliation, and life style model with definition of public service and private sector commitments, as shown in Figure 3. Depending on the approach one can go from decomposed sector elements to water use and then aggregate, or more simply from population via technical coefficients to water requirements. The water demand is developed as a function of population and unit use by quality characterization. The population is disaggregated from national cohort analyses first to statistical regions, and then to basins. This

TYPE	YEAR	APPLICATION
Eye Birth over death Logistic	1930's	Engineers & [illegible] phers
Arithmetic Geometric Incremental Population Theory Curvilinear	1940's	Engineers
Population synthesis Regional analysis Market demand model	1950's	Economists
Supply model Factor and component analysis Cohort analysis Input/output analysis	1960's	Econometricians
Goal orientation Econometric techniques	1970's	Reid Study

Fig. 1. Use of estimating techniques.

Type	Elements: Past Projection one	more	Goals Demographic	Goals Economic	Demographic	Constraints Economic	Physical
Eye	x						
Birth/Death		x					
Arithmetic	x						
Geometric	x						
Incremental	x						
Population Theory	x		x				
Curvilinear		x	x				
Population Synthesis				x		x	
Regional Analysis		x					x
Market Demand Model						x	
Supply Model		x		x	x		
Factor Analysis		x					
Cohort Analysis		x					
Input/Output		x					
Goals (Reid)		x	x	x	x	x	x

Fig. 2. Methodology checks.

process prevents double counting, and is responsive to fixed or variable cross-sections. That is, the composition of people and their demographic and economic activities can be held fixed or altered over time. Things can stay the same, get better, or worsen. This is a decision element. So we are always working over time to established goals. The same is true of the unit use. The unit use is predicted, by forecast modification, as a function of settlement criteria and/or population, urbanization, income, value-added, etc. The demands are responsive to various settlement patterns and people goals. For example, in Figure 4 the population is forecast from $P^n_{t=0}$ to P^n_t for the nation. Then it is successively disaggregated to the region (P^r_t) and basin (P^B_t). The cross section is altered depending on public (decision policy), e.g., concentration in 3-4 tremendous urban areas versus distribution throughout land, etc. For more comprehensive

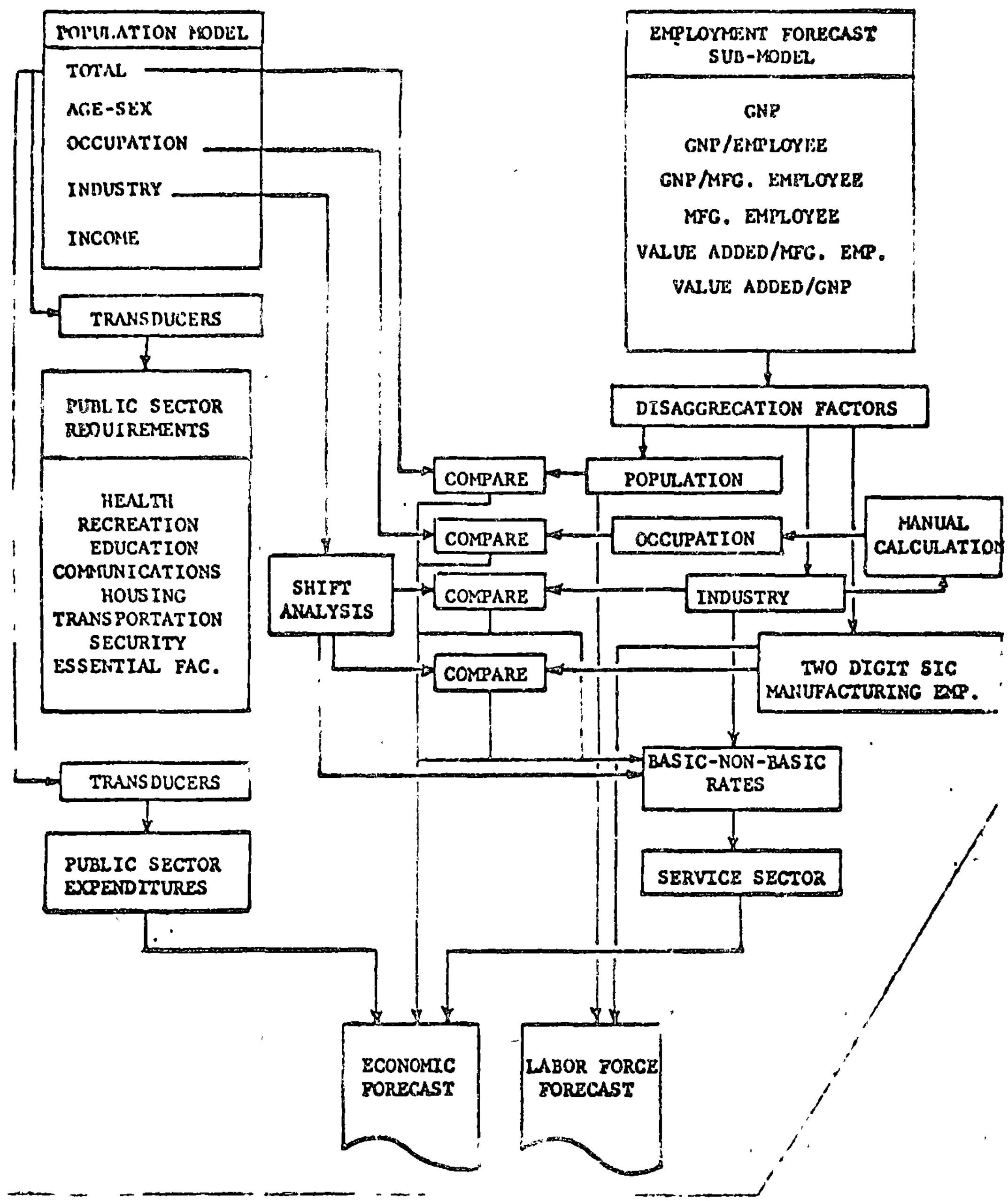


Fig. 3. Demand model format.

models, $_ip^n{}_t$ represent cohort 1 through i descriptors. The unit use can be established by synthesis to provide goals, e.g., so much per bath, so many baths, so much per car wash, so many cars, etc., for unit goal use.

The demand can be expressed as the summary of municipal, industrial, and agricultural, i.e., the major uses. The projected municipal use can be related, at (t=0), to the other categories and the relationship or cross section Fi altered by relative F1's to other requirements or purely to scale factors. Goals can be dealt with deterministically for all three categories. Goals, values themselves, can be developed by decomposing the category and looking for alternates in the domestic group, as in Figure 5. The final demands, of course, are the product of the two, Pop_t and $\mu\mu_t$, or $({}_i{}^DtK)$ demand for category (i) at time (t) under decision level (k).

The case process study grows the nation towards a series of goals both *probable and possible*. It does this by cohorts of *life style*. The national values are then disaggregated to a resource region, permitting possible worlds, and regressed on regional resource patterns, both *human and non-human*. Then the regional values are distributed in the region to the urban cluster by *econometric step-down procedures*.

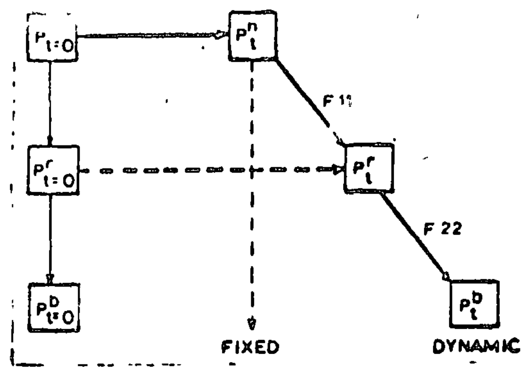


Fig. 4. Population model and logic diagram.

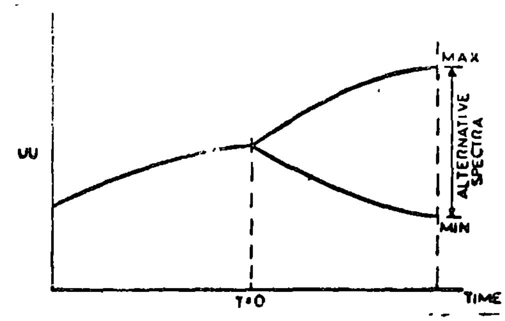


Fig. 5. Demand vs. time plot.

The model is thus determinative and probabilistic and in that it is articulated over time is *stochastic*. Both initial conditions and output goals are reset after Δt, and the process can be repeated.

A model for projecting municipal sector requirements is unique in that it will:

1. provide public, private, and service sector needs–
2. under various "life style" goals for
3. either possible or probable worlds
4. articulated over time and adjustable enroute to revised goals.
5. The model uses a national base, disaggregating and preventing double counting with
6. the disaggregating reflecting resource concepts, thus providing again possible postures.
7. The basic model uses both demographic and economic inputs and
8. provides, through shift analyses, adjudicated sector outputs.

The model is adoptable to a variety of linkage technical models or procedures to produce municipal and industrial water requirements.

1. The decomposed sector outputs can be fed into Main I to provide detailed future water requirements.

2. Technical coefficients can also be used directly with the population estimates, or gross sector estimates, to produce individual or total water needs.
3. Technical coefficients and their projections suitable for both needs have been developed and
4. the methodology for the municipal technical coefficients uses alternative goals, and regional regression concepts.
5. The industrial technical coefficient methodology provides for technological breakthrough.
6. The economic model outputs can also be used as inputs to econometric water requirements models, such as those developed by factor or principal component analyses.

Several techniques have been suggested for deployment. The Tulsa [1970] model used generalized technical coefficients tied to land uses. Few cities have as detailed land use data as that of Tulsa or the basic economic and demographic data.

I. The suggested procedure for municipal demand studies of cities in general would be used to use population and income projections developed for the city by regressive techniques only and to follow this with a demand model, with the unit use ($\mu\mu_o$), *precipitation (ppct)*, *income* and *population*. These data are generally available so:

$$WD_t = (Pop_t)\ (\mu\mu_o)\ \left[\frac{ppct_t}{ppct_s}\right]^x \left[\frac{Inc_t}{Inc_s}\right]^y \left[\frac{Pop_t}{Pop_s}\right]^z$$

This provides a *scale*, a *geographic*, and an *economic* index.

II. If the candidate city does have an extensive history of pumpage, including the relative amounts to the various components, particularly the water used domestically, the procedure of choice would be to develop the $\mu\mu_t$ graphically as shown in Figures 6 and 7.

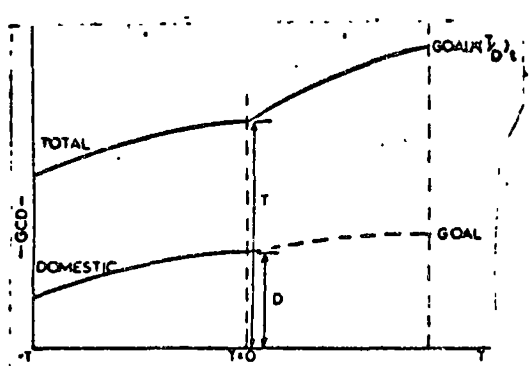


Fig. 6. Total-domestic requirement vs. time plot.

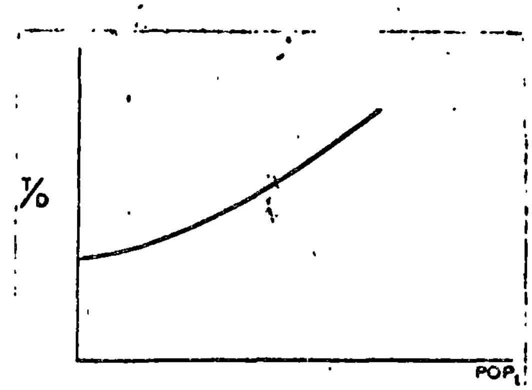


Fig. 7. Total-domestic ratio vs. population plot.

Thus, depending on the availability of local data, a part or all of the economic and technology models may be reliably used to develop projected needs for municipal water, which were the prime objectives of this study.

DEMAND ALTERNATIVES

The future applications are of considerable interest. Water Resources Management problems are concerned with basically *Supply-Demand Studies.* Supplies are easily studied and there has been developed a considerable body of knowledge such as paramebric hydrology, dam theory, etc., for this purpose. Supplies are also becoming limited. On the other hand, demand studies are only recently being developed and most methods are crude, and done essentially in isolation. It is very common for consulting engineers to wed detailed studies of a reservoir with "eye ball" demands. With supplies becoming limited, and with serious considerations of reuse, or use of brackish or saline water being evident, ***one should look at the demand alternatives–as additional*** supplies.

In present studies, it has been suggested that one should strive to provide all the municipal water desires–this has been the probable world. In part, this "rut" was a result of studies that indicated an inelasticity with price or cost of water. Consider the decomposition of the municipal use as follows:

Category	Present Use (gpcd)	Maximum Required (gpcd)	With Alternates (gpcd)	Suggestions
Domestic	30	80	5	Reuse at Home
Industrial	40	190	10	Reuse
Commercial	20	40	0	Air to air refrigeration
Public	10	14	0	Solid Waste Control
rrication	10	40	0	Astro-turf
Total	110	365	15	

From this tabloid, 365-15 = *350 gpcd new water* by considering alternatives is possible. This illustrates an important use of the demand model–namely, the discovery of alternates and their impact on supply systems. Once alternatives are sought, costs do become a comparative factor. *Once cost becomes elastic,* then trade-offs of water cost (alternatives) must be made against other public sector needs: transportation, drainage, recreation, etc. The model would be very useful along this line of inquiry.

Another area results from considering water supplies from various sources with various quality levels. To sensibly (imputed use of a systems approach on a basin, or interbasin bases) study the problem, demands to support various life styles should be postulated by quality as well as quantity. Thus, demand is considered at time (t) under decision levels (k) and quality (q) or $q^{D^t}k$. This as point requirements must be evaluated against supplies at (t), at quality (q) or S_q^t and Costs (c).

$$\Sigma_q D_k^t \leq S_q^t \text{ and } \Sigma C S_q^t \text{ must be minimized}$$

To work out this network program requires detailed estimates of $q^{D^t}k$. The model will provide this.

Even further, minimum cost criteria may be wanning–and benefits should be considered, so $B_q D^t{}_k - CS_q^t$ must now be maximized. Again the model becomes a useful tool.

On a regional or basin basis–irrigation, municipal, power, etc.–uses of water can be balanced through the model One cannot really optimize. One might ask–optimize what?

Economic benefit? Health, Welfare, etc.? The model provides the possibility of a balanced ecology or *life style*. This would be a very interesting study. Water demand studies also inclu... in the urban area demand for physical facilities–pipes, pumps, valves, etc. These are subjecte... to alternatives. One can fight fire differently–without water, thus the pipes could be small, etc., again "trade-off" against other public facilities must be looked at.

SUMMARY

A very flexible demand model capable of impacting has been developed and can be used as a tool on a wide variety of Supply-Demand Studies.

ACKNOWLEDGEMENTS

This work has arisen out of several studies, the most basic being that financed by OWRR, but field experience was developed through HUD sponsorship to Tulsa Metropolitan Area Planning Commission (Oklahoma P-91, March 1969 and P-117, April, 1970). The basic model was first publicly presented at the Colorado State College Urban Systems Water Conference in June, 1970.

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Water Resources Management

1. Management implies control for useful purpose. This implies also, an understanding of supply and demand. Regulation increase supply. The intermittant or variable stream flow can be regulated thru use of dams, and can potentially approach the median flow. Water can also be developed from the ground, the sea, brackish water, and reuse.

Supply = Surface + Ground + DeSalted & Reuse.

As water resource system and corresponding sectoral activities become more aggregate the availability of appropriate data decreases. As has been noted by most all the experts, as river basin concepts and strategy evolve there are changes in the interrelationship of physical and social structures of water management. Progressively, from largely unregulated river management that is supply oriented, structural in nature and usually handled project by project. Next, as pressure is experienced from water-related socio-economic development, orientation shifts to efficient use of resources and the basin concept to finally a demand orientation wherein allocations are preceived in the broadest dimensions, social, economic, involving nonstructured alternatives, interbasin transfers, even impact and conservation concepts.

2. Hydraulic management is only one facet. Quality management is also essential. They are, of course, interrelated:

Pollution Load = Concentration x Flow

and the rate change of pollution:

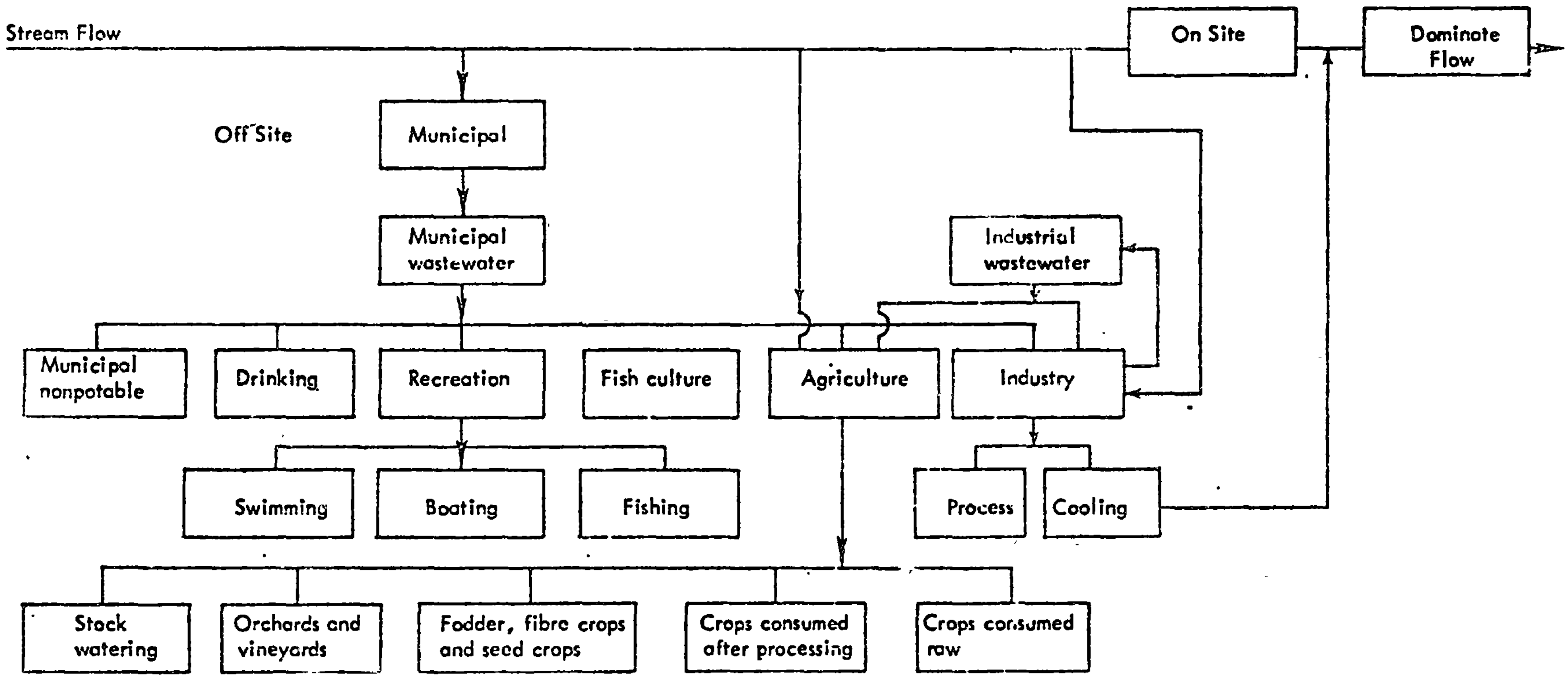
$$d^{G}/dt = \frac{D\partial^{2} C}{\partial \chi^{2}} + \frac{E\partial C}{\partial \chi} + KC$$

Pollutants are conserved or not.

3. The demand analyses involves several beneficial uses, resulting in off-site withdrawals, and consumptive uses; on site uses, and flow or aquifer level maintainance. These relationships are shown in Figure 1. These

FIGURE 1

GENERAL STRATEGIES



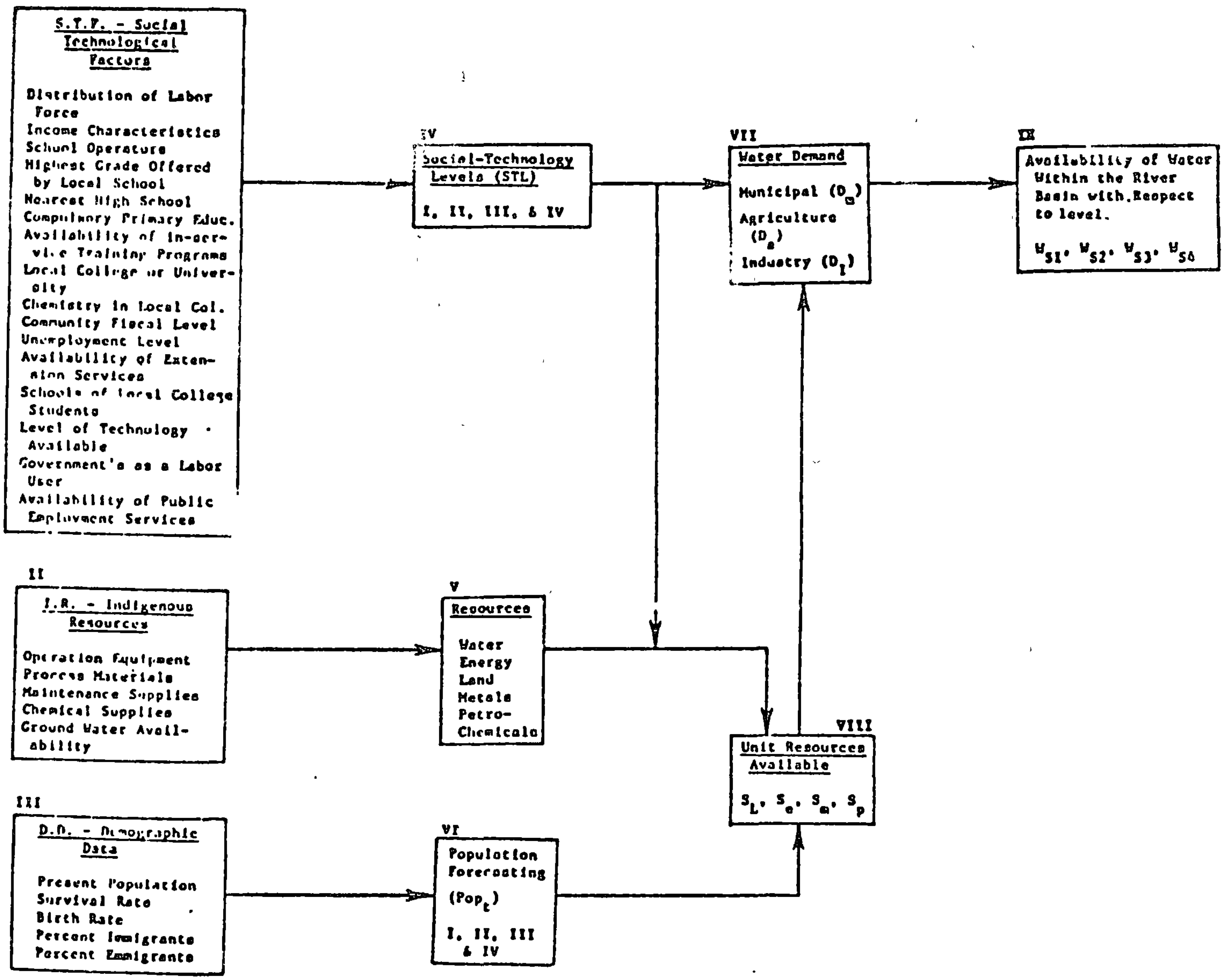


Figure 2: Socio-Economic Growth of a River Basin

TABLE 1: ESTIMATED PER CAPITA RIVERFLOW AND WATER DEMAND IN SELECTED RIVER BASINS OF AFRICA, ASIA, EUROPE AND THE AMERICAS

	River by Continents	Drainage Area 1,000 sq. km.	Population Millions		Per Capita Riverflow cu.m/year		Per Capita Riverflow gallons/capita/day		Average Demand* gallons/capita/day	
			1970	2000	1970	2000	1970	2000	1976	2000
Africa	Congo	4,015	18.0	41.2	69,000	30,000	48,300	21,000	129	462
	Zambezi	1,295	5.6	12.0	38,700	18,000	27,090	12,600	129	474
	Niger	1,114	16.7	40.9	11,200	4,600	7,840	3,220	129	474
	Senegal	338	2.4	5.0	9,100	4,500	6,370	3,150	129	474
	Orange	640	4.7	10.9	2,300	990	1,610	693	132	498
	Nile	2,980	50.0	106.0	1,720	830	1,204	581	129	462
	Africa	30,300	350.0	770.0	12,000	5,500	8,400	3,850	-	-
Asia	Irrawaddy	430	20.0	39.6	21,000	10,300	14,700	7,210	117	393
	Brahmaputra	935	51.8	110.4	11,200	5,600	7,840	3,920	123	405
	Ob-Irtysh	2,430	32.4	42.0	11,100	8,800	7,700	6,160	129	426
	Mekong	803	45.6	102.2	7,500	3,300	5,250	2,310	120	402
	Yangtze	1,943	202.0	300.0	3,400	2,300	2,380	1,610	126	426
	Indus	927	70.6	171.7	2,450	1,050	1,715	735	120	399
	Ganges	1,060	300.0	585.0	1,920	960	1,344	686	120	399
	Tigris-Euphrates	541	26.3	68.7	1,760	680	1,232	476	129	429
	Hwang-Ho (Yellow)	673	110.0	163.6	930	620	651	434	123	408
	Asia	45,000	2,047.0	3,800.0	6,550	3,550	4,585	2,485	-	-
Europe	Rhone	96	7.1	8.7	7,400	6,030	5,180	4,221	366	600
	Po	70	13.4	15.2	3,220	2,830	2,254	1,981	360	591
	Danube	816	75.0	84.6	2,540	2,260	1,778	1,582	357	585
	Rhine	145	39.2	42.8	1,710	1,580	1,197	1,106	363	594
	Vistula	197	19.5	23.9	1,700	1,410	1,190	987	357	582
	Europe	9,800	645.0	780.0	4,800	3,950	3,360	2,765	-	-
North America	Yukon	932	0.1	0.2	1,580,000	1,050,000	1,106,000	735,000	615	1254
	Mississippi/Misso.	3,222	56.0	72.2	9,600	7,500	6,720	5,250	621	1269
	Colorado	629	2.7	3.5	6,600	5,100	462	3,570	588	1203
	Rio Grande	352	5.0	6.5	750	590	525	413	576	1173
	North America	20,700	315.0	406.0	19,000	15,000	13,300	10,500	-	-
South America	Amazon	5,578	4.0	8.9	1,620,000	740,000	1,134,000	518,000	240	786
	Tocantins	907	2.2	4.9	145,000	65,000	101,500	45,000	246	783
	Orinoco	881	4.5	10.0	116,000	53,000	81,200	37,100	258	816
	Magdalena	241	18.0	41.9	12,800	5,500	8,960	3,850	243	765
	San Francisco	673	12.5	27.9	7,000	3,100	4,900	2,170	246	783
	Parana	2,305	61.0	110.0	6,800	4,200	4,760	2,940	252	798
	South America	17,800	190.0	400.0	54,500	25,000	38,150	18,200		-

general strategies illustrate only those causing pollution. Other beneficial uses include, power, navigation, drainage, etc.

In the global basins in both LDC's and DC's, the demand orientation stage is being approached but from the three basic water need sectors studies of municipal, industrial, and agricultural water, in the DC the demand orientation stage has not been reached. These relationships can be seen in Figure 2. In Stage II, resources orientation, it can be seen from Table I, that even in developed countries the available water per capita is more than the per capita use, but that available level would require structural management or river regulation. Under Stages I & II, water demand projections are thought to be relatively simple undertakings, local or project sources being abundant, with marginal costs low, with no reason to expect major changes in technology and management policy.

So past characterization should hold, and reasonable forecast can be devised from a relatively small amount of data and a simple extrapolation (of demographic, physical and economic projections. Large basin demands are developed Table 1 without direct reference to nonstructured considerations or high degree of basin regulation, interchanges, ecological consideration etc. Though, prudent economic efficiency and a basin approach is imputed.

The specific model used herein forecasts only industrial, municipal, and agricultural demands. Due to sparcity of industrial and agricultural water demand information, only the municipal demand is forecast directly by a regression analysis of scale, location and socio-economic indicators and their normative futures. The industrial and agricultural projections have been developed as multipliers or ratios, see i/m, and a/m ratios in Figure 2. They can be determined by regression analyses at country level.

TABLE ـ

GENERAL DATA AT REGIONAL LEVEL

Municipal

1. Water demand per capita
2. Population growth
3. Income per capita
4. Population served by water supply
5. Cost of treated water
6. Education level

Industrial

7. Distribution of work-force in skilled, unskilled and unemployed
8. Income per capita
9. Industrial gross national product
10. Annual industrial growth
11. Water demand/product produced

Agricultural

12. Calorie intake per capita
13. Percentage of land investigated
14. Water demand/product produced
15. Agricultural gross national product
16. Annual agricultural growth

TABLE 3

GENERAL DATA NEEDED TO DEVELOP MODEL AT COUNTRY LEVEL

I. Domestic Demand

1.1 Water demand per capita per day (gpcd)
1.2 Income per capita per year in United States dollars
1.3 Annual precipitation in inches
1.4 Population served by water supply in 1000
1.5 Average annual local or national temperature
1.6 Price of treated water per 1000 gallons
1.7 National average of persons in each household
1.8 Percent of national literacy
1.9 Percent of national Public Stand Post
1.10 Percent of homes connected to water supply systems

II. Industrial Demand

2.1 Water demand per unit product produced
2.2 Gross National Product - GNP
2.3 Annual industrial growth (percent)
2.4 Annual precipitation in inches
2.5 Annual temperature in °F
2.6 Annual rate of growth in housing industry (percent)
2.7 Percent of employment by industry
2.8 Percent of machinery imported
2.9 Percent of in-country mineral resources
2.11 Percent of improted petrochemicals/crude oil
2.12 Rubber consumption per capita (lb/capita)
2.13 Cotton consumption per capita (lb/capita)
2.14 Sugar consumption per capita (lb/capita)
2.15 Coffee consumption per capita (lb/capita)
2.16 Metals consumption per capita (lb/capita)
2.17 Paper consumption per capita
2.18 Industrial/Manufacturing Gross National Product

III. Agricultural Water Demand

3.1 Water demand per acre foot (AF)
3.2 Calorie intake per capita
3.3 Percentage of land irrigated
3.4 Total area
3.5 Percentage of land not irrigated
3.6 Gross National Product (GNP)
3.7 Annual precipitation
3.8 Annual temperature
3.9 Evapotranspiration
3.10 Humidity
3.11 Percent of land irrigated manually

III. Agricultural Water Demand (Continued)

3.12 Percent of land irrigated mechanically
3.13 Power (kilowatt/capita)
3.14 Income per person
3.15 Land available per person (acre/capita)
3.16 Agricultural Gross National Product
3.17 Area cultivated
3.18 Area irrigated

The community profiles are developed from socio-economic parameters (see Figure 2)

Where more information, say national levels, agriculture and industrial demands can be regressed. These data requirements are illustrated in Table 2 & 3. A typical demand model would look like:

$$y = \sum_{i=1}^{i=n} X_i \quad \text{or} \quad \prod_{i=1}^{i=n} X_i$$

A typical interlock -

Demands

		Ind	Irr	Agri
	Sweet	A_{ij}		
Supply	Desalt		or C_{ij}	
	Reuse			

A_{ij} units, development, treatment, transport

C_{ij} costs

At the local level, unit requirements, are also related to waste discharges. Generally, the approach is to use the concept of Population Equivalent. The shower response models are cast in terms of PE's, and a $P.E. = \frac{\text{strength(mgle) x vol.(mgd)x } 8.3}{0.016}$ and factor 0.016 is the strength/capita. Because of inclusion of more industry in larger cities the P.E. value varies from 1.0 - 1.7 as size increases. If individual wastes loads, primarily, Municipal, Petrochemical, Light industry and manufacturing, Food and kindred industry, Pulp and Paper, Textile, etc. are known, loads can be aggregated from wet strength and volumes.

$$\text{Load} = \sum_{i-o}^{n} \text{bod x volume/unit x production}$$

It is, of course, necessary to estimate the future volumes, and strengths, due to "in house reuse," save-alls, and treatment. EPA has established acceptable technology - for municipal waste, discharge concentrations, 30/30/200 for example, BOD/SS/COLI. For industry #BOD for unit of production.

Supply Life Style-Stages

I Supply

River unregulated 0% Q M^3/CAP/yr = 5,000 dry
200,000 wet

Relative abundancy,

Project by project,

Low marginal cost,

Structural management measures

Pollution by dilution, primary treatment

Individual plants, city plants

II Resource

Partial regulation, 30-60% 20,000 wet

Efficiency

Project by basin

Structural or nonstructural management measures

Secondary treatment - biological system

Basin system

III Demand

River completely regulated 60-100% 500 dry

Planned conjunctive use, groundwater, surface 2,000 wet

Reuse and desalt, efficiency requirement

Interbasin transfers

Project by region, institution of conservation

Tertiary treatment - chemical & aquatic systems

Regional plants, industrial plants, etc.

Demand Lifestyle

VI (DC)

Advanced industrial economy, scientific capability, education, social advances, ecological awareness, less dependence on religion, the family, low birth rate, increasing 60-70 year olds. Stress, pollution problems, democracies - US, CANADA, UK, JAPAN, SOUTH AFRICA

V ______

Primary school - up "over the hump in human resource development" except scientist & engineers, though quality is less. Secondary education complete - transport, communication good. Bottleneck in electronics, surplus of university types. Democracies, usually strong social, national standards - MEXICO VENEZUELA, IRAN

IV ______

Relatively advanced,

have nontechnical manpower

unable to develop high level experts

½ population subsistent level agricultural

mining, petroleum, textiles,

transportation, - JAMAICA, COLUMBIA, PHILIPINES, IRAG, TAIPEI

VII (LDC)

Require external aid

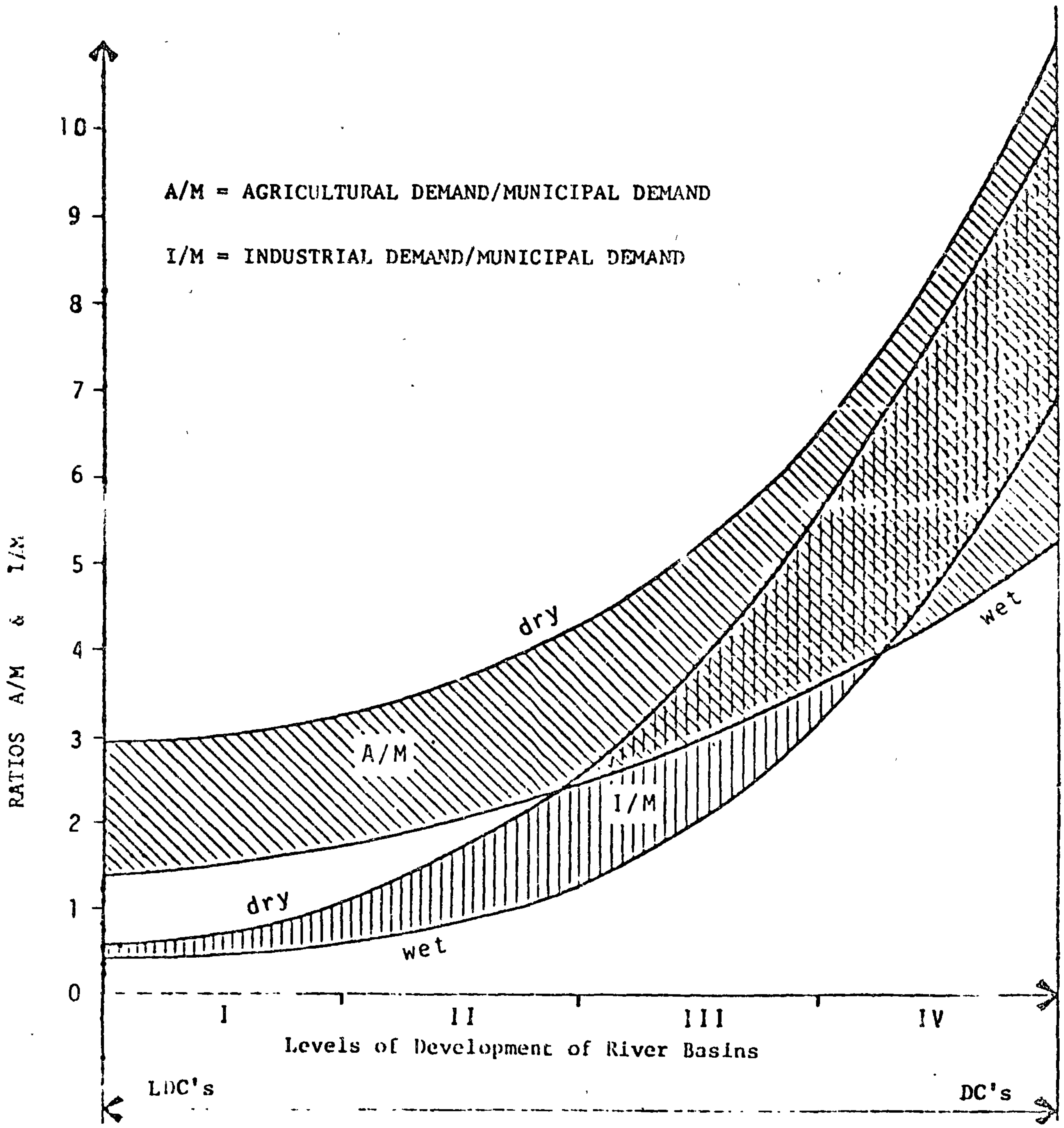
Agricultural, rural, nomades

Subsistive agriculture

Secondary education 1%

High birth rate, over crowded, unemployment, ECUADOR, PARAGUAY, INDIA, GHANA, NIGERIA, CAMBODIA, YEMEN

Figure 3: Ratios of I/M and A/M versus Level of Socio-Economic Development of River Basins



IDC - Industrially Developed Countries

DC - Developing Countries

centro de educación continua
división de estudios superiores
facultad de ingeniería, unam

METODOLOGIAS PARA DECLARACIONES DE IMPACTO AMBIENTAL

ESTUDIO DE CASOS

Marzo, 1978

SUMMARY SHEET

Status: Draft Environmental Statement

Subject Chatham West I Apartments
Brockton, Massachusetts

Name of Responding Agency: Department of Housing and Urban Development
Boston Area Office
15 New Chardon Street
Boston, Massachusetts

1. Nature of Action: Administrative

2. Brief Description of Proposed Action:

Construction of 350 units of multi-family housing in the City of Brockton, Massachusetts.

3. Summary of Environmental Impact and Adverse Environmental Effects:

The proposed project will adversely effect the aesthetic environment of the adjacent park to the degree that a portion of the project will be visible from the park. The impact on the physical environment due to drainage from the development has been treated to our satisfaction.

4. Alternatives considered:

(a) Maintaining the entire site as undeveloped open space.
(b) Residential use in configurations other than the proposed action.

5 List of Federal, State and Local Agencies from which comments have been requested.

Council on Environmental Quality
Environmental Protection Agency
Department of Transportation
Department of Health, Education and Welfare
Department of Commerce
Department of Interior
Department of Agriculture
Department of the Army, Corps of Engineers
Office of Economic Opportunity
General Services Administration

Federal Power Commission
Massachusetts Department of Natural Resources
Massachusetts Executive Office for Administration and Finance - Office of State Planning and Management
Old Colony Planning Council
Anne Vohl, Attorney
Brockton Conservation Commission
Brockton Citizens Conservation Group

6. <u>[D]ate Statement made available to CEQ and Public</u>

ENVIRONMENTAL IMPACT STATEMENT FOR CHATHAM WEST I

BROCKTON, MASSACHUSETTS

I. Description of the Project

The project, known as Chatham West I, consists of the construction and associated site development of 350 units of housing at Oak Street, Brockton, Massachusetts. The site consists of a single parcel of land of 20.4 acres.

The purpose of the project is to provide modern living facilities and environment for families of moderate and low income. The development comprises 174 units with two bedroom and 176 units with one bedroom. The one bedroom units will rent for $156 to $185, the two bedroom for $172 to $215. Forty-four one bedroom and forty-four two bedroom units will have their rents reduced through rent supplement payments. The two bedroom units are located in 87 two family, two story duplex dwellings arranged in clusters of four to six buildings. The one bedroom units are located in nine two story garden apartment buildings, each with 16 to 24 units. The site contains 462 or more off-street parking spaces. A community building contains meeting rooms, administrative offices, and a laundromat; there are also two separate laundries. The total cost of the development, including land, is $7,896,800.

The project is being financed by a mortgage loan in the amount of $7,106,000 from the Massachusetts Housing Finance Agency (MHFA). Upon completion of the project, 237 of the 350 units will have the benefit of interest reduction payments from the Federal Housing Administration, under Section 236 of the National Housing Act of 1934, as amended. Eighty-eight of the 237 units receiving interest reduction payments under Section 236 will also receive rent supplement payments under Section 101 of the National Housing Act; these units for low-income families will be scattered throughout the site. he balance of 350 units, 113 units, will rent to moderate-income families for $185 per month for a one bedroom unit, and

$215 for a two bedroom. The incomes of the moderate-income tenants at admission may not, under MHFA regulations, exceed six times the annual rental.

The owner of the project is Beacon Chatham West Associates, P.O. Box 2051, Montello Station, Brockton, Massachusetts. The contractor is Beacon Construction Company, of the same address.

An adjacent 20-acre parcel of land is owned by Beacon Construction Construction. A building permit has been issued to construct an additional 350 units on the adjoining site. No financing of any kind has been requested for housing on this parcel.

Presently, the project has received the approval of MHFA for funding. HUD-FHA funding is approved tentatively until the Environmental Impact Statement is finalized.

The project is situated in the City of Brockton (1970 population, 189,820). The site is 1½ miles from an interchange on Route 24, a highway giving access to Route 128 and the Boston area to the north, and Fall River and Providence to the south.

The surrounding land uses comprise several types: a regional public recreation area (D.W. Field Park); institutional facilities (the Brockton Art Center and the site of a Greek Orthodox Church); housing (garden apartments); a shopping center (Westgate Mall); industrial uses and vacant land.

Maps are attached showing the surrounding neighborhood of the project.

II. Environmental Impact of the Proposed Action

A. Physical Environment

1. Air Quality

There are no sources of air pollution or noxious odors from industrial emissions. The existing traffic flow is established by CLM/Systems, Environmental Systems Consultants for Beacon Construction Company to be approximately 850 vehicles passed the project between 7-8 a.m. and about 1320 vehicles between 4-5 p.m.

The housing will be heated electrically and thus will not create any smoke emissions. The project's contribution to the traffic flow is anticipated by CLM/Systems to be an increase of 260 cars in the morning. This is using an assumption of one worker per unit, except for the units set aside for rent supplements. During the evening peak hour assuming the return of 90 shopping trips and 260 workers, 350 cars would enter the development during the evening peak hours.

This traffic will obviously contribute air and noise pollution to the area detrimental to the neighborhood and the project itself. The actual effect has not been established.

2. Water Quality

There are no dangers presented to the project from any polluted water or potential flooding problems in the surrounding area.

Obviously, development of the proposed site for the project will increase the surface runoff with possible contribution of flooding and water pollution. Attached is a Drainage Study for Runoff Control Design prepared for Beacon Construction Company by Athanasios A. Vulgaropulos, a consulting engineer. The plan essentially proposes a Detention Basin #1 for the front portion of the site and a Detention Basin #2 to control runoff for the rear portion. Mr. Vulgaropulos estimates that a 25-year storm has a natural peak of 12.8 cfs. at the Oak

Street 30-inch culvert and with the operation of Detention Basin #1 the peak would be 11.3 cfs.

From the culvert inlet at Oak Street, the storm runoff from Detention Basin #1 flows through the existing 30-inch culvert a distance of about 430 feet, where it discharges in an open ditch along the westerly side of the Chateau Westgage property. From there it flows southerly in undefined stream channels through an undeveloped wooded area, then under the D.W. Field Parkway in a 48-inch culvert, and into Thirtyacre Pond. Thus the project site falls directly within the uncontrolled watershed area of Thirtyacre Pond.

Thirtyacre Pond is part of the Salisbury Brook watershed, which has its origin in Beaver Brook, in Stoughton and Avon. Beaver Brook flows through the Brockton Reservoir, which has a drainage area of about 1900 acres. Discharges from the Brockton Reservoir flow into Waldo Lake, (accumulative drainage area 2275 acres). Upper and Lower Porter Ponds, Thirtyacre Pond (accumulative drainage area 2430 acres), Ellis Brett Pond (accumulative drainage area 3770 acres), Cross Pond, Salisbury Brook (accumulative drainage area 4930 acres) and Salisbury Plain River (accumulative drainage area 10,500 acres at Meadow Lane).

At thirtyacre Pond, for a 100-year flood, the inflow peak is estimated at 270 cfs, and the outflow at 250 cfs, with a maximum flood level rise of 2.6 feet. Development of the site would tend to a faster and earlier runoff contribution to Thirtyacre Pond than at present. Most runoff from the site would arrive at Thirtyacre Pond in its rising stage and sufficiently prior to its peak rise so that the effect of the site runoff would be confined to increasing the early rate of rise and outflow of Thirtyacre Pond, but not the ultimate peaks. The flood conditions of Salisbury Pond and the Salisbury Plain River in Brockton are presently under study by the New England Division of the U.S. Army Corps of Engineers. The initial reconnaissance report has been completed and submitted to the Office of the Chief of Engineers in Washington, D.C. It is understood that this report is limited in scope to a very preliminary evaluation of flooding conditions and an evaluation of the potential case for further and more detailed studies.

The rear portion of the site presently drains to a water hole, off the site near the park road, which does not have a pipe outflow. The detention basin for this portion is designed to be more than 25% better than the natural area.

Thus the incorporation of the two detention basins into the design of the project creates greater storm water retention on the site than is now naturally available. Flooding problems are therefore not increased.

Regarding off-site pollution from silts, catch basin sumps should collect silts from paved area, depending on maintenance of the basins. Otherwise silts will be naturally deposited in detention basins before storm water flows from the site.

5. Noise Levels

The only noise pollution that could have an effect on the project would come from the traffic on Oak Street. The peak-hour traffic counts were mentioned above in the discussion of Air Quality. Noise level meters were implemented by the sponsor to measure the noise generated outside the site in accordance with guidelines set forth in HUD's Circular 13902. The results of the test showed the noise did not exceed 61 dB A more than eight hours per twenty-four hours. This means that the noise exposure of this site is "Normally Acceptable" by HUD's standards.

4. Land

The site is divided by a ridge line with two sections. The southern section presently drains naturally towards Oak Street where it flows into a 30-inch City storm drain.

The northern section has no natural surface outlet since it is cut off from Waldo Lake by the parkway road embankment. The total area of lowland in this section is 1.8 acres as determined by CLM/Systems, Inc. Three areas trap surface runoff. The standing water evaporates or seeps into the ground. Two of these areas are on the site and cover nearly half an acre with maximum depths of six inches. The third area is off the site and is approximately one-twentieth of an acre. This area holds stagnant water of depths up to one foot all year round. The other areas are seasonably wet.

Attached is a Soils Analysis Report by the United States Department of Agriculture - Soil Conservation Service on the site of the proposed project and the adjacent site. The northern portion of the subject site was reported to contain very poorly drained soils or wetlands. A recommendation of USDA is to retain this portion of the parcel for undeveloped open space. The wetlands portion, classified MU in the attached report, is the area designed for a Detention Basin.

The developer is not planning extensive grading or filling in the development of the project. Rather he is concerned with his construction conforming with the existing contours of the site.

5. Surrounding land uses and physical character of area

It is evident from the attached land use plan showing the area surrounding the subject site that there are no hazards or conditions which might breed unsanitary or vermin infestation. The only industry in the area is light industry across Oak Street which will not produce any bad effect on the project.

The only incompatible land use is the heavily traveled artery, Oak Street, bordering the front of the site. The existing traffic flow mentioned before is estimated during the peak hours at 850 vehicles between 7-8 a.m. and 1320 vehicles between 4-5 p.m. The traffic during the other hours of the day has not been estimated. Sixteen one bedroom and twenty-four two bedroom units are planned to be built within 100 feet of Oak Street. The traffic condition on Oak Street may be dangerous to the occupants, especially children in these units.

The proposed project's effect on the existing land use is changing an open space to a developed area. The density will be approximately 17 units per acre as opposed to the zoning of the area allowing 60 units per acre. The layout of the project incorporates good use of open space and existing contours on the site. The entire Oak Street area near Route 24 is becoming increasingly developed with five new apartment complexes under construction or recently completed for occupancy. Relative to these projects, Chatham West I will have a low profile of two story garden apartments and duplexes. The other complexes, aside from Beacon's Pine Grove Apartments which are 3-story buildings, consist of 3, 4 and 7 story apartment buildings. The density is low in relation to these other apartments in the neighborhood.

This proposed land use is incompatible with the park environment abutting the Northeast Section of the site from a scenic and recreational standpoint. The developer has designed the buildings on the site to be unobtrusive from the Park and to blend with natural setting of both park and site. The buildings are simple in shape with exterior siding of cedar clapboards, stained in earth tones to blend with park vegetation and asphalt shingles on the roof here possible existing trees on the site will be retained. In spite of these efforts the cluster of housing in the extreme northeast corner will be clearly visible from the West Parkway in winter when the trees are thin, and somewhat screened by foliage during the summer months.

The roof-line of the project's buildings will not appear on the horizon when viewed across Waldo Lake. The buildings are not more than 25 feet high from the ground and the trees are 50 to 60 feet high.

A Master Plan Study never adopted by the City was undertaken by the Brockton Park Commission. The study recommended acquisition of 18 parcels to extend the boundaries of D.W. Field Park. The parcels were given priority numbers from 1 to 18, the subject site's northern portion was ranked 17th with plans for a softball field and parking lot to be constructed in the area. The General Plan for the City shows the project parcel located in an industrial zone. The area has since been re-zoned R-3 for multi-family residential use.

6. Infrastructure

a. Water Supply

The project will utilize the municipal water supply system. Based on 700 persons (1.5 per one bedroom apartment, 2.5 per two bedroom apartment), and 80 gallons of water per capita per day, an upper estimate of the average daily water use will be 56,000 gallons per day. The peak demand rate could be six times the average. The project will draw its water, as does the rest of the City of Brockton, from the municipal water distribution system, which is supplied by the municipal water filtration plant. The primary source of water supply is Silver Lake, supplemented by overflow diversions from nearby Monponsett and Furnace Ponds. The diversion from these ponds has been about 5.1 million gallons per day (mgd). In times of emergency, the City of Brockton can draw on the Brockton Reservoir, located in D.W. Field Park. The water is treated at the Brockton Municipal Water Filtration Plant located in Halifax. The plant reportedly has a capacity to serve a population of 141,000 with an average demand of 13.5 mgd and 24-hour maximum of 24 million gallons.

Presently it serves the following cities and towns of the Central Plymouth County Water District.

	1970 Population
Brockton	89,040
Hanson	7,148
Whitman	13,059
Pembroke (part)	300 (est.)
	109,547

b. Sanitary Sewage

Sanitary wastes from the housing will be collected by sewers on the site and conducted by gravity flow to Oak Street. There is no sewer in Oak Street in front of the property. There are two possible ways of connecting into the City's separate sewerage system. Chateau Westgate, a housing development on the south side of Oak Street has an 8-inch sewer in its main driveway which connects to the municipal 12" sewer in Westgate Drive. It may be possible to cross Oak Street and connect into this sewer by gravity flow, if the owners are agreeable. There appears to be sufficient capacity in the 8-inch sewer to accommodate the additional flow from Chatham West.

Alternatively, there is a City-owned 10-inch sewer in Campanelli Drive which extends from Oak Street and connects to the same 12" sewer in Westgate Drive. The invert of the sewer in Campanelli Drive at Oak Street is higher than the invert of the sewer from Chatham West. In order to make a connection to this sewer, a sewer force main will have to be installed in or along Oak Street, and the sewage pumped by means of a lift station located on the site of Chatham West. The developers of Chatham West will bear the cost of installation of the necessary sewerage to serve the project. In either case, the sewage from the project site will be conducted through the West Intercepting Sewer to the municipal sewage treatment plant.

The project will contribute an average daily flow of 56,000 gallons per day (.06 million gallons per day), with a peak flow at the site six times the average, .34 mgd.

The municipal sewage treatment plant is designed to give secondary treatment to an average of 12 million gallons per day. This average design flow is occasionally exceeded on particular days. For example, the peak day in the last year was in March 1972, when 22.5 million gallons passed through the plant, almost twice the capacity of the plant. On days such as these, the excess flow is subject only to minimal treatment and passes into the Salisbury Plain River. Since the amount of flow differs so much in wet and dry months, it is assumed that the sewerage system is subject to significant infiltration by ground water. Two studies are presently underway; one, to increase the plant's capacity to 20 mgd and include tertiary treatment, and the other to trace major sources of infiltration in the older portion of the sewerage system. It is estimated that an increase of the plant's capacity would not be available for at least three years.

Since the proposed housing development will be one of a large number of urban land uses discharging sewage into the West Side Interceptor and Municipal Treatment Plant, it can be alleged that it is contributing towards a need for expanding the capacity of the Plant.

c. Storm Sewers and Drainage

This aspect was discussed in the Water Quality Section and the adequacy of the proposed system is detailed in the attached report of A.A. Vulgaropulos.

d. Roads

The present flow of traffic and the increase in flow expected from the proposed project is discussed in the Air Quality Section of this report.

The Highway Capacity Manual used by most engineers in designing roadways sets a capacity of 2,000 vehicles per hour in both directions for a two-lane road like Oak Street.

The traffic estimated by CLM/Systems to be generated by the proposed development will not cause Oak Street to exceed this level over the morning and evening peak hour. When the site is occupied the number of vehicles in the morning will be 1014 and in the afternoon 1403.

Engineers use the concept of level of service of a roadway as a qualitative measure of speed, travel time, traffic interruptions, freedom to maneuver, safety, driving comfort and convenience and operating costs. Levels of service are designated A to F. Level of service A describes a condition of free-flow with low volumes and high speeds; at the other end of the range, level of service F describes low speeds, volumes below capacity, and occasional stoppages because of congestion.

Oak Street at present has a level of service C, which is described in the 1965 Highway Capacity Manual as being ". . . in the zone of stable flow, but speeds and maneuverability are more closely controlled by the higher volumes. Most of the drivers are restricted in their freedom to select their own speed, change lanes, and pass. A relatively satisfactory operating speed is still obtained, with service volumes perhaps suitable for urban design practice."

An analysis of the traffic movements at the proposed development entrance by CLM/Systems for Beacon Construction during the peak hours indicates that the roadway can function at the existing level of service C.

B. Social Environment

1. Community Facilities and Services

The subject site is in close proximity to most community facilities offered by the City of Brockton. Cardinal Cushing Hospital, one of three public hospital in Brockton is within a mile of the site, D.W. Field Park, containing 750 of the City's 800 acres of parks abuts the site, a fire station is 1½ miles from the site, four elementary schools are within 1½ miles of the site, a Junior High School is one mile from the site on Oak Street, City Hall and the Police Station are downtown and 2 miles from the site. Tenants in the project will have pedestrian access to the Westgate Mall Shopping Center offering a variety of department and specialty stores.

The developer estimates that the project will bring an additional 19 children to the Brockton School System. This estimate is based on actual figures taken from applications for occupancy on their numerous other FHA 236 projects. Their figures show that for two bedroom units, 11.4 school-age children per one hundred units are present in the project and there are 73 preschool-age children per one hundred units. The fact behind these figures is that upwardly mobile young couples with infants move into FHA 236 projects and before the children reach school age the family finds more permanent residence.

Despite this low estimate of school-age children the Brockton Public Schools are experiencing a strain on its system because of recent growth, according to the Old Colony Planning Council.

There is no overload expected on any of the other community facilities from the development of this project.

2. Character of the Community

The community where Chatham West is planned to be built is being established as a "bedroom community" for families with heads of households working outside of Brockton. The area's proximity to Routes 24 and 128 is giving rise to this type of development. The developer in their market study for this project estimated 60% of the residents in similar projects in the area come from outside the Metropolitan Brockton Area and 56% of these tenants continued to work outside of Brockton.

It is evident that this socioeconomic and racial character will not be altered by Chatham West. There is already a good mix of low, moderate and high income families in the thousands of units comprising the many developments on Oak Street and the surrounding area.

Chatham West has been the subject of controversy in the entire Brockton area since early spring of 1972. With considerable press coverage the Brockton Conservation Commission, created by a city statute, came out against the project. In March, the City Council passed unanimously a proposal for a 1,000 foot protective buffer zone around D.W. Field Park. The Mayor vetoed this proposal and in late April at a public hearing the City Council was prevented from over-riding the Mayor's veto by one vote.

The reasons cited by the Conservation Commission for rejection of the project are: the draining of surface runoff from the entire site into Thirtyacre Pond, pollution of the ponds in the park due to oil and gas drippings from the site and a compounding of flood conditions of the Salisbury River since the ponds are tributaries of the Salisbury River.

Another group was organized as a result of the planning of this project. In early June a public meeting was held and the Brockton Citizens Conservation Group was formed. This Group wrote a petition signed by 8,000 Brocktonians supporting the Park Buffer Zone that was suggested with the specific intent of stopping Chatham West.

The Greater Boston Group of the Sierra Club came out against the proposal of Beacon Construction to build on the wetlands on the subject site.

These groups are primarily concerned about flooding that could result from the development of the now undeveloped site and the infringement upon the scenery of the park. The flooding problem we feel has been remedied by revisions in the plans made subsequent to the Conservation Commission Report and in the course of our review and analysis for this Statement. The scenery will definitely be impaired by the housing in the Northeast portion of the site.

The City Department of Building Inspection issued a building permit for the construction of these 350 units on September 27, 1971.

C. Aesthetic Environment

The Aesthetics of the area involved as discussed above will be affected by this project in that part of it will be visible from the park.

D. Impact Among Project Components

As evidenced by the attached plans of the site, sufficient open and recreational spaces have been designed into the site. The project is composed of two bedroom units in clusters of 4 and 6 duplex units with a common courtyard in front and each unit has a backyard to itself. The one bedroom units are in two story garden apartments consisting of 16 and 24 units.

The parking is arranged so that a resident's car will not be more than 100 feet from his home.

A community building containing meeting rooms and a laundromat is centrally located and there are also two separate laundries.

Project roads are for the most part peripheral and play areas are well protected from the roads. As mentioned above the building materials will be stained with soft earth colors to be compatible with the trees and vegetation in the area.

III Alternatives

A. No development of site

The only way to assure that the site is left in its natural state would be for the City of Brockton or some other public body to acquire the property and use it as conservation land. The Attorney for the Citizens Conservation Group asserts that funds are available for such an acquisition.

B. Decrease in Scope of Project

The most valuable portion of the site as far as conservation is concerned is the northern third of the site with the wetlands. This would be preserved if the project size were reduced so that only the units on the front of the site were built. Increasing the density of the front portion to too great a degree is undesirable.

Eliminating the development of the extreme northeast corner at the least would decrease the effect on the scenic beauty of the park environment.

Both of these alternatives have been suggested to this Department strongly by the opposing groups listed above.

IV. Adverse Environmental Impacts which Cannot be Avoided

Preserving the land as undeveloped obviously would eliminate all the adverse environmental impacts discussed above.

With any development of the site, increased surface runoff is unavoidable as well as the increase in all of the city's services and facilities.

V. Short-term Effects on the Environment

During construction, the noises of construction such as earth-moving equipment, saws and hammering will be heard in the Park and will disrupt its peaceful environment to a great degree. The construction will take 16 to 18 months but will not be done on weekends.

Dust from exposed land which will be blown about and exhaust from the engines of the heavy equipment will pollute the air of the Park.

Runoff, if uncontrolled, will wash silt into the drainage system and in turn will pollute Thirtyacre Pond.

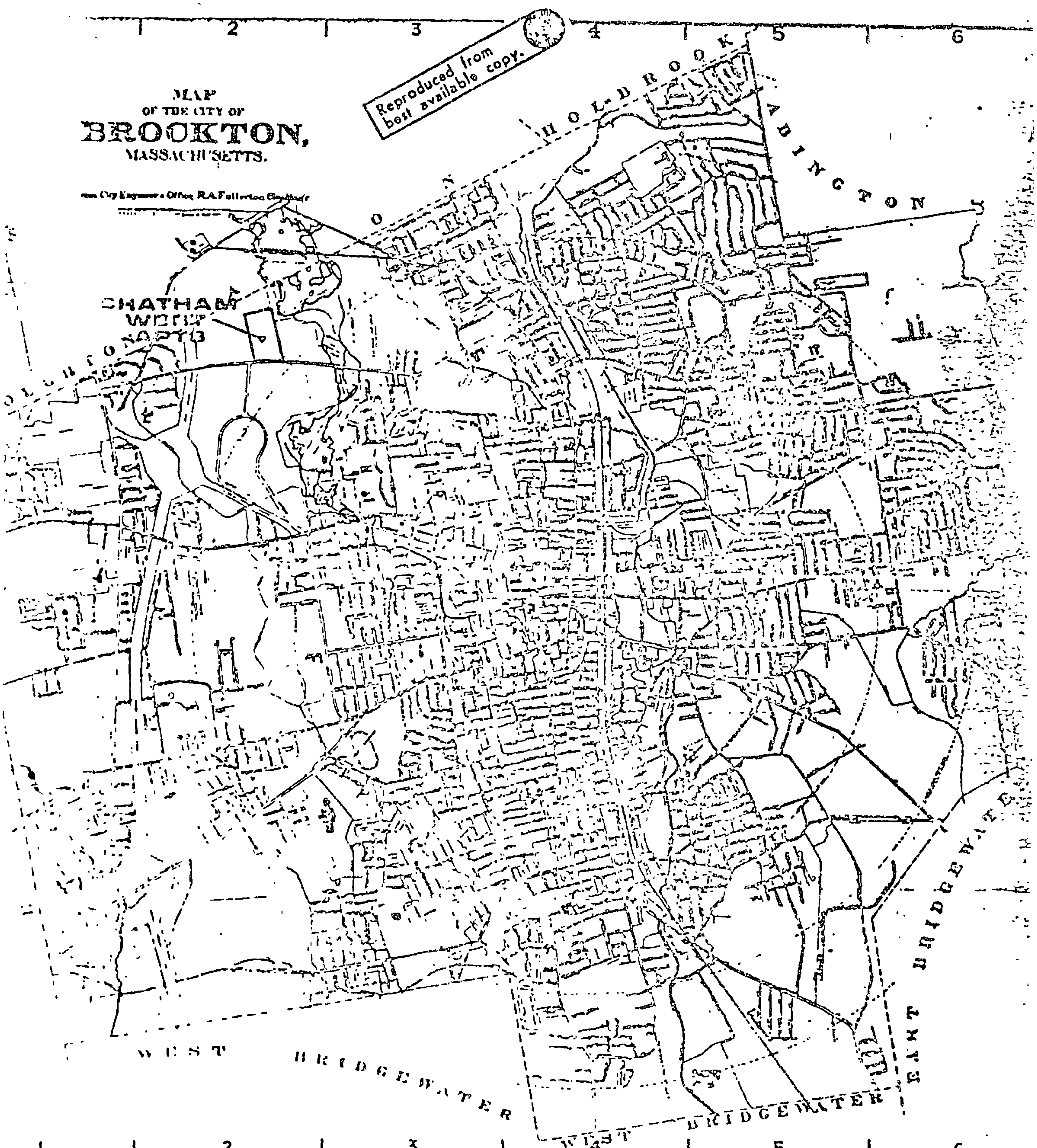
VI. Discussion of Problems and Objections Raised

Some have been touched on above but these and any others received as a result of the circulation of this Draft will be part of the Final Environmental Impact Statement.

VII. Recommended HUD Action on Proposal

Approval of the project as revised to include detention basins to decrease the effect of runoff on the pollution and flooding of the Salisbury River and its tributary system is recommended by HUD.

It is felt that there is an over-riding need for the housing which this project will make available to low and moderate income families from the Greater Boston-Greater Brockton area and that such low and moderate income housing will balance the growth in upper-moderate and upper income housing in the Brockton area. Further, it is felt that the modifications in the plan since work on this Impact Statement was initiated and undertaken as part of the review and analysis process of this statement, will minimize the ill effects of this project. Thus, the housing should be approved.


MAP
OF THE CITY OF
BROCKTON,
MASSACHUSETTS.
CHATHAM
WEST
APTS
HOLBROOK
ABINGTON
WEST BRIDGEWATER
EAST BRIDGEWATER
WEST BRIDGEWATER
1 2 3 4 5 6
2 3 4 5 6

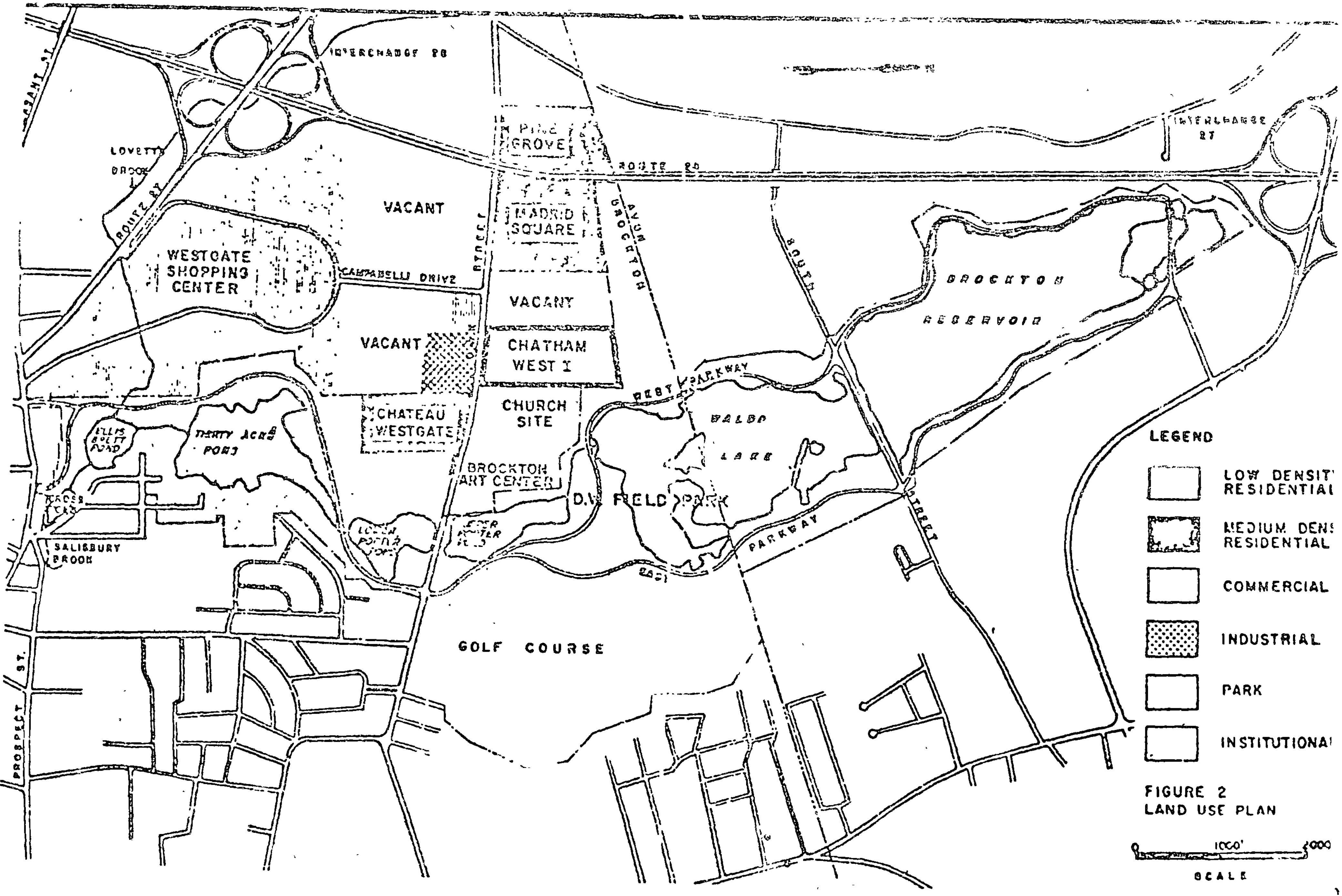


FIGURE 2
LAND USE PLAN

centro de educación continua
división de estudios superiores
facultad de ingeniería, unam

METODOLOGIA PARA DECLARACIONES DE IMPACTO AMBIENTAL

ESTUDIO DE CASOS

Dr. Jerry Murphy

Marzo, 1978

CASE STUDY MURPHY

(1)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C 20460

FEB 16 1977

OFFICE OF THE ADMINISTRATOR

Project Manager for Munition Production
Base Modernization and Expansion
Attn: AMCPBM-T-EV
Picatinny Arsenal
Dover, New Jersey 07801

D-USA-A11056-00

Dear Sir:

The U.S. Environmental Protection Agency (EPA) has reviewed the Army's Draft Environmental Impact Statement (EIS) on the RDX/HMX Expansion Facility. We have found that, although the scope and depth of your treatment of the potential environmental impacts at the three alternative sites is very good, several significant questions and issues still need to be resolved in the final EIS. Our detailed comments are enclosed in four sections: first, general comments and then comments specific to each of the three proposed sites.

For purposes of classifying our comments for publication, your draft EIS has been rated "ER-2"; that is, "environmental reservations-additional information required." The classification and the date of EPA's comments will be published in the Federal Register in accordance with our responsibility to inform the public of our views on proposed Federal actions under Section 309 of the Clean Air Act.

If you have any questions, please contact either Mr. Jay Stevens of this office at (202) 245-3006 or the appropriate Regional Office contact indicated in the enclosure.

Sincerely yours,

Rebecca W. Hanmer

Rebecca W. Hanmer
Director
Office of Federal Activities (A-104)

Enclosure
Detailed Comments, RDX-HMX Expansion Facility

pits, ponds and lagoons. Regarding the waste lagoon (volume I, Figure 12, page 31) and the surge pond for contaminated runoff (Volume I, Figure 6, Page 17), we would like to know if these facilities are lined and whether sludge build-up is expected in them.

Population influx and increased commercial/industrial activities due to and associated with the project will increase the amount of solid waste generated and thus increase the load on existing solid waste collection and disposal facilities. Project personnel should seek out the appropriate State and local solid waste management officials and discuss probable impacts so that they may be incorporated in a timely manner in the State and local solid waste management planning. We would encourage the plant to participate in or use local government solid waste management facilities whenever reasonably possible. Dealings with the Tennessee Department of Public Health on these matters should be with the following gentleman: Mr. Tom Tiesler, Director, Division of Solid Waste Management, Bureau of Environmental Health Services, Tennessee Department of Public Health, Capitol Hill Building, Suite 320, Nashville, Tennessee 37219, phone (615) 741-3424.

3. Newport Army Ammunition Plant, Indiana
EPA Contact: Mr. Gary A. Williams
EIS Review Coordinator, Region V
(312) 353-5756

(a) Water Quality

According to the EIS (page 8), the total water requirement for the RDX/HMX expansion facility is 38 million gallons per day. This is a considerable quantity of water, yet no information is provided regarding the source of this water for the Newport site. The discussion of water supply should also address any environmental effects associated with water withdrawals including the effects upon available supplies and aquatic impacts. For economic and environmental reasons, water recycling should be encouraged. The EIS should discuss any steps taken to require that water conservation and water recycling be incorporated into the project.

The discussion on page 18 of the draft EIS indicates that heavy metals are of concern and that the wastewater treatment system might be adequate for removing excessive amounts of heavy metals. The discussion of heavy metals should be expanded. Specific heavy metals should be indicated as well as concentrations. Based on this discussion, it appears that an evaluation of this potential problem on water quality and aquatic life should be provided in the final EIS.

Although the project will provide a high degree of wastewater treatment, we are concerned about the conclusion made in the EIS (page 175) which says that no adverse impact will occur in the discharge plume at the Newport site because no parameter in the proposed effluent exceeds the natural range of the Wabash River in the input reach. We have reservations about this statement because the existing ranges of the various parameters in the Wabash River have been affected by man-induced pollution and in some cases aquatic life in the Wabash River is critically stressed by man-induced pollution. Expensive pollution abatement programs are being planned and constructed along the Wabash River. In fact, the existing TNT plant at Newport, if operated, would not be in compliance with permit parameters. If Newport is selected, we would expect that provisions would be made for adequate waste treatment for the entire facility. (See pages 262 and 270)

Temperature of the discharge was also not addressed. Further information should be provided regarding the temperature of the discharge and any associated environmental impacts.

(b) Solid Waste

Solid waste disposal appears to be a problem, particularly at the Newport site. (See page 133.) According to the EIS, each day the RDX/HMX plant would generate 7,000 pounds of contaminated sludge, 54 tons of coal ash, 1,000 pounds of incinerator ash, 6,000 pounds of inert wastes and 100 pounds of sewage sludge. If SO_2 scrubbers are installed, additional quantities of solid waste will be generated. The EIS indicates that there would be difficulty in disposing of this material at the Newport site. Further information should be provided regarding the feasibility of providing adequate and environmentally acceptable solid waste disposal facilities at the Newport site.

(c) Air Quality

The proposed facility will use a considerable amount of energy, yet no discussion of energy conservation is provided.

According to the discussion of vehicle emissions (page 22), 700 to 800 automobiles will enter and leave the proposed facility on an average working day. With this volume of traffic, it appears that car pooling may be feasible as well as desirable to reduce energy consumption and vehicle emissions.

The EIS indicates that slash burning may be required during construction if landfilling is not feasible. If slash burning is required, we recommend that the accumulation of smoke be minimized by following these recommendations:

- Utilize the merchantable timber to reduce the volume of fuel and establish brush piles for wildlife.
- Burn only cured material where possible. Cured material burns hotter and produces less smoke.
- Burn rapidly. The objective is to develop maximum heat energy per unit to vent the smoke to the highest elevation possible.
- Confine burning to periods when smoke will not drift toward densely populated areas.
- Burn when atmospheric conditions are unstable. This results in better smoke dispersion.
- Burn material over a period of time.
- Avoid burning petroleum products.
- Utilize forced air pit burning.

Since low sulfur fuel is planned for the facility, the EIS should discuss the availability of this fuel at each site as well as the conditions that would necessitate using a high sulfur coal and incorporating SO_2 removal equipment.

Sludges originating from pits, ponds, and lagoons will be relatively inert, non-volatile sludges collecting over long periods of time.

Depending upon soil conditions, and local regulatory requirements, ponds may or may not be lined. Contaminated storm water will probably be contained in an unlined pond since pollutants in the runoff are primarily suspended soils and free oil. The flow equalization pond will be lined if soils are previous and local conditions dictate since all process waste waters flow through this basin. Sludge build-up is not expected.

Item 8 (Coordinate solid waste disposal plans with local and regional officials, and use local solid waste management facilities whenever reasonably possible).

No response required.

3. EPA Region V (Chicago, IL) Comments.

a. Water Quality.

Item 1 (Provide data on source of water at NAAP and on water conservation measures).

Three Ranney wells within the NAAP property will be used to pump the required water from gravel beds along the Wabash River. If required detailed performance and other data on each of the wells can be obtained from Mr. James F. Clarke, Newport Army Ammunition Plant, Newport, IN, telephone (317) 245-2251. Information on water conservation (and other resource recovery strategies) was provided to the EPA Washington office via a comprehensive report from the architectural engineer.

Item 2 (Expand the discussion on heavy metals).

Although mentioned in the EIS as an area of concern, toxic concentrations of heavy metals are not anticipated as a result of the production processes proposed. Experiments with biologic treatment, both fixed film and suspended growth type, conducted at Holston AAP using wastes similar to those expected at this plant indicated heavy metals were not present in the waste stream.

If heavy metals contamination should occur, treatment for removal should be provided at the source location. Instrumentation is available to detect certain heavy metals, such as copper, over broad ranges. A device to monitor the gross content of carbon constituents in the waste stream could be of use in alerting operating personnel to changing conditions and the need for more frequent laboratory or field tests of waste water influent. Continuous analyzers, except for pH control, do not appear justified, however their addition at a later time could be readily made. Any analyzers would be subject to safety approval as explosives will likely be present in the wastes.

Item 3 (Will an adverse impact occur in the discharge plume in the Wabash River at NAAP?).

Given the degree of waste treatment that will be utilized in the RDX/HMX facility, this plant will have no adverse effects on the Wabash River. Projected levels of nutrients and carbonaceous materials are consistent with the overall effort to clean up the Wabash River.

Regarding TNT plant operation, a copy of a message from HQ, ARRCOM, Rock Island, IL which commits the Army to pollution abatement before start-up of the TNT facility has been provided to EPA for review.

Item 4 (Temperature of the discharge was not addressed).

Heat is not expected to be a significant component of the process waste stream. Some cooling will take place through the treatment process and it is anticipated that the plant effluent will be within 5°F of ambient water temperature (this fact was stated for each of the proposed sites on pages 216, 218, and 220 of the Draft EIS). No environmental impacts are anticipated due to thermal pollution.

b. Solid Waste (Provide information on the feasibility of providing adequate and acceptable solid waste disposal facilities at NAAP).

Solid waste disposal of inert materials was acknowledge in the Draft EIS to be a special problem at NAAP, but mainly from the standpoints of soil trafficability and workability. Landfilling is certainly environmentally feasible. In the bibliography of the Draft EIS, the listed references 103 and 104 are particularly germane; these are detailed reports on solid waste disposal at NAAP, and can be supplied to EPA if desired. The state of Indiana is cognizant of and routinely inspects all solid waste disposal operations at NAAP. Finally, a contract has been let recently for off-plant disposal of inert wastes in a state-approved commercial landfill. Other facets of disposal of explosives and explosive-contaminated wastes have been commented on above.

c. Air Quality.

Item 1 (No discussion of energy conservation was provided).

An energy-conservation report has been sent to EPA for review.

Item 2 (Car pooling should be encouraged).

As suggested on page 268 of the Draft EIS, car pooling will be encouraged.

Item 3 (Various techniques to abate smoke from slash burning were suggested).

The US Army Corps of Engineers will include the EPA recommendations in the construction contract. However, slash burning will be minimized (if used at all) because marketable timber will be sold and acceptable slash will be chipped and used as ground cover for erosion control.

Item 4 (Is low sulfur coal available?)

See response to similar question above. The conditions necessitating use of a high sulfur coal (thus SO_2 removal equipment) would be the unavailability of low sulfur coal for a wide variety of reasons; however, in this event, defense-oriented operations might receive a higher national priority for uninterrupted supply.

d. Land Use (What are land-use alternatives?).

Although the amount of land required for the proposed action is about 6,000 acres, only about 1,000 to 1,200 acres will have to be cleared, grubbed, and graded. Natural topographic contours and surface features will be left intact on the remaining acres (for noise attenuation, safety reasons, etc.). The proposed construction site at NAAP is already rather highly developed, thus impacts on flora and fauna should be negligible (see Appendix C, Volume 2 of the Final EIS). Loss of timber production, cancelling of agricultural outleases, and impacts on soil, water, and wildlife were discussed in the Draft EIS, as well as the "no construction" option.

4. EPA Region VI (Dallas, TX) Comments.

a. Water Quality.

Item 1 (Is MNAD's domestic wastewater treatment system adequate to handle additional inflow?).

The most cogent response to this comment is that the proposed RDX/HMX facility will construct its own sewage treatment facilities to handle whatever waste load can not be accommodated by existing facilities (page 16, Draft EIS), thus existing sewage treatment capabilities on MNAD are not part of the proposed action. However, we recognize that generally increased activity on the installation as a result of RDX/HMX operations could cause an increment of increase to existing facilities. Officials at MNAD have recently advertised for bids on a contract which would correct the deficiencies noted in the Region VI report; completion date is scheduled for October 1977. When completed, MNAD officials expect that the renovated facility should be able to handle all domestic wastes incident to RDX/HMX construction and operation. Detailed data have been sent directly to EPA from MNAD for review.

U.S. Environmental Protection Agency
Detailed Comments
U.S. Army Draft Environmental Impact Statement
RDX/HMX Expansion Facility

1. General

The proposed project represents the interaction of a complex manufacturing facility with an even more complex set of natural and socio-economic environmental factors. It would be helpful to the reader of this statement if a summary chart or matrix of the projected impacts at the alternative sites could be presented either in the Summary section (pgs. S-1 to S-7) or in Section 3 of the Statement. Even though there are distinct limitations in the use of a matrix, a comparable and succinct summary of the impacts at each site would be valuable.

(a) Endangered Species

Page S-2 indicates that "no impact is anticipated on current or proposed endangered/threatened species." However, there appear to be two conflicts in the body of the EIS with that statement.

- On page 73, "There are many unique species of fish and molluscs in the Wabash River that are either legally protected now or probably will be in the future." Is this an indication of listing as endangered species? (Also see the Region V comment on wastewater treatment and your comments on page 175.)

  On pages 172-173, there is an indication that bald eagles winter on the western edge of Milan and that while the effect on them is unknown, "they presently co-exist with depot activities." The impact on the eagles may be severe. Co-existing with present activities is no criterion on which to judge the effects of the new construction.

(b) Noise

In assessing the noise impact at the three sites, it would be quite helpful to show site maps with projected noise contours superimposed and noise sensitive areas specifically designated. (Also see Region IV comments.)

(c) Solid Waste

Page 11, Volume II, Appendix B: The words "various sludges" should be identified more clearly since the optimal type of incineration varies with the chemicals in the sludges. More distinct chemical characterization should be provided for all sludges and process residues in order to select the optimal disposal plan.

Page 229: No emission controls are possible with an air curtain incinerator and it is therefore not usually acceptable to EPA unless assuredly inoffensive combustion products are discharged to the air. For burning a hazardous waste it is not acceptable. A dual chamber or multiple chamber incinerator may be acceptable but its inability to handle sludges, liquids, slurries, tars or powders precludes its use for processing most hazardous wastes. The average combustion temperature of 540°C (1000°F) is not high enough to ensure destruction of many hazardous materials. Higher temperatures could be achieved by additional auxiliary burners and proper construction materials. Rotary kiln and fluidized-bed incinerators have been tested on more than the pilot scale. (See ADL/TRW report on incineration of hazardous wastes, John Schaum, EPA, HWMD Project Officer, 755-9202. See also Alternatives for Hazardous Waste Management in the Organic Chemical, Pesticides and Explosives Industries by Process Research, Inc. Eugene P. Crumpler, Project Officer, EPA, HWMD 755-9206.)

The Army should be aware of provisions of the Resource Conservation and Recovery Act, P.L. 94-580 of October 21, 1976. DOD will have to comply with all Federal, State, interstate and local requirements both substantive and procedural. (Section 6001 Subtitle F.)

(d) Air Quality

The statement should provide information as to how the proposed facility will be accounted for in State Implementation Plans for attaining and maintaining air quality standards in the specific site regional areas.

The description of air quality for the environmental setting of the proposed facility should document specific air quality monitoring sites that were used to supply data for the regional air quality analysis.

The on-site air quality monitoring program should provide information as to the time period (month) for which air quality analyses were made as well as document what type of instruments and analytical procedures were employed in this program. Additionally, how many valid hours of air quality data resulted for each analysis from the on-site monitoring program? We would also suggest that due to differing seasonal patterns observed in most air pollutants, a one-month monitoring program cannot describe the ambient air quality in a site area.

The discussion on local meteorology for each site refers to the term "elevated inversions." The statement should document what height is associated with this terminology. In order to substantially support meteorological conditions at the proposed sites, a wind rose should be provided where wind frequency distribution and wind speed are given for stability conditions. This kind of information would help clarify the selection of "worst case" meteorological conditions for power plant and nitric acid plant sites. The selection of stability class "C" for the nitric acid plant is apparently in conflict with the discussion in paragraph 3 on page 81 of the draft EIS. We do not believe that the one hour of field data which was employed in the SF_6 tracer study verifies the model for all atmospheric wind stability conditions.

The draft EIS does not provide enough information concerning the specific type of cooling tower to be used at each site. We believe that the actual parameters for selection of cooling towers should be provided for each site.

Your attention is invited to 40 CFR 60, Standards of Performance for New Stationary Sources.

(e) Water Quality

The statement indicates, on pages 8 and 18, that the final stage of the industrial wastewater treatment process would be a polishing step using an adsorbent, but that an alternative option of dilution is being considered. EPA issued a policy statement on November 8, 1976 stating that "...low flow augmentation cannot be considered a substitute for the use of adequate treatment to meet water quality standards..." This policy statement did not categorically forbid the use of flow augmentation or dilution to meet water quality standards. It is EPA policy that Best Available Technology (BAT) defines the minimum level of treatment which is adequate and which serves as the threshold for consideration of dilution as a supplement to meet water quality standards. In some cases, however, BAT may represent more than the maximum use of technology within the economic capability of the owner of the facility. In these cases, less stringent limitations than those required by BAT may be considered "adequate treatment." The full burden of demonstrating that BAT should not be required for a facility must be borne by the owner of the facility. All exemptions from the BAT threshold are considered temporary and should be reviewed when each effluent discharge permit expires. Therefore, the Army must clearly demonstrate that dilution to meet water quality standards is required for this facility before a discharge permit can be issued where dilution is used in lieu of treatment to meet water quality standards.

On page 215, it is stated that appropriate steps will be taken to insure protection of aquatic life at the water intake structures. No details of these structures were provided, but the design and location should conform to the recommendations contained in "Development Document for Best Technology Available for the Location, Design, Construction and Capacity of Cooling Water Intake Structures for Minimizing Adverse Environmental Impact," EPA 440/1-76/015-a, dated April 1976. Although the site for the proposed facility had not been selected in the draft, the final should indicate the selected site and provide more specific information regarding water intake and discharge structures, cooling towers, stack locations and other similar environmental features.

LETTER FROM: United States Environmental Protection Agency, Washington, DC

DATED: 16 February 1977.

RESPONSE: Cover letter - No response required.

Comments from Washington Office:

1. General (Provide a summary chart of projected impacts).

   A summary chart has been included as part of the Executive Summary in the FINAL EIS.

   a. Endangered Species.

      Item 1 (Are "unique" species of fish and molluscs in the Wabash the same as "endangered" species?).

      As detailed in Appendix E, Volume 2 of the Draft EIS, there are many aquatic species in the Newport area that have been or could be listed by US Department of Interior as "endangered" or "threatened", or could otherwise be protected legally if Indiana enacts endangered/threatened species legislation in the future. Our desire to identify all "unique" species that might be protected in the future was occasioned by recent litigation regarding construction of the Tellico Dam (i.e., after plans for the dam were approved and money appropriated, and after construction began, an endangered fish was discovered making a subsequent court injunction retroactive in effect). The statement on page 73 of the Draft EIS is supported by detailed data in Appendix E, Volume 2.

      Item 2 (Impact on bald eagles at MNAD could be severe even though, "... they presently co-exist with depot activities.").

      Additional data are also provided in Appendix E on MNAD's wintering bald eagles that were alluded to on pages 172 and 173 of the Draft EIS. Although the eagles winter on the western edge of the depot several miles away from the site proposed for RDX/HMX construction, increased human activity on the installation could constitute an adverse impact. If MNAD is selected as the RDX/HMX site, a strategy to avoid adverse impacts on the eagles will be evolved with US Department of Interior and Oklahoma officials.

b. Noise.

Item 1 (Show noise contour maps for each of the candidate sites).

Noise impacts were predicted by measuring ambient noise at each of the three candidate sites, then superimposing noise levels from operations at Holston Army Ammunition Plant (the only producer of RDX/HMX in the US). Because undesirable noise impacts were anticipated beyond the boundaries of MNAD and MAAP, the architectural engineering firm designing the proposed facility was tasked to perform another noise impact assessment based on the actual equipment to be used in the RDX/HMX plant (not on the Holston overlay). Their conclusion was that all three candidate sites could be made acoustically acceptable (i.e., noise would be abated to an L_{dn} of 55 or below at the installation boundary), although the MNAD site would require acoustic treatment and/or relocation of certain facilities unless a waiver of the limiting criteria would be allowed. A copy of a report on the results of the acoustic study with extra noise contour maps has been sent to EPA for review, and the text of the Final EIS has been amended to reflect the above facts.

c. Solid Waste.

Item 1 (Identify the term "various sludges" more clearly).

Various sludges produced in liquid waste treatment are difficult to define in detail at this stage of design. The constituents of various sludges can be identified in a broad sense by matching process inputs in Appendix B with what is removed in the treatment (e.g., see Table 2, Appendix B on estimated removal efficiencies). Our best estimates at this time of the chemical characteristics of sludges are as follows:

- Sludges will originate from the gravity separator, chemical coagulation, clarification, and biological treatment processes. From primary sedimentation or the gravity separator the sludges will consist of inert solids, trace amounts of RDX, HMX, and a small amount of organic matter. These sludges are expected to be of low BTU content with a moisture content ranging from 95 to 99 percent before dewatering.

- Sludge produced by coagulation will be primarily metal hydroxides of aluminum and iron. These sludges will be of low BTU content with a moisture content of from 90 to 97 percent.

- Biological sludges will be produced from the activated sludge process, nitrification, and aerated nitrogen stripping. These sludges will have a BTU content ranging from 5000 to 10,000 BTU per pound with a moisture content from 95 to 98 percent.

Based on the proposed system processes, all sludges will be thickened and dewatered by belt pressure filtration before incineration. Moisture content before incineration will range from 60 to 75 percent.

Item 2 (Air curtain incinerators are not usually acceptable to EPA, especially for hazardous wastes).

Regarding the air curtain incinerator, perhaps there was a misinterpretation of the term "contaminated wastes". Our definition includes <u>only</u> explosives-contaminated wastes, not wastes contaminated with pesticides, herbicides, PCB's, heavy metals, or other hazardous compounds. For handling explosives-contaminated wastes, an air curtain incinerator is effective (explosives burn at 200°F), and use of the device has received tentative acceptance from several EPA regional offices (one such incinerator is now in operation at Radford Army Ammunition Plant, Virginia). The text of the Final EIS (Sections 3b(7)(b)2c and d) has been modified to reflect recent decisions regarding disposal of materials contaminated with explosives, and waste explosives themselves. In addition, copies of correspondences from EPA regional offices and other regulatory agencies regarding use of air curtain incinerators at Army ammunition plants have been sent to the EPA Washington office for perusal.

Item 3 (The Army should be aware of Public Law 94-580 and several reports on hazardous waste incineration).

We are thankful for the references on incineration of hazardous wastes and on alternatives for hazardous waste management, and are aware of the provisions of Public Law 94-580.

d. Air Quality.

Item 1 (Discuss the status of the proposed project in terms of State Implementation Plans).

Final accounting of the RDX/HMX facility would normally be handled in each of the three regions as part of the state's permitting process, thus an explicit point-by-point accounting is premature at this time. One state air pollution agency did comment on their State Implementation Plan in relation to the RDX/HMX plant. The Indiana State Board of Health said (their complete comments are printed in this volume of the Final EIS), "The NO_2 concentrations in the [Newport TNT] site area, as predicted by computer models, are in excess of the National Ambient Air Quality Standard, and therefore are not consistent with the Indiana Plan of Implementation; however, if the facility meets the Federal New Source Performance Standards the NAAQS could be met." In response to this comment, a telegram was received from Headquarters, US Army Armament Materiel and Readiness Command, Rock Island, Illinois; a copy of the message was sent to the Air Pollution Control Division, Indiana State Board of Health. It states, in part, "Prior to shutdown of TNT operations at Newport, violations of air and water pollution standards did occur. Although the TNT lines are the new design, they were first generation and not constructed with air pollution controls. Since that time, nitrogen oxide controls have been developed for TNT lines and were installed on the new TNT lines at Volunteer AAP and Joliet AAP. The HQ, ARRCOM policy is that prior to TNT line reactivation, except in an extreme national emergency, the lines would be retrofitted with the proper controls."

At McAlester, the predicted non-compliance with the 24-hour particulate standard as a result of concurrent operations of existing facilities and the proposed RDX/HMX plant will be mitigated. The major contributor here is Plant B at MNAD, and a project is now underway to design and install particulate removal equipment utilizing cyclone collectors and wet scrubbers with a combined removal efficiency of 99 percent.

In gathering regional background air quality data for the Draft EIS, we noted that several pollutants exceeded standards in nearby metropolitan areas. However, we stated that these excesses did not accurately reflect prevailing conditions at the three candidate sites which are essentially in rural areas. Representatives of state air pollution agencies in each of the states (John W. Gallion, Chief, Air Quality Service, Oklahoma State Department of Health; James W. Hayes, Chief, Engineering Program, Division of Air Pollution Control, Tennessee Department of Public Health; and Edgar F. Stresino, Air Pollution Control Division, Indiana State Board of Health) were contacted by telephone on 9 March 1977, and each endorsed the above philosophy.

Finally, the most difficult problem of non-compliance with which to deal is that of non-methane hydrocarbons (NMHC). Our onsite air monitoring program noted violations of the 3-hour NMHC standard at each of the three sites (in fact, according to the Chief of Air Quality Service for the Oklahoma State Department of Health, this was the first record of NMHC violations in that region of Oklahoma). Our difficulty in interpreting the severity of this violation and especially in assessing the constraints it might impose has been occasioned by a lack of explicit guidance. We understand, and communications with each of the state air pollution agencies (op. cit.) confirmed that the NMHC standard is to be used as a guideline in interpreting ambient levels of photochemical oxidant. In our admittedly short one-month onsite monitoring programs, we did not detect a violation of ozone standards at any of the three candidate sites. Some regional ozone standards were exceeded in urban areas but, as stated above, we did not believe these were relevant to the rural sites. The Larsen model also predicted ozone non-compliance, but in the absence of corroborating data from the field, we de-emphasized the mathematical predictions. We also realize that in many, perhaps even a large majority of the areas in the US, standards for both hydrocarbons and oxidants are being exceeded in very rural areas such as the candidate sites for the RDX/HMX plant. Probably many of these violations reflect transport of photochemical oxidant and its precursors from distant urban centers. In addressing this potentially constraining circumstance, we reviewed "Air Quality Standards; Interpretative Ruling: Requirements for Preparation, Adaption, Submittal of Implementation Plans" (Federal Register 41(246):55524-55531, 21 December 1976). Each of the state air quality officials contacted (op. cit.) indicated their complete willingness to achieve an equitable solution to siting the proposed facility in their area considering the rationale for NMHC standards, the recent interpretative ruling, and the degree of control on new-source emissions offered via permitting systems.

Item 2 (All air quality monitoring sites should be documented).

As indicated in Section 1c(1)(g) of the Draft EIS, ambient air quality at each of the candidate sites was defined on the basis of a combination of an onsite monitoring program and the results of long-term regional monitoring conducted by local regulatory agencies. As referenced in the text, annual state air quality reports were used to document the regional air quality. In each instance the latest available annual period was utilized. Background air quality levels for each site location were discussed in terms of data available from these sources within roughly a 50-mile radius of each candidate site. Many of the regional data within the study radii came from urban monitoring programs (appropriate care was exercised in utilizing these data to represent conditions at the rural project sites, and emphasis was placed on county-wide emissions rather than point-source emission levels). Data examined were of the five most commonly referenced pollutants, i.e., sulfur dioxide, nitrogen dioxide, carbon monoxide, particulates, and hydrocarbons. Background dispersion meteorological conditions were also described for each of the three areas. STAR (STability ARray) data (which constitute a joint frequency distribution of atmospheric stability class, wind speed, and wind direction) were the best source of data, and were used as the basic input to the modeling analysis. The closest sources of STAR data were Tulsa, OK, Jackson, TN, and Indianapolis, IN.

Item 3 (Provide a time during which onsite air quality monitoring was conducted, and provide data on instrumentation and analytical procedures).

SITE	PERIOD OF MONITORING
Newport, IN	23 NOV to 28 DEC 1975
McAlester, OK	30 NOV to 25 DEC 1975
Milan, TN	16 JUN to 25 JUL 1975

The reason the Milan site was surveyed at a different time is because it was added to the list of RDX/HMX candidate sites much later than the other two. Regarding instrumentation and analytical procedures, comprehensive back-up reports have been sent to EPA for their review. We agree that due to differing seasonal patterns observed with most air pollutants, a one-month monitoring program cannot completely describe the ambient air quality in a site area. However, several circumstances are extenuating, one of which is the severe cost limitation that would be imposed by having to conduct field surveys at each of the three sites for a year or more to characterize not only ambient air quality, but also ambient water quality and ambient noise. However, some valid options and alternatives were used to provide adequate information for EIS purposes. First, existing data were used to the maximum extent possible. Second, by e·· · ·ing statistical confidence limits, results of relatively short surveys can be used to make long-term inferences within reasonable bounds. For example, in the Draft EIS on page 125 it was stated, "Ideally, a blast noise assessment should be based on data taken over a complete range of meteorological conditions. Practically, such extensive measurements are too costly and time consuming to be feasible. In lieu of such extensive measurements, blast noise levels must be simulated by the use of statistical models." Similarly, the US Army Environmental Hygiene Agency at Aberdeen Proving Ground, MD has recommended the following: "In order to adequately describe the variation in air quality at any location, measurements of specific parameters should be taken over a minimum period of several months and preferably for at least a year (Arthur C. Stern, Air Pollution, 2nd Edition, Academic Press, 1968). In order to obviate this requirement, a statistical method of predicting the geometric mean concentrations will be employed (R.I. Larsen, A New Mathematical Model of Air Pollution Concentration, Averaging Time, and Frequency, J Air Poll Control Assoc 18, 1969). A fundamental requirement of this technique is the accumulation of sufficient data to form a representative cumulative frequency distribution. The determination of the amount of data required to form this frequency distribution is made by following the procedure described by Dixon and Massey (W. J. Dixon and F. J. Massey, Introduction to Statistical Analysis, McGraw Hill, 1957). The frequency distribution is satisfactory if it falls within ± 5 percent of the true distribution at the 95 percent confidence level. Using this confidence interval, the required minimum number of valid samples is 740 per parameter sampled."

Realizing that there are practical limits to such a program (e.g., a sampling period of such short duration can be heavily influenced by such phenomena as dust storms, heat waves, and tornadoes), its use is nevertheless dictated by the pragmatic considerations of time and money. If the mathematical ground rules are known, we believe such an approach has merit.

In addition, fall and winter tend to produce the highest frequency of occurrence of limited dispersion conditions; these result usually in the highest observed pollutant ground level conditions for most contaminants with the possible exception of photochemical oxidant and suspended particulates. Onsite monitoring was conducted during this typically restrictive period at Newport and McAlester. The only reason Milan surveys were done at the odd time was that this potential site was added late to the list of candidate installations. The data gathered at all sites were in general agreement with most local air quality data collected over longer periods by regulatory agencies in nearby rural areas.

Item 4 (Provide more data on "elevated inversions")

Comprehensive tables were used to ascertain the height of elevated inversions in the vicinity of each of the candidate RDX/HMX sites. The tables provided listings of morning and afternoon inversion base heights on a seasonal and annual basis. The data in the tables are based on soundings taken at the closest upper air station to each of the three site locations (Oklahoma City, OK, Nashville, TN, and Peoria, IL). These data are in excellent agreement with the discussions on mixing height for each of the three sites reported in the Draft EIS. The tables will be supplied to EPA if required.

Item 5 (Provide wind roses).

Wind roses in the form of joint frequency distributions of atmospheric stability class, wind direction, and wind speed have been forwarded to EPA for review.

Item 6 (The discussion on page 81 of the DEIS seems to conflict with the choice of worst-case meteorology for the nitric acid plant, i.e., stability C and a light wind speed).

The discussion in the referenced paragraph is quite general and was provided to give the uninitiated reviewer an idea of the type of conditions which could yield high ground-level pollutant concentrations for various sources. However, the actual definition of the worst-case meteorological condition for each of the proposed RDX/HMX sources, as well as the existing sources, was determined by using the air quality model PTMAX. This model (available to users from EPA) provides the actual worst-case meteorological conditions for a given source's specific exit characteristics. In this instance, pollutant concentrations in slightly unstable conditions and a light wind speed were predicted to be higher than those which would be experienced under neutral, very windy conditions. For another set of source exit characteristics, this might not be the case. In summary, we do not believe that the referenced discussion conflicts with the selection of stability class C for the nitric acid plant.

Item 7 (Is one hour of field data in an SF6 tracer study sufficient to verify the model for all atmospheric wind stability conditions?).

If EPA inferred that only one SF6 test was done, this is incorrect. As stated on page 191 of the Draft EIS, a representative SF6 test and its results were presented (to acquaint an uninitiated reviewer with the procedure).

If the implication is that one hour's worth of data cannot validate a model under all sorts of atmospheric wind stability conditions, the following discussion is offered. The Gaussian modeling approach used by our contractor in the air quality analyses represents a well tested technique presently used widely in the industry for such applications. The purpose of the SF_6 tracer program was not to validate or calibrate selected models. Rather the modest tracer programs were designed to insure the reasonableness of the Gaussian approach at each site (i.e., to insure that the limited relief at each site was not creating an undue influence on the dispersion of effluents). The example sited in the text of the DEIS is indicative of the results of this analysis and was portrayed to demonstrate the compatibility of the Gaussian approach. We acknowledge that much more field testing under a variety of meteorological conditions would be required to calibrate the chosen models. However, we did not believe the UNAMAP models utilized in this analysis required this level of validation.

Item 8 (Not enough specific information was provided on cooling tower design).

At the time the Draft EIS was prepared, only the most rudimentary of data concerning cooling towers was available. For this reason, the assumptions provided for an analysis of cooling tower impacts were quite conservative. For example: an assumed salt concentration in the drift of 3,000 ppm is higher than expected under normal operating circumstances; assuming a mean annual plume height of 116 meters was most conservative because drift droplets (especially those of larger sizes) do not reach this height; downwash effects were ignored; an assumed cooling tower flow rate of 72,000 gpm was too high because probably several smaller towers will be constructed with a central tower having a flow rate of 40,000 gpm and nitric acid and acetic anhydride towers totalling 17,000 gpm. As indicated by comments from the Huntsville (Alabama) Division, US Army Corps of Engineers later in this volume of the Final EIS, cooling tower size, design, and placement is still tentative. If, when final decisions are made, the probable impacts from cooling towers are significantly different from those presented in this Final EIS, then an appropriate amendment to the EIS will be filed with CEQ and made available for review and comment.

Item 9 (Our attention is invited to 40 CFR 60).

No response required.

e. Water Quality.

Item 1 (Will dilution be necessary to meet water quality standards in the proposed RDX/HMX facility?).

The current guideline (BPCTCA) for nitrobodies in effluents from munitions plants is 0.5 mg/l. This level could be achieved in the RDX/HMX wastewater treatment system without the final polishing step of carbon adsorption. A complicating factor, however, is that current toxicological work being performed by US Army Medical Bioengineering Research and Development Laboratory might result in a new nitrobody limit of 0.05 mg/l. Technologically, this maximum value is achievable using a carbon adsorption system or a particular ion exchange resin. However, these processes have never been proven on a large scale. Also, the technology is not yet at hand to reactivate the carbon economically, thus imposing a great cost on the process. Use of flow augmentation has been suggested as a contingency to achieve nitrobody concentrations of 0.05 mg/l, and the quantity of water that would be required for this procedure has been used throughout the planning stages. It is agreed that dilution is the least desirable alternative; it will only be used if technology is not economically achievable to reduce nitrobody levels as dictated by results of the Army's current work in promulgating data to establish standards for allowable discharge concentrations.

Item 2 (How will aquatic life be protected at water intake structures?).

The design and location of water intake structures will conform to the recommendations contained in EPA's April 1976 publication entitled, "Development Document for Best Technology Available for the Location, Design, Construction, and Capacity of Cooling Water Intake Structures for Minimizing Adverse Environmental Impact". These techniques would be applicable only at the McAlester (Lake Eufaula) site because the source of water at the other two candidate sites is wells.

Item 3 (The Final EIS should indicate the selected site and provide more specific information on various features of the proposed facility).

A "preferred alternative" has been selected and published in the Final EIS. Master plans have been developed for each of the three candidate sites; these indicate locations of facilities with potential impact on the environment. Detailed plans and site drawings have been sent to EPA for review.

2. EPA Region IV (Atlanta, GA) Comments.

a. Water Quality.

Case Study - Murray

(3)

SUMMARY

RDX/HMX EXPANSION FACILITY

Draft (X) Final Environmental Statement

Responsible Office:

HQDA, DAMA-CSM-P, ATTN: LTC Robert P. Gail/Telephone (202)694-4131
WASH DC 20314

1. Name of Action: (X) Administrative ( ) Legislative
RDX/HMX Expansion Facility Environmental Impact Statement.

2. Description of the Action: The proposed action consists of constructing and operating a large chemical/industrial complex to manufacture the explosives RDX (Research Department Explosive and HMX (High Melting Explosive), and various blended products. The Department of the Army is the proponent of the action.

This proposed action is required to expand the RDX/HMX production capacity. The new facility will initially comprise two RDX/HMX lines based on the current projection of mobilization requirements; however, in order to satisfy requirements for future expansion, the final site selected will be capable of accommodating a total of four lines. Three sites have been considered in detail for the facility: McAlester Naval Ammuniti Depot in southeastern Oklahoma; Milan Army Ammunition Plant in west-central Tennessee; and Newport Army Ammunition Plant in west-central Indiana.

Construction of the proposed plant, estimated to cost betwee $372 and $386 million (1975 constant dollars), would encompass about 5,000 to 6,000 acres but only about 20 percent of this area would be cleared, grubbed, and graded.

Annual operating costs are estimated roughly at $44 million (two-line production) or $83 million (four-line production) with payrolls estimated at approximately $9 million (two lines) or $14 million (four lines) at mobilization levels.

3. Summary of Impacts:

a. Beneficial Impacts.

The primary favorable impacts will be the provision of substantial short-term economic benefits to the area. During the five-year construction period and during times of partial or total mobilization, thousands of direct and indirect jobs would be created. These temporary influxes of money would lower unemployment and would provide a considerable but transitory stimulus to the regional economy (increase in local business volume, higher personal income, higher tax revenues, increases in value of local real property).

b Adverse Impacts. (A summary sheet of adverse impacts and mitigation measures is shown on pages S-9 and S-10 of this Executive Summary.)

(1) Impacts on Vegetation, Fish, and Wildlife.

Clearing, grubbing, and grading the 1,000 to 1,200 acres needed to construct the proposed facility would extirpate the ecological communities currently inhabiting the area. This impact would be most severe at Milan and least severe at Newport (here old buildings occupy most of the site).

At McAlester, intermittent oxygen stress caused by RDX/HMX effluent in the upper reaches of the discharge course would reduce the diversity of invertebrates by temporarily eliminating sensitive species; however, recolonization would occur rapidly.

No impact is anticipated on current or proposed endangered/threatened species on federal or state lists.

(2) Impacts on Air Quality.

The three-hour guideline for non-methane hydrocarbons is presently being exceeded at all three candidate sites. However, these excesses are inconsequential because the hydrocarbon guideline is evaluated in conjunction with ozone levels; these will be in compliance at all three sites, and project hydrocarbon emission strengths will be insignificant.

Operation of the TNT facility concurrently with an RDX/HMX Plant at Newport could result in a violation of the annual NO_2 standard in a small area located mostly within the installation's boundary. Abatement tecniques for NO_2 will be used to bring this emission into compliance if Newport is selected as the site for the proposed facility.

Similarly, a projected particulate violation at McAlester due to concurrent operation of Plant B with the proposed RDX/HMX plant will be eliminated by installing cyclone collectors and wet scrubbers on the Plan B exhaust stack (project due for completion in 1978 prior to construction of RDX/HMX facility)

(3) Impacts on Water Quality.

Under certain conditions at McAlester, up to seven miles of receiving streams could fall below the state standard for dissolved oxygen due to discharge of treated RDX/HMX effluent. These streams normally stop flowing during dry periods. The reduction of dissolved oxygen due to the facility effluent would have a relatively small aquatic impact due to the intermittency of the stream flow. Also, under certain flow conditions, violation of the Oklahoma sulfate standard would occur, but no direct toxic impact is expected due to the sulfate violation.

(4) Noise Impacts.

The US Environmental Protection Agency has established a maximum of 55dB(A) at the plant boundary as a long term goal. Noise contours between 55 and 60 were projected to extend beyond McAlester's and Milan's boundaries with the RDX/HMX plant and existing facilities operating concurrently. As a result, architectural engineers have redesigned the proposed facility to attain L_{dn} of 55dB at the boundaries of each of the proposed sites.

(5) Solid Wastes.

No serious solid waste disposal problems are anticipated at any of the three sites, although physical characteristics of NAAP's soils would pose the most difficult problems in efficient disposal. Clearing of vegetation during construction will create the largest quantities of solid wastes at Milan, and the least at Newport. Construction wastes and inert wastes from operation of the RDX/HMX plant will be land-filled. Disposal options are still being evaluated for explosives and contaminated wastes but the technology is at hand to dispose of these wastes in an environmentally acceptable manner.

(6) Impacts on Utilities.

Considerable amounts of power (about 5 to 6 million KW-hours per month for two production lines) will be needed to run the proposed plant, but local utilities companies in all three areas affirmed that current generating capacity is adequate to meet the demand.

(7) Seismic Risk.

Milan is in a seismically active region, and the possibility exists of failure, during an earthquake, of a critical component in automated systems which govern parts of the manufacturing process. Under worst case, this could transit into an explosion. Critical system components that are specially designed and constructed to resist seismic incidents will be used if this site is chosen.

(8) Archaeological Sites:

Two prehistoric sites exist at Milan, and one is adjacent to the proposed construction site at NAAP. Adequate precautions will be taken to avoid these sites during new construction.

(9) Aesthetic Impacts.

The 300- to 500-foot steam plant exhaust stack will be visible from afar, and will probably be displeasing to some. The water intake structure at McAlester's Lake Eufaula could constitute an aesthetic impact to those using the area for recreation.

(10) Cooling Tower Impacts.

Impacts from visible plume, fogging and icing, salt deposition, and augmentation of rain and snow are expected to be local and not severe.

(11) Socioeconomic Impacts.

Oscillations in employment levels as a result of fluctuating demands for RDX/HMX products, constitute a potential adverse impact. It has been demonstrated that the existence of a major metropolitan area considerably softens the blow of a base closure or cut-back on the surrounding community. The Newport area has a population roughly twice as dense as Milan's, and three times as dense as McAlester's. The conclusion is that McAlester's economy would be the most adversely affected (higher proportions of unemployed and welfare recipients, depressed housing market) during slack periods in production.

The cash infusions into the local economies from a mobilized four line RDX/HMX plant would account for 17.4 percent of the total annual business volume in the McAlester region, for 4.9 percent in the Milan region, and for 3.8 percent in the Newport region. The higher the proportion, the more dependent the region is on military dollars, i.e., the less diversified is its economic base.

Schools are the most crowded in the Milan region, and significant immigration could have an adverse impact;

this would be offset somewhat by receipt of federal impact funds for children of federal employees (including construction contractors), and federal school construction money (badly backlogged, however). Also current school construction projects in the Milan region will alleviate local crowding and will increase the enrollment capacity.

4. Alternatives:

a. No Construction.

This option would circumvent all adverse environmental impacts; however, beneficial impacts would not be realized. This alternative is not reconcilable with national defense objectives.

b. Procure RDX/HMX Products from Private Industry or from Allies.

There is no commercial producer of HMX in North America; RDX is manufactured in Canada but only in quantities sufficient for that country's own use.

c. Stockpile RDX/HMX Products in Lieu of Building a New Production Facility.

Stockpiling is quite costly because of needs for surveillance and storage facilities, and costs of retrieval methods, inventory, and deterioration of the products.

d. Construct RDX/HMX Lines at Holston Army Ammunition Plant, Tennessee Where the Same Products are Currently Being Produced.

Holston has insufficient space for construction of the proposed plant because of existing and planned facilities. Also, pollution problems at Holston would be exacerbated and the strategic advantage of having two separate RDX/HMX plants would be lost.

e. Construct a Series of Small RDX/HMX Plants as Opposed to One Large One.

Most adverse environmental impacts would be "diluted" among several installations instead of being concentrated at one. However, requirements for greater capital costs, redundant support facilities, additional real estate, and multiple operating crews make this alternative uneconomical.

f. Construct New RDX/HMX Production Facilities at Sites Other Than Military Installations.

No additional real property can be acquired by the Department of Defense unless property under the control of other federal agencies is not suitable and available for use. Public Law 94-212 precludes designing, procuring equipment, or constructing new ammunition plants except at locations where existing ammunition plants are being closed, placed in layaway, or where production has been curtailed.

g. Alternative Sites Considered.

Thirty Army and Navy installations were considered for the proposed RDX/HMX facility in an exhaustive site-selection process. From this process, the final candidates of McAlester, Milan, and Newport were selected.

The detailed consideration of each of the three sites in this EIS represents the best possible analysis of feasible alternative sites from an environmental viewpoint.

h. Reschedule (Delay) the Proposed Action.

This alternative would delay adverse environmental impacts, perhaps long enough for development of new pollution abatement measures. However, construction and operation costs would be greatly inflated and delaying the project is not reconcilable with the national defense objectives of expanding and diversifying the RDX/HMX production base as soon as possible.

5. List of Coordinating Agencies:

Distribution List for Draft EIS for RDX/HMX Expansion Facility:
Assistant Secretary of Defense (Health & Environment)Washington DC
Office of the Assistant Secretary of Defense(Installation & Logistics)
Assistant Secretary of the Army (Civil Works)
Office of the Chief Engineer (DAEN-ZCE)
Assistant Secretary of the Navy (Research & Development) Washington, DC
Chairman, Council on Environmental Quality
Environmental Protection Agency, Director of Office of Federal Activities
Administrator, Region IV, Environmental Protection Agency, Atlanta, Georgai
Administrator, Region V, Environmental Protection Agency, Chicago, Illinois
Administrator, Region VI, Environmental Protection Agency, Dallas-Ft. Worth, Texas

RDX/HMX EXPANSION FACILITY

SUMMARY OF ADVERSE IMPACTS AND MITIGATION MEASURES

Candidate Site	Environmental Acceptable for RDX/HMX Facility?	Unavoidable Adverse Impacts	Environmental Acceptability Contingent on These Mitigating Measures
McAlester	Yes	1. Clearing about 1,200 acres.	1. Successful wastewater contingency plan.
		2. Disposal of large quantities of solid wastes.	2. Abate particulates at Plant B.
		3. Aesthetic impact of 300-500' steam plant exhaust stack.	3. Possibly dredge upper receiving channels or pipe aqueous wastes to bigger drainages to avoid flooding.
		4. Highly unstable economic base will be created.	4. Keep BOD_5 below 4 mg/l in the effluent.
		5. Stress on local public services due to immigration.	5. Abate noise to 55dB(A) or below at the installation's boundary.
		6. Water-intake structure will impact on Lake Eufaula recreational site.	6. Acquire right-of-way for 18-mile pipeline.
Milan	Yes	1. Clearing about 1,200 acres.	1. Successful wastewater contingency plan.
		2. Disposal of large quantities of solid wastes.	2. Avoid archaeological impacts due to relocation of test area.

Candidate Site	Environmental Acceptable for RDX/HMX Facility?	Unavoidable Adverse Impacts	Environmental Acceptability Contingent on These Mitigating Measures
		3. Aesthetic impact of 300-500' steam plant exhaust stack.	3. Possibly dredge upper receiving channels or pipe aqueous wastes to bigger drainages to avoid possible flooding
		4. Moderately unstable economic base will be created.	4. Abate noise to 55dB(A) or below at the installation's boundary.
		5. Moderate stress on local public services due to immigration.	5. Use of equipment, especially critical system components, resistant to seismic events.
		6. High loss of revenue due to termination of agricultural leases and loss of timber production.	
Newport	Yes	1. Clearing of about 1,200 acres.	1. Successful wastewater contingency plan.
		2. Disposal of large quantities of solid wastes (especially difficult here because of soil workability and trafficability problems.	2. Use a multi-point diffuser to mix aqueous wastes in the Wabash River.
		3. Aesthetic impact of 300-500' steam plant exhaust stack.	3. Bring TNT aqueous effluents into NPDES compliance.
		4. Moderate loss of revenue due to termination of agricultural leases and loss of timber production.	4. Abate TNT-related NO_2 air emissions to comply with the annual standard

1. PROJECT DESCRIPTION.

a. Purpose of the Action.

This proposed action consists of constructing and operating a large chemical/industrial complex to manufacture the explosives RDX (Research Department Explosive) and HMX (High Melting Explosive). The plant will be a government-owned, contractor-operated facility.

b. Description of the Action.

(1) Name of the Action.

The proposed action considered in this Environmental Impact Statement is the "RDX/HMX Expansion Facility."

(2) Rationale.

Explosives for all of the Armed Services are produced by the US Army, and products of RDX/HMX are used in various munitions. Currently, the only ammunition plant in the United States capable of producing RDX/HMX is the Holston Army Ammunition Plant (HAAP) in Kingsport, Tennessee. There are no major producers of RDX/HMX-based explosives in private industry, and planners do not anticipate that such a capability will be developed in the future.

The Holston plant was built on an emergency basis during World War II, and has been operated beyond its life expectancy and design capabilities. It has had difficulties recently in complying with increasingly stringent regulations for pollution abatement. In the event of a war, the current production facilities at HAAP could not meet mobilization requirements for RDX/HMX products. Also, in the event of a milita. attack, sabotage, or serious accident at HAAP, the total US production capability for RDX/HMX products would be immobilized.

(3) Products.[1]

The major product will be an explosive called Composition B or "Comp B" which comprises 60 percent RDX (cyclonyte), 39 percent TNT (trinitrotoluene), and 1 percent wax; of these components, only RDX will be manufactured at the proposed facility. The chemical formulas of RDX and TNT along with a detailed description of production processes are contained in Appendix A.

Composition B is used extensively as an explosive in shells and bombs, and has improved qualities with respect to its original components. For example, it is more easily exploded than TNT, but is less sensitive than RDX (the wax has a desensitizing effect). Comp B has a high chemical and physical stability, e.g., the cast explosive can be drilled without undue hazard. Also, it is relatively resistant to impact and is not exploded easily by heat or shock (it is detonated in the field by the shock of a primary explosive such as tetryl or Comp A5. Other RDX blends that could be produced at the proposed facility include PBX N-6 (95 percent RDX, and 5 percent elastomer), and Composition C-4 (91 percent RDX, 5 percent plasticizer, 2 percent polyisobutylene, and 2 percent process oil); see Appendix A for details.

The second major explosive compound to be manufactured at the proposed facility will be 75/25 Octol (75 percent HMX, 25 percent TNT), a special product which takes advantage of the slightly higher stability and lower sensitivity of HMX (see Appendix A for details).

(4) Chemical Processes, Material and Other Requirements, and Associated Pollutants.[1]

The six major components of the proposed complex will be: explosives manufacturing lines (two lines to be constructed initially with the capacity to expand to four if necessary); feedstock production/preparation; steam production; process support; non-process support; and materials receipt, storage, and shipment. The interaction of these components is shown in Figure 1, and a conceptual site layout is depicted in Figure 2 (actual configuration of the facility will, of course, depend on the site selected).

Proposed product mix per line per month will be as follows:

Line No. 1 - 4,500,000 pounds of RDX used to produce 7,500,000 pounds of Composition B.

Line No. 2 - Any of three options:

- 4,500,000 pounds of RDX used to produce 7,500,000 pounds of Composition B.
- 682,500 pounds of RDX used to produce 750,000 pounds of Composition C-4, plus 475,000 pounds of RDX used to produce

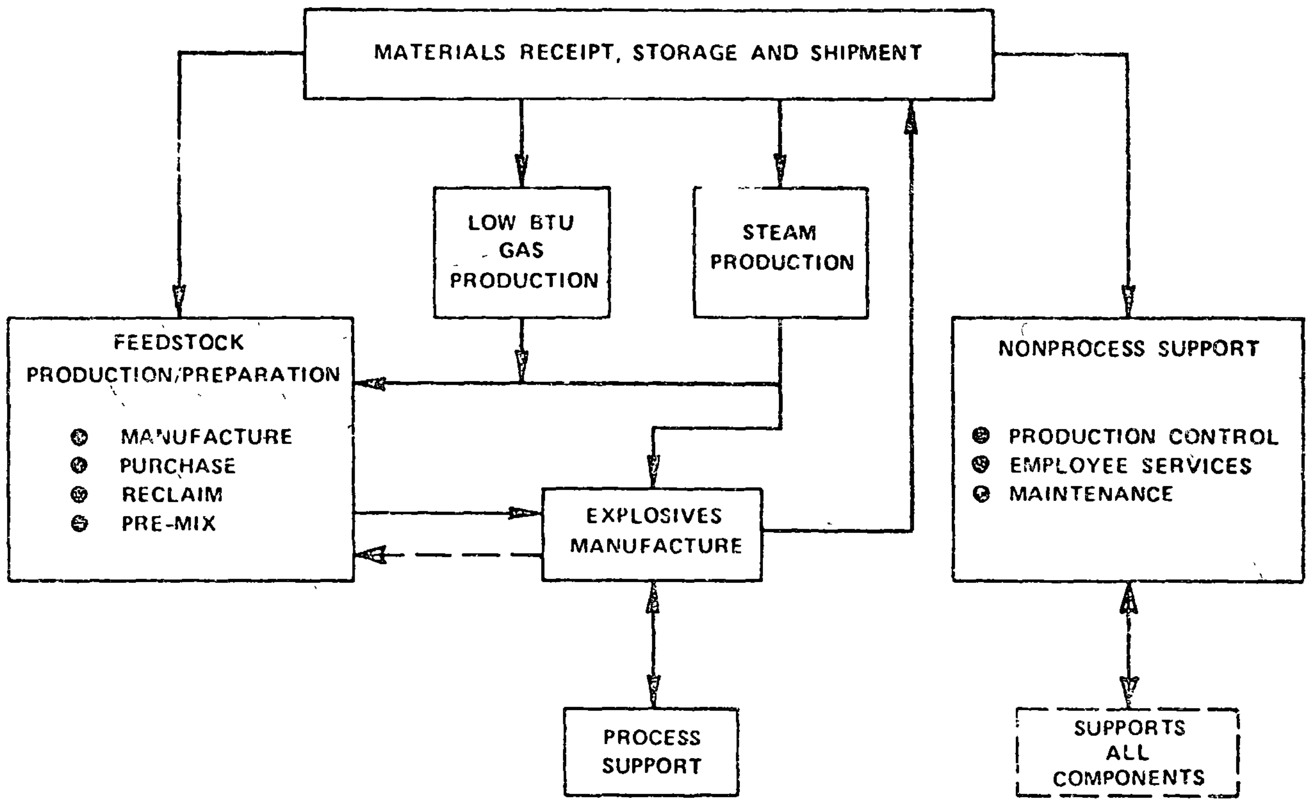
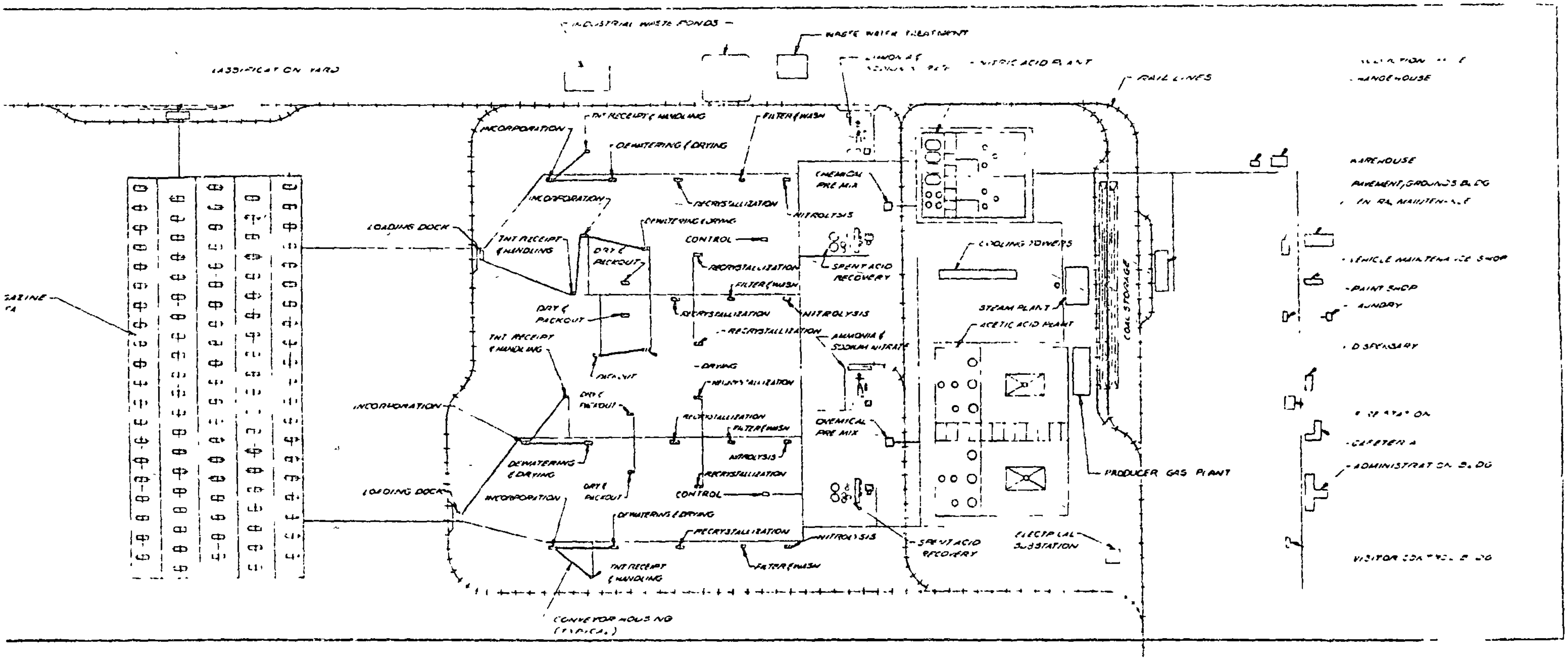


Figure 1. SCHEMATIC REPRESENTATION OF MAJOR COMPONENTS: RDX/HMX PRODUCTION FACILITY



A HYPOTHETICAL SITE LAYOUT
NOT TO SCALE

Figure 2 CONCEPTUAL SITE LAYOUT
RDX/HMX PRODUCTION FACILITY

500,000 pounds of PBX N-6, with the balance of RDX used to produce Composition B.

- 500,000 pounds of HMX used to produce 667,000 pounds of 75/25 Octol.

Therefore, the maximum output will occur when both lines are producing RDX.

(a) Unit Operations.

Each explosive manufacturing line will consist of a series of sequential operations from the synthesis of RDX or HMX to packaging of the product. A system overview of the production process is shown in Figure 3. A detailed description of the chemical reactions occurring and the unit operations involved is provided in Appendix A. The manufacturing sequence will occur through the following processes, with each process housed in a separate building (production figures are for two lines):

<u>1</u> Nitrolysis.

This is the synthesis of RDX and HMX by reaction of hexamine (dissolved in acetic acid) with ammonium nitrate (dissolved in nitric acid) and acetic anhydride.

<u>2</u> Filtration and Washing.

The products which formed in the solid state will be separated from the reaction medium and washed with water.

<u>3</u> Recrystallization.

Products will be purified by dissolving in the solvent cyclohexanone or acetone, then reprecipitated out of solution.

<u>4</u> Dewatering and Drying.

Water present will be removed by filtration, and the products will be dried with hot air.

<u>5</u> Incorporation and Packaging.

RDX and HMX will then be blended with other components, and the final explosives will be casted, packaged, and palletized.

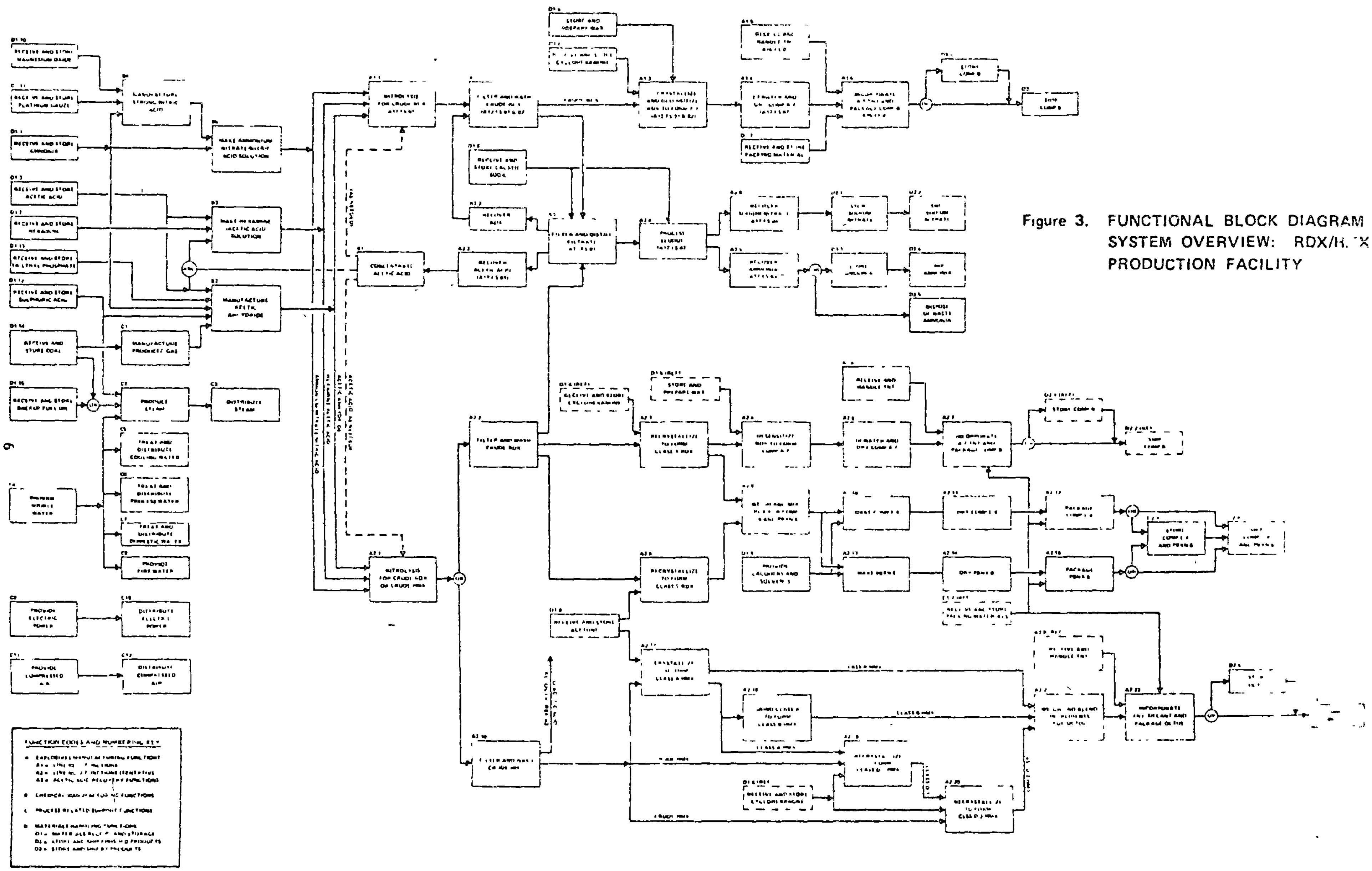


Figure 3. FUNCTIONAL BLOCK DIAGRAM SYSTEM OVERVIEW: RDX/HMX PRODUCTION FACILITY

6 Recovery of Acetic Acid and Chemical By-Products.

Acetic acid is used both as a solvent and as a raw material (see the paragraph below on the synthesis of acetic anhydride). Spent acetic acid will be recovered through a series of chemical and physical processes and then recycled. Simultaneously, two marketable by-products, sodium nitrate (1,125,000 pounds per month) and ammonia (125,250 pounds per month), will also be recovered.

7 Manufacture of Acetic Anhydride.

Acetic anhydride, one of the reagents required for the synthesis of RDX and HMX, will be manufactured on the site at a rate of 340 tons per day. At this time, the manufacturing process has not been selected. A candidate process (described in Appendix A) will use acetic acid as a starting material and will require heating to high temperatures in a furnace. The furnace will be heated partly with No. 2 fuel oil which would supply 68 percent of the energy (5,669 gallons per day required); a combustible gas obtained as a by-product of the reaction itself would supply the remainder of the energy required.

8 Manufacture of Nitric Acid.

Strong nitric acid, one of the reagents required for the synthesis of RDX and HMX, will be manufactured on site at a rate of 179.5 tons per day of 100 percent acid. One of the basic reagents, ammonium nitrate, will also be prepared on site by mixing ammonia with the nitric acid. A final process for manufacturing nitric acid has not been selected at this time. A candidate process (explained in Appendix A) would produce strong nitric acid directly from the stepwise oxidation of ammonia. This process would require 30.6 tons per day of oxygen, which would be procured.

(b) Utilities.

The requirements for utilities at the proposed facility include water supply, electricity, steam generation, and compressed air.

1 Water Supply.

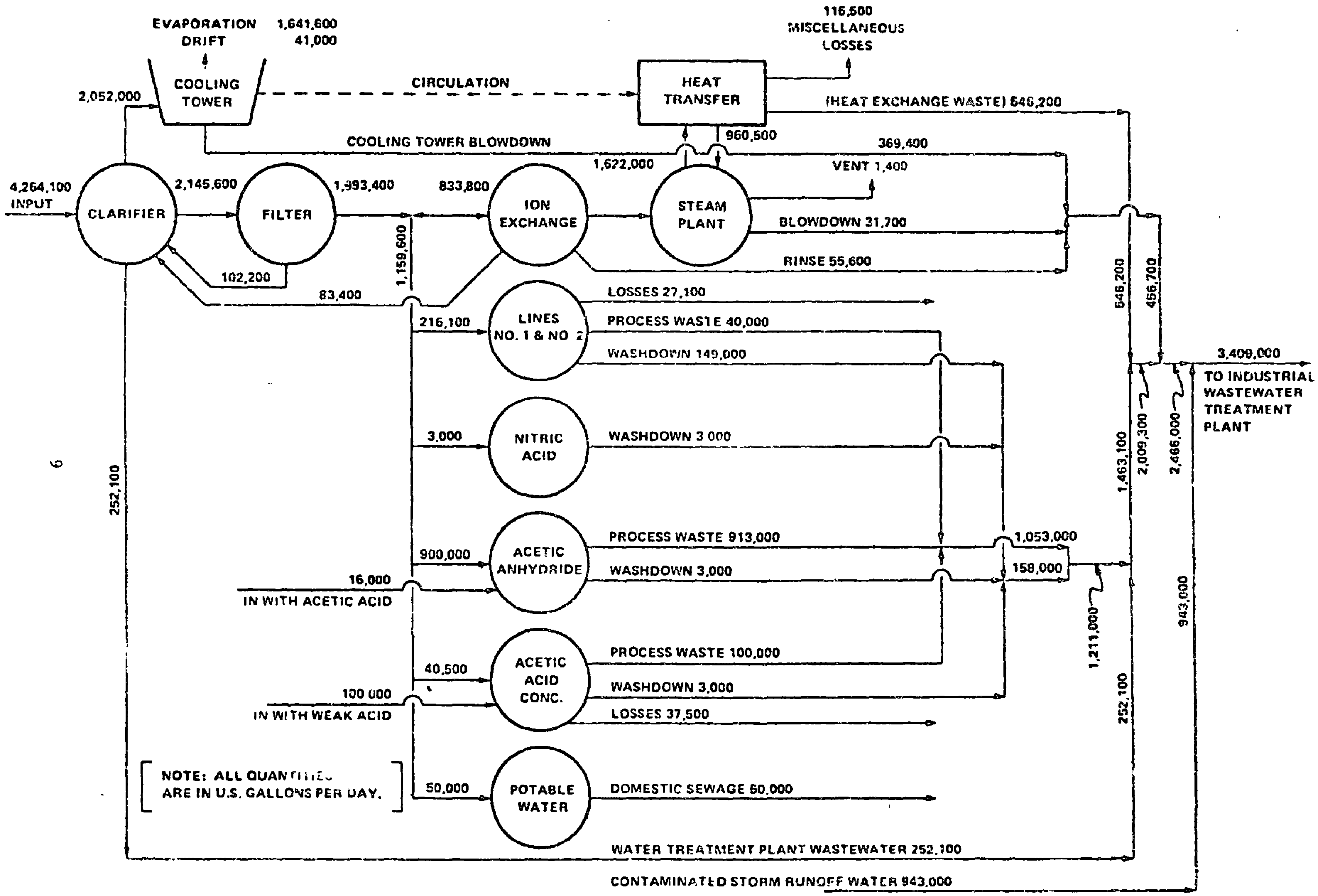
When two manufacturing lines are operating, an estimated 4,264,100 gallons of water per day would be needed. A 100 percent contingency factor was established for the estimated process water requirements for site selection criteria purposes to insure sufficient water would be available. The proposed action is to build two explosive lines expandable to four. Thus, the total process water requirement used as a site selection parameter for the explosive complex was 18 MGD. Treatment of incoming water and its utilization in the proposed facility are depicted in the water balance diagram in Figure 4. After removal of suspended solids in a clarifier, about half of the water input will be used as cooling-water makeup to compensate for water losses in the cooling tower because of evaporation and drift (airborne spray). The remainder of the water will be filtered through sand; part will then be directed without further treatment to the various process units, part will be demineralized via ion exchange and used as feedwater for the boilers in the steam generating plant, and part will be chlorinated and used as potable water.

Extensive study has been given to determining water requirements for the proposed facility.[1, 12] Since the RDX/HMX plant is not scheduled to operate until the end of 1983 or possibly 1984, it is necessary to consider both Best Practicable Control Technology Currently Available (BPCTCA) and Best Available Technology Economically Achievable (BATEA). The current guideline for BPCTCA is 0.5 mg/l for nitrobodies; this level will be achieved in the proposed facility by the wastewater treatment system. Current toxicity studies indicate that a new guideline of 0.05 mg/l maximum of TNT will probably be established. Technologically, this maximum value of 0.05 mg/l is achievable by an adsorption system using activated carbon or a particular ion exchange resin. However, dilution may be allowable as an option if the 0.05 mg/l threshhold exceeds BATEA, especially with regard to cost effectiveness. Thus, site criteria have been established to provide up to 20 mgd of water (for four lines) to reduce TNT and other nitrobody concentrations in the event the more stringent nitrobody requirements are legally applicable when the plant becomes operational. The total water requirement for the RDX/HMX expansion facility is thus 38 MGD.

2 Electricity.

Based on 720 hours of operation per month and a 0.7 load factor, the maximum energy consumptions per month (kwh) in operating two or four RDX/HMX production lines (excluding existing loads) are estimated at (see paragraph 1b(5) for a description of the three candidate sites):

	McAlester	Milan	Newport
Two-line Consumption	5,836,000	5,967,000	4,910,000
Four-line Consumption	11,632,000	11,411,000	10,352,000



Water Balance

These estimates, taken from site data brochures dated 1 December 1976 prepared by the Army Corps of Engineers (Huntsville, Alabama), include onsite raw-water pumping requirements at each site plus offsite pumping requirements at McAlester.

Estimates of peak load demands (in MW, excluding existing onsite loads) are as follows:

	McAlester	Milan	Newport
Two-line Peak Load Demand	11.58	11.84	9.74
Four-line Peak Load Demand	23.08	22.44	20.54

Detailed itemizations of estimates of maximum energy consumption and peak load demand at each site are contained in Volume 3 of this Final EIS in comments by the US Army Engineer Division, Huntsville, Alabama.

Power will be stepped down from an incoming high-voltage transmission line to 13,800 V at the central substation of the proposed facility. Electrical current will be carried by overhead distribution lines from this central substation to transformers located in various substations that will supply individual buildings or facilities. Service to any building or facility classified as hazardous will be routed underground.

Some components (such as the nitrolysis building) will house processes where continuous operation would be essential for safety reasons. Therefore, these buildings will be supplied with sources of emergency power (provided by 30 kw generators driven by 50 to 75 hp diesel engines located in each building) to maintain agitators, instruments, and other critical equipment in the event of a power outage.

3 Steam.

The estimated total steam requirements of the proposed facility with two manufacturing lines operating at full capacity is 475,000 pounds per hour. These requirements should decrease by 10 to 12 percent during summer months when no space heating would be needed. Three steam boilers (two on-line and one standby) will be provided, each capable of generating 250,000 pounds of steam per hour at 475 psig and 750°F.

Low-sulfur coal (12,500 btu/lb, 10 percent or less ash, and 542 tons per day required) will be used to fire the boilers. If low-sulfur coal is not available, a sulfur dioxide scrubber will be used. The boilers will be capable of conversion to firing with low-sulfur No. 6 fuel oil.

Coal handling and storage facilities include a long-term dead storage facility with a 120-day capacity at maximum demand, a live storage silo for service to the boilers with a 16-day capacity at maximum demand, and individual coal hoppers for each boiler.

The steam plant will be provided with an electrostatic precipitator to control particulates (fly ash), and a stack for dispersion of effluent gases. Although no decision has been made on the effluent stack, the following parameters are typical of a steam generating plant of this size (and have been used later in this document to evaluate potential impacts on air quality):

Stack Height	300 to 500 feet
Stack Diameter	10 feet
Flue Gas Velocity	100 feet per second
Flue Gas Temperature	500^{o}F

Major subsystems which are planned for the steam plant are shown in Figure 5.

4 Compressed Air.

Compressed air will be produced in a central plant by compressors driven by electric motors. The quantity of compressed air needed has not yet been determined. Noise levels incident to the operation of this plant will comply with OSHA and EPA standards, and are expected to be attenuated to acceptable levels.

(c) Transportation, Storage, and Requirements for Raw Materials.

Many materials, both solid and liquid, will be transported to the proposed RDX/HMX expansion facility. Also, end-products and by-products will be stored and shipped from the site. Thirty-day storage requirements have been specified for the raw materials and the utility materials at the plant, and for the products manufactured. The sole exceptions are coal (120 days) and sodium nitrate (180 days).

The amounts required to satisfy storage requirements, the form purchased, the delivery mode, the delivery quantity, the means of transportation, the days supply for delivery, and the type of storage required are listed in Table 1 for raw materials (used in the manufacturing process) and in Table 2 for utility materials (used for process support).

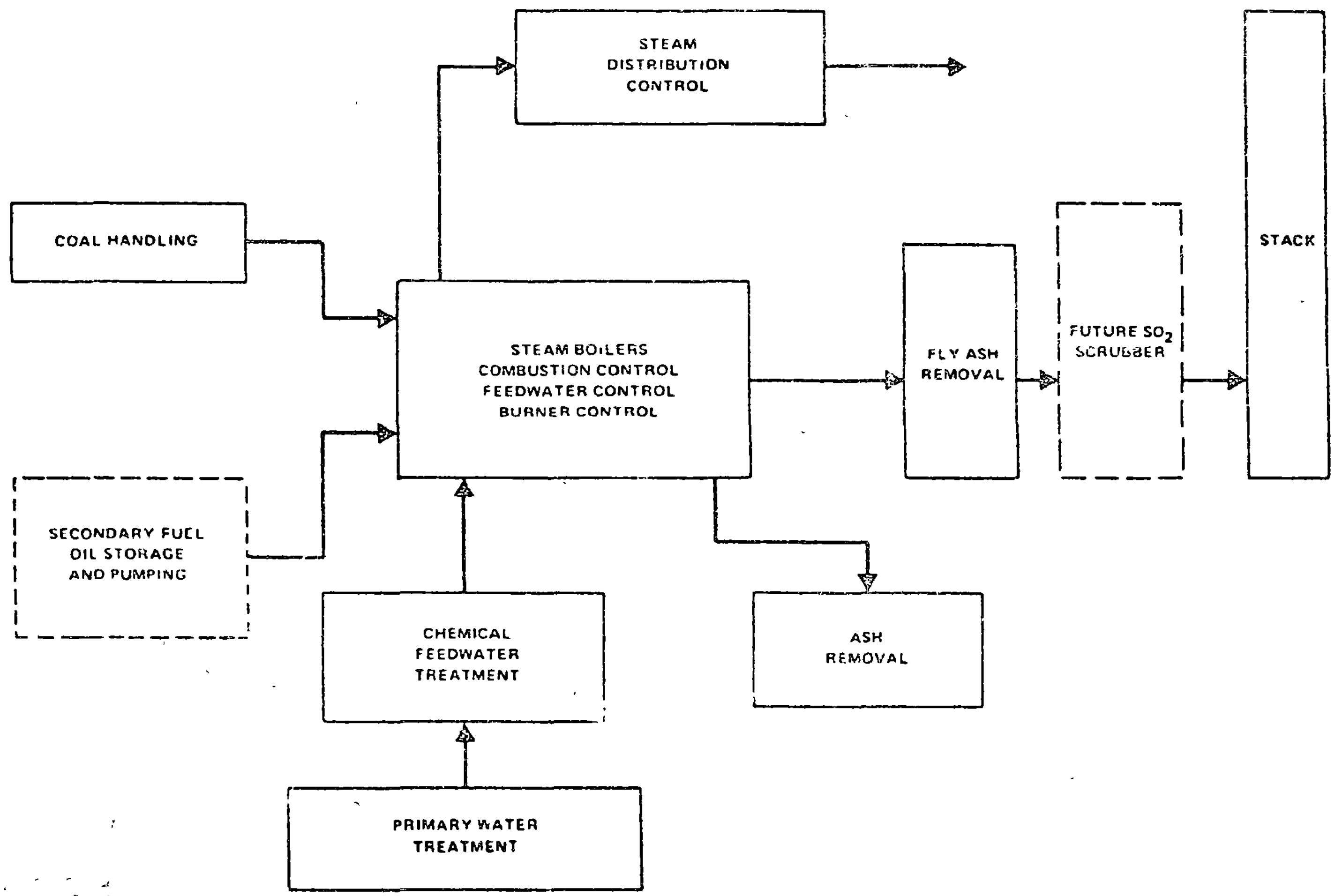


Figure 5. BLOCK DIAGRAM OF MAJOR STEAM PLANT SUBSYSTEMS

Maximum end-product storage coincides with the monthly production outputs detailed above. Rail cars used to ship finished products will be loaded with 81,600 pounds per rail car. The number of rail cars required per month, assuming full production from two lines and no shipments by truck, would be 184. Truck trailers used to ship finished products would be loaded with 43,200 pounds each. If no shipments were made by rail, the total number of trucks required per month for full production would be 347.

A special class of materials includes the raw materials and products required for the construction of the RDX/HMX facility. A preliminary estimate of these materials is presented in Table 3. The estimate does not include materials for construction activities accomplished outside the facility such as may be required for electric power or water supply lines.

(d) Disposal of Waste Products and Potential Pollutants Generated.

1 Wastewaters.

Operation of the proposed RDX/HMX facility will generate a large quantity of wastewater. A detailed description of the composition of wastewater streams, the process treatment units, and the treatment alternatives is contained in Appendix B.

Different types of wastewaters will be generated by various production and process support units. Major streams and sources can be summarized as follows:

- Process wastewater from the explosive manufacturing lines, the acetic acid concentration plant, and the acetic anhydride plant.

- Process washdown water from the same units mentioned above and from the nitric acid plant.

- Heat-exchange wastewater which will consist of condensates from heat-exchange systems.

- Blowdown water, i.e., part of the water circulating in the cooling tower and the boiler systems which is removed to avoid an over-concentration of chemicals in the system.

Table 1. REQUIREMENTS FOR DELIVERY AND STORAGE OF PROCESS-RELATED MATERIALS FOR TWO RDX/HMX PRODUCTION LINES

Raw Material	30-day Storage Requirement	Form of Purchase	Number of Units/ Pallet	Number of Skids or Pallets Required for Storage	Delivery Mode	Delivery Quantity per Vehicle	Rail Cars or Trucks Required/ Month	Days Supply per Delivery	Number of Skids Pallets/ Delivery	Total Skid or Pallet Storage Required	Type of Storage Required
Acetic acid	925,800 lb	Bulk			Rail or tank car	178,000 lb	5.2	6			Tank farm
Acetone	36,838 lb	Bulk			Road or tank truck	40,000 lb	0.9	33			Tank farm
Ammonia	4,363,520 lb	Bulk			Rail or tank car	52,000 lb	83 9	0.4			Tank farm
Caustic soda	2,613,520 lb	Bulk			Rail or tank car	128,000 lb	20.4	1			Tank farm
Copolymer	25,545 lb	50- to 55-lb cartons	54	10	Road or truck	30,000 lb	0.9	33	11	21	Warehouse
Cyclohexanone	96,231 lb	Bulk			Rail or tank car	160,000 lb	0.6	50			Tank farm
Dioctyl adipate	41,952 lb	Bulk			Road or tank truck	40,000 lb	1.0	30			Tank farm
Gelatine	145 lb	240- to 320-lb drums	4	1	Road or truck	1,500 lb	0.1	300	1	2	Warehouse
Hexamine	3,403,920 lb	50-lb bags	66	1,037	Rail or boxcar	85,800 lb	39.7	0.7	26	1,058	Hex. Fac
Isobutyl acetate	25,680 lb	390-lb drums	4	17	Road or truck	23,400 lb	1.1	27	15	32	Warehouse
Magnesium oxide	8,800 lb	100-lb bags	11	8	Rail or boxcar	65,000 lb	0.1	300	59	67	Warehouse
Motor oil	11,581 lb	400-lb drums	4	8	Road or truck	24,000 lb	0.5	60	15	23	Warehouse
n-Propyl acetate	75,000 lb	Bulk			Road or tank truck	40,000 lb	1.9	15			Tank farm
Platinum gauze	37.2 troy oz	Rolls	1		Air and truck	As ordered	0.2	120			Vault
Polyisobutylene	17,506 lb	75-lb bales	30	8	Road or truck	37,000 lb	0.5	60	14	21	Warehouse
Polyvinyl alcohol	670 lb	50-lb bags	20	1	Road or truck	1,000 lb	0 7	42	1	2	Warehouse
Sulfuric acid	95,702 lb	Bulk			Rail or tank car	180,000 lb	0 5	56			Tank farm
Toluene	8,732 lb	Bulk			Road or tank truck	40,000 lb	0.2	137			Tank farm
Triethyl phosphate	44,420 lb	Bulk			Rail or tank car	140,000 lb	0.3	95			Tank farm
TNT	5,789,620 lb	55-lb cartons	45	2,340	Rail or boxcar	118 000 lb	49 1	0.6	48	2,388	Magazine
		55-lb cartons	45		Road	34 000 lb	170 [illegible]	0 2	14		Magazine
Wax, desensitizing	133,680 lb	Bulk			Road or tank truck	40,000 lb	3 3	9			Tank farm
		2 [illegible] lb pallets	1	67	Rail or boxcar	[illegible],000 lb	1 2	25	56	[illegible]23	Warehouse
1-in pressure sensitive tape	291,666 ft	[illegible] carton	16		Road or truck	188 80[illegible]	0 8	3[illegible]	[illegible]	[illegible]	Warehouse
1 in Permacel tape	15,626 ft	6,480 ft/carton	36	[illegible]	Road or truck	19,440 ft	0.8	37	1	[illegible]	Warehouse
No. 4 fiber carton	250,000 ea	480/pallet	480	521	Rail or boxcar	[illegible],120 ea	11 8	[illegible]	44	565	Warehouse
No 4 plain liners	250,000 ea	3,000/pallet	3,000	84	Road or boxcar	180,000 ea	1.4	21	60	144	Warehouse
No 4 polycoated liners	10,000 ea	3,000 pallet	3 000	4	Road or truck	90 000 ea	0 1	300	30	34	Warehouse

Table 2. REQUIREMENTS FOR DELIVERY AND STORAGE OF UTILITY RAW MATERIALS FOR TWO RDX/HMX PRODUCTION LINES

Utility Material	30-day Storage Requirement	Form of Purchase	Number of Units/ Pallet	Number of Skids or Pallets Required For Storage	Delivery Mode	Delivery Quantity	Rail Cars or Trucks Required/ Month	Days Supply per Delivery	Number of Skids or Pallets/ Delivery	Total Skid or Pallet Storage Required	Type of Storage Required
Alum, liquid	237,500 lb	Bulk			Rail or tank car	110,000 lb	2.2	14			Tank farm
Aluminium sulfate	12,500 lb	100-lb bags	25	5	Road or truck	25,000 lb	0.5	60	10	15	Warehouse
Calgon	5 000 lb	25-lb bags	40	5	Road or truck	3,000 lb	1.7	17	3	8	Warehouse
Chlorine, bulk	20,000 lb	Bulk			Rail or tank car	110,000 lb	0.2	165			Tank farm
Chlorine, cylinder	650 lb	150-lb cylinder			Road or truck	9 cyl	0.5	62			Chlorine shed
Coal	15,000 tons[a]	Bulk			Rail or coal hopper	100 tons	150.0	0.2			Coal yard
Disodium phosphate	1,000 lb	50-lb bags	48	1	Road or truck	2,400 lb	0.4	75	1	2	Warehouse
Fuel, diesel	900 gal	Bulk			Road or tank truck	2,500 gal	0.4	83			Tank
Fuel, gasoline	1,000 gal	Bulk			Road or tank truck	2,500 gal	0.4	75			Tank
Fuel oil, No. 1	500 gal	Bulk			Road or tank truck	2,500 gal	0.2	150			Tank
Fuel oil, No. 2	254,000 gal	Bulk			Rail or tank car	20,000 gal	12.7	2			Tank
Lime, hydrated	4,500 lb	50-lb bags	36	3	Road or truck	5,400 lb	0.8	37	3	6	Warehouse
Lime quick	27,500 lb	Bulk			Road or truck	45,000 lb	0.6	49			Silo
Rock salt, bag	4,500 lb	100-lb bags	30	2	Road or truck	3,000 lb	1.5	20	1	3	Warehouse
Rock salt bulk	82,500 lb	Bulk			Road or truck	45,000 lb	1.8	16			Brine tank
Sodium sulfate	1,000 lb	100-lb bags	30	1	Road or truck	3 000 lb	0.3	100	1	2	Warehouse
Sulfuric acid	93,900 lb[b]										

[a]Estimated for the steam plant using 12,500 Btu coal.
[b]This quantity of sulfuric acid is included among the raw materials in Table 1 and further information will not be repeated in this table

TABLE 3

Estimates of Requirements for Construction Materials to Build a Two-Line RDX/HMX Production Facility

Item	Units	Production Line	Other	Total
Concrete	Cubic Yards	42,700	11,300	54,000
Reinforcing Steel	Tons	5,800	1,000	6,800
Structural Steel	Tons	450	2,650	3,100
Steel Sheet	Tons	20	1,600	1,620
Steel Rail	Tons	0	250	250
Masonry Materials	Tons	20	3,200	3,220
Piping:				
Ferrous	Lineal Ft/Ton	142,250/409	140,000/770	282,250/1,179
Non-Ferrous	Lineal Feet	42,000	40,000	82,000
Asphalt Paving	Tons	1,250	1,250	2,500
Aggregate Materials	Tons	2,400	9,200	11,600
Electrical Conductor	Lineal Feet	10,000	10,000	20,000

- Ion exchange rinse water.
- Water treatment plant wastewater.
- Contaminated runoff, i.e., rainwater flowing over contaminated areas.
- Domestic sewage.

These sources and their estimated flows were shown in Figure 4 in diagram form.

Industrial wastewaters will contain a variety of contaminants originating from different chemicals used in manufacturing explosives. However, blowdown water and ion exchange rinse water will be the least contaminated, the former by anti-corrosion compounds and the latter by mineral salts. Domestic sewage lines will not be combined with industrial effluents, and will be treated in a separate sewage treatment plant.

Decontaminating the industrial effluents (to remove or convert the contaminants to less harmful compounds in order to achieve environmental compatibility) will occur through a series of treatment units shown in Figure 6 (their function and operation are described in Appendix B). This system is contingent upon final design and is presented as a feasible approach to achieve the required effluent quality.

The reduction in contaminants anticipated using this pollution abatement scheme is shown in Table 4 (NOTE: The 0.02 level for nitrobodies is predicated on the use of a "polishing" step after the sand filter using an adsorbent (activated carbon or an ion exchange resin). However, as more fully described in 1b(4)(b)1, above, an alternative option of dilution is also being considered.

In addition to the contaminants shown in Table 4, heavy metals are also of concern; these can originate in the process from metal catalysts and from corrosion. Metal catalysts might be employed in the manufacturing processes for acetic anhydride and nitric acid; however, exact compositions cannot be stated because final processes have not been selected. But metals are adsorbed by organic sludges, and the wastewater treatment system suggested might be adequate for removing excessive amounts of heavy metals. Other modifications such as the addition of lime to precipitate heavy metal hydroxides would improve the effectiveness of the treatment if required.

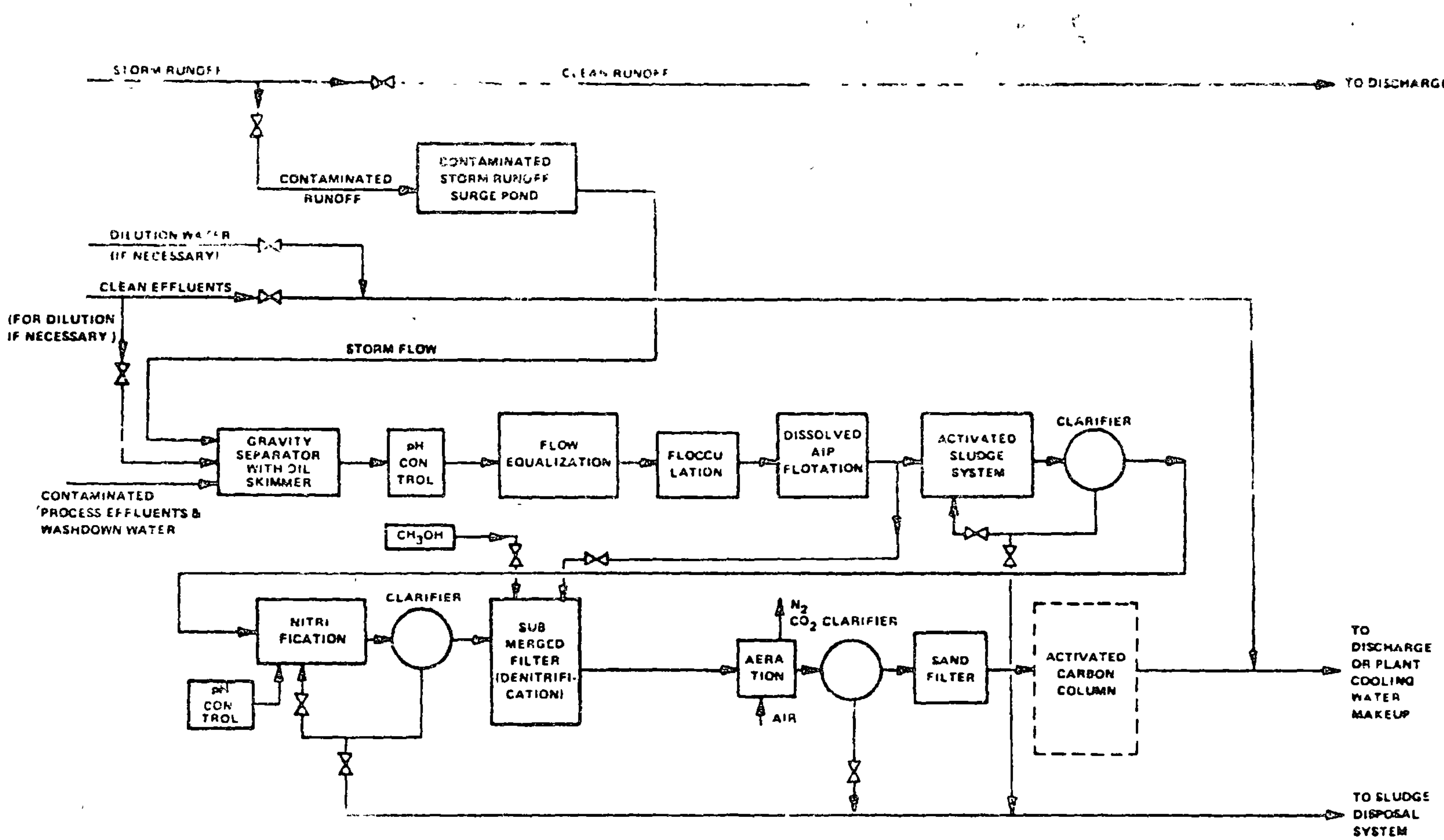


Figure 6. PRELIMINARY CONCEPT: INDUSTRIAL WASTEWATER TREATMENT SYSTEM

2 Air Pollutants.

Major sources of air pollutants at the proposed RDX/HMX facility would be the steam generating plant, the acetic anhydride furnace, the nitric acid plant, and waste incinerators. Vehicular emissions would represent a minor but quantifiable source. The potential impact of these and other sources are discussed in detail in the section entitled "Impacts on Air Quality."

a Steam Generating Plant.

The coal-fired steam generating plant would be the major contributor of air pollutants. Its heat input of 565 million (MM) btu per hour classifies it as a "major source," subject to both federal and state standards. Before discharge, emissions would be improved by use of an electrostatic precipitator for particulate control, tangential burners and possibly other combustion-modification techniques for nitrogen oxides, and low-sulfur coal for controlling sulfur oxides. Estimates of anticipated emissions are shown in Table 5.

The amount of sulfur dioxide shown on Table 5 was calculated from the combustion of a 12,500 btu/lb coal containing 0.78 percent sulfur assuming that 5 percent of the sulfur dioxide generated is absorbed by the ash.[2] Any coal of significantly higher (greater than 1%) sulfur content or of lower heat input at the same sulfur levels would require control systems for sulfur dioxide.

b Acetic Anhydride Furnace.

This is the second major combustion source of air pollutants. Sixty-eight percent of its heat requirements (36 MM btu/hour) will be satisfied by use of No. 2 fuel oil, and 32 percent (17 MM btu/hour) by use of the combustible off-gas generated as a by-product of the synthetic reaction (see Appendix A).

The fuel oil mentioned is rated at 152,000 btu/gallon, and typical specifications mention a density of 33° API (7.16 lb/gal), a sulfur content of 0.2 percent, and a maximum ash content of 0.01 percent. Quantities of pollutants anticipated are shown on Table 5; nitrogen oxide emissions were calculated according to Danielson.[3]

c Nitric Acid Plant.

The candidate process mentioned for nitric acid manufacture produces strong nitric acid directly, and federal and state air quality standards might not apply. For example,

TABLE 4

Components of the Influent and Effluent of the RDX/HMX Wastewater Treatment Plant (Two Production Lines)

Water Quality Parameter*	Influent Lbs./Day	Influent mg/l	Effluent** Lbs./Day	Effluent** mg/l
COD	4,851	253	18.2	0.95
BOD_5	3,329	173	3.9	0.20
Total Suspended Solids	2,113	110	2.0	0.11
Oil and Grease	72	4	nil	nil
Total Nitrogen	651	34	20.0	1.05
Ammonia (as nitrogen)	38	2	nil	nil
Nitrates-Nitrites (as nitrogen)	247	13	19.0	0.99
Phosphates	66	3	10.7	0.77
Nitrobodies (RDX + HMX + TNT)	93	5	0.5	0.02

*Also pH of 6.0 to 9.0 (satisfied).

**Worst case with volume of contaminated storm runoff of 943,000 gallons as shown on Figure 4.

TABLE 5

Sources and Emissions of Air Pollutants (Pounds per Day) from the Proposed RDX/HMX Facility with Two Lines Operating, Both Producing RDX*

Source	Particulates	Nitrogen Oxides (as NO_2)	Sulfur Dioxide
Steam Generating Plant	1,355	9,485	16,064
Acetic Anhydride Furnace	4	240	162
Nitric Acid Plant	--	538	--
Multiple-Chamber Contaminated Waste Incinerator	7	--	--
Fluidized-Bed Explosive Waste Incinerator**	--	--	--

*Additional detailed data on emissions are contained in the section of this EIS entitled "Impacts on Air Quality," an approximation of four-line emissions can be obtained by doubling the figures in the table.

**Data not available; see text.

federal and Tennessee standards mention "weak ac. ...ts" only, and the definition in the Oklahoma standard includes nitric acid plants where a strong acid is obtained indirectly. Indiana has no state nitric acid standard; thus, Indiana relies upon the federal nitric standards. These circumstances are discussed in more detail in the section entitled "Impacts on Air Quality." Potential NO_2 emissions from the plant are shown in Table 5.

d Waste Incinerators.

A multiple-chamber incinerator has been suggested for disposing of non-explosive contaminated waste and contaminated sludge. Particulate control systems are available to reduce particulate emissions, and use of excess air should reduce carbon monoxide emissions to negligible levels. Also, only small amounts of nitrogen oxides are expected at the moderate combustion temperature anticipated.

Use of a fluidized-bed incinerator has also been proposed for the thermal oxidation of explosive wastes. This is a new technique for which no previous experimental data are available, thus emission levels cannot be estimated. See the section on solid waste impacts later in this document for more discussion.

e Vehicle Emissions and Other Sources.

A reasonable estimate is that approximately fourteen tractor-trailers, one train, and 700 to 800 automobiles will enter and leave the proposed facility on an average working day to transport supplies, products, and workers (see Tables 1 and 2, and the section on transportation impacts). Methods of quantifying emissions as provided by EPA[4] could be used to quantify potential air pollutants, but factors in these computations are expressed in grams per mile and a definition of the area affected is required. The size of this hypothetical area varies with site-specific meteorological factors and distance traveled by the vehicles; a detailed discussion of assumptions used in predicting emissions due to these sources is presented later in "Impacts on Air Quality."

Additional potential sources of air pollutants are explosive manufacturing lines, storage tanks for volatile compounds, and fugitive dust. Controls on those hard-to-quantify emissions will be: scrubbing for the explosive manufacturing lines; vapor-recovery systems for storage tanks containing volatiles; and wetting and strict housekeeping for fugitive dust.

3 Solid Wastes.

The proposed RDX/HMX facility will require a maximum of 5,000 to 6,000 acres of land, but only about 20 percent of this area will be cleared, grubbed, and graded (the remainder of the tract will be utilized in buffer or safety zones). Solid wastes during construction will be generated in the form of cleared vegetation plus rubble such as bricks, concrete, metals, plastics, wood, and scrap. Other debris will be generated as a result of asphalt or concrete production and placement, building temporary roads, and constructing the components of the facility. The quantity of these wastes is difficult to estimate. For example, the amount of cleared vegetation will depend on the site selected for construction. Decisions on various design options being considered now would also influence quantities of solid wastes. Amounts could vary because of weather factors, explicit construction contract specifications, safety constraints (e.g., building in a seismically active zone), and other considerations. However, a general estimate of the total quantity of solid wastes to be generated during construction is as follows:

Concrete waste products	3,000 cubic yards
Waste masonry material	160 cubic yards
Asphalt paving	110 cubic yards
Aggregate material	70 cubic yards

All of the above quantities would be anticipated at any of the sites. Waste materials from clearing and grubbing will be site-specific depending on the quantity of vegetation to be removed; estimates are as follows:

McAlester NAD	160,000 cubic yards
Milan AAP	300,000 cubic yards
Newport AAP	60,000 cubic yards

The maximum amount of municipal-type solid wastes anticipated during construction is about 5,600 pounds per day assuming 4.5 pounds per capita per day[5] multiplied by a maximum labor force of 1,250 workers in the third construction year (see Table 7).

Types and quantities of solid wastes associated with normal operation and maintenance of the proposed RDX/HMX facility were provided by personnel from the architectural engineering firm designing the plant based on what they believed were reasonable quantities to be expected from the new facility. These are summarized in Table 6.

Small amounts of waste explosives will probably accumulate during processing operations; these will be collected and placed in containers for daily disposal. Larger quantities will also be generated during cleanout operations, and would be removed immediately from the site for disposal.

Contaminated wastes include those materials that have come into contact with explosives or other chemicals, e.g., soiled explosives boxes or box liners, dunnage packing materials, clothing, chemical bags, and demolition waste. Non-combustible contaminated wastes include pieces of machinery and process equipment that would have to be "burned out" for decontamination prior to disposal or recovery.

Inert (non-explosive) wastes would include office and cafeteria refuse, uncontaminated wood and paper packing materials, glass, shop wastes, and others generally from non-process areas.

(5) Candidate Sites.

The proposed RDX/HMX production facility will be constructed at one of three candidate sites: McAlester Naval Ammunition Depot (MNAD) located in Pittsburg County in southeastern Oklahoma; Milan Army Ammunition Plant (MAAP) located in Gibson and Carroll Counties in west-central Tennessee; or Newport Army Ammunition Plant (NAAP) located in Vermillion County in west-central Indiana. The rationale for selecting these three prospective sites is summarized in section 4a ("Alternative Sites Considered") of this document.

(a) MNAD.

Pittsburg County, Oklahoma comprises about 869,000 acres in southeastern Oklahoma. The county is bounded by the South Canadian River to the north and the counties of Haskell, Latimer, Pushmataha, Atoka, Coal, and Hughes in a clockwise fashion from the northeast. The city of McAlester (the county seat) is in the center of Pittsburg County, and is located only a few miles northeast of the main entrance gate to MNAD. The McAlester Naval Ammunition Depot occupies 44,960 acres and is situated generally between State Route (SR) 31 to the north, SR 69 to the east, and the county line to the south and west. Figure 7 shows a general map of the area.

Construction plans for each of the three sites are tentative - they will be finalized when a site is selected. A proposed construction layout at MNAD is shown in Figure 8; the site is located on the east-central boundary of the installation. In order to supply industrial water to the proposed facility, a pipeline would be constructed from Lake Eufaula (about 18 miles northeast of MNAD). The proposed route of this waterline and relevant engineering dimensions are shown in Figures 9 and 10, respectively.

(b) MAAP.

This ammunition plant lies partly in Gibson County and partly in Carroll County in west-central Tennessee. Gibson County, encompassing an area of 388,480 acres, is bounded

TABLE 6

Solid Wastes Anticipated from the Proposed RDX/HMX Facility with Two Manufacturing Lines in Operation, Both Producing RDX

Type of Solid Waste	Amount Per Day (Dry Weight)
Explosive Waste	1,500 lb.
Contaminated Waste	8,000 lb.
Contaminated Sludge	2,000 lb.
Coal Ash	54 tons
Incinerator Ash	1,000 lb.
Other Non-Ash Inert Wastes	6,000 lb.
Sewage Sludge	100 lb.

CASE STUDY - MURPHY

(2)

State Planning Services
Agency

[illegible] Governor
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State of Indiana

COMMENTS ON RDX/HMX EXPANSION
FACILITY DRAFT ENVIRONMENTAL IMPACT STATEMENT
AND
STATEMENT OF SUPPORT OF THE NEWPORT, INDIANA SITE LOCATION

The State of Indiana through its State Planning Services Agency is submitting the following comprehensive review comments and statement.

Review Process

The following major State Agencies reviewed the Draft Environmental Impact Statement and their comments are included in Appendix.

- Indiana Department of Commerce
- Indiana Department of Natural Resources
- Indiana State Board of Health
- Indiana Department of Civil Defense
- Indiana State Highway Commission
- Indiana State Planning Services Agency

In addition, comments from two Regional Planning and Development Commissions covering the proposed site location are submitting comments included in Appendix.

Region IV Development Commission

Region VII - West Central Economic Development District

The comments can be summarized by the following statement:

"The proposed construction and development of the RDX/HMX facility in Newport, Indiana will not have any adverse environmental impact for the environment and the socio-economic structure of the area. It will have a positive impact on the economic structure of the area which will provide for the improvement of the quality of life, and creation of a lasting economic benefit for the local economy "

Analysis

In general, all comments on the Draft Environmental Impact Statement coming from the State and sub-state agencies are positive with respect to the location of the proposed project at the Newport, Indiana site. Some suggestions are presented relating to the development of the final Environmental Impact Statement which, it is hoped, will be useful to the Department of the Army. Also a few concerns were raised which may not have been addressed in the Draft Environmental Impact Statement to the extent which would satisfy final site location considerations but which do not present serious problems. In any event, however, no objections are offered by any party included in this review to the location of the RDX/HMX Expansion Facility at the Newport Army Ammunition Plant. In fact, there is general accord that the location would be desirable for such a facility.

The Department of Natural Resources and the State Board of Health Speak to Environmental Considerations

The Department of Natural Resources indicates that there would be no significant damages to fish, wildlife, and botanical resources at the Indiana site if the proposed plan is implemented as expected and much less than at either the Oklahoma or Tennessee sites. The Department of Natural Resources expressed some concern with the emission of salt from the cooling tower and indicates the need for monitoring possible damage. It is also noted that there is several local wood using industries available to utilize whatever wood fibe resource may be taken out during construction.

It is pointed out that recreation facilities and opportunities in the area of the Newport site is not as abundant as the Draft Environmental Impact Statement indicates and that any population migration into the area could lead to stress on the part and outdoor recreation system in the area but would not significantly impact on State recreation properties. As will be noted later in this report, however, an analysis of the Indiana candidate area reveals little or no in-migration would occur

The State Board of Health comments are from that agencies' divisions of Air Pollution Control, Water Pollution Control, and the Solid Waste Management Section, and Water Supply Section. The Air Pollution Control Division noted that NO_2 concentrations in the plant site area, as predicted by computer models, are in excess of the National Ambient Air Quality Standard, and therefore are not consistent with the Indiana Plan of Implementation, however, if the facility meets the Federal New Source Performance Standards the National Ambient Air Quality Standard could be met. The Water Pollution Control Division states that by July, 1977, under a revised waste load allocation, there should be sufficient capacity in that section of the Wabash River that would receive effluent from the existing and proposed plant to comply with the 1983 requirements of Best Available Technology. Local commercial landfill operations may be inadequate to accomodate wastes that could be generated but soil types in the Newport site area and existing engineering technology are such proper solid waste disposal arrangements could be made. Ground water is adequate to satisfy the future expansion requirements. The State Board of Health concludes that it has no objection to the proposal under review.

The State Highway Commission, the Department of Commerce, the Department of Civil Defense, and the State Planning Services Agency generally commented on matters of economic and social concern

The State Highway Commission states that the improvement of State Road 63 which serves the immediate Newport site area will provide a four lane divided highway which would connect the Newport Army Ammunition Plant with two of Indiana's interstate routes, (I-74 on the North and I-70 on the South), thus providing an adequate transportation cooridor to serve the proposed facility. With this improvement the Commission finds that the establishment of the new RDX/HMX Expansion Facility would have no adverse effect on the existing and proposed transportation facilities in the area.

The Department of Commerce comments reveals that the Newport area appears to be able to meet labor requirements called for by the proposed project and fill all anticipated jobs without significant in-migration occurring. The economic benefits which would acrue tend to counter possible economic costs - of which the negative business and investment impact probably would be minimized due to the proximity to large urban areas. Housing should provide no problem with more than enough standard vacant units to meet the need. Potential effects on other externalities in the Newport renion including education, transportation, law enforcement, fire protection and health care pose no fore-seen problems. Please refer to the attached paper developed by the Indiana Department of Commerce entitled "Economic Impact Estimates" for further information aboutthe above summarized remarks.

The Department of Civil Defense, while pointing out some things which the Final Environmental Impact Statement should address, does indicate that the proposed Indiana site location is not now located in a High Risk Area as per Defense Preparedness Agency Technical Report (TR)-82. The area could become a Category II High Risk Area along with the Indiana Army Ammunition Plant at Charleston and the Crane Naval Weapons Support Center in Martin County at such time as the proposed facility becomes operational and possibly before that date.

The State Planning Services Agency has statutory responsibility to coordinate state planning efforts. This agency is also responsible for State planning in certain areas to include land use, housing, and related concerns. This agencies' comments confirm that made by the Department of Commerce that housing is adequate to fulfill projected demands. In the area of land use concerns, there are no serious negative impacts resulting from the project location at the Newport, Indiana. Land is available and suitable for construction of the proposed facility. The area has the ability to support any increased demands due to additional employment and resultant demands on public services. From available data, it appears that the Indiana site is better suited for the proposed development than either of the alternate sites. Aesthetically, the Newport site affords natural buffer zones to shield existing residential areas. Existing and proposed transportation is adequate to meet needs and existing rail access to the Newport Army Ammunition Plant is excellent. The reader is referred to State Planning Services Agency Comments in Appendix.

The above narrative serves to summarize state agency A-95 Review comments. The comments made by the Regional Planning and Development Commissions are to be submitted separately through the State Clearinghouse but are in accord with State Agency responses and concerns raised by these Commissions are generally addressed by the various State Agency comments. The Regional Planning and Development Commission responses are included in Appendix A, however, for ease of reference.

SUPPORTING STATEMENT ON BEHALF OF THE STATE OF INDIANA

Indiana is in the heart of the midwest industrial area. This area has long provided industry with a strong labor force, food for the table and adequate shelter. However recent trends in the national economy have provided a surplus in two of these elements, labor and housing in west central Indiana. Like the rest of the nation, the area around Newport Indiana can supply a variety of labor skills for any new industry that may establish itself in the area. Construction and maintenance personnel, blue collar factory labor, clerical and transportation workers to name a few. There is a great variety that would be available for the RDX/HMX facility. This labor force has always been commuting labor force, to industrial centers such as Terre Haute, Lafayette and the other smaller communities in the area. Surveys have indicated that there is in this same area, an inordinate supply of a variety of home styles available, both for sale and rental, resulting from families who have left or are waiting to sell their homes so that they may move closer to sources of new employment.

The economy of this area will be enhanced, not only through the salaries received from the new industry, but also through the expansion of local businesses brought about by the new money in the area.

In addition there are many educational and social amenities associated with the area. There are three major universities within commuting distance of Newport at which new or long term residents may take advantage.

The draft EIS evaluates the proposed sites for the RDX/HMX Expansion facility in light of eleven Impact factors: Impacts on the fish, wildlife and vegetation; Impacts on air quality; Impacts on water quality; Noise Impacts; Solid waste Impact; Impacts on unilities; Seismic Ricks; Archaeological sites; Aesthetic Impacts; Cooling tower Impacts; and Socialeconomic Impacts.

In order to more accurately assess the benefits of locating the Expansion facility at the Newport site the statement will address the Impact factors as they affect each of the proposed sites. Following that discussion a summary will be provided that addresses the shortcomings of the Newport site and how they can be overcome.

Impacts of fish, wildlife and vegetation is stated in the summary of the Draft EIS.

Clearing, grubbing, and grading the 1,000 to 1,200 acres needed to construct the proposed facility would extirpate the ecological communities currently inhabiting the area. This impact would be most severe at Milan and least severe at Newport (here old buildings occupy most of the site). Further in the text of the Draft EIS it is acknowledged that the construction and operation activities at NAAP would not affect any legally protected terrestia (plants or animals). While at the MNAD site there was a possibility that the scarlet snake would have to be cleared from the area. At MAAP the Coppers hawk or the sharp-skinned hawk might be impacted.

II. Impacts on Air Quality

In terms of Air Quality, Milan Tennessee appears to be the most favorable site. However, at the Newport site there is only a possible violation of the annual NO_2 standard and that could be corrected with the use of abatement techniques..

I. Impacts on Water Quality

At the McAlester site, under certain conditions, up to seven miles of receiving streams could fall below the state standard for dissolved oxygen. Also violation of the Oklahoma sulfate standard would occur.

The big problem at Milan appears to be the present water supply with the existing wells providing 7 MGD and The Expansion facility requiring 38 MGD.

There appears to be no significant Impact on w... ...ity at the Newport site.

IV. Noise Impacts

The summary statement states, "The US Environmental Protection Agency has established a maximum of 55dB(A) at the plant boundary as a long term goal. Noise contours between 55 and 60 are projected to extend beyond McAlester's and Milan's boundaries if the RDX/HMX plant and existing facilities operate concurrently. Since noise levels up to 65dB(A) are acceptable for military housing, this impact is considered minimal."

Solid Wastes

"No serious solid waste disposal problems are anticipated at any of the three sites. Clearing of vegetation during construction will create the largest quanities of solid wastes at Milan, and the least at Newport. Construction wastes and inert wastes from operation of the RDX/HMX plant will be land-filled. Disposal options are still being evaluated for explosives and contaminated wastes but the technology is in hand to dispose of these solid wastes in an environmentally acceptable manner."

Impacts on Utilities

Considerable amounts of power (5,600,000 KW-hours per month for two production lines) will be needed to run the proposed plant. but local utilities companies in all three areas affirmed that current generating capacity is adequate to meet the demand.

Seismic Risk

Both the McAlester and Newport sites lay wi[illegible] minor damage area. However, the Milan site is within a Zone 3 or major damage area, MMVIII and larger. The Milan site is in a seismically active region, and the possibility exists of failure during an earthquake, of a critical component in the automated systems.

In summary, a careful evaluation of the seismological settings of the three candidate sites and of data presented in Appendix D indicate that MNAD and NAAP have very similar, and low, seismic ricks; i.e., the probabilities of seismic events of various intensities occurring in the future at these two sites is almost the same. As for the Milan site, the seismicity and hence the risk is much higher than the other two.

Archaeological Sites

No impacts are anticipated on historical sites or cemetaries at any of the sites. The cemetary within the safety zone of the proposed facility at MAAP will not be compromised.

At NAAP, there is evidence via field surveys of a prehistoric village just northwest of the proposed production area. At MAAP, relocation of the burning ground and demolition ground would impact adversely on known archaeological sites. However, Milan has a FY78 construction project to erect a contaminated waste incinerator and explosive waste incinerator.

These incinerators will make relocation of the burning and demolition grounds unnecessary. These incinerators will be located in such a manner that no historical or archaeological resources will [illegible] impacted."

sthetic Impacts

sthetically speaking, the Newport site appears to [illegible] best shape since it is completely developed. At McAlester the water-intake structure at Lake Eufaula could constitute an aesthetic impact to those using the area for recreational purposes. And at Milan, the wood lots would have to be removed.

X. Coding Tower Impacts

Impacts from visible plume, fogging and icing, salt deposition, and gmentation of rain and snow are expected to be local and not severe. However, at McAlester visible plumes of length over 1-2km will occur with a frequency of less than 10 hours per year. In other words visible fog plume will be contained within the boundaries all but 10 hours per year. At Milan, the same situation is expected to occur. There is no expected visible plume beyond the boundaries at the Newport site.

XI. Social Economic Impacts

The summary statement for the draft EIS impertantly takes note of the fact that from a socioeconomic standpoint Newport appears to be the best site.

"Perturbations in employment levels constitute a potential adverse impact. It has been demonstrated that the existence of major metropolitan area considerably softens the blow of a base closure or cut-back on the surrounding community. The Newport area has a population roughly twice as dense as Milan's, and three times as dense as McAlester's. The concl[illegible]on is that McAlester's economy would be the most adversely affected (higher proportions of unemployed and welfare recipients, depre[illegible] housing market) during slack periods in [illegible]uction. The case infusions into the local economies from a mobilized four line RDX/HMX plant would account for 17.4 percent of the total annual business volume in the McAlester region, for 4.9 percent in the Milan region, and for 3.8 percent in the Newport region. The higher the proportion, the more dependent the region is on military dollars, i.e. the less diversified its economic base.

Schools are the most crowded in the Milan region, and significant immigration could have an adverse impact; this would be offset somewhat by receipt of federal impact funds for children of federal employees (including construction contractors), and federal school construction money (badly backlogged, however)."

Being that the socioeconomic aspect is so important, the next several paragraphs devote attention to the benefits of the Newport site.

[illegible]or requirements for operation of the RDX/HMX facility with two productions lines is 768 workers and 1,132 workers with four production lines. The Newport area appears to be able to fill all anticipated jobs without significant imigration occurring. The Newport area has 9.4% of the families below the poverty level: on an absolute basis there are 6,[illegible]42 families below the poverty level.

Housing should provide no problem. Assuming that the complete work force during the highest year of employment (1,250 workers in 1981) had to obtain new housing or of the four line mobilization work force (1,132 employees) had to obtain new housing, there would be more than enough standard vacant units (4,700 in NAAP) to meet the need. This does not include the projected secondary jobs, but since in-migration would be minimal this should present no problem.

[illegible] schools in Indiana would receive a bonus because new rulings on

impact funds can be distributed only in school districts located in the same state as the federal property: Illinois schools would not benefit. Again the limited in-migration will dampen the possible effect on local schools. The close proximity of excellent four year colleges and technical schools provides a positive impact in maintaining a skilled work force.

State Highway 63 provides the main access to the Newport site for vehicular traffic and the current Volume/Capacity ratio indicates use at 32% of capacity. In the peak construction year it is estimated that there would be 833 additional vehicles that could be expected and 755 additional vehicles during production with four-line mobilization. No problem is foreseen with respect to vehicular traffic except potential traffic congestion at the site due to lack of park facilities. Car pools and busing workers would however alleviate this problem. Locational factors are also important with respect to transportation. The Newport facility is strategically located with respect to other important supporting facilities. Close geographic proximity to the Naval Ammunition Depot at Crane Indiana, the Army Ammunition Plant at Charlestown, Indiana, the Indiana Ordinance facility at Connersville, Indiana and Jefferson Proving Ground at Madison, Indiana should provide significant transportation cost savings as well as important time savings.

No law enforcement, fire protection or health care problems are foreseen. Additional staffing will be necessary and increased commuter traffic may increase pressure on local police agencies; again this problem is minimized by the anticipated low immigration into the Newport area. In the NAAP area there are 9.6 hospital beds per 1,000 people and one physician for each 1,122 persons. These ratios are not expected to change significantly at the Newport site.

he Ne... region has many outdoo. ecreation poss... es plus the ...ity to large urban areas provides possibilities for many cultural pursuits.

In summary of the eleven Impact factors used in the evaluation of the proposed three sites the Newport area has a clear advantage in seven of the Impact factors Of the remaining four factors:

A. All sites are capable of providing the needed utilities,

B. Newport and McAlester are both within a favorable area as far as seismic is concerned;

C Newport would need to use abatement techniques to control the NO_2 standard, the cost of such projects will be minimal;

D There is evidence of a prehistoric village just northwest of the Newport site. However, that village is not within the proposed boundary, and;

An additional consideration is introduced in the comments of Region IV Planning and Development Commission which reveals the fact that "Community attitudes toward the expansion of the Newport Indiana facility are favorable". We feel that this is of major importance for such a project in support of the Newport facility.

Statement

behalf of the State of Indiana based on analysis of environmental and soc... economic factors, we strongly recommend that the Newport site be selected as ... site for expansion of the proposed PDX/HMX facility because the Newport, ... location is leading all other proposed locations based on a comprehensive ... of all considerations.

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METODOLOGIAS PARA DECLARACIONES DE IMPACTO AMBIENTAL

TEMA VI: METODOLOGIAS

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Marzo, 1978

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Lecture #6

STATEMENT METHODOLOGIES

by

L. W. Canter*

Parts A and B of Section 102 in the National Environmental Policy Act require agencies to utilize systematic and interdisciplinary approaches, and to develop methods and procedures which will insure that presently unquantified environmental amenities and values may be given appropriate consideration in decision-making along with economic and technical considerations. In response to these requirements, numerous environmental impact assessment methodologies have been developed since 1970.

I. Purposes of Environmental Assessment Methods

There are several purposes which are served by impact analysis methods. One is to insure that all environmental factors which need to be considered are included in the analysis. This purpose is relevant since the environment is a complex system of physical-chemical, biological, cultural, and socio-economic resources; and various types of actions can create complex impacts and interrelationships on these resources. Methods which provide an approach for systematically considering environmental factors are desirable.

Impact analysis methods should provide a means for evaluation of alternatives on a common basis. Many impact statements adequately describe the environmental impacts of proposed actions; however, they only consider the relative economic evaluation of alternatives to the proposed action. Methods of impact analysis provide the approach for evaluating absolute or relative impacts of alternatives. In conjunction with impact evaluation, it may be determined that there are data deficiencies either in terms of the description of the environmental setting, factors associated with the proposed action, or technology available for impact prediction and assessment. Methods for impact analysis can aid in identifying data needs and planning special studies or field studies.

Another important purpose of methods of impact analysis is associated with evaluation of mitigation measures. Direction of attention toward measures which will minimize the environmental impact of alternatives and the proposed action should be accomplished. Methods for impact analysis aid in evaluation of the effectiveness of proposed mitigation measures.

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Another purpose for assessment methodologies is to provide information in summary form for public participation. Utilization of a systematic, inter-disciplinary, and organized approach gives credence to the validity of the impact analysis. Care must be exercised in any public distribution of information resulting from the application of an impact methodology that the information does not appear to represent an attempt on the part of the preparers to mislead the public or misrepresent or confuse the results. Information which is presented to the public should be provided in summary form only.

Finally, methods of impact analysis are required to insure compliance with the spirit and intent of the National Environmental Policy Act.

II. Definitions

A. Matrices: These methodologies incoporate a list of project activities in addition to a checklist of potentially impacted environmental characteristics. These two lists are related in a matrix which identifies and impacts. Matrix methodologies may specify which actions impact which environmental characteristics or may simply list the range of possible actions and characteristics in an open matrix to be completed by the analyst.

B. Checklists: Checklist methodologies present a specific list of environmental parameters to be investigated for possible impacts but do not require the establishment of direct cause-effect links to project activities. They may or may not include guidelines on how parameter data are to be measured and interpreted. They may have developed parameter weighting systems.

Categories of Checklists

1. Simple checklists: a list of parameters is indicated, however, no guidelines are provided on how parameter data are to me measured and interpreted.

2. Descriptive checklists: a list of parameters is indicated, and guidelines are provided on how parameter data are to be measured.

3. Scaling checklists: same as descriptive checklists with information provided as to subjective scaling of parameter values.

4. Scaling-weighting checklists: same as scaling checklists with information provided as to subjective weighting or parameter with respect to each other.

III. Leopold Interaction Matrix

A. Principle of the Method

Basic principle is the use of a matrix with 100 different specified actions and 88 environmental items. An impact is identified at the interaction between an action and an environmental item. See Figure 1. List of actions and items in Table 1.

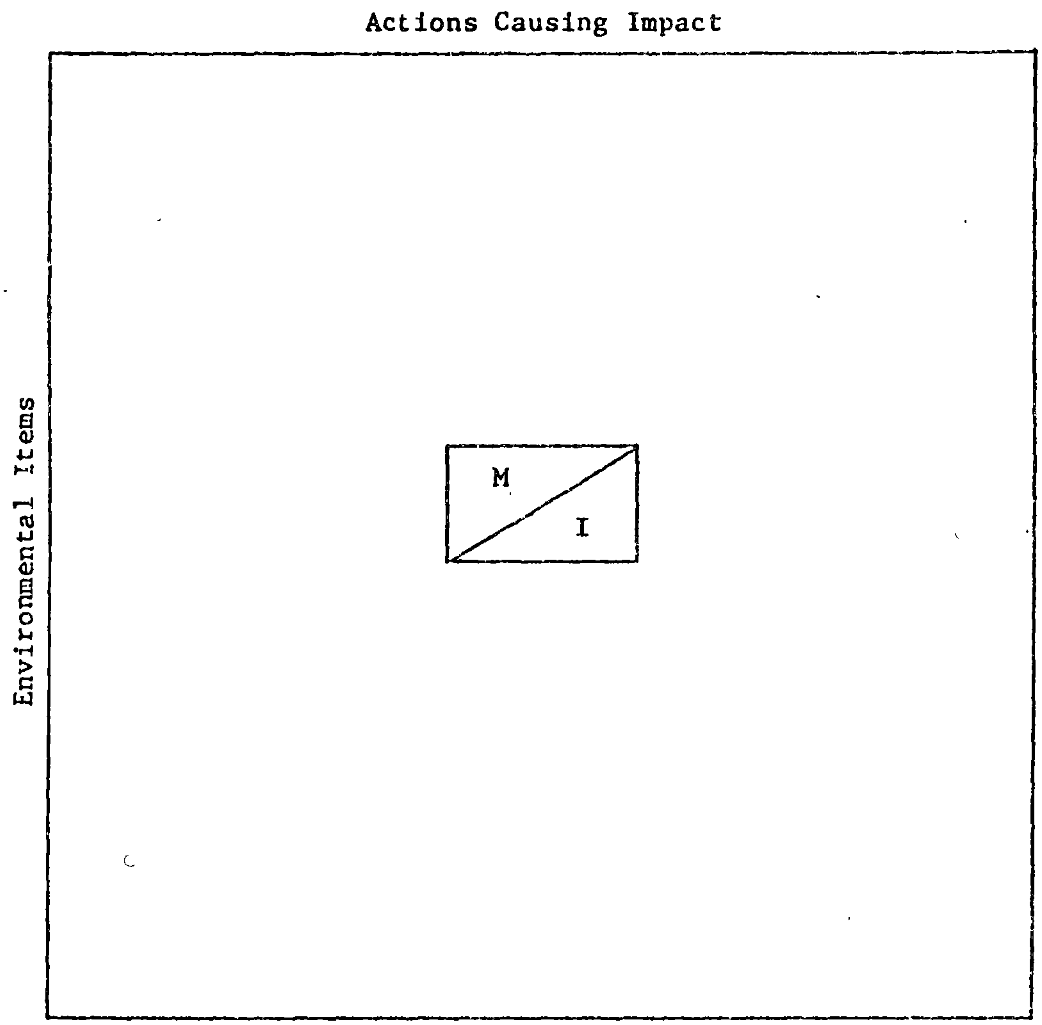


FIGURE 1: Leopold Interaction Matrix

TABLE 1: Actions and Items in Leopold Interaction Matrix

Actions

Category	No.	Description
A. Modification of Regime	a.	Exotic Fauna Introduction
	b.	Biological Controls
	c.	Modification of Habitat
	d.	Alteration of Ground Cover
	e.	Alteration of Ground Water Hydrology
	f.	Alteration of Drainage
	g.	River Control and Flow Modification
	h.	Canalization
	i.	Irrigation
	j.	Weather Modification
	k.	Burning
	l.	Surface or Paving
	m.	Noise and Vibration
B. Land Transformation and Construction	a.	Urbanization
	b.	Industrial Sites and Buildings
	c.	Airports
	d.	Highways and Bridges
	e.	Roads and Trails
	f.	Railroads

Environmental Items

Category	No.	Description
A. Physical and Chemical Characteristics		
1. Earth	a.	Mineral Resources
	b.	Construction Material
	c.	Soils
	d.	Land Form
	e.	Force Fields and Background Radiation
	f.	Unique Physical Features
2. Water	a.	Surface
	b.	Ocean
	c.	Underground
	d.	Quality
	e.	Temperature
	f.	Recharge
	g.	Snow, ice, and perma frost
3. Atmosphere	a.	Quality (gases, particulates)
	b.	Climate (micro, macro)
	c.	Temperature
4. Processes	a.	Floods
	b.	Erosion
	c.	Deposition (Sedimentation, precipitation)

Actions			Environmental Items		
Category	No.	Description	Category	No.	Description
	g.	Cables and Lifts		d.	Solution
	h.	Transmission Lines, Pipelines and Corridors		e.	Sorption (ion exchange, complexing)
	i.	Barriers including Fencing		f.	Compaction and Settling
	j.	Channel Dredging and Straightening		g.	Stability (Slides, Slumps)
				h.	Stress Strain (Earthquakes)
	k.	Channel Revetments		i.	Air Movements
	l.	Canals	B. Biological Conditions		
	m.	Dams and Impoundments			
	n.	Piers, Drawalls, Marinas, and Sea Terminals	1. Flora	a.	Trees
				b.	Shrubs
	o.	Offshore Structures		c.	Grass
				d.	Crops
	p.	Recreational Structures		e.	Microflora
				f.	Aquatic Plants
	q.	Blasting and Drilling		g.	Endangered Species
	r.	Cut and Fill		h.	Barriers
				i.	Corridors
	s.	Tunnels and Underground Structures	2. Fauna	a.	Birds
				b.	Land Animals Including Reptiles
C. Resource Extraction	a.	Blasting and Drilling		c.	Fish and Shellfish
	b.	Surface Excavation		d.	Benthic Organisms
				e.	Insects
	c.	Subsurface Excavation and Retorting		f.	Microfauna
				g.	Endangered Species
	d.	Well Dredging and Fluid Removal		h.	Barriers
				i.	Corridors

Actions			Environmental Items		
Category	No.	Description	Category	No.	Description
F. Resource Renewal	a.	Reforestation	4. Cultural Status	a.	Cultural Patterns (Life Style)
	b.	Wildlife Stocking and Management		b.	Health and Safety
	c.	Ground Water Recharge		c.	Employment
	d.	Fertilization Application		d.	Population Density
	e.	Waste Recycling	5. Man-Made Facilities and Activities	a.	Structures
G. Changes in Traffic	a.	Railway		b.	Transportation Network (Movement, Access)
	b.	Automobile		c.	Utility Networks
	c.	Trucking		d.	Waste Disposal
	d.	Shipping		e.	Barriers
	e.	Aircraft		f.	Corridors
	f.	River and Canal Traffic	D. Ecological Relationships Such As:	a.	Salinization of Water Resources
	g.	Pleasure Boating		b.	Eutrophication
	h.	Trails		c.	Disease-Insect Vectors
	i.	Cables and Lifts		d.	Food Chains
	j.	Communication		e.	Salinization of Surficial Material
	k.	Pipeline		f.	Brush Encroachment
				g.	Other
H. Waste Replacement and Treatment	a.	Ocean Dumping	Others		
	b.	Landfill			
	c.	Emplacement of Tailings, Spoils, and Overburden			
	d.	Underground Storage			
	e.	Junk Disposal			
	f.	Oil Well Flooding			
	g.	Deep well emplacement			

Actions			Environmental Items		
Category	No.	Description	Category	No.	Description
	h.	Cooling Water Discharge			
	i.	Municipal Waste Discharge Including Spray Irrigation			
	j.	Liquid Effluent Discharge			
	k.	Stabilization and Oxidation ponds			
	l.	Septic Tanks, Commercial and Domestic			
	m.	Stack and Exhaust Emission			
	n.	Spent Lubricants			
I. Chemical Treatment	a.	Fertilization			
	b.	Chemical Deicing of Highways, etc.			
	c.	Chemical Stabilization of Soil			
	d.	Weed Control			
	e.	Insect Control (pesticides)			
J. Accidents	a.	Explosions			
	b.	Spills and Leaks			
	c.	Operational Failure			
Others					

B. Interactions

1. Described in terms of <u>magnitude</u> and <u>importance</u>.

2. Magnitude

   a) related to extensiveness or scale

   b) objective evaluation based on facts

   c) scale from 1 to 10; 10 represents greatest magnitude; 1 represents lowest

3. Importance

   a) related to significance

   b) subjective evaluation based on the judgment of interdisciplinary team

   c) scale form 1 to 10; 10 represents most important, 1 the least important

C. Evaluation of the Leopold Interaction Matrix

1. Can be expanded in either direction

2. Can be used as:

   a) gross screen for identification purpose

   b) technique for visual display of impacts

3. Can be used for various temporal phases of the project under consideration:

   a) construction

   b) operation

   c) post-operation

4. Can be used for various spatial boundaries

   a) site

   b) region

5. Used to define three levels of impact

   a) major (important)

   b) intermediate

   c) minor

6. Can show plus or minus impacts

7. Summation of rows or columns might offer some insights, as well as product of magnitude and importance values

8. Very minimal focus on socio-economic considerations

IV. Scaling Checklist (Adkins and Burke)

A. Principles

1. This method was developed for transportation projects. It basically consists of a checklist and scaling of impacts of alternatives on a relative basis from -5 to +5 (+5 is the highest score).

2. An example of the use of the system for the environmental portion of the checklist is in Table 2, and a summary of the results from each portion is in Table 3.

B. Evaluation

1. Good for summarizing impacts and showing trade-offs.

2. Flexible

3. Application to alternatives of different type is questionable.

V. Scaling-Weighting Checklist (Battelle Environmental Evaluation System)

A. Principles

1. Oriented to water resources development projects

2. System Characteristics (See Figure 2)

a) Hierarchial -- accounts for levels of information
general -- Environmental Categories (4)
intermediate -- Environmental components (17)
specific -- Environmental parameters (78)

b) Measures impact in commensurate units

c) Alert system (red flags --- major and minor)
sensitive areas
data need

3. Commensurate Units

a) Needed due to variety of units of expression for 78 environmental parameters

b) Steps

Table 2: Example of Adkins-Burke
Method in Environmental Category

Factor	Definition or Explanation	Rating Alternative 1	2	3	Comments
II. ENVIRONMENTAL	NEPA and PPM 20-8				
A. Community (Local Area)					
1. Noise pollution	Relation to present levels PPM 20-8				
(a) Adjacent to freeway		-2	-1		Relief of street traffic helps offset.
(b) General area		+3	+1		Improves due to relief of street traffic.
2. Air Pollution	PPM 20-8				
(a) Adjacent to freeway		+2	+1		Relief of street traffic.
(b) General area		+5	+2		Relief of street traffic.
3. Drainage	Effects on chances of flooding, etc.				
(a) Adjacent to freeway		+1	0		Rte. 1 will help slightly.
(b) General area		0	0		
4. Water Supply					
(a) Water pollution	PPM 20-8 Permanent or serious temporary	0	0		Little, if any, effect.
(b) Water Quantity	Interference with movement or level of ground water	0	0		Little, if any, effect.
5. Waste disposal	PPM 20-8 Access to, interference, etc.	0	0		Little, if any, effect.
6. Flora effects	NEPA and PPM 20-8 and Irreplaceable losses, etc.	0	0		Little, if any, effect.
7. Fauna effects	NEPA and PPM 20-8 Breeding or nesting, etc.	0	0		Little, if any, effect.

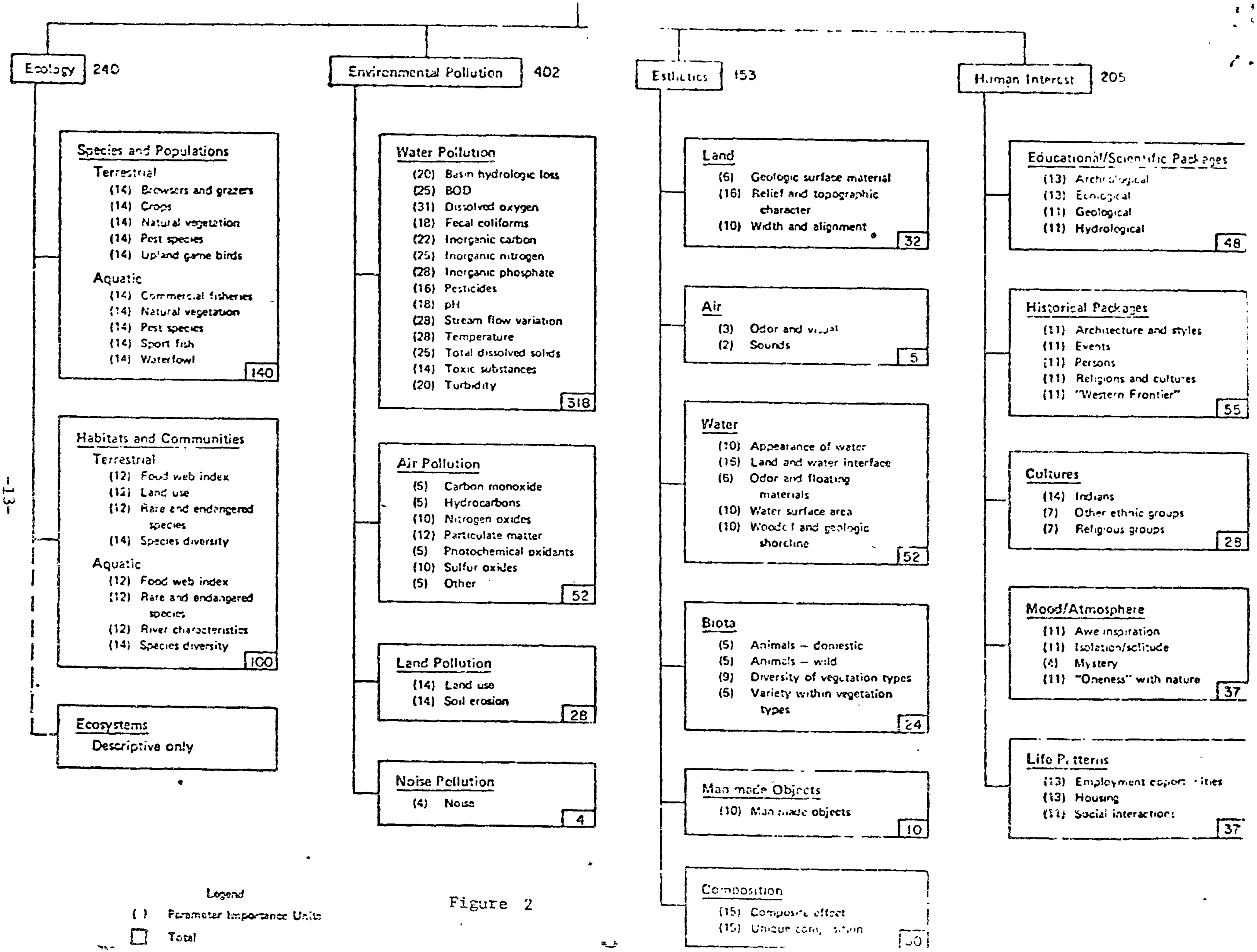
Factor	Definition or Explanation	Rating Alternative 1	2	3	Comments
8. Parks	PPM 20-8 Improvement or damage to	+5	+2		Improves access to.
9. Playgrounds	PPM 20-8 Improvement or damage to	+5	0		Rte. 1 improves access to.
10. Archeological sites	NEPA and PPM 20-8 Loss of or access to, etc.	0	0		None affected.
11. Historical sites	PPM 20-8 Loss of or access to, etc.	+2	+1		Improves access to.
12. Open space		+3	+1		Opens area by removing structures, some undesirable.
13. Visual aspects	PPM 20-8 Community view of freeway	X	X	X	
(a) Adjacent to freeway		+3	+1		Thru proper treatment areas will be improved.
(b) General area		+2	0		Rte. 1 would help. Rte. 2 not likely to help.
14. Safety	PPM 20-8 Any change in hazards	X	X	X	
(a) Traffic		+3	+1		Rte. 1 gives more relief to streets & removes rr.
(b) Pedestrian		+5	+1		" Rte. 1 more persons involved.
(c) Other_______		-	-		
15. Other_______	PPM 20-8 e.g., other resources				
B. Freeway Motorist Experience	PPM 20-8	X	X	X	
1. View of freeway	Appearance and security	+3	+1		Rte. 1 clearer and nicer view.
2. View of adjacent area	Aesthetics or special sights	0	+1		Rte. 2 could give special views on curves.
3. Panoramic views	Vistas	+1	+3		Rte. 2 good. Rte. 1 downtown area
4. Area hazards	Hazards to freeway users and vehicles	+3	-1		Rte. 1 would displace hazards. Rte. 2 would expose motorists to industrial smog, etc.

PART II. Summary Rating:

	Alternative 1	2	3		Alternative 1	2	3
No. of plus ratings	15	12	___	Algebraic sum of ratings	44	1[illegible]	___
No. of minus ratings	1	2	___	Average of ratings	2,75	1,00	___
Ratio of plus ratings	.94	.86	___				

Table 3: Adkins-Burke Method:
Overall Comparison of Ratings

Part	No. of Plus Ratings	No. of Minus Ratings	Total No. of Ratings	Algebraic Sum of Ratings	Ratio of Plus Ratings	Average Rating
IA. Transp., Local Area						
Alt. 1	7	6	13	18	.54	1.38
Alt. 2	4	2	6	1	.67	.17
Alt. 3						
IB. Transp., Metropolitan Area						
Alt. 1	8	0	8	34	1.00	4.25
Alt. 2	6	1	7	7	.86	1.00
Alt. 3						
II. Environmental						
Alt. 1	15	1	16	44	.94	2.75
Alt. 2	12	2	14	14	.86	1.00
Alt. 3						
IIIA. Socio, Community						
Alt. 1	9	2	11	27	.82	2.46
Alt. 2	6	3	9	-1	.67	-.11
Alt. 3						
IIIB. Socio., Metropolitan Area						
Alt. 1	9	0	9	31	1.00	3.44
Alt. 2	6	1	7	7	.86	1.00
Alt. 3						
IV. Economic Impact						
Alt. 1	15	14	29	27	.52	.93
Alt. 2	14	14	28	-11	.50	-.39
Alt. 3						
All Ratings						
Alt. 1	63	23	86	181	.73	2.10
Alt. 2	48	23	71	17	.68	.24
Alt. 3						



Ecology 240
Species and Populations
Terrestrial
(14) Browsers and grazers
(14) Crops
(14) Natural vegetation
(14) Pest species
(14) Upland game birds
Aquatic
(14) Commercial fisheries
(14) Natural vegetation
(14) Pest species
(14) Sport fish
(14) Waterfowl
140
Habitats and Communities
Terrestrial
(12) Food web index
(12) Land use
(12) Rare and endangered species
(14) Species diversity
Aquatic
(12) Food web index
(12) Rare and endangered species
(12) River characteristics
(14) Species diversity
100
Ecosystems
Descriptive only
Environmental Pollution 402
Water Pollution
(20) Basin hydrologic loss
(25) BOD
(31) Dissolved oxygen
(18) Fecal coliforms
(22) Inorganic carbon
(25) Inorganic nitrogen
(28) Inorganic phosphate
(16) Pesticides
(18) pH
(28) Stream flow variation
(28) Temperature
(25) Total dissolved solids
(14) Toxic substances
(20) Turbidity
318
Air Pollution
(5) Carbon monoxide
(5) Hydrocarbons
(10) Nitrogen oxides
(12) Particulate matter
(5) Photochemical oxidants
(10) Sulfur oxides
(5) Other
52
Land Pollution
(14) Land use
(14) Soil erosion
28
Noise Pollution
(4) Noise
4
Esthetics 153
Land
(6) Geologic surface material
(16) Relief and topographic character
(10) Width and alignment
32
Air
(3) Odor and visual
(2) Sounds
5
Water
(10) Appearance of water
(16) Land and water interface
(6) Odor and floating materials
(10) Water surface area
(10) Wooded and geologic shoreline
52
Biota
(5) Animals – domestic
(5) Animals – wild
(9) Diversity of vegetation types
(5) Variety within vegetation types
24
Man made Objects
(10) Man made objects
10
Composition
(15) Composite effect
(15) Unique composition
30
Human Interest 205
Educational/Scientific Packages
(13) Archeological
(13) Ecological
(11) Geological
(11) Hydrological
48
Historical Packages
(11) Architecture and styles
(11) Events
(11) Persons
(11) Religions and cultures
(11) "Western Frontier"
55
Cultures
(14) Indians
(7) Other ethnic groups
(7) Religious groups
28
Mood/Atmosphere
(11) Awe inspiration
(11) Isolation/solitude
(4) Mystery
(11) "Oneness" with nature
37
Life Patterns
(13) Employment opportunities
(13) Housing
(11) Social interactions
37
Legend
( ) Parameter Importance Units
Total

Figure 2

1) transform parameter estimates into environmental quality (EQ)

2) assign importance weights to parameters (PIU)

c) multiply EQ x PIU to obtain environmental impact unit (EIU)

$$EIU = EQ \times PIU$$

4. EQ

a) values from 0 to 1

b) 0 = extremely bad quality

c) 1 = vary good quality

d) range of values

e) provides common bases

f) value function based data and/or judgment

5. PIU

a) 1000 PIU divided among categories, components, parameters

b) "ranked pairwise comparisons"

c) example of ranked pairwise comparison: Distribution of 100 PIU among 3 water pollution parameters: Turbidity (2), D.O.

1) Chlorides (3)

Assign to DO value of	1.5
Turbidity = 1/2 of D.O. =	0.5
Chlorides = 1/5 of Turbidity =	0.1
	1.6

$$DO = \frac{1.0}{1.6}(100) = 63$$

$$Turbidity = \frac{0.5}{1.6}(100) = 31$$

$$Chlorides = \frac{0.1}{1.6}(100) = 6$$

B. Usage

1. Obtain parameter data without the project for each of the 78 environmental factors. Convert this parameter data into environmental quality scale values for each of the 78 parameters. Multiply these scale values by the parameter importance units for each of the individual parameters to develop a composite score for the environment without the project.

2. For each alternative, predict the change in the environmental parameters. Utilizing predicted changes in the parameter values, determine the environmental quality scale for each parameter and each alternative. Multiply the environmental quality values for each alternative by each parameter important unit, and aggregate the information for a total composite score.

C. Evaluation

The numerical evaluation system provides a tool that serves to guide environmental impact analysis. The Battelle Environmental Evaluation System is a very highly-organized methodology, and as such, it helps to insure systematic (all-inclusive) approaches and identify critical changes. As is the case with many other methodologies, very little emphasis is given to socio-economic factors in this method.

One of the key points to note is that there is no passing or failing score in the Battelle System, since the resultant numerical evaluations must be subjected to professional interpretation. The methodology is valuable for an analysis of trade-offs within a component, within a category, or between categories.

One of the key points of criticism with regard to the Battelle System is that it is an inflexible methodology in terms of application to projects of different types. The concept of the methodology has been converted and applied to a rapid transit system project in Atalanta. It has also been applied to various water resources projects within the Bureau of Reclamation as well as a multi-purpose reservoir project of the U.S. Army Corps of Engineers.

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METODOLOGIAS PARA DECLARACIONES DE IMPACTO AMBIENTAL

TEMA VII: EL PROGRAMA "EIS" Y SU REGULACION

Dr. Jerry Murphy

Marzo, 1978

Regulatory Assessment of Effectiveness of EIS Program

I. Application to Decision Making

A. Actions Applicable to EIS Process - Explicit, but flexible direction needed from CEQ to assist Federal Agencies to determine:

1. Whether or how actions can be grouped as programs in terms of geographical, generic or other common factors.

2. How impact statements can be timed & organized to tie in w/ subsequent statements or related individual actions.

3. How agencies can determine scope and level of detail necessary for program analysis.

B. Assessments/Negative Determinations - assessment used by many Federal Agencies to determine which projects call for EIS & improve projects that do not. Also used to document agencies' position if challenged (negative determinations) as to why EIS was not prepared. Deficiencies that should be addressed include:

1. All projects should be covered to determine if EIS is required by assessment procedures.

2. Negative determinations should be short statements, backed-up with documentation, & with public notice and provision to make available documented assessment to concerned groups.

3. Notice of Intent to prepare EIS should be published quarterly in Federal Register.

C. Influence on Federal Decision-Making -
Influence felt more at lower & middle management level, rather than top management. Improvement needed by:

1. Agencies integrating EIS process in administrative operations & issue of clarifying directives in terms of not eliminating alternative at too low in the management level before consideration, at least in the assessment phase, at top level.

2. Ensure analytical EIS's are as concise as possible to focus decision makers on impacts + alternatives that are most revelant.

3. Pinpointing inefficiency in departmental timely management + preparation of EIS.

4. Insuring explicit agreement between agencies involved in joint or lead agency role in affecting EIS, to define mutual responsibilities.

II EIS Comment & Response Process

Over the years comments have improved but still often are; neither constructive or supported with appropriate data; are hurried and diluted because agencies solicited for comments have limited staff or experts for review are at diverse field location or have limited time (45 days) to comment affecting the quality of review; also comments often

... NOT elicit Adequate response from initiating Agency and no procedure exists to insure comments are accommodated. These problems are best dealt with by -

A. Commenting agencies limiting their comments to special areas of expertise rather entire documentation. E.G. Federal Energy Agency gives priority to reviewing projects effect on energy supply and conservation. Also, provide recognition or incentives to significant individual contributors.

B. Reviewing agencies should alert CEQ on sensitive area of comment & pursue matter with issuing agency to satisfy response requirement.

C. Federal agencies should review response procedures to insure comments are addressed and integrated into project EIS & impact as appropriate to decision on project.

III Quality and Content of the EIS

A. Major concern with the type of impacts considered, their significance and level of analysis depth and how project relates to previous or subsequent EIS's.

1. Type of impacts that require consideration include: physical, aesthetic, historic, cultural, social & economic dimensions; whether primary (direct) or secondary (indirect). The degree each is addressed is a function of the project considered.

2. Significance of Impacts - Key problem deals with how to measure & predict significance of physical & social impact. Many agencies adopt numeric thresholds to measure magnitude of impact or list types of impact to be considered in judging significance. Developing such techniques for social impacts has been especially challenging & development is in early stages.

3. Levels of Analysis - Teired approach often used successfully - Heart of matter is that EIS documentation should be succinct and a discussion of impacts & alternatives should be dominant. Example of Tiered approach is Forest Service where in implementing Forest + Rangeland Renewable Resources Planning Act, EIS 1st level of analysis was to analyze broad nat'l and regional alternatives & impacts. 2nd level of analyze was planning areas between 20,000 - 200,000 acres. 3rd level was site specific analyze of road construction, major timber sales & land acquistion.

Improvements required encompass -

1 Make EIS more managable in size, summarize data, supply references/appendices/supporting mat'l readily available to reviewers. Focus data + analysis on issues of significant impact & reasonable alternatives.

2. Determine Appropriate levels of analysis for types of EIS's and related criteria, as well as guidelines to determine thresholds defining significance of social, natural + other impacts on "human environment" -

3. Set standards to define scope of "human environment" and reasonables limits of analysis of social, economic & all secondary impacts.

IV Special Problems in Appl(y)ing NEPA

A. Permit Impact Statements - [1] Numerous private industries or corporations are subject to the impact statement process when appling for Federal permits for projects that may cause environmental effects. Some examples follow -

- Nuclear Regulatory Commission licenses nuclear power plants
- Federal Power Commission licenses Hydroelectric & liquidified natural gas terminals
- Dept. of Interior, Commerce, Corps of Engineers, Forest Service, Coast Guard, Food & Drug Administration and State Dept grant permits on - pipelines crossing international borders - transmission and pipe lines crossing federal land - and bridge, dock piers or other construction on navigable waterways.

-THESE AS well AS permits for CONSTRUCTION of fossil fuel PLANTS, paper mills, MAJOR housing OR RECREATION PROJECTS, REQUIRE IMPACT STATEMENTS.

2. Applicants for Such permits must submit environmental Reports which AGENCIES USE AS the basic foundation in preparing their impact Statements. SEVERAL APPROACHES TO INDUSTRIES AND Federal AGENCIES, ALTHOUGH AGENCY IS TOTAL Responsible for preparing IMPACT STATEMENTS, developing Appropriate DATA/ANALYSIS for PROJECT. MOST ACCEPTED IS Applicants Hiring CONSULTANT TO WORK CLOSELY WITH AGENCY TO develop EIS, SO long AS Federal AGENCY MAINTAINS CONTROL OVER the environmental ANALYSIS, REMAIN OBJECTIVE When evaluating DATA, ESTABLISH SCOPE of ANALYSIS & Reasonable ALTERNATIVES TO BE ADDRESSED IN NEPA PROCESS.

3. Inherent with the APPLICATION of the principles outlined Above is the NEED TO INSURE THAT STATE and local Views are Considered early AND Addressed in the EIS Process. This ACTION Along with following CEQ Guidance to have STATE and FEDERAL AGENCIES design Common permit Application Requirements, will facilitate Timely Preparation & Improve Quality of EIS.

B. GRANT ACTIONS - Problems associated with Many Federal Agencies which manage GRANT Applications to STATE AGENCIES, ARE Similiar to permits previously discussed. Unique to grants is the proposition that since States develop their own GRANT proposals, i.e. Hiway/Transportation Systems, STATE Recreation plans, they are delegated responsibility to prepare EIS's for numerous plans which they develop. CEQ is studying the effects of this Action to define the circumstances when such an Approach should be AUTHORIZED.

C. WATER RESOURCES ACTIONS - Conflict exists in Complying with 2 mandated laws - NEPA & Principles And STANDARDS of the WATER RESOURCE Council (P&S). Duplication is inherent in complying with both requirements. Agencies can resolve this Conflict internally by developing and circulating the EIS for WATER RESOURCE PROJECTS to ALL parties that receive either document.

D. INTERNATIONAL ACTIONS.

A. TWO FOLD POSITION RELATIVE TO APPLICATION OF NEPA TO FEDERAL ACTIONS ABROAD.

— STATE DEPT. AGREES THAT EIS PROCESS APPLIES IF ACTION HAS SIGNIFICANT IMPACT ON USA OR ENVIRONMENT OUTSIDE ANY NATION'S TERRITORIAL JURISDICTION.

— AID POSITION THAT NEPA APPLIES IF ACTION RESULTS ENVIRONMENTAL IMPACT IN TERRITORIES OF NATIONS RECEIVING AID OR IN ADJACENT NATIONS

B. AID IS DEVELOPING PROCEDURES TO CLARIFY ITS EIS OR ENVIRONMENTAL ASSESSMENT ENCOMPASSING THE FOLLOWING PRINCIPLES.

1. ASSESS EVERY PROPOSED NEW DEVELOPMENT ACTIVITY FOR POTENTIAL ENVIRONMENTAL EFFECTS; INCLUDING CAPITAL DEVELOPMENT PROJECTS, TECHNICAL ADVISORY SERVICES, TRAINING, EDUCATION PROGRAMS, RESEARCH + COMMODITY PROCUREMENT.

2. FOR ACTIVITIES IN A SPECIFIC COUNTRY, ENVIRONMENTAL ASSESSMENT WILL BE CONDUCTED BY QUALIFIED EXPERTS IN AND WITH DIRECT PARTICIPATION OF HOST GOVERNMENT.

3. ENCOURAGE AND ASSIST THE HOST GOVERNMENT TO INVOLVE COUNTRYS' CITIZENS & SPECIAL INTEREST GROUPS TO PARTICIPATE IN THE DECISION-MAKING PROSESS, ESPECIALLY THOSE POTENTIALLY MOST AFFECTED BY ENVIRONMENTAL EFFECTS.

4. WHERE NOT COUNTRY SPECIFIC (E.G. RESEARCH) AID WASHINGTON WILL PREPARE EIS AND CIRCULATE IT TO AID OVERSEAS MISSION ~~FOR~~ AND HOST GOVERNMENT FOR INFORMATION, GUIDANCE

And comment.

5. For actions impacting beyond a nations' boundary, host governments will be urged to consult with neighbors in advance of project development & negotiate mutually acceptable accommodations.

6. Contribution to international institutions & programs will require environmental assessment only where financial commitment can be directly related to a specific activity where AID has unilateral right to control expenditures. However, when it is not possible to protect or predict end uses of funding, AID will work with other donor agencies to develop comprehensive policies & procedures in considering environmental consequences of development efforts.

APPENDIX F

POLICY DETERMINATION

DEPARTMENT OF STATE
AGENCY FOR INTERNATIONAL DEVELOPMENT

PD-63
August 1, 1975

ENVIRONMENTAL ASPECTS OF DEVELOPMENT ASSISTANCE

It is AID policy:

-- to assist in strengthening the indigenous capabilities of developing countries to appreciate and evaluate the potential environmental effects of proposed development strategies and projects, and to select, implement, and manage effective environmental protection measures, and

-- to ensure that the environmental consequences of proposed AID-financed activities are identified and considered by AID in collaboration with the host country prior to a final decision to proceed, and that appropriate environmental safeguards are adopted.[1]

This policy reflects AID's recognition of the responsibility incumbent on all agencies of the U.S. Government to conduct their operations in a manner that mitigates or avoids any potential short- or long-term deleterious environmental effects of local, regional or global proportions. It also derives from the opportunity to make a special contribution in an area of increasing concern to developing countries, and the world in general, by virtue of the unique scientific and managerial expertise the United States has developed to deal with environmental problems.

1 Virtually all AID activities concerned with raising basic living standards can be considered "environmental" in a positive sense. However, this and subsequent references to AID's "environmental policy" refer specifically to those precepts, procedures, programs and actions which, by deliberate design, seek to improve or protect the quality of air, water and land resources by: (1) eliminating or mitigating undesirable effects of development projects or commodities financed under the Foreign Assistance Act through better program planning and review; and (2) building and strengthening the indigenous capabilities of developing countries to identify, assess and prevent environmental degradation through programs of education, training, research, and technical advisory services.

Filing instructions: Will be published in Handbook 2

AID's environmental policy conforms with concepts embodied in the National Environmental Policy Act of 1969. That Act establishes, as national policy, that the United States will "promote efforts which will prevent damage to the environment and biosphere, and stimulate the health and welfare of man," and calls upon all agencies of the Federal Government to review programs and procedures with "particular reference to their effect on the environment and on the conservation, development and utilization of natural resources." It further directs all government agencies to:

> "recognize the worldwide and long-range character of environmental problems, and where consistent with the foreign policy of the United States, lend appropriate support to initiatives, resolutions and programs designed to maximize cooperation in anticipating and preventing a decline in the quality of mankind's world environment...."

It is AID policy to seek consistently to further these <u>broad environmental objectives within the framework of the U.S. bilateral development assistance program</u> -- recognizing that the sovereignty of developing countries as well as their differing priorities, stages of development, cultural and social values, environmental concerns, and sensitivity to external efforts to influence their national development plans make this a difficult and delicate task.

Despite these potential constraints, provision of U.S. bilateral assistance involves decisions by AID which must be taken with full cognizance of <u>all</u> associated costs and benefits (including environmental). AID asserts that quality-of-life improvements in the developing world can be realized and sustained only by the acceptance of the principle that environmental planning must be an integral component of national development plans and programs. Conservation of renewable resources and prevention of harmful environmental effects can often be achieved if incorporated early in the design of overall development strategies and projects. In other cases, negative effects may be unavoidable and, therefore, require difficult choices which should be made on the basis of a clear recognition and analysis of alternative pathways toward the desired development objective.

It is AID policy to seek close collaboration with recipient developing countries in carrying out its environmental responsibilities. In the larger sense, worldwide environmental goals will be achieved only with the willingness and ability of the developing countries to assume the responsibility for anticipating potential effects, carrying out sound planning and project design, and managing and monitoring the activities.

ENVIRONMENTAL ASSESSMENT POLICY

It is AID policy to assess systematically every proposed new development activity at the earliest possible state for significant potential environmental effects, and to prepare a detailed environmental assessment in each case where significant effects are probable. "Activities" to be assessed include capital development projects (e.g., construction of roads, irrigation systems, ports), technical advisory services, training and education programs, research, and commodity procurement.

In the case of AID activities which are either carried out within or focused on specific LDCs, environmental assessments will be conducted by qualified experts in and with the direct participation of host government institutions whenever possible. Consultations will be held between AID staff and the host government on the results and significance of the completed assessments, and agreement reached on any necessary modifications prior to final approval of the proposed activities. In addition, AID will encourage and assist, if possible, the host government to involve broad elements of the country's citizens in the decision-making process, particularly those potentially most affected by any environmental effects. Subject to authorization by the host government, AID will make the assessments available to interested parties within the United States in advance of final actions on the proposal.

Where the proposed AID activity is not "country-specific" (e.g., research at a U.S. institution), or where it constitutes one of a class of activities (e.g., pesticides procurement), a single environmental assessment will be made in AID/Washington, circulated to AID's overseas Missions and host governments for information, guidance and comment, and made available within the U.S. to interested parties.

AID will assess and react to situations where the environmental assessment indicates that potential effects may extend beyond the national boundaries of the recipient country. When adjacent foreign nations may be affected, it is AID policy to urge the country requesting assistance to consult with its neighbors in advance of project development and to negotiate mutually acceptable accommodations which will then be reflected in the bilateral agreement reached with AID.

Where an assessment indicates that a proposed activity would significantly affect the environment of areas outside any nation's territorial jurisdiction (e.g., the oceans), or would significantly affect the environment of the United States, AID will, subject to foreign policy considerations, comply with the procedural requirements of Section 102(2)(C) of National Environmental Policy Act, (as amplified by the Guidelines for Federal Agencies under the National Environmental Policy Act, issued by the Council on Environmental Quality, revised May 2, 1973). This requires preparation of an "environmental impact statement" and its circulation for comment within the U.S. prior to any final project decision by the Agency. The impact statement will also be provided to Missions and LDCs for information and comment.

In some cases, AID is only one of several donors for a particular activity. Nevertheless, it is AID policy to factor environmental considerations into its own decision on whether to contribute to a proposed multi-donor activity. When AID is the (or a) major contributor toward an activity which, upon initial examination, may cause significant environmental effects, it will take the lead in ensuring that an environmental assessment is prepared, ideally through the collaborative efforts of the principal donors. When AID's potential involvement is that of a minor contributor, it will look to and encourage the major controlling donor(s) to prepare a comprehensive assessment that meets the needs of both AID and all other participating donor institutions. If potential effects from such multi-donor activities may significantly affect the United States or areas outside national jurisdictions, environmental impact statements will be submitted to AID as prescribed by Section 102(2)(C) of the National Environmental Policy Act. In every instance, the assessments and impact statements will be made available to all donors and the developing countries involved.

With respect to contributions to international institutions and programs, environmental assessments are required in those cases where the financial commitment can be directly related to a specific activity or program for which AID has the unilateral right to control expenditures. However, assessments are not prepared for core support to an international or regional body, or to an LDC intermediate credit institution, when it is not possible to project and predict the specific end uses of the funding. In the latter situation, AID will work with other donor agencies to develop common and comprehensive policies, strategies, and procedures for addressing the environmental aspects of development, and with LDC governments to help build an environmental consciousness and capability which they themselves can then apply.

Foreign policy considerations, political sensitivities on the part of recipient LDCs, restrictions on United States access to LDC data, and emergency situations may, on occasion, preclude or constrain AID's ability to carry out a definitive environmental analysis. Situations may also arise where a foreign government may request AID assistance for a specific project, the design of which is already committed. This obviously limits AID's ability or reason to evaluate project alternatives. In such cases, AID's final decision must be based on a less-than-optimal analysis, and possibly limited to consideration of the environmental benefits and costs of the only approach desired a priori by the host country.

Regardless of difficulties, AID's policy is to conduct the best environmental assessment possible -- consistent with the type and overall scale of the activity being considered. The assessments are to be comprehensive and include the following components:

-- overview description and analysis of the proposed activity.

-- probable significant environmental effects, both beneficial and negative, along with their estimated magnitudes.

-- relationship of the activity to land-use policies, plans and controls for the affected area(s).

-- an exposition and evaluation of the environmental effects of reasonable alternatives, particularly those that might enhance environmental quality or avoid some or all of the adverse effects.

-- significant adverse effects which cannot be avoided.

-- anticipated trade-off potential for improving or degrading man's environment (considering the local short-term uses versus the maintenance and enhancement of long-term productivity), and the extent to which the activity forecloses possible future options.

-- other interests and considerations of the United States and the host country thought to offset any adverse environmental effects.

When AID unilaterally considers that there is a reasonable risk of significant adverse effects on the environment from an activity proposed to it for support, and where efforts to encourage the incorporation of appropriate safeguards are unsuccessful, AID reserves the prerogative of declining to participate in the activity

ENVIRONMENTAL ASSISTANCE TO DEVELOPING COUNTRIES

While the international development assistance effort collectively carried out by all multilateral and bilateral donors is significant, it nevertheless supports only a small fraction of the economic development activities conducted in the developing world. Consequently, protecting the environment of developing countries -- and, in turn, safeguarding the U.S. and the world environment from the potential threat of increasing global pollution -- requires more than the application of new environmental policies and procedures by official aid donors. Over the long-term, environmental goals will be achieved only through the commitment, action and abilities of the developing countries themselves. It is, therefore, AID policy to stimulate and assist cooperating countries to develop the knowledge and institutional capabilities necessary to address successfully the environmental aspects of their national development programs.

AID sponsorship of environmental activities responds to a steadily growing demand by developing countries for U.S. assistance in this area, and recognizes the fact that the U.S. is in an excellent position to make a significant and unique contribution to the international effort by virtue of its past experience and existing capabilities. Also, AID is the only U.S. agency authorized to provide concessional technical assistance to developing countries on environmental matters.

AID assistance in the environmental field both includes and transcends the traditional focus of Agency programs, i.e., coping with the "pollution of poverty" by accelerating economic and social development. It includes support for activities which are principally designed to aid developing countries to identify, assess and mitigate the undesirable secondary impacts of traditional development projects on human populations, land, air, water and other natural resources. Priority is assigned to strengthening national capabilities for identifying potential problems, establishing new environmental policies, laws and institutions, and calculating the costs and benefits of alternative approaches to protecting or rehabilitating the environment. Implementation involves financing of U.S. technical advisors; provision of training for developing country policy makers and managers; dissemination of information, and sponsorship of research and demonstration projects designed to advance the state-of-the-art for pollution control and environmental management in the developing world.

AID recognizes a special responsibility for addressing the undesirable secondary impacts associated with the development activities it finances. Consequently, it is Agency policy to apply routinely the technical expertise needed to help evaluate potential problems associated with proposed AID-financed projects, and to incorporate appropriate safeguards into project design. Further, high priority is accorded to LDC requests for assistance to strengthen their capabilities for monitoring and managing the environmental aspects of those projects which are subsequently implemented. AID is also receptive to LDC requests for U.S. assistance to cope with important environmental problems unrelated to specific AID projects.

COOPERATION WITH INTERNATIONAL BODIES

AID is committed to working with other international development agencies to seek harmonization of policies, procedures and guidelines for building environmental safeguards into development activities.

Since the United States is the largest financial contributor to the multilateral donors with mandates to conduct environmental programs, AID will continue to join with the Department of State and other U.S. agencies in helping design and influence those programs. Special priority will be given to cooperation with the UN Environment Programme (UNEP) which has lead responsibility to develop a coordinated international environmental program. AID is prepared to consider specific LDC requests for bilateral assistance channeled through the UNEP, UNDP and UN Specialized Agencies.

COLLABORATION WITH THE U.S. ENVIRONMENTAL COMMUNITY

It is AID policy to encourage participation of broad segments of the U.S. public and private sectors in the design and implementation of Agency environmental policies and programs. In the conduct of its environmental-related analyses and projects in developing countries, AID will seek to employ the best U.S. talent available.

AID will also take steps to improve public awareness of the Agency's environmental policies, procedures and projects and to increase opportunities for public input into environmental policy formulation and strategy.

/s/ Daniel Parker
Daniel Parker
Administrator

1 August 1975
Date

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METODOLOGIAS PARA DECLARACIONES DE IMPACTO AMBIENTAL

TEMA VIII: EVALUACION DEL IMPACTO CAUSADO POR LOS DESECHOS SOLIDOS

Dr. Larry W. Canter
Marzo, 1978

Lecture #8

Evaluation of Solid Waste Impacts

by

L. W. Canter*

Solid waste management has become a focal point of public interest within the last decade. Attention has ranged from municipal solid waste collection and disposal, to resource recovering and materials recycling, to hazardous waste management. Some reasons for the increasing attention include increasing quantities due to per capita generation increases and population increases, detrimental environmental impacts resulting from improper collection and disposal, and loss of materials and revenues resulting from lack of materials and energy recovering.

I. Federal Laws

A. Solid Waste Disposal Act of 1965

B. Resource Recovering Act of 1970

C. Resource Conservation and Recovering Act of 1976

II. Information Needs and Terminology

A. Quantities and Composition

1. Total weight (lb. or tons) and volume (yd^3).

2. Composition --- see Tables 1 and 2.

*Director and Professor, School of Civil Engineering and Environmental Science, University of Oklahoma, Norman, Oklahoma.

TABLE 1 : Definitions of Mixed Municipal Refuse Components

Newsprint	Newspapers. Does not include magazines, handbills, etc.
Cardboard	Corrugated boxboard and the heavier paperboard used in cartons. Light cardboard in food packages and the backing of paper pads are included with "miscellaneous mixed paper".
Miscellaneous mixed paper	All other paper not included above.
Metallics	Tinned and aluminum cans, hardware, bottle caps, utensils, wire, and other ferrous and nonferrous metal articles.
Food (garbage) waste	Wastes, from the handling, preparation, cooking, and serving of foods. Does not include packaging materials or paper discarded with garbage.
Yard waste	Lawn, garden, and shrubbery clippings, sod and small yard debris other than branches.
Wood waste	Branches, scrap lumber, and other wooden articles.
Glass	Glass and ceramic materials.
Plastic	Film plastics and molded plastic articles.
Miscellaneous	Stones, metal oxides, articles made of natural and synthetic fibers, rubber products, and leather goods.

TABLE 2 : Expected Ranges in Mixed Municipal Refuse Composition

Component	Percent composition as received (dry weight basis)	
	Anticipated range	Nominal
Paper	37-60	55
Newsprint	7-15	12
Cardboard	4-18	11
Other	26-37	32
Metallics	7-10	9
Ferrous	6-8	7.5
Nonferrous	1-2	1.5
Food	12-18	14
Yard	4-10	5
Wood	1-4	4
Glass	6-12	9
Plastic	1-3	1
Miscellaneous	< 5	3
		100

Moisture content:

Range (percent) 20-40

Nominal (percent) 30

B. Information Uses

1. Collection system design (trucks, routes, crews, transfer stations)
2. Disposal method selection and design.
3. Evaluation of resource recovery potential.
4. Determination of general personnel requirements.
5. Development of financing methods for solid waste management systems.

C. Hazardous Wastes

1. Definitions of hazardous wastes:

...any waste or combination of wastes which pose a substantial present or potential hazard to human health or living organisms because such wastes are lethal, nondegradable, or persistent in nature; may be bioligically magnified; or may otherwise cause or tend to cause detrimental cumulative effects.

...those materials of combinations of materials which require special management techniques because of their acute and/or chronic effects on the health or welfare of the public (or those individuals who handle them) when they are disposed of by waste management processes...

2. The term "hazardous waste" means a waste or combination of wastes of a solid, liquid, or semisolid form which in the judgment of the EPA Administrator may cause, or contribute to, an increase in mortality or an increase in serious irreversible or incapacitating reversible, illness, taking into account the toxicity of such waste, its persistence, and degradability in nature, and its potential for accumulation or concentration in tissue, and other factors that may otherwise cause or contribute to adverse acute or chronic effects on persons or other living organisms.

3. Includes toxic and carcinogenic chemicals, pesticides, acids, caustics, flammables, explosives, biological and radiological residuals.

III Technical Review of Resource Recovery Processes (Reference: Midwest Research Institute, "Resource Recovery," report prepared for Council on Environmental Quality, February, 1973, pp. 1-2 and 6-16).

A. General Classifications

The various resource recovery processes covered in this study* may be classified into the following general categories:

1. Energy Recovery Processes: Processes that recover the energy content of mixed municipal wastes, in the form of either steam, electricity, or fuel.

2. Materials Recovery Processes: Processes which separate and recover the basic materials from mixed municipal wastes, such as paper, metals and glass.

3. Pyrolysis Processes: Processes that thermally decompose the mixed municipal waste in controlled amounts of oxygen and produce products such as oil, gas, tar, acetone and char.

4. Compost Processes: Processes which produce a humus material from the organic portion of the mixed waste.

5. Chemical Conversion Processes: Processes which chemically convert the waste into protein and other organic products.

B. Energy Recovery Processes

1 Heat recovery incinerators. European countries have pioneered in heat recovery from the incineration of municipal refuse. Heat recovery incinerators have been in operation for a number of years in France, Germany, and Switzerland. Steam is produced and used for heating and/or for the generation of electrical power. European engineers have led in the development of the refuse-fired boiler plant utilizing waterwall furnaces. Waterwalls are favored over refractory walls primarily because they permit operation at temperatures considerably higher than with refractory walls, thereby substantially increasing the efficiency and reducing the excess air requirement.

* The resource recovery processes included in this study represent a broad spectrum of the present technology; however, not all individual processes were included.

Heat recovery incinerators have been introduced into U.S. waste disposal operations in recent years (e.g., Norfolk Naval Base, 1967, Braintree, Massachusetts, and Chicago, Illinois, 1971). The introduction of this European technology to the U.S. provides the incinerator-boiler plant designer a wider selection of well established technology from which to choose. Three widely used European stokers are receiving serious consideration by North American designers. The reverse reciprocating German Martin grate is being used for the first time in North America in the New Chicago Northwest incinerator, and the Swiss Von Roll stokers were installed in Montreal's Descarriers plant. The drum grate developed in Germany and used in several European plants, has received considerable attention but has not yet been installed in an American plant.

The Chicago Northwest Incinerator is designed to burn 1600 tons of waste per day and produce steam for sale. Most of the major components were built by an experienced commercial organization in Germany and shipped to Chicago. The basic design is similar to several other large incinerator plants in Europe.

In spite of the advanced state of development of this systems, a considerable amount of time has been required to build and get the Chicago plant to operate smoothly. Construction was started in 1969. As of the spring of 1972, the plant reliability has not yet reached the point where steam could be generated for sale. Difficulty has been experienced in burning excessively wet refuse and boiler corrosion problems have been experienced. Some of the difficulties being experienced in getting this plant into operation is due to inexperience with this type of incinerator. There is no doubt that this and the other start-up problems will be answered and the plant put into full operation.

From a technical standpoint this type of resource recovery plant should present a minimum amount of technical problems because of its advanced stage of development. Furthermore, this type of plant is usually designed for large capacities and therefore particularly applicable to large cities. However, care must be taken in locating the plant close to steam consumers, since steam cannot be transported over long distances. Large cities which have an immediate solid waste disposal problem can give immediate consideration to building heat recovery incinerators because these incinerators are one of only two resource recovery systems (composting is the other system) which is fully developed at this time.

In addition to steam or power generation from heat recovery incineration, other uses are possible. The City of Ansonia, Connecticut, employs heat recovered from incineration to dry sludge from the city's water pollution control plant. Sludge containing less than 10 percent solids is pumped directly to a spray dryer and the dry product, containing less than 13 percent moisture, is pneumatically conveyed to the furnace for burning in suspension. The Oceanside plant at Hempstead, New York, uses recovered heat for desalination of sea water for in-plant use. A new plant at Hamilton, Ontario, will use recovered heat to produce steam which will drive equipment such as shredders and fans.

Although heat recovery from waste incinerators is an established practice, there are still some technical problems, even in the most advanced plants. The principal problems are slagging, erosion and corrosion of boiler components, and difficulties in burning excessively wet waste.

.2 Fuel recovery. The feasibility of using mixed urban refuse as a substitute for conventional fuels in power plants and industrial furnaces has been under study in the U.S. in recent years. Combination fuel fired systems have been found to be feasible and several systems have been proposed to further demonstrate the concept.

The City of St. Louis, Union Electric Company, and the consulting firm of Horner and Shifrin, with partial funding from EPA, have constructed a 300 TPD (8-hour shift) processing plant for using refuse as a supplementary fuel for electrical power plants. The refuse is milled and magnetic material is removed. The milled material is pneumatically fed to a power plant furnace where it is burned along with pulverized coal (separate nozzles are used to inject the milled refuse into the furnace). The refuse contributes 10 to 20 percent of the total fuel.

The demonstration plant was started up April 4, 1972. The only major changes that have been made in the original system design to date are the substitution of a belt conveyor for a vibratory conveyor at the refuse truck receiving pit and the substitution of a drag conveyor for a belt conveyor at the output from the Atlas storage bin at the power plant. The addition of an air classifier after shredding to remove heavy pieces is planned to improve pneumatic flow and reduce pipeline wear in the boiler furnace feed system. All of the major components in both plants are commercially available equipment, although not necessarily shelf items.

A. M. Kinney, Inc. (consulting engineers) has also proposed a process which recovers the thermal energy from municipal refuse by burning it in combination with fossil fuels in conventional steam boiler furnaces. The Kinney system utilizes a hydrapulper to convert all pulpable materials to an aqueous slurry. Nonpulpable materials are ejected continuously from the hydrapulper, conveyed to a drum washer and thence to a magnetic separator where ferrous metal is recovered. Following removal of nonfibrous materials in a liquid cyclone, the pulped slurry is dewatered and compressed into a cake with 50 percent solid content. The solid cake can be used as a power boiler fuel with or without additional processing depending upon the type of boiler used. A. M. Kinney estimates that from 5 to 20 percent of the heat input for a given furnace might come from this fuel source.

The Kinney system is only in the design stage and no pilot plant exists at this time. However, the technical feasibility of wet grinding municipal solid waste to produce a homogeneous slurry has been proved during 2 years of pilot plant operation by the Black-Clawson Company and by the operation of the Black-Clawson Solid Waste Disposal Plant in Franklin, Ohio. A. M. Kinney has conducted engineering studies to assess the feasibility of using wet grinding in the process to recover the thermal energy from refuse in conventional boiler systems. Because the pulped and dewatered refuse (50 percent moisture) is similar to bark and bagasse, which contain 40 to 60 percent water and have been used successfully as boiler fuel in pulp and sugar mills, it appears that pulped refuse, with its greater homogeneity, more uniform water content, and smaller particle size, would also burn successfully in power boilers.

3 <u>Generation of electricity</u>. A new system for recovering energy from mixed municipal waste is being developed by the Combustion Power Company, Menlo Park, California. In this system, called the CPU-400, the refuse is shredded, burned in a high pressure fluid bed combuster, and the hot gases drive a gas turbine/generator to produce electricity.

The CPU-400 is now in the early pilot plant stage; system studies and subscale experiments have been completed and development and testing of portions of the pilot plant are under way. Pilot plant testing to date has been centered on three areas: (1) the shredding and classifying of the solid waste, (2) the combustor feed system, and (3) the fluid bed combustor. The solid waste handling subsystem has been developed and extensively tested. Pneumatic transport of the fuel and injection at the base of the fluidized bed has also been demonstrated satisfactorily.

Tests conducted on the fluid bed combustor have disclosed several problems that have required changes or additions to the original system design. Foremost among the problems encountered to date are: (1) agglomeration of bed material particles--a phenomenon that places an upper limit on operational bed temperatures; (2) combustor and exhaust system deposits formed by the impingement of aluminum oxide particles on surfaces; and (3) elutriation of bed material.

Items (2) and (3) have led to extensive design changes in the system. To solve the elutriation problem the original horizontal fluid bed combustor with its attendant low freeboard height has been abandoned and a new vertical combustor unit designed and installed. An alumina removal chamber has been added between the combustor and the gas cleaning train to solve the deposit problem. The performance of the new combustor unit and alumina removal system will be evaluated in a series of pilot plant tests. At this point, the configuration of this key subsystem has not been finalized and the performance of the total system must be viewed as an unknown at this time.

4 High temperature incineration. Another new thermal recovery method is high temperature incineration. The first U.S. high-temperature incineration pilot plant was built in 1966 by American Thermogen, Inc., in Whitman, Massachusetts. Steam and frit are the principal products of the system. The incinerator is a shaft furnace in which refuse is charged at the top and molten materials are withdrawn out the bottom. As the refuse descends through the bed, it undergoes partial pyrolysis and eventual combustion in the lower portion of the furnace. The melt-down at the bottom of the furnace is accomplished at temperatures of about 3000°F by burning auxiliary fuel, either oil or gas. A similar system is being developed by Torrax Systems, Inc., at North Tonawanda, New York.

C. Materials Recovery Processes

1 Fiber recovery. Cellulose comprises from 40 to 50 percent (wet basis) of typical mixed municipal waste, and most of the cellulose is paper. Both wet and dry process fiber reclaiming systems have recently been developed. The Black Clawson Company, Middleton, Ohio, has developed a wet process system for recovering paper pulp from mixed municipal solid waste. In addition to the recovery of paper pulp, steel, glass, aluminum and ash are also recoverable. The heart of the Black Clawson system is a Hydrapulper which receives all incoming waste, except for large, bulky items. Friable materials such as food waste, paper, plastic, rubber, rags, glass, and wood are mixed with water and pulped into a slurry. Heavier objects are ejected from the bottom of the pulper and passed through a magnetic separator which recovers the ferrous metal portions. The glass and aluminum separations will be accomplished with an air classifier. An optical sorter will be used to separate clear glass from colored glass, developed by the Sortex Company of North America.

The Black-Clawson Hydraposal/Fibreclaim demonstration plant at Franklin, Ohio, has been in operation since June 1971. The design capacity of the plant is 150 tons of raw waste per 24-hour day. However, the plant has averaged only about 50 tons per day because of a lack of delivery of refuse. There is a charge made to dump raw refuse at the plant and landfill sites have been competing for the area refuse. Nevertheless, an hourly throughput of about 8 tons per hour has shown that the plant is capable of meeting the design capacity. The plant burns about 32 percent of the total incoming waste.

At the present Black-Clawson is recovering only paper pulp and magnetic metals. Equipment to recover the glass and aluminum will be added in late 1972. To date, they have been landfilling the mixture of glass and nonmagnetic metals. They have experienced lipids and fines in the pulp which is undesirable from both the end pulp product (asphalt roofing felt) and then it tends to clog the processing equipment (which adds to the maintenance costs). They are in the process of adding equipment to reduce the contaminants. This involves treating the pulp with steam and caustics, and subsequent washing.

The Franklin Institute, Philadelphia, Pennsylvania, is in the process of developing a dry process primarily for extracting paper from mixed municipal refuse. Shredded refuse is screened and sent through a ballistic separator. The ballistic separator consists of a rotating wheel which hurls the material in a horizontal direction. A downward blast of air causes the lightest materials (paper and plastics) to drop out first and the heaviest materials (metals, glass, etc.) last. A plastics collector separates the plastics from the paper. Laboratory tests indicate an effective separation of paper (90 to 95 percent purity). A pilot plant of the system has been constructed and full scale tests were initiated July 1972.

2 Incinerator residue recovery. The Bureau of Mines, College Park, Maryland, has developed a method for processing incinerator residues on a continuous basis to reclaim the metal and mineral values. The process utilizes conventional and proven mineral engineering equipment consisting of a series of shredding, screening, grinding, and magnetic separation procedures. Metallic iron concentrates, nonferrous metal composites, glass fractions, and fine carbonaceous ash tailings are products of the system. A demonstration plant is to be built at Lowell, Massachusetts.

D. Pyrolysis Processes

Considerable potential exists for reforming, by pyrolysis, the organic portion of municipal solid wastes into lower molecular weight compounds having significant economic value. Because pyrolysis reactions often termed "destructive distillation," can be conducted in the absence of oxygen or in controlled oxygen environments, product composition can be regulated. Unlike combustion in an excess of air, which is highly exothermic and produces primarily heat and carbon dioxide, pyrolysis of organic material is analogous to a distillation process and is endothermic.

The high temperatures (1000 to 2000°F) and lack of oxygen result in a chemical breakdown of the waste organic materials into three component streams: (1) a gas consisting primarily of hydrogen, methane, carbon monoxide, and carbon dioxide, (2) a "tar" or "oil" that is liquid at room temperature and includes organic chemicals such as acetic acid, acetone, methanol, and (3) a "char" consisting of almost pure carbon plus any inerts (glass, metals, rock) that enter the process unit. Residence time, temperature, and pressure can be controlled in the pyrolysis reactor to produce various product combinations.

Laboratory and pilot plant pyrolysis units have been successfully constructed and operated, and these units have demonstrated the technical feasibility of the pyrolysis of municipal refuse. Laboratory investigations of the pyrolysis of various organic wastes have been conducted at the University of California (Berkeley), Bureau of Mines, Rensselaer Polytechnic Institute, New York University, and the Utilities Department of the City of San Diego, California. Batch retorts, fluidized beds, and rotary kilns have been successfully used as reactors in these laboratory studies. Pilot plant studies of pyrolysis systems for municipal wastes have been conducted by Garrett Research and Development Company, Monsanto's Enviro-Chem Systems, Battelle Northwest, the University of West Virginia, and Union Carbide.

Garrett Research and Development Company has a resource recovery system designed to recover salable synthetic heating fuels, glass, and magnetic metals from mixed municipal refuse. The system is an outgrowth of nearly 4 years of intensive research into methods of production of synthetic fuels. The system contains all operations necessary for receiving, handling, shredding, and classifying solid waste; for separation of magnetic metals and glass from the classified waste; for pyrolyzing the organic fractions of the waste; and for the recovery of oil and char generated during the pyrolysis step.

The heart of the Garrett system is the flash pyrolysis process. The pyrolysis process has been studied in considerable detail in a laboratory reactor system for over a year. A wide variety of organic materials were used as feed materials in these tests. The laboratory pyrolysis tests defined the operating conditions needed to maximize the yields of heating fuels. The laboratory test program demonstrated that the pyrolysis reactor can be operated in either a liquefaction or gasification mode. Garrett claims that over one barrel of oil per ton of input refuse can be produced in the liquefaction mode, while 6,000 scf of gas with a heating value of 800 Btu/ft^3 can be produced in the gasification mode without relying on additional fuel sources.

In order to obtain the high yields of oil and gas, the feed to the reactor must consist of essentially a pure, dry organic material of small particle size. To meet this requirement, the first stages in the Garrett process involve extensive shredding, air classification, screening, and drying steps. The materials handling and preparation section is one of the most comprehensive proposed for any current recovery system. A 150 ton per day demonstration plant is to be built at San Diego, California.

The Monsanto "Landgard" System is based on pyrolysis with the primary objective being the disposal of all types of municipal solid waste while offering practical opportunities for resource recovery. The Landgard systems encompass all operations for receiving, handling, shredding, and pyrolyzing solid waste; for quenching and separating the residue from pyrolysis; for generating steam from waste heat, and for purifying the off-gases.

A rotary kiln is utilized as the pyrolysis reactor in the Monsanto system. A prototype or pilot plant of 35 TPD capacity was operated by Monsanto for nearly 3 years at St. Louis, Missouri. All components for the system were tested to some degree at the pilot plant. Although long-term, steady-state operation was not performed during pilot plant operation, sufficient experience was gained from the pilot plant operation to demonstrate system feasibility. A 500 ton per day demonstration plant is to be built at Baltimore, Maryland.

The city of Charleston, West Virginia, has recently proposed a Regional Resource Recovery System that incorporates a pyrolysis system as the key unit process. The pyrolysis system is an outgrowth of research work conducted by Professor Richard Bailie at the University of West Virginia at Morgantown, West Virginia. The Charleston system utilizes twin fluid beds, the first bed acts as a pyrolyzer, and the second bed as a combustor. Shredded and air classified refuse is fed to the pyrolyzer which is operated at about 1400°F. Gas, char and some tar are produced in the pyrolyzer. The gas produced in the pyrolyzer has a heating value of about 400 Btu/ft^3. The char and tar are subsequently burned in the fluid bed combustor to provide the heat to operate the pyrolyzer unit. Energy released by the combustion of the char and tar is reported to be sufficient to maintain the pyrolyzer at operating temperature without the need of supplemental energy input. Professor Bailie has operated both the pyrolyzer and combustion units independently, but both units have never been tied together into an integrated system.

Hercules, Inc., has designed a 500 TPD reclamation plant for the State of Delaware which incorporates composting, pyrolysis, and materials separation operations. Residential refuse, after removal of ferrous metals, will be mixed with sewage sludge and composted in a Fairfield digestion unit. Noncompostable organic components will be pyrolyzed. Inorganic residues will be sorted and reclaimed. Industrial and commercial wastes will be handled in a similar fashion, following a preliminary reclamation stage. The pyrolysis unit is a Herreshoff furnaceof the type used to make wood charcoal. This equipment is a multiple chamber, continuous feed and discharge unit with mechanical movement of material from chamber to chamber in the furnace. A demonstration plant is to be built for the State of Delaware.

Battelle Northwest has been conducting pyrolysis-incineration research for EPA and the City of Kennewick, Washington. An outgrowth of this research has been the construction and operation of pilot plant equipment capable of processing about 2 tons per day of refuse on a batch basis. The heart of the process is a closed vertical reactor where the refuse is progressively dried, charred, and finally oxidized at relatively low temperatures under carefully controlled conditions. The refuse undergoes three transformations in a packed bed settling under the force of gravity while reactant and combustion product gases rise counter-current to the direction of solids movement.

To produce a heating gas with the Battelle process the solid char, the product of pyrolysis in the upper portion of the reactor, is oxidized in the bottom part of the reactor by a mixture of oxygen (from either air of commercial oxygen) and steam. The hot reaction product gases continue upward and release their heat to cause charring of the entering refuse. Finally, the residual heat in the gases evaporates moisture from the entering refuse at the top of the reactor. The gases which leave the reactor contain hydrogen, oxides of carbon, water vapor, and a mixture of hydrocarbons. These gases may be cleanly burned in a secondary burner since they contain no ashy materials. Alternately, they may be processed for recovery of organic compounds, further treated to produce a heating gas, or processed still further to yield a 75 percent hydrogen and carbon monoxide mixture which may be used to synthesize methane.

Linde Division of Union Carbide Corporation recently announced the development of a high temperature incinerator system that utilizes oxygen in place of air to develop the requisite high temperatures in the melt zone. The Carbide system utilizes a vertical furnace into which all municipal waste can be fed, including garbage, paper, wood, rubber, all metals, plastics, glass, and bulky items. As with other high-temperature incinerators, the Oxygen Refuse Converter is primarily a refuse disposal system and not a resource recovery system, although the off gases can be cleaned for use as an industrial fuel gas. A 5 ton per day pilot plant has been in operation at Tarrytown, New York, for about 9 months. The objective of the tests conducted during this period were to determine furnace operating characteristics, oxygen consumption rates, and the influence of refuse composition on furnace performance.

E. Composting

Composting of municipal refuse has been practiced in Europe and the U.S. for many years. European activity in composting has included research in such diverse fields as engineering technology, public health and pathogen survival, use in strip mine reclamation, use in vineyards and use in general agriculture. The technology of composting is well advanced and there are no real technological barriers to making compost.

In the United States, composting plants have been established in various communities over the last 20 years. In general, these plants have met with little success and most have closed. The major problem for these plants is the lack of a viable market for the compost. Currently, only two plants, Altoona FAM, Inc., Altoona, Pennsylvania, and Ecology, Inc., Brooklyn New York, are known to be operating on a regular basis.

In the Fairfield-Hardy Process used at Altoona, refuse is ground in a wet pulper, followed by dewatering presses before it is fed into the digester for a 5-day processing cycle. Stirring is provided in the digester by augers suspended from a rotating bridge in the circular tank. Air is provided by means of a blower and air pipes embedded in the floor of the tank. The digestion system of Fairfield Engineering Company appears to offer a superior engineering design, a more automated operation than other compost techniques, and an ability to produce a superior humus product.

The Varro composting process used by Ecology, Inc., is distinguished from other composting processes by several factors. First, the digester can compost refuse with a paper content of up to 90 percent (most composting plants send paper to landfills since they cannot readily process it). Second, noncompostable materials do not have to be separated from compostables before beginning the composting process; only ferrous metals (removed after shredding) do not go through the digester. Third, the digester permits control of variables in the decomposition process and consequently enables production of a compost with uniform composition. Also, nutrients are added to the compost to encourage its use as fertilizer.

F. Chemical Systems

Chemical methods that have been suggested for converting municipal refuse into usable products include hydrolysis, hydrogenation, wet oxidation, photo degradation and anaerobic digestion.

These methods use only the cellulosic portion of municipal refuse, so that separation and pretreatment of the raw refuse is required.

Hydrolysis of cellulosic waste to produce protein and glucose is the only process that has been tested at the pilot plant level. Hydrogenation and wet oxidation have been studied in laboratory equipment, while photodegradation and anaerobic digestion are in the conceptual state.

A pilot plant for the production of single-cell protein from waste sugarcane bagasse has been designed, constructed, and operated at Louisiana State University. The pilot plant's equipment can be grouped into five distinct process sections: cellulose-handling, treatment, sterilization, fermentation, and cell harvesting. The plant was designed so that it could operate in both batch and continuous-flow modes. The initial operation of the pilot unit has been limited to a single waste celluosic substrate, sugarcane bagasse. Purified ground wood pulp has also been used as a control substrate in several runs. Single-cell protein with a crude protein content of 50 to 55 percent has been produced.

IV. EIS's for Sanitary Landfills

A. Reference: Stearns, R. P. and Ross, D. E., "Environmental Impact Statements for Sanitary Landfills," Public Works, Nov., 1973, pp. 63-66.

B. Five Basic Components
1. Description of the proposed sanitary landfill and its locale.
2. Discussion of all foreseeable positive and negative impacts on the physical and social environments.
3. Discussion of measures planned to mitigate the adverse effects.
4. Coverage of alternatives to the proposed landfill site.
5. Conclusions: A subjective assessment of whether the potential good of the project will outweigh the potential harm to the environment.

C. Mitigation Measures---see Table 3

D. Project Alternatives
1. No project at all.
2. Alternative locations for the sanitary landfill.
3. Alternative means to dispose of the solid waste.

V. Method for Comparative Evaluation of Impacts

A. Reference: Caffrey, P., et al, "Evaluation of Environmental Impact of Landfills," American Society of Civil Engineers, Environmental Engineering Division, Journal, 101(EE1): pp. 55-69, Feb., 1975.

B. Overall Study---The comparative method involved visually evaluating ratings for 20 field factors to determine the effect on air quality, water quality, land use, esthetics, noise, and vectors. The procedure was used to evaluate 69 sites in Wisconsin. Land use and esthetics were affected most by landfills followed by air and water quality with lesser effects on noise and vectors. Additional statistical analysis revealed that sites operated by city or county government had less environmental impact/ton of refuse than town and village sites.

C. Landfill Rating Factors---see Table 4.

D. Results of Study---Tables 5-8 and Figure 1.

Table 3—Summary of Adverse Impacts and Counteractive Measures

Anticipated Adverse Impact	Actions Planned to Mitigate Adverse Impact
Public Health and Esthetics	
Litter	Provide proper fencing. Control working face area.
Dust	Periodic watering.
Odors	Assure prompt and consistent coverage of exposed wastes.
Leachates	Diversion of runoff and drainage of precipitation incipient on the surface. If necessary, install underdrains and a collection/treatment system.
Air Quality Impairment	Control dusts.
Heavy Equipment and Collection Vehicle Movement	Provide proper traffic directors and spotters. Assure adequate access roads.
Methane Gas Generation	Install appropriate gas control venting system. Minimize water infiltration to waste by drainage control.
Local and Regional Biota	
Vegetation	Remove only the vegetation necessary for operations. Install gas vents to preclude root-zone damage to adjacent vegetation.
Animal Life	Landscape finished landfill to reattract displaced native species. Control leachates from entering water courses.
Land and Land Use	
Visual Unattractiveness	Plan cut and fill areas to minimize "desecration" appearances.
Restricted Land Use	Plan for parks, golf courses, and open space.
Social and Economic Environments	
Public Opposition	Develop a comprehensive public relations/education program to promote and explain need for sanitary landfill and its operation. Arrange for public meetings to air grievances—dispel aura of public powerlessness and promote participation in planning process.
Cost Increase	Incorporate discussions for landfill economics into public relations program.

Table 4: Landfill Rating Factors

1. Refuse Placement: Confined, 0; partially confined, 2; and unconfined, 4.

In the process of dumping and spreading, the refuse should be confined to the smallest possible area. An "unconfined" working space results in more blowing paper, an "open dump" appearance, and requires more time, energy, and soil to cover the refuse. "Confined" means the refuse is dumped and spread in as small an area as is feasible to handle truck and equipment traffic and obtain satisfactory compaction. "Partially confined" means that there is some control over refuse dumping, but a larger area than necessary is used.

2. Compaction: Satisfactory, 0, limited, 1; and none, 3.

Proper compaction reduces refuse volume and thus increases landfill capacity and site life. Settlement is reduced and stability of the completed site improved by compaction. As with refuse placement, compaction does not have a large effect on the environment (relative to some other factors to be covered later) and the total rating values are therefore low.

"Satisfactory" compaction indicates the refuse is compacted by a tractor or steel wheeled compactor in compacted layers not over 2 ft (0 6 m) thick. "Limited" compaction indicates that the refuse undergoes only partial compaction in the process of spreading, or else is not compacted until the depth is too great to allow proper compaction of lower layers [compacted layer thickness exceeding 2 ft (0.6 m)].

3. Periodic Soil Cover: 6 in. (152 mm) daily-complete layer or milled, 0; daily, thin, and spotty, 3; monthly (except winter), 6; semi-annual, 10; and no cover, 15 (Use one-half value if no garbage or paper is dumped.)

Periodic soil cover is very important in minimizing environmental damage from land disposal of solid wastes. Infrequent or insufficient initial (periodic) soil cover increases problems with vectors, odors, fire, leachate, blowing paper, runoff, and esthetics, and thus the rating values are set high. These problems are less severe if no paper or garbage is present, and thus in this case the rating values are halved. The previous rating criteria are self-explanatory. Often the actual rating given a site was based on records from the Wisconsin Department of Natural Resources as it is extremely difficult to determine in the field whether a site is covered monthly or semi-annually. Note that the DNR requires sites to be covered daily, monthly, or semi-annually, depending mainly on the population served by the site and the types of waste disposed. The rating scale used conforms closely to the classification established by the DNR.

4. Final Cover (over periodic cover): 2 ft (0.6 m) or more, 0; less than 2 ft (0.6 m), 6; and none, 12.

Final cover is important in keeping refuse permanently buried, eliminating vectors, and providing a surface for future uses, mainly support of vegetation. At many sites no areas had been completed and therefore did not yet require any final cover or surface finishing In these cases the sites were given the benefit of the doubt and rated zero

5. Surface Finish: Graded-seeded, 0; rough-weeds, 4; and barren-eroding, 9

The surface finish on any completed portion of a landfill should fulfill several purposes Slope and vegetation are critical factors in determining infiltration and resulting leachate production, and thus the surface finish can be important in controlling ground-water pollution. The surface topography and vegetation should also be planned to suit the intended use of the site after landfilling is completed. The surface finish should also create an esthetic appearance and prevent erosion which could uncover the decomposing refuse. Those sites having no completed portions were given a zero rating.

6. Blowing Litter: None, 0; controlled, 1; partially controlled, 3; and uncontrolled, 6.

Blowing litter accounts for a large number of the public complaints concerning landfills. Blowing paper and plastic can obviously create a very unesthetic appearance. "None" indicates that no loose paper or plastic is disposed. "Controlled" is a site where sufficient screens and fences are provided to catch blowing litter, and all loose litter is picked up frequently. "Partially controlled" refers to a site where some precautions are taken to prevent blowing litter, but some problem still exists. "Uncontrolled" indicates a blowing litter problem exists and no efforts have been made to control it. During site evaluation special consideration should be given if unusually high winds occur. (This problem did not occur during evaluation of sites in the three-county study.)

7. Bulky Items—Demolition: Covered or none, 0, small amount not covered, 3; and large amount not covered, 6.

Bulky items (white goods, bed springs, stumps, etc.) and demolition debris often create special problems at landfill sites because they are difficult to handle. Large piles of these items tend to collect, creating an eyesore and mass housing for rodents. "Small amount not covered" indicates that bulky items are covered, although possibly not as often as other refuse, and some piles may be picked up periodically by salvage dealers. "Large amount not covered" indicates there is no apparent program to cover bulky items.

8. Burning: None, 0, controlled ACD, 2; open burning—monthly or less, 4; and open burning—more than monthly, 6.

Open burning creates significant problems in terms of air pollution, esthetics, and resulting neighbor complaints. "Controlled" burning implies the use of an air curtain destructor (ACD) or other air pollution control device. Open burning is any burning without such control devices.

9. Vectors. No signs, 0, some flies, birds, 3; and flies, birds, rodents, 6.

Vectors, most commonly rats, skunks, mice, birds, and flies, are undesirable at a refuse disposal site because they may transmit disease or become nuisances. Flies can be seen easily if present, except on windy days and in cold weather. Birds or their droppings, or both, and tracks can be noticed easily. Rodent presence is indicated by tracks, droppings, and burrows. It was felt that vectors, burning, bulky items, and blowing litter all create environmental problems of similar magnitude, and thus all were given the same maximum rating value.

10. Hazardous Toxic Materials: None, 0; covered impermeable soil, 3; covered permeable soil, 6; and not covered, 9

Explosive, highly flammable, or toxic materials can create severe problems if not properly disposed of. Toxic materials pose a threat to wildlife and ground-water quality that may be both more severe and of longer duration than the problems created by ordinary refuse. A cover of impermeable soil protects wildlife and reduces infiltration which may carry toxic wastes into the ground water. Note that impermeable cover may require provisions to vent volatile gases. Special consideration may have to be used to evaluate special methods (neutralization, evaporation, etc.) that may be used with toxic wastes and a rating between 0 and 9 selected.

11. Ground Water: Refuse remote from ground water, 0; refuse near (5 ft) (1.5 m) ground water, 5; and refuse contacting ground water, 9

Many factors affect the quantity and quality of leachate entering the ground water from a solid waste landfill. The location of refuse with respect to the ground-water table is one of the most important. The elevation of the ground-water table usually can be estimated by nearby surface water or excavations on or near the site. If the refuse is placed in the ground water, highly potent leachate is produced by infiltration and horizontal ground-water flow. If the leachate must pass through a layer of unsaturated soil between the refuse and the ground water the quality of the leachate is improved. As with hazardous-toxic materials a higher than average maximum rating of 9 is assigned, mainly because the possibility of relatively long-term effects exist.

12. Surface Water (Lakes and Streams): None near, 0, seepage or eroded materials, or both, entering surface water, 3; and refuse contacting surface water, 6.

The direct pollution of surface water by a landfill is usually visually evident and thus the rating scale can be applied easily. Because of the visual evidence of surface water pollution by landfills, and because the effects will generally be short term rather than long term, the maximum rating applied is less than for ground-water pollution.

13. Drainage: Well drained, 0; some ponding likely, 5; and drainage into site, 9.

Surface drainage patterns are very important in determining the amount of infiltration, and therefore leachate, at a landfill site. A "well-drained" site will have the surface sloped so that precipitation drains away from areas containing refuse. If depressions are allowed in the landfill area so that "some ponding is likely" infiltration will be increased in these areas. Additional problems are created by ponding, most notably odor and mosquitos "Drainage into site" is especially undesirable, as surface runoff from adjacent areas drains into the landfill creating additional ponding and leachate problems. Drainage is therefore important both in an active site and in a completed site Drainage patterns can generally be evaluated easily by observation of surface topography

14. Dust: No dust—controlled, 0, some dust—not severe—partially controlled, 2; and severe dust, 4.

Dust is created by equipment and vehicle traffic on the site and the access road. The dust can obviously have an adverse effect on plant, animal, and human life in the vicinity, and on esthetics. Dust can be controlled by paving, oiling, or watering. Soil type, dust collected in protected areas, and evidence of dust control can be used to estimate dust problems in wet weather. In rating dust problems, "severe dust" is any dust sufficient to cause visible effects over 100 ft (31 m) from the source

15 Visibility of Site Not visible—screened, 0, visible to less than five homes, no main highway, 3; and visible to more than five homes or a main highway, 6.

For obvious esthetic reasons it is desirable to have a landfill site protected from public view. This can be accomplished by site remoteness, natural topography and vegetation, or artificial screening. This rating does not reflect the appearance of the actual disposal area, but merely whether this area is visible.

16. Routes to Site: No highway haul (on site disposal by industry), 0; sparsely populated, farm, or industrial, 2; low to medium density residential, 4; and urban residential, 6

Truck traffic to landfill sites can cause many complaints concerning noise, blowing litter, and traffic safety. Therefore traffic through residential areas should be minimized. "Urban residential" is any area where houses are located relatively continuously along a street and spaced less than 200 ft (61 m) apart. The other categories are then self-defining.

17. Site Noise: Remote—no undue noise, 0; noise annoying at less than five residences, 3; and noise annoying at more than five residences, 6.

Site noise is due mainly to heavy equipment operation and truck traffic. Annoying noise is considered as any noise that would affect someone listening to music outside their home. It was felt that site visibility, routes to site, and site noise had approximately equal potential for environmental damage, and thus all were given a maximum rating of 6. Dust was considered slightly less of a problem and was rated at 4.

18. Land Type Utilized: Barren-stripped, 0; agricultural, 4; cleared grassland, 8; and woodland-marsh, 12.

This is not intended to evaluate the financial value of the land used for a landfill, but rather is intended to provide a somewhat indirect indication of the effect of the landfill site on flora and fauna. For example, it is considered that there would be a greater adverse effect on flora and fauna by a landfill located in a wetland than one located in a hayfield. In the three-county study area, "barren-stripped" land consisted entirely of abandoned sand and gravel pits, which are commonly used for landfill sites. In some instances a landfill overlapped land of two different classifications, and in this case a proportioned value between the two individual ratings was used. This category was considered an important measure of the landfill's impact on flora and fauna, and therefore the maximum rating of 12 is rather high. The four rating categories require no additional clarification.

19. Organization, Administration, Site Plan: Well planned, site work organized, 0; some planning and organization, 6; and no planning—operator untrained, 12.

Organization and a well-thought out site plan can reduce the environmental damage from most of the factors previously examined. A site plan is also very important in increasing site capacity, reducing soil cover requirements, and reducing the men and equipment hours necessary to operate the site. A good plan also allows designing the site to best suit the intended final use. All of these factors have direct or indirect environmental effects. Unplanned sites often result in refuse being dumped such that compacting and covering is very difficult, or dumping near the front of the site may prevent access to the back of the site before the back portion is filled. This factor generally can be evaluated by observing site layout, dumping or working face progression and traffic routing. If an operator is present a brief conversation may reveal some problems not readily apparent. This factor is considered to have the potential for substantial environmental effect, and therefore is given a maximum rating of 12. Field experience shows that sites generally fall rather easily into one of the three given categories.

20. Preparedness: Prepared for breakdown, fire, wind, etc., 0; partially prepared, 3, and unprepared, 6.

If a site is not prepared to handle special situations that may arise, such as equipment breakdown, fire, high winds, and expanding rodent populations, significant problems can quickly arise with undesirable environmental effects. The site operator should know what steps to take in the event of any "likely" emergency. A well-prepared site has plans for unexpected fire, wet periods, and extended cold weather and frozen soil. A partially prepared site considers some of these problems, but not all.

TABLE 5—Proportional Contribution of Field Parameters*

Factor (1)	Air quality (2)	Water quality (3)	Land use (4)	Esthetics (5)	Noise (6)	Health (7)
Refuse placement			0.7	0.3		
Compaction			1.0			
Periodic cover	0.3	0.3		0.4		
Final cover			0.8	0.2		
Surface finish		0.2	0.4	0.4		
Blowing litter				1.0		
Bulkies—demolition wastes			0.4	0.6		
Burning	1.0					
Vectors						1.0
Toxic—hazardous wastes	0.1	0.5	0.4			
Ground water		1.0				
Surface water		0.8		0.2		
Drainage	0.2	0.6	0.2			
Dust	0.6			0.4		
Site visibility				1.0		
Routes to site				0.5	0.5	
Site noise					1.0	
Land type utilized			0.6	0.4		
Organization*			1.0			
Preparedness	0.3	0.3		0.3		0.1

*To avoid "double counting" only direct effects are assigned values. For example, ground-water pollution can affect health, but only through the change in water quality which is the direct effect. Explanation of parameters is given in the appendix.

TABLE 6—Field Ratings

Factor (1)	Maximum possible* (2)	Average (3)	Average/maximum, as a percentage (4)
Refuse placement	4	0.8	20
Compaction	3	0.9	30
Periodic soil cover	15	4.8	32
Final cover	12	0.8	7
Surface finish	9	1.9	21
Blowing litter	6	1.8	30
Bulky items—demolition	6	3.0	50
Burning	6	3.8	63
Vectors	6	3.3	55
Toxic-hazardous materials	9	0.3	3
Ground water	9	0.4	4
Surface water	6	0.2	3
Drainage	9	3.3	37
Dust	4	0.2	5
Visibility of site	6	1.3	22
Routes to site	6	2.2	37
Site noise	6	0 0	0
Land type utilized	12	3.0	25
Organization, site plan	12	3.8	32
Preparedness	6	2.2	37
	Total = 152	Total = 38 0	Average = 26

*Higher values indicate greater potential environmental damage

TABLE 7—Evaluation Summary

Environmental parameter (1)	Average value (2)	Total, as a percentage (3)	Minimum value (4)	Maximum value (5)
Air	5.2	13.6	0 0	9.0
Water	5.2	13.6	0.0	16.5
Land use	10.4	27 3	0.0	31.0
Esthetics	12 6	33.1	4.0	23.1
Noise	1.1	2.9	1 0	2.0
Vectors	3.6	9.5	0.0	6.6
Total	38.1	100 0	Minimum total = 11 0	Maximum total = 73 0

Note Thirty sites had total values exceeding the average of 38 and 39 sites had total values less than the average of 38

TABLE 8—Sample Comparison of Means

Grouping (1)	Group* (2)	Mean Ratings: Air (3)	Water (4)	Land (5)	Esthetics (6)	Noise (7)	Vectors (8)	Total (9)
Type of operator	City or county (11)	2.4	4 1	6 7	10 9	1.4	1.4	26.9
	Village (14)	6.4	5 0	11.6	13.1	1 2	3.9	41.2
	Town (35)	5 8	5 3	9 7	12.7	1 0	4 4	38.9
	Private and other (9)	4 3	6.9	15 6	13 3	1.0	2.1	43.2
	95% confidence of significant difference	Yes	No	Yes	No	Yes	Yes	Yes
Department of Natural Resources classification	Sanitary (21)	2.7	4.7	8.9	10.3	1 1	2.8	30.6
	Modified (33)	6.4	5.5	10.8	13.3	1.1	4.5	41.5
	Open dump (11)	7.0	5.7	10.9	14.6	1.3	2.9	42.3
	Other (4)	3.8	4.9	12.8	13.1	1.0	1 6	37.2
	95% confidence of significant difference	Yes	No	No	Yes	No	Yes	Yes

*The numbers in parentheses represent the number of sites in the group.
Note All numbers are dimensionless rating values

	Refuse Placement	Compaction	Periodic Cover	Final Cover	Surface Finish	Blowing Litter	Bulkies-Demolition	Burning	Vectors	Toxic-Hazardous	Groundwater	Surface Water	Drainage	Dust	Site Visibility	Routes to Site	Site Noise	Land Type Utilized	Organization	Preparedness
Air Quality			.3					1.0		.1			.2	.6						.3
Water Quality			.3		.2					.5	1.0	.8	.6							.3
Land Use	.7	1.0		.8	.4		.4			.4			.2					.6	1.0	
Esthetics	.3		.4	.2	.4	1.0	.6					.2		.4	1.0	.5		.4		.3
Noise																.5	1.0			
Health									1.0											.1
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

PROPORTIONAL CONTRIBUTION
MATRIX

×

	RATING MATRIX
1	4
	3
	15
	12
5	9
	6
	6
	6
	6
10	9
	9
	6
	9
	4
15	6
	6
	6
	12
	12
20	6

=

	TOTAL EFFECT MATRIX
1	17.4
2	31.8
3	46.0
4	41.2
5	9.0
6	6.0

Example:

Air Quality: 0.3(15) + 1.0(6) + 0.1(9) + 0.2(9) + 0.6(4) + 0.3(6) = 17.4

It can be seen that, using this weighting, the potential impact of a landfill is greatest for land use, esthetics, and water quality.

FIG. 1.—Matrix Indicating Total Site Effect on Each of Six Basic Environmental Parameters

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METODOLOGIAS PARA DECLARACIONES DE IMPACTO AMBIENTAL

TEMA IX: PREDICCION Y ESTABLECIMIENTO DEL IMPACTO EN MEDIOS ACUIFEROS

Dr. George W. Reid
Marzo, 1978

Lecture #9

by G. W. Reid

Prediction and Assessment of Impacts on Water Environment.

1. Scope, Courses

a- Short term, construction etc.
b- Long term, permanent land use.
c- Resevoirs, powerplants, industry, parks.
d- Direct, indirect

2. Basic Steps

a- Identify types of pollution - attributes
b- Existing water quality and quantity levels
c- Forecast Pollutants levels
d- Identify treatment, alternatives, costs.
e- Impact

Mesoscale - aggregate loads
Construction phase
Microscale - specific concentrations frequency, location

3. Data

a- Pollution - Ecological Normal
b- Pollution - Ecological Abnormal
c- Water Quality Attributes
d- Sources

Industry
Municipal
Non-Point
Agricultural
Erosion

Lecture #9

by G. W. Reid

WATER QUALITY MODELS

One of the increasingly important elements in the design of water resource projects is, of course, the management of quality and a technology that was almost purely hydrological and hydraulic is now being expanded to include what might be classed as the environmental and ecological impact areas and systems. So, it is no longer sufficient to understand the interrelationships, flows and transports, but to this must be added the impacts on the living and nonliving water, and peripherral environments; with a need to develop ecological models or more specifically, water quality models. Unfortunately, there is rarely adequate data to properly describe these interrelationships. The methodology used for hydrological studies involving inadequate data such as the transfer of observed points to points of interest; short term intense studies; or use of simulatinn techniques, can and are being used in quality management modeling. Perhaps more basic is an understanding of data requirements, using the system approach, the sequence of events are (1) problem formulation, (2) symbolic modeling, (3) data collection, (4) analysis and (5) design. (See Figure 1) Frequently, the order is changed, particularly the entire process will start with available data.

The complexities, of course, arise due to the fact that the processes associated with water quality management: hydraulic, hydrological, chemical, biological and ecological -- are extremely and imperfectly understood. So, that is a complex reality, with a great many variables on which there is available very poor measures and which themselves interrelate in ways very inadequately understood -- must be measured and appropriately related to be useful. Certainly, one recognizes the superiority of an explicit quantifiable data and models over intuitive models and hunches. The alternatives to such a model, based on partial knowledge, is a mental model, based on the mixture of incomplete information and intuition similar to those controlling most political decisions. A mathematical model deals with the same incomplete information available to an intuitive model, but through organization of information from many different sources into a closed loop at last analyses is permitted and data needs studied.

Problem Formulation: To arrive at a water resource project design, the number of variables is enormous, and they are mostly nonlinear. The structure of the system is more hierarchical than functional, and many of the parameters and variables are unquantified at present, certainly those associated with ecology. Nonetheless, to some degree, a merging of disciplines and the increased use of the system approach has been taking place in the study of water systems, and it is not just a matter of collecting data and figuring out what one has.

If one looks at the type of models being postulated for the design of water quality systems today, it will be seen (Figure 2) that they fall within a spectrum ranging from erudite mathematical models at one end of the spectrum to scenarios at the other. In the first case, the mathematical models may be rigorously developed in a mathematical sense, but all too often are of little use in describing a real complex system in inadequate data. On the other hand, the scenario model -- little data, numerour ideas -- may accurately depict the significant elements of the real system, but it is of little use to the engineer-planner because he cannot manipulate it or quantify it.

The target one should try to hit is a reasonable and useable balance between the poles of intuition and selecting hard data. One would like to be able to use the mathematical rigor of the physical scientist and, at the same time, give equal weight to the hueristic insight of the social scientist. The result would be a useable model for a system design. So, perhaps, or certainly, for planning purposes, one is dealing with the lowest level of quantification that allows good estimates and the lowest level of complexity which gives a reasonable picture of the real world system with the hope of expounding in both directions.

The application of mathematical modeling techniques to water quality management can significantly aid the decision-makers to arrive at better decisions. Thus, modeling provides relevant facts and alternatives, the decision-maker chooses the strategy. Operational models are still primitive, primarily because of the probilistic or random nature of the physical processes involved in waste diffusion. One is sometimes inclined to be skeptical of the value of increasing model sophistication which often seems to have progressed much further than our understanding of the complex real world situation; all models currently proposed in the literature have enormous data requirements which far exceed the data usually available, and which, for the most part, must be derived from actual measurement. Many parameters in the more sophisticated models are simply not known in actual situations.

The water quality management problem requires:

1. The cause and effect relationship between pollution from any source and the present deteriorated quality of water in the estuary.
2. Forecasting variation of water quality due to the natural and man-made causes.
3. Methods of optimal management, including treatment and flow regulation to control the quality in the estuary for municipal, industrial, agricultural, fisheries, recreation and wild life propagation.
4. Chemical, biological, hydrological, hydraulic, at the same time, same place, and same accuracy.

<u>Models</u>. In modeling there is always a certain incompatibility between concepts of substance and generality; data representativeness of the real world. The aim, of course, is to provide through an idealized abstraction an approximate behavior of the system which always in a compromise between simplicity and reality. Water quality models can be used to simulate, describe and predict, and programming leading to optimization of design. Programming which leads to policy requires an explicit set of objectives, or an objective function to maximize benefits or minimize costs. Simulation does not require explicit results. So, simulations are

misunderstood, if one expects to use the numerical projections and values.

Using numbers is wrong if it leaves the impression that design projections are in any way predictions of the future. It is helpful, not as a prediction but to get one to realize how short-sighted — how present-oriented — images of the future ordinarily are, but extrapolation of present trends is a time-honored way of looking into the future. Most people intuitively and correctly reject extrapolations — the point is that it provides indications of the system's behavioral tendencies and as an analysis of current trends, of their influence on each other, and of their possible outcomes.

Models may be classified usefully by areal extent into national, regional and local . At the highest, or national level, data is necessary for broad planning purposes, such as to determine an overall level of water pollution, to determine the total investment necessary for pollution abatement, to determine national policies and to project the problems into the future. At the second highest level, the regional level, all of the above information is necessary, plus the particular information needs for the region. The third, local level, consists usually of checking the operation of waste treatment plants to insure compliance with regulations and statutes. Thus, due to the different requirements and objectives, a data program which may be optimal at one level, is usually far from optimal at some other level. Unless a clear objective has been set, there is no guarantee that all critical bits and bytes of information are collected, and that the gathering of useless data is minimized. Similar calssification classification can be made with relation to time.

Hypothetical attempts to describe the intricate relationships between nutrients, phytoplankton, zooplankton, fish, detritus, bacteria and man-induced waste loads have resulted in a great variety of models. One of the first developed, classical Streeter-Phelps equation, describes adequately the deoxygenation and reoxygenation in the river. The familiar form of the oxygen sag equation is:

$$D = \frac{kL_o}{r-k}\left(e^{-k_1 t} - e^{-k_2 t} + D_o e^{-k_2 t}\right)\left(\frac{k_1}{k_2} - \frac{L_o}{k_1}\right) \qquad (1)$$

where:
D = oxygen deficit at time t
D_o = oxygen deficit at time zero
L_o = BOD at time zero
t = time (distance) in days
k_1 = deoxygenation coefficient
k_2 = reoxygenation coefficient

This equation has been expanded to provide for evection and diffusion; algae growth, benthal deposits, etc., into, inreality, impossible data requirements. The basic need is for models somewhere between two poles that are built using existing data and as such can be responsive to the needs of the action agencies. It is in this realm in which the author has developed a series of water quality models. The projects being modeled generally are of such a nature that the ultimate realization will occur long after the departure of the designers, and as such direct validation procedures are impossible, necessitating some form of internal validation or internal integrity. The problem is one of using what information is available for a 50-100 year future, and doing it in such a fashion that it is not so elegant that it becomes a classroom make-believe world. The essential thread in the author's methodology is that of recognizing the complexity of a problem and drawing on a combination of OR techniques, deterministic techniques, as well as imperical, phenomological, and analytical methods. River system models respond to organized pollution in modes.

There are suggested six categories of stream responses: biodegradable, nutritional, bacterial, solids, persistant of slowly degradable chemicals and thermal. The response of a given stream to these categories can be formulated; or the reverse, given an instream criteria (RQS), allowable effluent quality can be calculated. The specific criteria now can be grouped under response headings; for nutritional, one might select N, P, [illegible] or [illegible], etc. If primary treatment is established as a lower constraint on the effluent, the solids criteria can be deleted; and further, if public health constraint on toxic and bacterial levels can be exercised, four rather than six responses can now be used leaving a four-by-four matrix to be examined.

TABLE I

	Municipal	Industrial	Agricultural	Recreational
Biodegradable	Controlled by D. O. levels			
Nutritional	Controlled by N and P levels			
Thermal	Controlled by Temperature increases			
Persistent Chemical	Controlled by Salt	CCE's or ABS, etc.		

So, a response/use matrix, changing with time will set goals; based on a matrix such as the one in Table I and alternative socio-operated projections. A linking technical basin model can be built and operated to provide the optimal use of water resources, and of necessary treatments; or in planning for future population increases and the concomitant increased use of water, it is possible to build mathematical models depicting the optimum treatments and stream flows necessary to meet the RQS. The one-to-one input-output relationships for the four catagories of waste discharges follows with the Low Flow Augmentation FA), associated with each treatment level (TL_i), will be Q_L, Q_N, Q_P and Q_T. This is a terminal flow in MCD. TL_i is a fraction where i refers to BOD, N and P.

BIODEGRADABLE MODEL (L)

$$Q_L = \frac{Y}{\epsilon} + (1-Y) \frac{PE \text{ or } P}{C_s - RQS_{DO}} A \ (P) \qquad (2)$$

(1) where:

Y = Fraction of total population in SMA's
ε = Efficiency term, Point Load/Uniform Load
PE = Population Equivalent in millions
P = Percentage discharge to river, expressed

as a fraction, Decision Variable = (1-TL)

C_s = DO saturation level @ given temperature

$A = \dfrac{942,900}{k_2 \frac{nL}{V}}$ relates to stream characteristics

where n is essentially the number of reoxygenized volumes, k_2 the reaeration constant, L the reach, V the velocity -- these values will change as the stream itself is subject to management.

ACCELERATED EUTROPHICATION MODEL (N)

$$Q_N = \frac{Z \cdot P}{F_N \cdot RQS_N} \quad (1-TL_N - 1.44\ (1-TL_L) \quad (TL_L 3250) \tag{3}$$

$$Q_P = \frac{Z \cdot P}{F_P \cdot RQS} \quad (1-TL_P) - .27\ (1-TL_L) \ (TL_L\ 1080) \tag{4}$$

where:

Q_P or Q_N = Nutritional Dilution Required, MGD

Z = Relative portion impounded and effected by RQS_{AGP} level

P = Population, millions

TL_P or TL_N = Phosphorus or Nitrogen removal level expressed as a decimal

F_N or F_P = BOD/P Ratio divided by optimum combining ratio

TL_N = BOD removal level expressed as a decimal

RQS_P or RQS_N = Acceptable level, RQS determined by RQS_{AGP}

THERMAL MODEL (T)

$$Q_r = \frac{\Delta T_W - C}{\Delta T_Q + C} \cdot \Delta Q \tag{5}$$

Q_r = Thermal Dilution Required, MGD

ΔT_W = Allowable temperature difference between added flow and RQS_t $(t-RQS_t)$

ΔT_Q = Allowable temperature change $(RQS_T - T_o)$

C = Ratio of K/V_x when K = Geometric mean for Bowmen's ratio and V =

subsidance velocity

ΔQ = Waste Flow, MGD

CONSERVED OR PERSISTENT CHEMICAL MODEL (C)

$$Q_C = \frac{W_C \times \Delta Q}{RQS_C} \qquad (6)$$

These models, though cast in terms of dilution requirements, can be altered, given a diluted level to provide permissible loadings. The models (2) thru (6) are based on organized (sewered) pollution. Models for storm drainings or dispersed pollution have also developed such as:

DISPERSED POLLUTION MODEL (D)

$$Y_2 = 4.8 + 0.0827X_2 + 0.489X_8 \qquad (7)$$

where Y_3 is BOD

$$Y_5 = 2.36 - 0.188\ \ln X + .310\ \ln X_{10} \qquad (8)$$

where Y_5 is ON and Y_6 is PO_x in

$$Y_6 = 2.90 + .00003X_1 - .0001X_3 - .0137X_8 - .741X_{11} \qquad (9)$$

and X_1 = population

X_2 = population density

X_3 = number of households

X_8 = commercial establishments

X_{10} = streets

X_{11} = environmental index

Models (2-9) can be used to relate waste inputs to stream responses under varying municipal stream characteristics and against varying goals (RQS). Many technical models are available to project flows (Q), and other stream characteristics k_2, L, V, etc. but a final model is needed for evaluation of the effects of the rural upstream watershed programs on downstream runoff to complete the set. Such a model was developed for the Congress in 1969.[1,2]

1 For details of model development see, THE OUTLOOK FOR WATER, Wollman and Bonem, The John Hopkins Press, Baltimore & London, 1971, Appendix C., p. 203.

2 This was a special consultative report to the Secretary of the Interior, October, 1967.

UPSTREAM USE MODEL (U)

$$Y = -16 + X_1X_3 - 137X_2 \tag{10}$$

Where:

Y = percentage of normal runoff
X_1 = percentage of normal precipitation
X_2 = percentage of watersheds controlled by hydraulic structures
X_3 = annual above one inch precipitation

In these equation, the simple Phelps equation (1) has been reduced to:

$$dL = \frac{k_2}{k_1} dO = f\ dO \tag{11}$$

That is to say, the load equals the capacity. Distribution factors are added, load is put in terms of people, PE's, etc. This is useable. On the other hand and by way of contrast, O'Connor uses a one dimensional, differential equation, first involving:

$$\frac{\partial D}{\partial t} = \frac{1}{A} \frac{\partial}{\partial x} (QC) - kdL - k_n L^n + ka\ (C_s - C) -$$

$$S_B (X_1 t) + P(X_1 t) - R(X_1 t) + C_r \left(\frac{\partial \Omega}{\partial X} /A\right) \tag{12}$$

Expanding this to three dimension, (x, y, z,) would require:

$$\frac{\partial O}{\partial t} = \frac{E_x \partial^2 O}{\partial x^2} + \frac{E_y \partial^2 O}{\partial y^2} + \frac{E_z \partial^2 O}{\partial x^2} -$$

$$\frac{U_x \partial O}{\partial x} - \frac{U_y \partial O}{\partial y} - \frac{U_z \partial O}{\partial x} - k_i c \text{ , etc.} \tag{13}$$

Also the evaluation of E's, U, K_i, etc. in terms of velocity, solar energy, depth, turbidity, etc. [3]

The effectiveness of models is, of course, acceptance. Actually, very few models have been used. Limitations of applying them to "real" systems are rooted in many factors, most related to data inadequacies; the acquisition of proper data, adjustment of non-homogenity, or inconsistency, to name a few.

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[3] SYSTEMS ANALYSIS AND WATER QUALITY, Thoman, Environmental Science Service, New York, 1972.

Every model, or system, is always embedded in a larger system in space or time, so one is limited to selection of a free body cut and exogenously determined parameters. Finally, serious factors, mostly associated with social values cannot, at present, be quantified.

An efficient use of models thus, argues for different models to answer different question. For example, one for sediments, one for social costs, etc. The systems process is iterative and continues while the models are refined and until satisfactory results are obtained.

The flow of information for all the mested models eventually leads to the decision process. Forward and feedback information flows take place between models until the alternative selection and information developed is accepted for decision-making. As illustrated, there is no attempt to "hang" all models together. More important, different levels of data, can be used in each mode, providing homogenity in each model.

DATA

The data must support the models. Some of the questions for which answers are needed are, goals, include,:

1. What significant parameters of water quality should be measured, for an alert system, for treatment plant control, for a quality forecasting system, for a river management system?
2. What should be the periodicity or time interval in collecting specific data?
3. What are the cross correlations of these parameters?
4. Are there any synergistic relationships between the parameters?
5. What is being accomplished to develop instrumentation that can gage quantitatively those essential parameters, such as BOD, that are not being measured automatically at the present time?

So, there are all sorts of data, much of it redundant. One needs a model to discover needs, costs, etc. The process is shown graphically in Figure 3.

Data has a cost, collection and deferral of decisions.

The quantity of information collected should be increased so long as the present value of the investment opportunity (or cost savings if this is the use to which the information is put) is increased by more than the cost of the information.

The expected value of a decision will be low with little data available, but will rise with more data available. With little data available, the solution often would be overstated (resulting in unused capacity) or understated (resulting in lost opportunity), thus reducing the expected present value of the opportunity. For small enough quantities of data, the expected value will be negative.

The conclusion that the decision take place when the cost of getting one more year of information is equal to the resulting increase in expected present value. The cost of getting one more year of data is made up of two elements, the outlay during the during the year to get the data, k, and interest on the expected present value of the opportunity one would experience if a year of waiting is not included. That is, if V(t) is the basic function, one should not wait until its rate of increase, V'(t), is equal to [rV(t) + k], where r is the rate of discount (the rate of return on investment).

Several conclusions are evident. First, it never will pay to wait for "complete" information. Second, an extremely important element of the problem is the cost coming from postponement of the stream of net revenues from the decision. This factor means it does not pay to accumulate data until the increment in expected value is equal to the annual cost of the data.

Experience in the United States has resulted in the common utilization of only eight water quality parameters that are thought to satisfy the requirements of reliability, accuracy, and low maintenance. These parameters are dissolved oxygen, pH, turbidity, conductivity, temperature, ORP, solar radiation intensity and chlorides. Time sequence is important. Parameters needed today may not be the correct ones tomorrow.

FIGURE 4

TIME SCHEDULE FOR WATER POLLUTION ABATEMENT

Time	Secondary Treatment	BOD Eff	N&P Eff	TDS Eff	Thermal Eff
1960	x				
1970	x	x			
1980	x	x	x		
1990	x	x	x	x	
2000	x	x	x	x	x
Criteria	Fish Kills Water Treatment Problems		Eutrophication	Reuse	Recycle

Figure 4 suggest a water pollution abatement time scale; that is, the standard will be upgraded with time, and the resource must be used within these constraints.

One is still concerned with the frequency with which data should be collected, the optimum locations of collection, the provisions for data storage and the resources for analysis of the data. The use of a short-term survey approach or establishment of a minimal number of permanent stateions. An analysis of historical data will yield insight into those parameters which require continuous analysis because of significant fluctuations and help to identify those locations which best identify changing conditions in the receiving water.

In contrast to the monitoring of a simgle point over a long period, studies can be concentrated over shorter times but more intensive. There is a question of manual collection versus continuous, automatic recording. All parameters of interest can be determined on a continuous basis and the results transmitted to a central storage facility, while water quality parameters that can be economically and dependently measured in the field are still somewhat limited.

CONCLUSIONS

Briefly, models to illucidate design parameters should be built with available data in mind. By a process of separating and nesting, submodels can overcome inconsistencies. If goals are precisely stated as to function, various parameters can be represented by what is available. The author has developed a series of models using very general data, leaving a latitude of alternative data items to define a parameter. Data has a cost, collection and opportunity or decision errors also cost. If inadequacies continue, short-term intensive studies are justified, either now or backward, for example, point reviews can be used. Manual systems can be replaced by automatic monitors; all eight suggested parameters handled by electrodes. Generally speaking, however, automatic monitors tend to provide more data than are needed, because noone dares to turn these expensive machines off or set the sampling interval to such a time interval that meaningful deviations can be recorded.

One never has adequate data, nor can one afford to wait for it. So, models must be made using every device available, recognizing that the final result will still involve uncertainty and risks, and require judgement — the only defense against inadequate data.

TABLE 8

EROSION RATES REPORTED FOR VARIOUS SEDIMENT SOURCES

Sediment Source	Erosion Rate ton/sq. mi./year	Geographic Location	Comment
Natural	15-20	Potomac River Basin	Native Cover
	32-192		Native Cover
	200	Pennsylvania and Virginia	Natural Drainage Basin
	320	Mississippi River Basin	Throughout Geologic History
	13-83	Northern Mississippi	Forested Watershed
	25-100	Northwest New Jersey	Forest and Under-Developed Land
	115		Soils Eroding at the Rate They Form
Agricultural	12,800	Missouri Valley	Loess Region
	13,900	Northern Mississippi	Cultivated Land
	1,030	Northern Mississippi	Pasture Land
	10,000-70,000		Continuous Row Crop Without Conservation Practices
	200-500	Eastern U.S. Piedmont	Farmland
	320-3,840		Established as Tolerable Erosion
Urban	50 50,000	Kensington, Maryland	Undergoing Extensive Construction
	1,000-100,000		Small Urban Construction Area
	1,000	Washington, D.C. Area	750 Square Mile Area Average
	500	Philadelphia Area	
	146	Washington, D.C. Area Watersheds	As Urbanization Increases
	280		
	690		
	2,300		
Highway Construction	36,000	Fairfax Co., VA	Construction on 179 Acres
	50,000-150,000	Georgia	Cut Slopes

Table 2: REPRESENTATIVE RATES OF EROSION FROM VARIOUS LAND USES

	Metric Tons/ sq km/year	Tons/ sq mi/year	Relative to Forest = 1
Forest	8.5	24	1
Grassland	85	240	10
Abandoned Surface Mines	850	2,400	100
Cropland	1,700	4,800	200
Harvested Forest	4,250	12,000	500
Active Surface Mines	17,000	48,000	2,000
Construction	17,000	48,000	2,000

RELATIVE EROSION FROM VARIOUS LAND USES: NATIONWIDE

Commercial Forests	1
Abandoned Surface Mines	< 1
Active Surface Mines	2
Construction	6
Harvested Forests	11
Grassland	11
Cropland	168

Figure 3

Relationship of Drainage Area, Sediment Yield and Construction Activity: Suburban Maryland

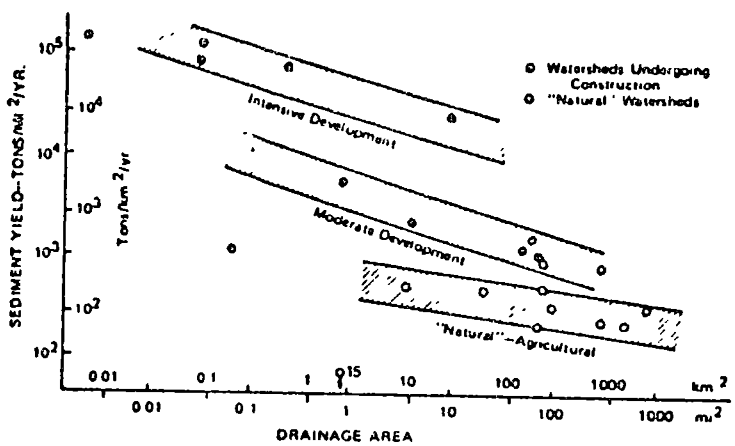


Table 3

Annual Non-Point Pollutional Impacts by Land Use

LAND USE	QUALITY PARAMETERS						
	IMPERVIOUSNESS (DEGREE)	BOD LBS/ACRE/YEAR	N LBS/ACRE/YEAR	P LBS/ACRE/YEAR	PO_4 LBS/ACRE/YEAR	EROSION	TEMPERATURE CHANGE
NATURAL FORESTS (GRASSLANDS)	LOW	SMALL	89	009	3	LOW	
AGRICULTURE (FARMS)	LOW		2 4 24	92 3 88		HIGH POTENTIAL	SMALL
FEEDLOTS	HIGH	VARYING WITH ANIMAL TYPE DENSITY & MANAGEMENT PRACTICES				HIGH POTENTIAL	SMALL
SINGLE FAMILY RESIDENTIAL	LOW MEDIUM	5 9	6	2	6		VARIES WITH DEGREE OF COVER REMOVED AND SURFACES HEATED (5° to 15°)
MULTI FAMILY RESIDENTIAL	MEDIUM	14	2 5	67	2 1		
COMMERCIAL	HIGH	4 [illegible]	2 4	1 3	3 9		
INDUSTRIAL	VERY HIGH	23 4	3 3	58	1 7		
RESOURCE EXTRACTION	VARIES WITH METHODOLOGY AND MANAGEMENT PRACTICES						
RECREATION	VARIES WITH INTENSITY OF USE-EXTREMELY SENSITIVE TO OVERUSE						
URBAN & ROAD CONSTRUCTION						30,000-150 000 TONS/ACRE	

TABLE 4

SUMMARY OF REPORTED NUTRITIONAL LOADINGS

Source	Nitrogen Pounds/Acre/Year	Phosphorous Pounds/Acre/Year
Farmland runoff	---	0.35 (Total-P)
Good management	1.0 (NO_3-N)	0.10 (PO_4-P)
Poor management	5.3 (NO_3-N)	0.25 (PO_4-P)
4 lb/A/yr applied	0.7-3.0(Total-N)	0.06-0.2 (Total-P)
Irrigation return flow	2.45-24.0(Total-N)	0.95-3.88(Total-P)
Urban runoff	8.2 (Total-N)	0.87 (Total-P)
	2.95-15.97(organic-N)	3.32-20.20 (PO_4-P)
Rainfall at 30"/yr	4.8-32 (NO_3-N)	0.18-0.54 (PO_4-P)
	0.14-9.5 (inorganic-N)	---
	10 (N)	---
Forest runoff	1.30-2.96 (Total-N)	0.32-0.77 (Total-P)
	0.5 (Total-N)	0.03-0.06 (Total-P)
leaf litter	6.5×10^{-7} (NO_3-N)	---
Domestic waste	lb/cap/yr	lb/cap/yr
	6.9-10.7 (Total-N)	1.3-3.8 (Total-P)
Septic tanks	8 (NO_3-N, ground water seepage)	
Waterfowl	lb/duck/yr	lb/duck/yr
	1.2 (inorganic-N)	0.3 (Total-P)

TABLE 5

AGRICULTURAL POLLUTIONAL LOADS

	TOTAL N (Lbs/Acre/Year)	TOTAL P (Lbs/Acre/Year)
Surface	2.45 - 28.3	0.68 - 3.99
Subsurface	38 - 166	2.5 - 8.9

Source: Sylvester, Robert O., Algae and Metropolitan Wastes, Transactions of the 1960 Seminar, U.S. Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, 1961. (Bartsch, Alfred F., Ed.) (2)

Witzel, Stanley A., Nitrogen Cycle in Surface and Subsurface Waters, Water Resources Center, The University of Wisconsin, December 1968. (23)

TABLE 6

SUMMARY OF REPORTED BOD LOADS

Source	Load	
Urban runoff, 34" rainfall/yr	30.5 lb/Acre/year	
Rural cultivated land runoff	0.5-23 mg/l	
Silo drainage	4400 mg/l	
Stock floor washings	2000 mg/l	
Rainfall	9-16 mg/l COD	
Domestic waste	73 lb/cap/year	
Industrial waste	lb/unit produced	mg/l
Explosives	320/100,000 lb TNT	1070
Synthetic fibers	77/1000 lb product	713
Paper and pulp	53/ton product	266
Poultry	26.1/1000 chickens	476
Sugar beet	13/ton produce	580
Meat packing	12/1000 lb live wt	1384
Tanning	4.55/100 lb hides	806
Brewery	2.6/barrel	964
Textile	2.45/100 lb each process	440
Milk	1.16/1000 lb intake	857
Cannery	0.365/case	1188

TABLE 7: TYPICAL COMPOSITION OF DOMESTIC-SEWAGE
(All values in mg/liter)

Constituent	Strong	Medium	Weak
Solids, total	1000	500	200
Volatile	700	350	120
Fixed	300	150	80
Suspended, total	500	300	100
Volatile	400	250	70
Fixed	100	50	30
Dissolved, total	500	200	100
Volatile	300	100	50
Fixed	200	100	50
BOD (5-day, 20 degrees C)	300	200	100
Oxygen consumed	150	75	30
Dissolved oxygen	0	0	0
Nitrogen, total	86	50	25
Organic	35	20	10
Free ammonia	50	30	15
Nitrites (NO_2)	0.10	0.05	0
Nitrates (NO_3)	0.40	0.20	0.10
Chlorides	175	100	15
Alkalinity	200	100	50
Fats	40	20	0

TABLE 8

SUMMARY OF BACTERIAL LOADS

Source	Coliforn/100 ml	Coliform/cap-day
Raw sewage	1,000,000	$3.7x10^9$
Treated sewage		
Primary treatment	500,000	$1.8x10^9$
Activated sludge	60,000	$2.3x10^8$
Biological plus		
chlorination	15,000	$5.7x10^7$
Urban runoff 34" rainfall/yr	1,275,000	$5.5x10^{10}$/A-day
Irrigation returns	—	insignificant

Water Quality Rating Systems Short Comings

Say Attribute/Points

Attribute/Points	1	2	3	4	5
Turbidity	.1	1	10	100	200
Zn	.03	0.3	3.0	30	60
Coli	0	1	5	10	100
pH	5	6	7	8	9

WQR Underlined

Case I

		Points
Turbidity	10	3.0*
Zn	.05	1.0
Coli	1	2.0
pH	5	1.0
		7.0

Case II

Turbidity	1	1.0
Zn	3.0	3.0
Coli	1	2.0
pH	6	2.0
		8.0

or-

Zn @ pH5	.03
Zn @ pH6	3.0

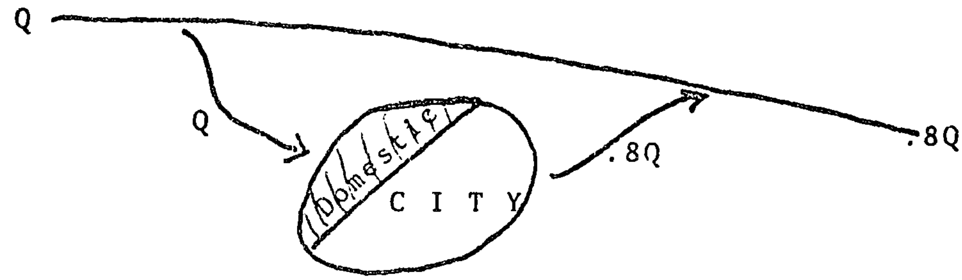
TREATMENT/REUSE/USE/ETC./LAND MANAGEMENT

There exists considerable concern as to the selection of the proper alternative for waste handling, usually classified as Treatment and Reuse, Land Application or Treatment and Discharge. These general strategies are graphically displayed in Figure 1. and Tables I and II. All strategies can be considered looked at as reuse, intentional or unintentional. That is to say, water is a reuse commodity, there is no ownership involved. It is just a matter of who does what, or more specifically perhaps the level of aggregation.

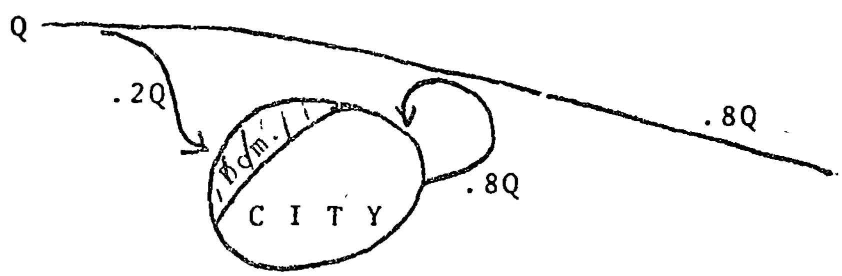
The comparative feasibility of each of the general propositions, discharge, land application, and intentional reuse, are difficult to assess, because they will vary with source of water (river, ground, brackish, or sea). They will vary with, as has been noted, the regulatory levels of discharge, e.g., 30/30 vs 10/10. They will vary with intended uses usually classified as; process, cooling, groundwater recharge, and of course, with the economies of scale.

To structure these comparisons the authors have resorted to a series of strategies -

I. Treatment and Discharge: Herein, the full flow required is treated and returned to the river, ground, or sea, the receiving system. The losses are estimated at 20%, that is a depletion of .2Q results and a return flow of 0.8Q.

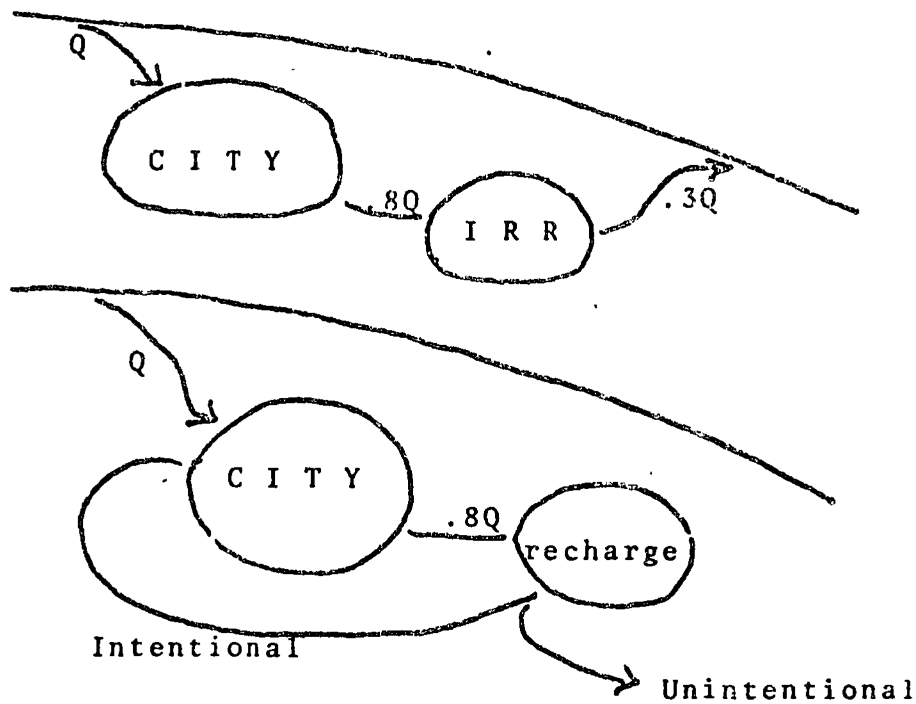


II. Treatment and Reuse: The amount of treated waste that can be used is reused. At the present, this is limited to nonpotable demands. Two quality levels are suggested.



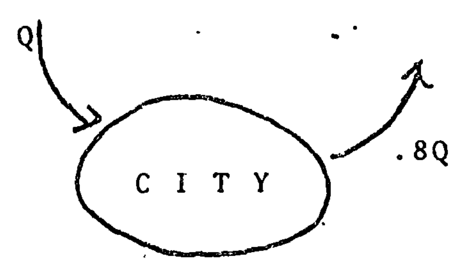
The new water required is essentially the domestic demand. This is not rigorously true, because reuse is limited by solids buildup, possibly to three cycles. The reuse demand potential, of course, will vary with the size and character of the city's industry. If it is less than 180% of the overall demand more new water will be required. So the flow pattern could vary from the above to that in Strategy I.

III. Land application: This, of course, depends on availability of land, etc.



Irrigation will cause considerable flow depletion, comparison of the three land application strategies are shown on Table III.

IV. Brackish or Sea Water Source: The important consideration here, is that reuse treatment cost, and desalting cost are essentially the same.



V. Internal "In Plant" Reuse: Internal "in plant" reuse, has problems of surge capacity, but is generally given as a cure for the "end of the line or pipe syndrone". Actually, treatment cost are very responsive to economies of scale and the other strategies are cheaper because of scale and opportunities of natural balancing to make it possible to treat an aggregate waste and recycle it. The piping costs would possibly increase.

Reuse is considered primarily because domestic use of reuse water is not practical at present. This is because of consumer attitudes and because there simply are not adequate operational central tests for viruses, organics, and toxic materials. Unfornately, one must rely on processes. Ongerth and Jopling (3) (Water Renovation and Reuse, Academic Press, 1977) have reported consumer opposition of 30% as psycholgically repugnant, 20% lack of purity, 10% can cause disease 10% bodily contact repugnant etc.

Viruses that have been isolated from wastewater are Adenovirus, Coxsackievirus, Echovirus, Poliovirus and Reovirus. Virus removal in water or wastewater treatment is dependent upon the type of treatment process utilized. Certain processes are more effective in virus removal than other processes. Very precise measurements of treatment efficiency in virus removal are not possible now because we are not able to efficiently concentrate small numbers of viruses from large volumes of water, nor are we able to identify the possible viruses that may exist. The development of efficient technology for detecting viruses and identifying those viruses has been, and continues to be, a central need in water pollution research. Coagulation, filtration, and application of free chlorine appears to be the method of choice. At present the virus concentration test requires 2-3 weeks at a cost of approximately $100/test, with a sensitivity of a "spiked" sample of log 5, or 99,999%. Use of chlorine and activated carbon in virus control have secondary problems; i.e., producing undesirable CCl_4, chloroform and phthelates (4).

Heavy metals and many synthetic chemical compounds are being classified as toxic chemicals to the water users or receiving environment. Generally, the largest single source of heavy metals and synthetic compounds is industrial waste flows. There are numerous treatment processes available to remove individual elements within these general categories. However, currently it appears that the single most effective treatment process for the removal of all wastewater pollutants, including toxic chemicals, is reverse osmosis. It has been suggested that reverse osmosis can effectively remove large organic molecules and poly-di- and mono-valent ions. Activated carbon adsorption, and ion exchange, chemical precipitation, electro-chemical plating are also considered to be effective methods for removing heavy metals and toxic chemicals.

However, all of these listed methods require pretreatment to remove suspended solids and organic compounds that interfere with the process efficiency. Although industrial wastewaters can be excluded/segregated from the wastewater reclamation and reuse system, small concentrations of these compounds still find their way to the collection system through the domestic use of high-strength cleaning products, liquid drain-cleaners, pesticides, and petroleum products. Unit processes capable of removing heavy metals and synthetic compounds are significant to the wastewater reclamation and reuse system. It is important also to provide for identification of trace organics and heavy metals. At present the best methods are TOC and PIXE (Proton Activation Analyses) analyses.

The main terrance of dominate flow where a river is the water source is of considerable importance. The depleted water can be made up by low flow augmentation by providing off-stream or in-stream storage. The cost of storage has been estimated from 10¢ to $1.00/1000 gallons based on Wollman, Bonem, The Outlook for Water, John Hopkins Press, 1971 (5) and Reid, Print 29 Selected Committee of US Senate 1969 on Low Flow Augumentation (LFA) 1969 (6). It is very sensitive to scale. Bearing in mind the aforementioned limitations, the authors will attempt a comparison of sorts of the aforementioned strategies. Cost and flow notations are on Table IV. In Strategy I, Treatment and Discharge, the relative costs, using the cost of treating raw water as 1.0 would be as follows:

$C = Q + C_1 \times .8Q + C_2 \times .2Q$ with adequate dilution available

$C = Q + C_3 \times .8Q + C_2 \times .2Q$ with tertiary treatment required.

Both require a drainage charge for stream flow depletion, estimated as a LFA cost. These are C_1 as 1.0, the relative cost would be:

$$C = 1 + .8 \times 4.5 + .2 \times 10 = 6.5$$

$$C = 1 + .8 \times 7 + .2 \times 10 = 8.6$$

In Strategy II, Treatment and Reuse, Two levels of reuse quality (cooling and processing) are assumed:

$$C = .2Q + C_4 \times .8Q + C_2 \times .2Q$$

$$C = .2Q + C_5 \times .8Q + C_2 \times .2Q$$

or the total cost comparisons would be the following. It is assumed also that there is sufficient industry to use .8Q.

$$C = .2 + 2 \times .8 + .2 \times 10 = 3.8$$

$$C = .2 + 13 \times .8 + .2 \times 10 = 12.6$$

The cost would range from 2.8 - 12.6 depending on the blend of uses. If there is less need for reuse water than .8Q, the cost would also adjust towards 6.5 and 8.6, or Strategy I.

Strategy III, Land Application for Irrigation or Recharge would be:

$$C = Q + C_1 \; .8Q + .7QC_2$$

$$C = Q + .8QC_1 + .4QC_2$$

the comparisons are:

$$C = 1 + 4.5 \times 18 + .7 \times 10 = 11.5$$

$$C = 1 + 4.5 \times .8 + .4 \times 10 = 8.5$$

So in general terms, the lowest cost alternative would be treatment and reuse for cooling or similar quality requirement. The next order would be treatment and discharge where there is adequate dilution. This has assured thru out equal industrial productivity. If higher order treatment for reuse is used then treatment and discharge is superior. Land application is less desirable. In this analyses the need to maintain dominate flow or replenish flow thru LFA courses the considerable differences between discharge and reuse on one hand and land application on the other.

In addition to the cost-effectiveness and conceptual comparisons presented above, process selection also requires consideration of environmental impacts. The key concern is to select wastewater treatment strategies which will minimize detrimental changes and maximize beneficial ones. Selected environmental factors for assessing water quality management plans are shown in Table V. Delineation of the changes in each factor resulting from treatment and discharge strategies, recycle and reuse strategies and land application strategies would enable environmental impacts to be considered in process selection.

A specific comparison of four selected environmental impact factors for a 10 mgd plant is shown in Table VI. Tertiary treatment requires the most energy usage and leads to the greatest atmospheric emissions and traffic; while land application requires the most land of the three strategies shown. Decision models are available for aiding the comparison of alternative strategies and selecting the least process with minimum detrimental environmental impacts.

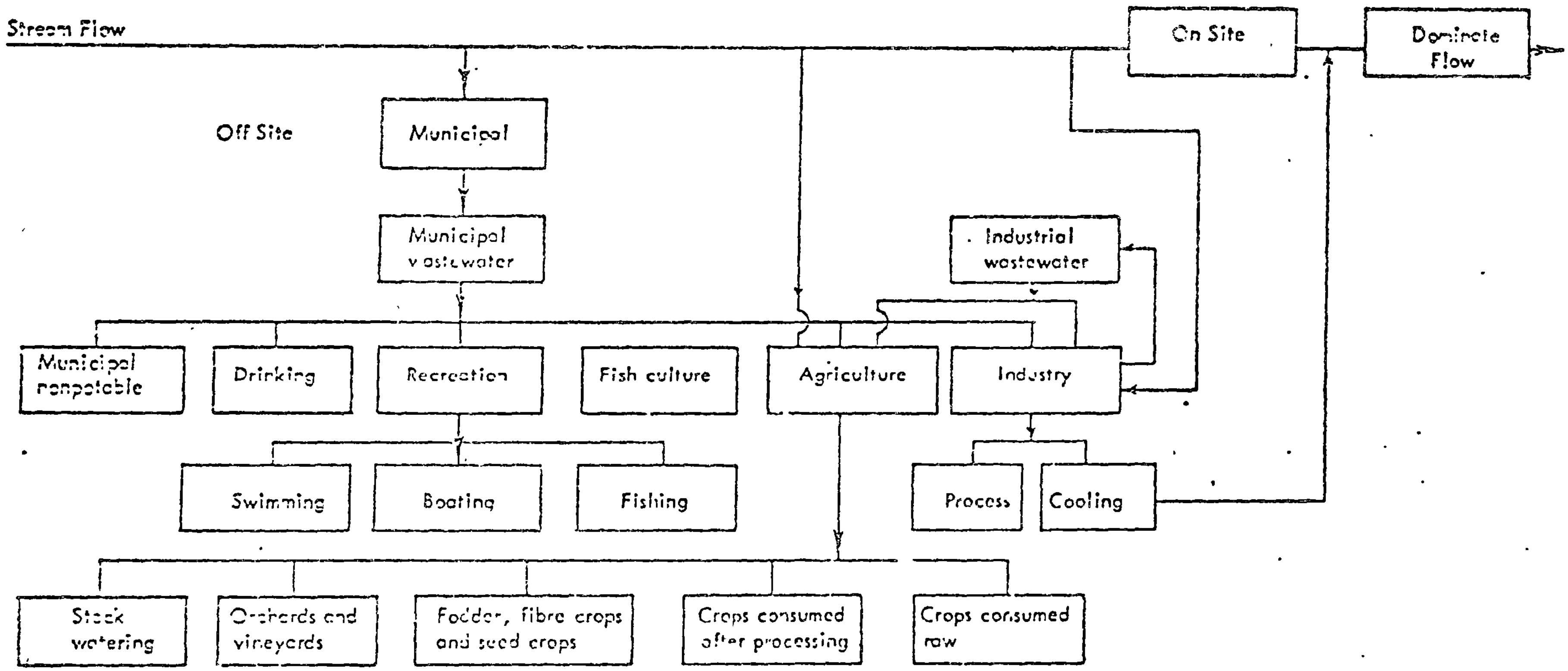
The cost model now becomes:

Cost = Water + Waste Treatment + Revised Treatment + Piping + LFA + Impacts

A benefit and/or net benefit model could also be constructed. The optimal solution of benefits would perhaps be different than the minimum cost model, because the reuse application value varies widely. The total cost equation would have close to 250 possible out-comes, again depending on treatments and levels. Considering the variables and combinations, no specific conclusions should be drawn but rather a methodology to approach a specific problem.

FIGURE 1

GENERAL STRATEGIES



Source: WHO Technical Report Series #517 Geneva 1973 (1).

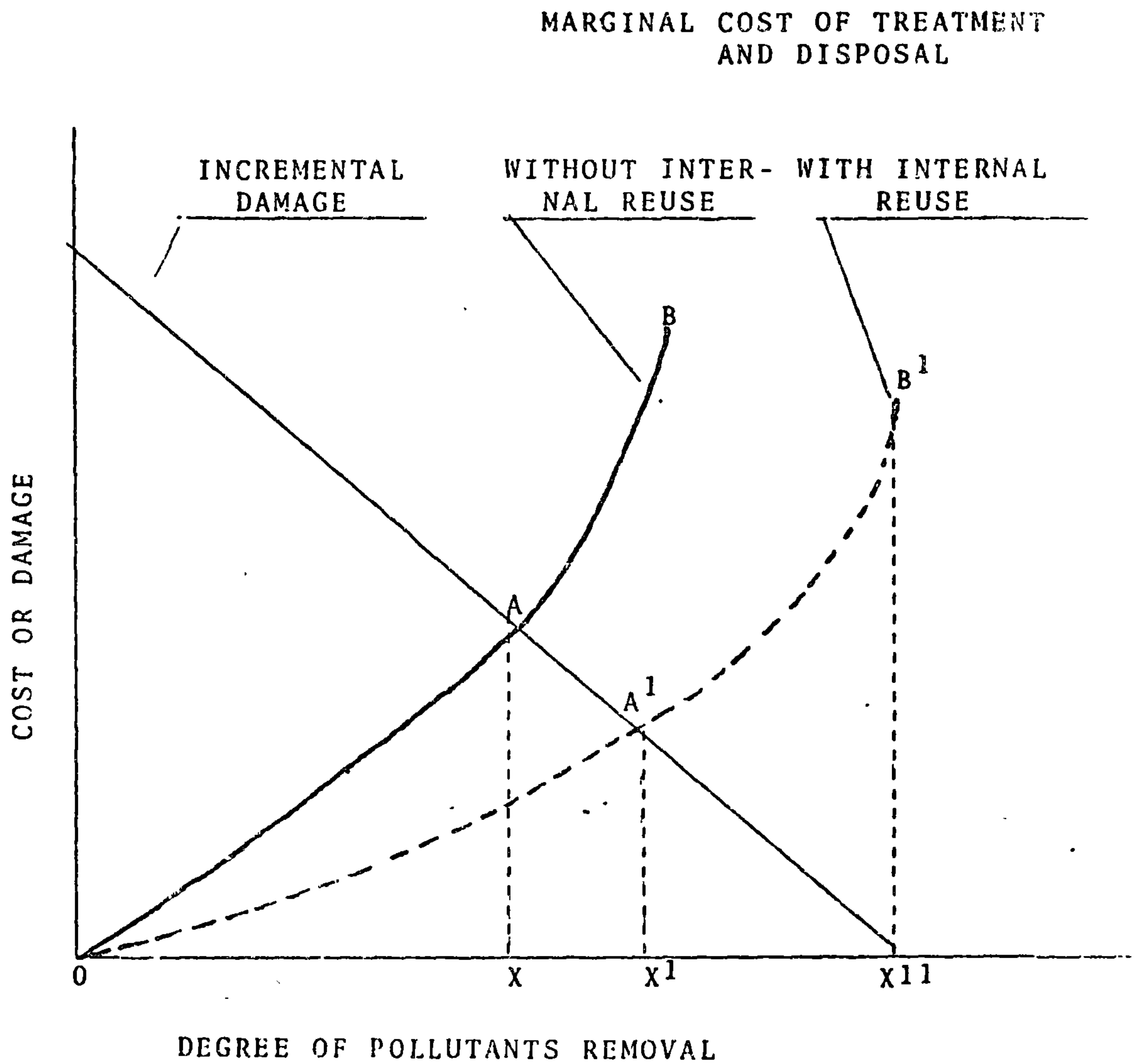


Fig. 2. Effect of wastewater reuse on economically optimal degree of pollutants removal.

TABLE I
CATEGORY DEFINITIONS (REUSE)

Unintentional	-	downstream use, essential as augumentation of river water or LFA, Winhock, etc.
Intentional	-	return of treated waste effluent from a city to the same city's industries, for power, for process
Land Application	-	irrigation, surface discharge, and ground water recharge
Internal	-	recycling around an individual user

TABLE II
EXAMPLES OF WASTEWATER
MANAGEMENT STRATEGIES AND TREATMENTS

Category	Strategies
Treatment and discharge	(1) Biological treatment including ponds, activated sludge, trickling filters, nitrification, and denitrification.
	(2) Physical-Chemical treatment including chemical flocculation, filtration, activated carbon, breakpoint chlorination, ion exchange, and ammonia stripping.
	(3) Systems combining the above techniques.
	(4) Storm and combined sewer control measures.
Wastewater reuse	(1) Industrial processes.
	(2) Groundwater recharge for water supply enhancement or preventing saltwater intrusion.
	(3) Surface water supply enhancement.
	(4) Recreation lakes.
	(5) Land reclamation.
Land application	(1) Irrigation including spray, ridge and furrow and flood.
	(2) Overland flow.
	(3) Infiltration-percolation.

Source: "Environmental Factors Affecting Treatment Process Selection", Canter, L.W. & Reid, G.W., April 1977, Stillwater, Oklahoma(2).

TABLE III
COMPARATIVE CHARACTERISTICS OF
LAND-APPLICATION APPROACHES

Factor	Type of Approach: Irrigation	Overland Flow	Infiltration-percolation
Liquid-loading rate	0.5 to 4 in/wk	2 to 5.5 in/wk	0.3 to 1.0 ft/wk
Annual application	2 to 8 ft/yr	8 to 24 ft/yr	18 to 500 ft/yr
Land required for 1-MGD flow	62 to 560 acres plus buffer zones	46 to 140 acres plus buffer zones	2 to 62 acres plus buffer zones
Application techniques	Spray or surface	Usually spray	Usually spray
Soils	Moderately permeable soils with good productivity when irrigated	Slowly permeable soils such as clay loams and clay	Rapidly permeable soils such as sands, loamy sands, and sandy loams
Probability of influencing groundwater quality	Moderate	Slight	Certain
Needed depth to groundwater	About 5 ft	Undertermined	About 15 ft
Wastewater losses	Predominantly evaporation or deep percolation	Predominantly surface discharge but some evaporation and percolation	Percolation to groundwater
Use as a treatment process with a recovery of treated water	Generally impractical	50 to 60% recovery	Up to 90% recovery
Use for treatment beyond Secondary			
1. For BOD and suspended solids removal	90-99%	90-99%	90-99%
2. For nitrogen removal	85-90%	70-90%	0-80%
3. For phosphorus removal	80-99%	50-60%	70-95%
Use to grow crops for sale	Excellent	Fair	Poor
Use as direct recycle to the land	Complete	Partial	Complete
Use to recharge groundwater	0-30%	0-10%	Up to 90%
Use in cold climates	Fair[a]	--[b]	Excellent

[a]Conflicting data-woods irrigation acceptable, cropland irrigation marginal.

[b]Insufficient data.

Source: Land Treatment of Municipal Wastewater Effluents, EPA Jan 1976
Alternate Waste Management Technology for Best Practicable Waste Treatment, EPA-430/9 75-013 October 1975.

TABLE IV
NOMENCLATURE

City Water Demand = Q, for purpose of this problem estimated at the S-10 MGD level

Cost Estimate Levels, Surface Water Treatment	5¢/1000 gal
Croundwater	Nil
Brackish Water	25¢/1000 gal
Sea Water	65¢/1000 gal
Reuse Water (cooling)	10¢/1000 gal
(process)	65¢/1000 gal
LFA	50¢/1000 gal
Discharge Water (secondary)	23¢/1000 gal
(tertiary)	35¢/1000 gal

<u>Cost Coefficient</u>

C_1 ratio of secondary treatment to intake surface waste water treatment

$23/5 = 4.5$

C_3 ratio of tertiary treatment to intake water

$35/5 = 7.0$

C_3 ratio of LFA to intake water

$50/5 = 11.0$

C_4 ratio Reuse (cooling) to intake water treatment

$10/5 = 2.0$

C_5 ratio Reuse (process) to intake water

$65/5 = 13.0$

TABLE V
ENVIRONMENTAL FACTORS FOR ASSESSING
WATER QUALITY MANAGEMENT PLANS

Area	Component Group	Environmental Factors
Water	1. Aquatic Species and Populations	Vegetation Fish Waterfowl Pests
	2. Aquatic Habitats and Communities	Rare and Endangered Species Species Diversity Species Quality
	3. Water Quality	Coliform Organisms Dissolved Oxygen Nutrient Materials Toxic Materials Total Dissolved Solids Hydrogen Ion Concentration (pH) Temperature Suspended Solids
	4. Hydrologic Environmental Factors	Basin Hydrologic Loss Frequency of Extreme Flows
Air	1. Air Quality	Particulate Matter Gaseous Pollutants and Odors
Land	1. Terrestrial Species and Populations	Vegetation Browsers and Grasers Small Game Animals & Birds Pests
	2. Terrestrial Habitats and Communities	Rare and Endangered Species Species Diversity
	3. Land Use	Compatibility of Use with Existing or Other Planned Uses Intensity of Use Permanency of Use
	4. Topography	Surface Contour Alteration Surface Characteristics Stream, Reservoir and Estuary Shoreline Alteration Geologic Surface Material
Aesthetic	1. Environmental Interests	Recreation Accessibility Recreation Activities Educational/Scientific Educational/Cultural
	2. Man-Made Structures	Architectural Design of Structures Location of Structures
	3. Noise Pollution	Frequency and Duration of Disturbing Noise Intensity of Disturbing Noise

TABLE VI
COMPARISON OF SELECTED ENVIRONMENTAL IMPACTS
FOR A 10 mgd PLANT

Strategy	Energy Usage (KWH/day)	Land Requirement (acres)	Atmospheric Emissions[a] (lb/day)	Traffic[b] (trips/day)
Secondary treatment*	5200	34	none	0.37
Tertiary treatment**	30,000 ($2.7x10^8$BTU) (90 therms)	75	SO_2(7) Hcl(1) Metals(4) NOx(39) Particulates(70)	1.95
Land application***	5900	1305	none	0.21

*Activated sludge process; organic sludge treatment via flotation, anaerobic digestion, sand drying and landfill; liquid effluent quality is 30 mg/l BOD, 30 mg/l S.S., 25 mg/d N, and 10 mg/l P.

**Activated sludge process followed by coagulation-filtration, carbon sorption, and ammonial removal by ion exchange; organic sludge treatment via flotation, anaerobic digestion, sand drying and landfill; chemical sludge treatment via gravity thickening, vacuum filtration, incineration and landfill; liquid effluent quality is 1 mg/l BOD, 0.3 mg/l S.S., 1 mg/l N, and 1 mg/l P.

***Land application following primary treatment; organic sludge treatment via flotation, anaerobic digestion, sand drying and landfill; liquid effluent quality is 3 mg/l BOD, 5 mg/l S.S., 5 mg/l N, and 0.1 mg/l P.

a: from sludge incineration, odors are neglected.

b: traffic reflects the number of trips per day necessitated by a truck-capable of hauling 20 tons of sludge from the plant plus the traffic involved in supplying plant chemical needs.

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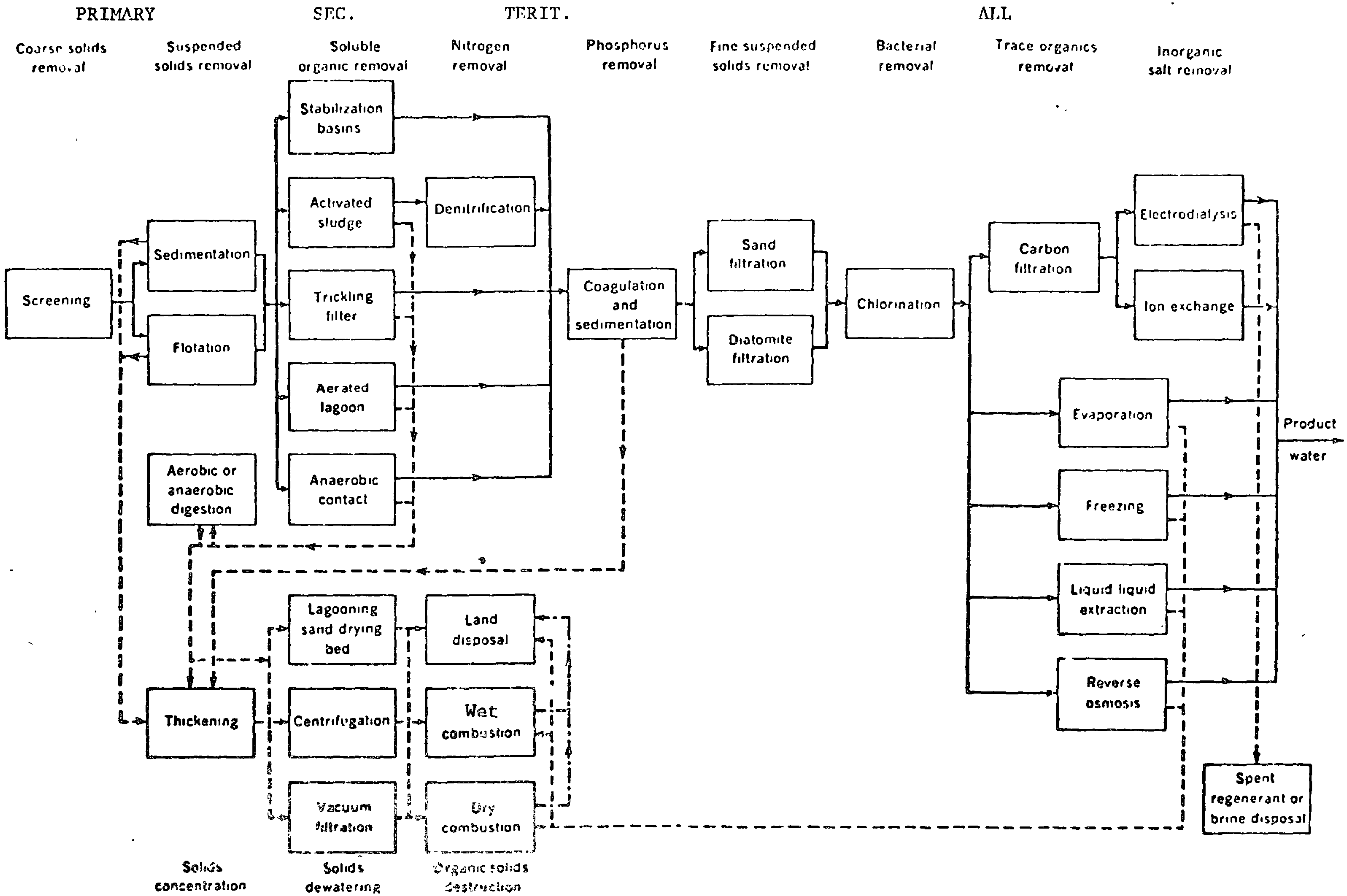
TREATMENT TECHNOLOGY



Estimated Total Operating Costs of Several Treatment Combinations(1)

Combination of Treatment Processes	*Treatment Cost (¢/1000 gal.)*			*Estimated Total Contaminant Removal (%)*			
	1 mgd	*10 mgd*	*100 mgd*	*COD* or BOD_5***	*Phosphorous*	*Nitrogen*	*TDS*
1. Primary + activated sludge (including sludge disposal)	23.3	13.5	8.2	85**	–	–	–
2. Primary + activated sludge + activated carbon	55.6	24.3	15.4	97*	–	–	–
3 Primary + activated sludge + activated carbon + lime treatment + separate nitrification + chlorination	90.3	37.6	22.7	97*	98	85	–
4 Primary + activated sludge + activated carbon + ion exchange + chlorination		47.2 (700 mg/l) 60.2 (1000 mg/l) 73.9 (1500 mg/l)		98*	99	76 (NH_3-N) 86 (NO_3-N)	86
5. Primary + activated sludge + dual-media filtration + reverse osmosis	71.6	49.4	39.3	99+*	99.7+	95 (NH_3-N) 75 (NO_3-N)	95
6. Primary + activated sludge + activated carbon + reverse osmosis	95.4	55.5	43.4	99+*	99.7+	95 (NH_3-N) 75 (NO_3-N)	95
7. Chemically clarified raw sewage + activated carbon + reverse osmosis (product aeration)	86.5	55.3	46.0	95+*	99.7+	90 (NH_3-N) 75 (NO_3-N)	95
8. Chemically clarified raw sewage + dual-media filtration + reverse osmosis (product aeration)	64.2	49 6	43.1	95+*	99.7+	90 (NH_3-N) 75 (NO_3-N)	95

(1) Source Reuse in Water Management, AGS.

SUGGESTED TREATMENT PROCESSES TO MEET THE GIVEN HEALTH CRITERIA FOR WASTEWATER REUSE

	Irrigation			Recreation			Municipal reuse	
	Crops not for direct human consumption	Crops eaten cooked; fish culture	Crops eaten raw	No contact	Contact	Industrial reuse	Non potable	Potable
Health criteria (see below for explanation of symbols)	A + F	B + F or D + F	D + F	B	D + G	C or D	C	E
Primary treatment	●●●	●●●	●●●	●●●	●●●	●●●	●●●	●●●
Secondary treatment		●●●	●●●	●●●	●●●	●●●	●●●	●●●
Sand filtration or equivalent polishing methods		●	●		●●●	●	●●●	●●
Nitrification						●		●●●
Denitrification								●●
Chemical clarification						●		●●
Carbon adsorption								●●
Ion exchange or other means of removing ions						●		●●
Disinfection		●	●●●	●	●●●	●	●●●	●●● [a]

Health criteria:

A Freedom from gross solids; significant removal of parasite eggs.

B As A, plus significant removal of bacteria.

C As A, plus more effective removal of bacteria, plus some removal of viruses.

D Not more than 100 coliform organisms per 100 ml in 80% of samples

E No faecal coliform organisms in 100 ml, plus no virus particles in 1000 ml, plus no toxic effects on man, and other drinking-water criteria.

F No chemicals that lead to undesirable residues in crops or fish.

G No chemicals that lead to irritation of mucous membranes and skin

In order to meet the given health criteria, processes marked ●●● will be essential. In addition, one or more processes marked ●● will also be essential, and further processes marked ● may sometimes be required.

[a] Free chlorine after 1 hour

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METODOLOGIA PARA DECLARACIONES DE IMPACTO AMBIENTAL

TEMA X: PREDICCION Y ESTABLECIMIENTO DE IMPACTO POR RUIDO

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Lecture #10

PREDICTION AND ASSESSMENT OF NOISE IMPACTS

by
L. W. Canter*

Another one of the major impacts from many actions is on the noise environment in and adjacent to the project area. Construction of power plants, highways, airports and pipe lines generates noise intrusions. Utilization of airports and highways, and the operation of compressor stations lead to persistent noise intrusions in the environmental setting.

I. Basic Steps for Prediction and Assessment

A. Identify noise levels for the alternatives under consideration during both the construction and operational phases.

B. Determine existing noise levels for the project area. This may involve field measurements or the determination of land usage patterns. Identify unique noise sources in the area as well as unique places where noise levels must be minimized.

C. Procure applicable noise standards and criteria for the area.

D. Determine the microscale impact by predicting anticipated noise levels for each alternative during both construction and operational phases. Compare predicted noise levels with applicable standards or criteria in order to assess impact.

E. If standards or criteria are exceeded, consider noise abatement methods to minimize impact on the noise environment.

II. Basic Information

A. Terminology

1. Noise can be defined as unwanted sound, or sound in the wrong place at the wrong time. Noise can also be defined as any sound which is undesirable because it interferes with speech and hearing, or is intense enough to damage hearing, or is otherwise annoying.

2. Values of sound power or sound pressure do not provide a practical unit for sound or noise measurement for two reasons:

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a) There is a tremendous range of sound power and sound pressures produced. Expressed in microbars, one-millionth of 1 atmosphere of pressure, the range is from 0.0002 microbar (μbar), the minimum sound pressure of a healthy young human ear can detect, to 10,000 μbars for peak noises within 100 ft. from large jet and rocket propulsion devices.

b) Our ears do not respond linearly to increases in sound pressure. The nonlinear response is essentially logarithmic. The human ear can discern without pain sounds ranging from a threshold to sounds 10^{12} times as intense. (2)

3. The number of compressions and rarefactions of the air molecule density in a unit of time associated with a sound wave is described as its frequency. The unit of time is usually one second, and the term "Hertz" (after an early investigator of the physics of sound) is used to designate the number of cycles per second. Again, the human ear and that of most animals has a wide range of response. Humans can identify sounds with frequencies from about 16 Hz to 20,000 Hz. (2)

B. Sound and Noise Measurement (3)

1. The measurement needs are met by a term, sound pressure level (SPL), expressed as a logarithmic ratio to a reference level and stated in a dimensionless unit of power, the decibel (dB). The reference level is 0.0002 μbar, the threshold of human hearing.

$$SPL = 20 \log_{10} \left(\frac{P}{Po}\right)$$

where SPL = sound pressure level expressed in dB

P = sound pressure (μbar)

Po = reference pressure (0.0002 μbar)

2. Table 1 contains a summary of various sound pressures and the corresponding decibel levels, with examples of recognized sources of noise being cited.

3. As the SPL-decibel scale is logarithmic, decibel values are not additive. For example, and SPL of 74 dB from one source superimposed on one of 75 dB does not result in 149 dB. An SPL of 77.6 dB results. To determine the total effect, it is necessary to convert decibel readings to intensity ratios, then reconvert the new sum back to a decibel value. To aid in this process, Table 2 is provided for determining the cumulative decibel values of two or more known observations

Table 1: THE DECIBEL SCALE OF SPL, WITH SOUND PRESSURES IN MICROBARS, AND RECOGNIZED SOURCES OF NOISE IN OUR DAILY EXPERIENCES

Sound Pressure μbar	dB	Example
0.0002	0	Threshold of Hearing
0.00063	10	
0.002	20	Studio for sound pictures
0.0063	30	Studio for speech broadcasting
0.02	40	Very Quiet room
0.063	50	Residence
0.2	60	Conventional speech
0.63	70	Street traffic at 100 ft.
1.0	74	Passing automobile at 20 feet
2.0	80	Light trucks at 20 ft.
6.3	90	Subway at 20 ft.
20	100	Looms in textile mill
63	110	Loud motorcycle at 20 ft.
200	120	Peak level from rock and roll band
2,000	140	Jet plane on the ground at 20 ft.

Table 2: DETERMINING THE CUMULATIVE DECIBEL SPL WHEN THE DIFFERENCES BETWEEN TWO OR MORE LEVELS ARE KNOWN

Difference between levels, dB	No. of dB to be added to higher level
0	3.0
1	2.6
2	2.1
3	1.8
4	1.5
5	1.2
6	1.0
7	0.8
8	0.6
10	0.4
12	0.3
14	0.2
16	0.1

on individual sources. The value in the difference column in Table 2 is always added to the highest of the two decibel values being handled.

4. In most noise considerations, the A-weighted sound level is used. This level is explained as follows: The ear does not respond equally to sounds of all frequencies, but is less efficient at low and high frequencies than it is at medium or speech range frequencies. Thus, to obtain a single number representing the sound level of a noise containing a wide range of frequencies in a manner representative of the ear's response, it is necessary to reduce, or weight, the effects of the low and high frequencies with respect to the medium frequencies. The resultant sound level is said to be A-weighted, and the units are dB. A popular method of indicating the units, dBa, is frequently used. The A-weighted sound level is also called the noise level. Sound level meters have an A-weighting network for measuring A-weighted sound level.

C. Some General Facts on Noise Abatement---The "Noise Control Act of 1972" is the basic Federal legislation for noise emissions from a broad range of sources. (4)

III. Anticipated Noise Levels (Step 1)

A. Construction Equipment and Operations. (1)

1. Table 3 shows typical energy equivalent noise levels at construction sites. Energy equivalent noise level (Leq) refers to the equivalent steady noise level which in a stated period of time would contain the same noise energy as the time-varying noise during the same time period. (6)

2. Noise levels observed 50 ft. from construction equipment are shown in Table 4.

B. Examples of Noise Levels from Project Operation

1. Examples to be considered include highway vehicles, aircraft, rail systems, recreation vehicles, internal combustion engines, industrial machinery, building equipment, and home appliances.

2. The noise levels produced by highway vehicles can be attributed to the following three major noise generating systems: (7)

a) rolling stock; tires and gearing

b) propulsion system: engine and related accessories

c) aerodynamic and body

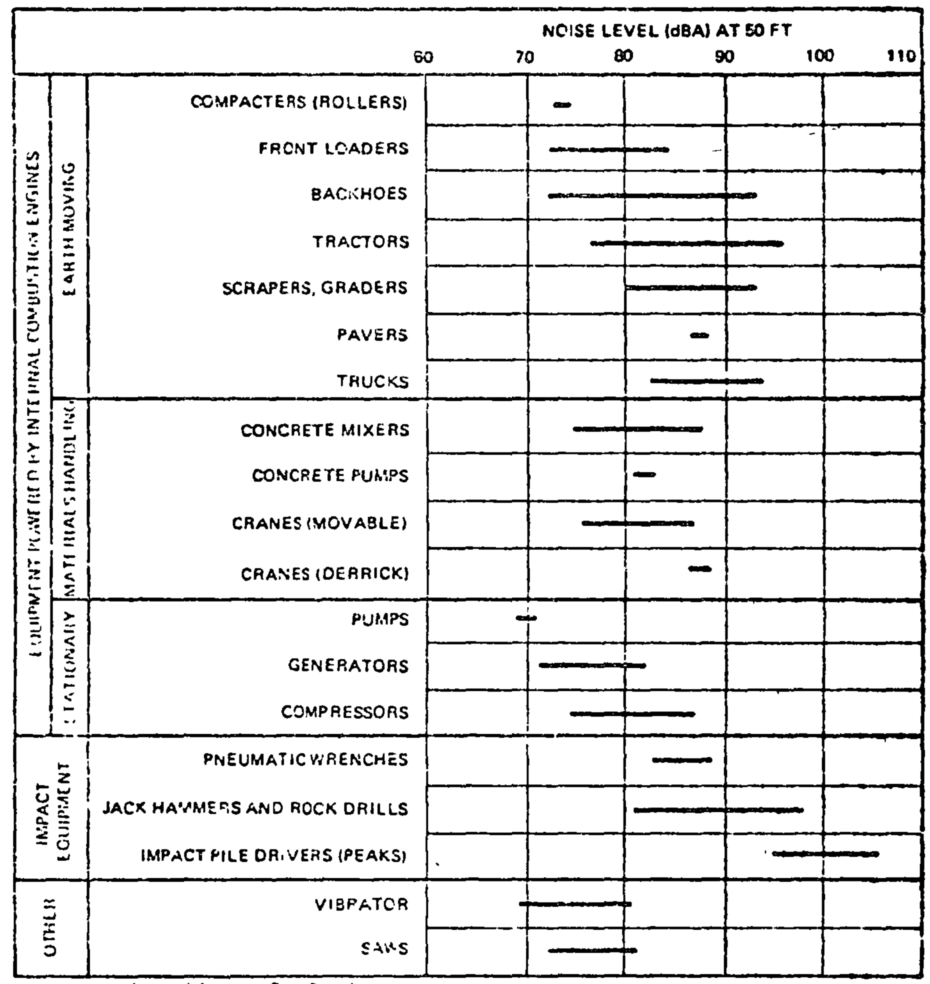
TABLE 3: Typical Ranges of Energy Equivalent Noise Levels, L_{eq} in dBA, at Construction Sites

	Domestic Housing		Office Building, Hotel, Hospital, School, Public Works		Industrial Parking Garage, Religious Amusement and Recreations, Store, Service Station		Public Works Roads & Highways, Sewers, and Trenches	
	I	II	I	II	I	II	I	II
Ground Clearing	83	83	84	84	84	83	84	84
Exaavation	88	75	89	79	89	71	88	78
Foundations	81	81	78	78	77	77	88	88
Erection	81	65	87	75	84	72	79	78
Finishing	88	72	89	75	89	74	84	84

I - All pertinent equipment present at site.

II - Minimum required equipment present at site.

TABLE 4: Construction Equipment Noise Ranges



Note Based on Limited Available Data Samples

3. The noise levels produced by highway vehicles are generally dependent upon vehicle speed, as illustrated for a number of different vehicle types in Figure 1.

IV. Existing Noise Levels (Step 2)

A. Typical Values

1. The outdoor daytime residual noise level in a wilderness, such as the Grand Canyon rim, is of the order of 16 dB(A), on the farm it is of the order of 30 to 35 dB(A), and in the city it is of the order of 60 to 75 dB(A). (8)

2. Noise levels for the urban population are shown in Table 5. (6)

L_{dn} = day-night noise level

B. Tie to Land Use

V. Noise Standards and Criteria (Step 3)

A. General Comments (3)

1. Effects---Information on effects of noise is best for hearing loss due to noise at work. Other effects of occupational noise, except speech intelligibility interferences, are less certain. These are changes in psychological and physiological states, including annoyance and sleep interruptions. The last two are principal complaints against community and aircraft noise. Property damage by actual vibrational or boom destruction and by depreciation because noise paths and patterns impinge on the property is known, and is to some degree measurable and predictable. Effects on animals seem to have been studied very little. These effects are of concern for wildlife around airports and along highways, and for fish and wildlife in the pathways of sonic boom. In the first instances habitats may be lost, but the creatures have a chance to migrate and to reestablish beyond the reach of the noise. If there are bad immediate effects on those in the sonic boom paths, there is no escape time.

2. A statistical analysis of the noise level gives the percentage or total time that the value of the noise level is found between any two set limits. Such data can be presented directly in the form of histograms, or be used to obtain a cumulative distribution in terms of the "level exceeded for a stated percentage of time." For the sample statistical distribution of Table 6, the noise level exceeds 60 dB(A) for 1 percent of the hour, 55 dB(A) for 10 percent of the hour, 50 dB(A) for 50 percent of the hour, and 45 dB(A) for 90 percent of the hour. These noise levels are abbreviated symbolically as L_1, L_{10}, L_{50}, and L_{90}, respectively. (8)

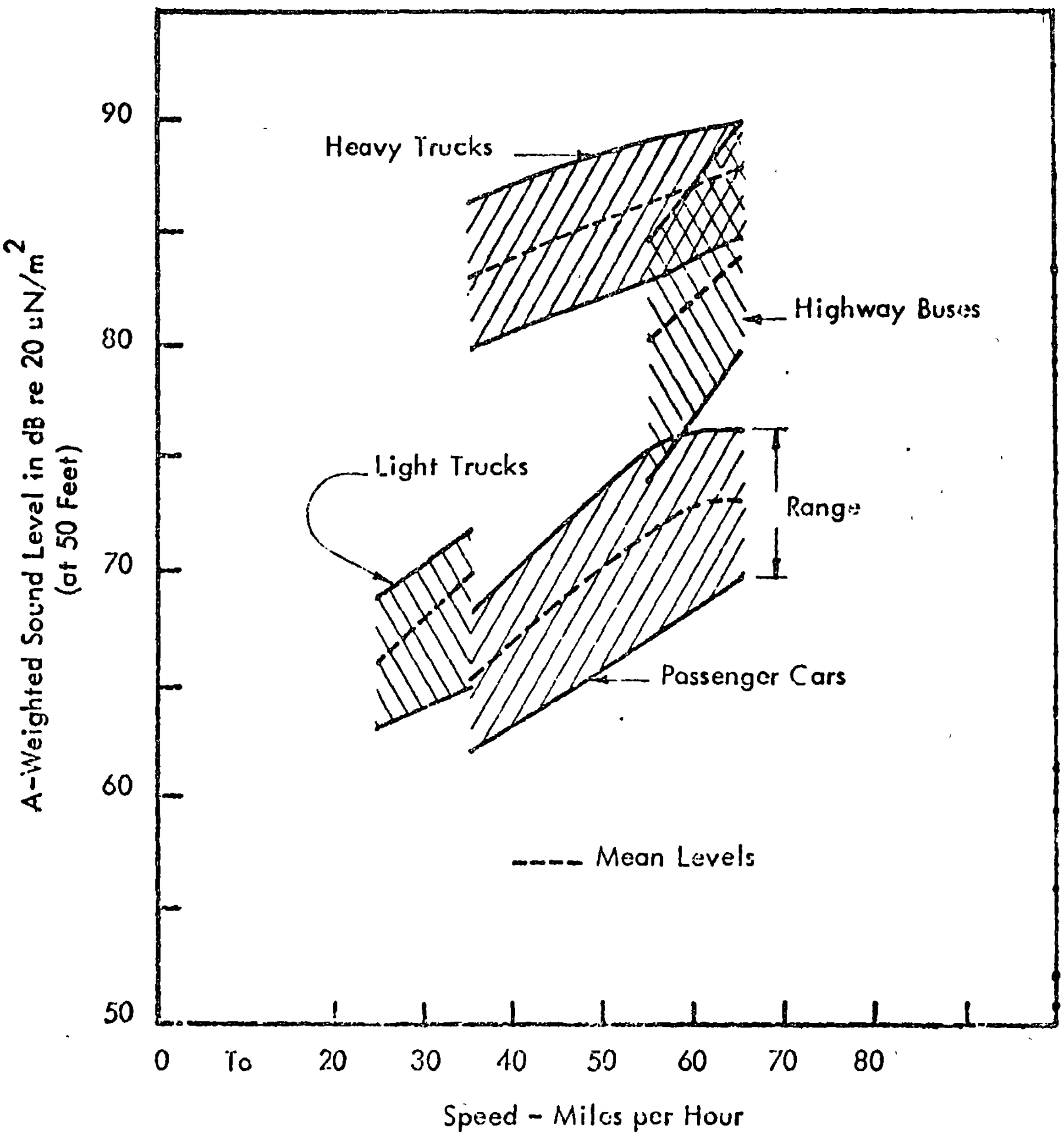


Figure 1: Single Vehicle Noise Output as a Function of Vehicle Speed

TABLE 5: Estimated Percentage of Urban Population (134 Million) Residing In Areas With Various Day-Night Noise Levels Together With Customary Qualitative Description Of The Area

Description	Typical Range L_{dn} in dB	Average L_{dn} in dB	Estimated Percentage of Urban Population	Average Census Tract Population Density, Number of People Per Square Mile
Quiet Suburban Residential	48-52	50	12	630
Normal Suburban Residential	53-57	55	21	2,000
Urban Residential	58-62	60	28	6,300
Noisy Urban Residential	63-67	65	19	20,000
Very Noisy Urban Residential	68-72	70	7	63,000

TABLE 6: Example of Statistical Distribution of Outdoor Noise Analyzed in Intervals of 5 dB Widths

Interval in dB(A)	Percent of Total Time	Cumulative Percent of Total Time
61 through 65	1	1
56 through 60	9	10
51 through 55	40	50
46 through 50	40	90
41 through 45	10	100

B. Criteria for Protection of Public Health and Welfare (6)

1. The phrase "health and welfare" is defined as complete physical, mental, and social well-being and not merely the absence of disease and infirmity.

2. See Table 7 for criteria.

VI. Prediction of Noise Level (Step 4)

A. General Model (10)

1. Sound travels through the air in waves, with characteristics of frequency (cycles per second or Hertz) and wave length.

2. If a sound were created at a point, a system of spherical waves would propagate from that point outward through the air at a speed of 1100 feet per second, with the first wave making an ever-increasing sphere with time. As the wave spreads, the height of the wave or the intensity of the sound at any given point must diminish as the fixed amount of energy is spread over an increasing surface area of the sphere. This phenomenon is known as geometric attenuation of the sound.

3. For point-source propagation

$$\text{sound level}_1 - \text{sound level}_2 = 20 \log \frac{r_2}{r_1}$$

where the sound level at station one minus the sound level at station two is equal to twenty times the log of the ratio of the radii. This means that for every doubling of distance, the sound level will decrease by 6 decibels.

4. Line-source propagation---When a number of vehicles are lined up and constitute a continuous stream of noise sources, the situation is no longer characterized by a spherical or hemispherical spreading of the sound, but rather the reinforcement by the line of point-sources makes the propagation field like a cylinder or half a cylinder. In this case the equation is as follows:

For Line-Source Propagation:

$$\text{sound level}_1 - \text{sound level}_2 = 10 \log \frac{r_2}{r_1}$$

Thus, the decrease in sound for each doubling of distance from a line source is only 3 decibels.

B. Aircraft Noise Predictions (11)

1. Aircraft sound description system

TABLE 7: Yearly Average* Equivalent Sound Levels Identified as Requisite to Protect the Public Health and Welfare with an Adequate Margin of Safety

	Measure	Indoor Activity Interference	Indoor Hearing Loss Consideration	Indoor To Protect Against Both Effects (b)	Outdoor Activity Interference	Outdoor Hearing Loss Consideration	Outdoor To Protect Against Both Effects (b)
Residential with Outside Space and Farm Residences	L_{dn}	45		45	55		55
	$L_{eq(24)}$		70			70	
Residential with No Outside Space	L_{dn}	45		45			
	$L_{eq(24)}$		70				
Commercial	$L_{eq(24)}$	(a)	70	70(c)	(a)	70	70(c)
Inside Transportation	$L_{eq(24)}$	(a)	70	(a)			
Industrial	$L_{eq(24)}$(d)	(a)	70	70(c)	(a)	70	70(c)
Hospitals	L_{dn}	45		45	55		55
	$L_{eq(24)}$		70			70	
Educational	$L_{eq(24)}$	45		45	55		55
	$L_{eq(24)}$(d)		70			70	
Recreational Areas	$L_{eq(24)}$	(a)	70	70(c)	(a)	70	70(c)
Farm Land and General Unpopulated Land	$L_{eq(24)}$				(a)	70	70(c)

Code

a Since different types of activities appear to be associated with different levels, identification of a maximum level for activity interference may be difficult except in those circumstances where speech communication is a critical activity.

b Based on lowest level

c Based only on hearing loss

d An $L_{eq(8)}$ of 75 dB may be identified in these situations so long as the exposure over the remaining 16 hours per day is low enough to result in a negligible contribution to the 24-hour average, i.e., no greater than an L_{eq} of 60 dB.

Note: Explanation of identified level for hearing loss: The exposure period which results in hearing loss at the identified level is a period of 40 years

*Refers to energy rather than arithmetic averages

2. Noise exposure forecast

3. Composite noise rating

4. L_{dn}

C. Highway Noise Prediction Models

1. The Federal Highway Administration PPM 90-2 (9) stated that two highway noise prediction methods were acceptable:

   a) The method in the National Cooperative Highway Research Program Report 117. (12)

   b) The method in the Department of Transportation, Transportation Systems Center Report DOT-TSC-FHWA-72-1. (13)

2. A model developed at Argonne National Laboratory was published in 1973. (11) Basically, the model requires characteristics of the highway segments as input. The characteristics include a description of the traffic using the highway (the speeds and volumes of both automobiles and trucks), the physical dimensions of the facility (the elevation, depression, grades and surface types), and the aspects of the environment bordering the facility that have an effect on the noise levels (the landscaping, structures, and barriers). Fundamentally, the model calculates a noise level at a particular point along the highway and a perpendicular distance away from the highway. Once this noise level is calculated, the model moves outward an incremental distance away from the facility and calculates another noise level. This process is repeated until the model reaches a maximum prescribed distance away from the highway. At this point, the model moves farther down the highway and calculates another group of noise levels. This is repeated until the model has covered the entire length of the highway. The model prints out a contour map of noise levels at given distances from the facility.

VII. Noise Control Practices (Step 5)

A. Principles

1. Reduction of vibrating sources

2. Enclosure of source

3. Attenuation by absorption

B. Industrial Noise (3)

The methods of noise control in the United States are well formulated for controlling industrial noise. The principles embrace plant planning; substitution of quieter equipment, processes, and materials; reduction at the source and reduction by transmission by air.

C. Subsonic Aircraft Noise Abatement (10)

The following lists some of the current noise abatement techniques, procedures, and other alternatives to counter subsonic aircraft noise sources:

1. Aircraft Deisgn or Modification

   a) New quiet engine designs with high bypass ratios and low velocity nets.

   b) Acoustically treated nacelles and ducts.

   c) Exhaust silencers for reciprocating and turboshaft engines.

   d) Noise suppression for on-board auxiliary power units.

   e) Rotor and propeller aerodynamics for reduced noise.

   f) Noise suppression for mechanical components such as helicopter gear boxes.

   g) Vehicle aerodynamics to allow for steeper ascent and descent, and/or reduction in time required for ascent/descent.

2. Aircraft Operations

   a) Restrict operations by type of aircraft, number of operations or time of day.

   b) Power cutback on takeoff or steep climb-out depending on situation.

   c) Steep or multi-segment approach depending on situation.

   d) Preferential runway assignments

3. Aircraft Maintenance

   a) Restrict engine "runups" during ground maintenance operations.

   b) Maintenance of additional hardware for noise suppression (i.e., treated nacelles or auxiliary-power-unit silencers.

4. Aircraft Route Location

   a) Avoid noise sensitive areas in new route assignments.

   b) Modify existing routes to avoid noise sensitive areas.

   c) Utilize noise-insensitive areas for ascent and descent paths.

5. Landscape Architecture

   a) Shield airport surroundings from noise resulting from aircraft ground operations and surface vehicle operations.

6. Acoustic Insulation

   a) Insulation of dwellings against aircraft noise.

   b) Insulation of commercial structures against aircraft noise.

7. Land Use

   a) Control by zoning authorities for compatible land use.

D. Highway Noise Abatement (10)

1. Three options for noise reduction are:

   a) Man-constructed barriers to obstruct or dissipate sound emissions.

   b) Elevated or depressed highway through grading.

   c) Absorption effects of landscaping (trees, bushes, shrubs, etc.).

2. Constructing Barriers

   A rigid (fairly massive) barrier can be an effective means to reduce noise from highways depending upon the relative heights of the barrier, the noise source, and the affected area, as well as the horizontal distance between the source and the barrier and between the barrier and the noise-affected area.

3. Elevated or Depressed Highways

   Often a highway in an urban area can be built above or below the surrounding property. Such differences in grade provide some shielding of traffic noise and can reduce the noise levels at adjacent properties.

4. Effects of Planting

   Planting adjacent to a highway produces little physical reduction in noise level unless it is very dense and of significant depth.

5. Some other noise control measures for highways:

   a) Limitations on allowable grades.

   b) Road surface repairs.

c) Route locations planned to insure maximum separation between roadway and existing noise sensitive areas and to make maximum use of shielding provided by natural barriers.

d) Provide for compatible use of land adjacent to highways.

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METODOLOGIAS PARA DECLARACIONES DE IMPACTO AMBIENTAL

TEMA XI: PROGRAMA PARA EVALUAR EL DESARROLLO DE NUEVAS TECNOLOGIAS

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Marzo, 1978

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ENVIRONMENTAL ASSESSMENT PROGRAM FOR EVALUATING DEVELOPMENT of NEW TECHNOLOGIES

I. INTRODUCTION

A. Increased Environmental Concern, economic and raw material constraints have forced a more systematic approach toward technical system development. As critical choices between various technologies becomes more imminent, the value of systematic evaluation becomes more sensitive. Environmental Impact Statements, though basically legal documentation mandated by law, provided an order which has lead to the evolution of "Environmental Assessments" (EA). Contrary to an Impact Statement, which is aimed at fulfilling statutory regulations, an environmental assessment is more a design & planning tool. It serves to highlight technical areas requiring additional research or to provide adequate lead time for developing related technology (e.g. pollution abatement equipment). The EA can be applied to evaluating existing systems or in the conceptual stage of developing proposed systems. Neither is it limited to a specific geographical area, in fact a goal in appling the assessment may be site selection. The principle goal of an environmental assessment is focus on uncovering potential pollution problems as early as possibly in a technological systems' development cycle.

B. Some of the critical areas in which environmental assessment data will have significant benefit include:

- Identification of potential impact on environment of technological system
- Technological system design
- Development of source performance standards for specific pollutants
- Development of improved control technology
- Development of improved environmental surveillance monitoring.
- Design of toxicological studies
- Design of ecological field tests
- Discovery of anticipated pollutants
- Natural resource management
- Land use planning

II. MAJOR TASK AREAS OF ENVIRONMENTAL ASSESSMENT

A. General - Functionally, the assessment parallels the physical processes associated with a pollution source (see attached figure 1)

- Emitted pollutants are identified & quantified
- Transport or conversion mechanisms are investigated to define the pollutants sphere of influence.
- The sphere of influence is evaluated to identify potential impact

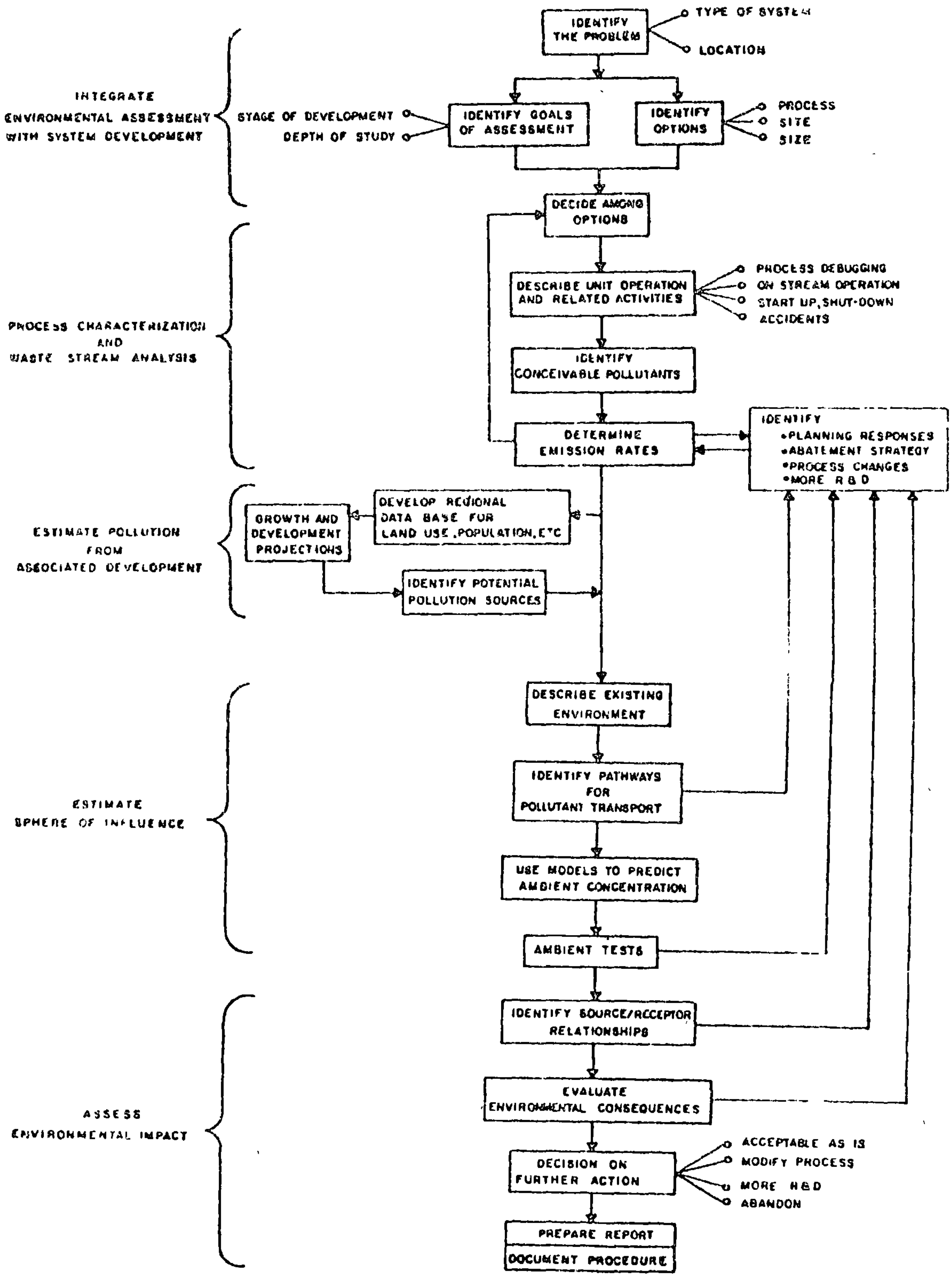

Figure 1. Flow diagram for a comprehensive environmental assessment program

B. MAJOR TASKS IN ENVIRONMENTAL ASSESSMENT -

1. INTEGRATE ENVIRONMENTAL ASSESSMENT WITH SYSTEM DEVELOPMENT -

a. Scope of Assessment dependent on stage system has been developed, literature available to reveal understanding of system, options available to define employment of system. These factors identify the goals of the assessment program, a few suggestions include:

- Assist in derivation of new source performance standards.
- Identify potential pollutants with screening tests of effluent streams.
- Identify control measure (process modification or add-on technology) to reduce concentration of potential pollutants.
- Design of tests to determine consequences of transferring pollutant from one media to another.
- Predict acceptable limits for emissions using senerios based on projected pollutant impact.

2. PROCESS CHARACTERIZATION & WASTE STREAM ANALYSIS -

a. Effluent streams from process are qualitatively & quantitatively defined on the basis of:

- Source tests
- Available pilot plant data
- Material or energy balances
- Theoretical calculations

b. Technology or process mode of operation, load or production rate influence on waste stream characterization must be integrated into defination study.

3. Estimate Pollution From Associated Development
Pollution from construction or land development associated with the nature of technology (expanded private facilities & public services) can cause substantial environmental problems & must be analysized.

4. Estimate Sphere of Influence: Each site for application or employment of the process or technology must be characterized as to its topography, hydrology & climatology. Federal & state data banks exist to determine the prevailing ambient concentration of pollutants of interest as well as input parameters to project changes in ambient concentrations with superposition of the technology on the site using predictive models.

5. Assess Environmental Impact: Within each sphere of influence at every site the impact can be established using comparative data for acceptable level of pollutants based on ecological, human health and material effects of the pollutants.

6. Dependent on the Comprehensiveness inherent to the Assessment program the following tasks may evolve:

- Identify & Fill Information Gap
- Design & Execute Source Sampling or Ambient Monitoring Programs.
- Review & Analyze existing process engineering/Cost data
- Determine emission goals for processes
- Analyze control efficiency & cost A various levels of control efficiency
- Maintenance of A data storage/Retrieval Information System.

III. Demonstration of Technology Environmental Assessment

Discuss Case Study - Demilitarization of Toxic War Munitions (See Handout)

AIR POLLUTION ASPECTS

OF

HAZARDOUS MATERIAL DISPOSAL

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MAY, 1977

AIR POLLUTION ASPECTS OF HAZARDOUS MATERIAL DISPOSAL

INTRODUCTION. The Army is continually identifying complex munition/chemical material which have become obsolete or deteriorated. Inherent to retention of such material are costly quality assurance measures and repackage, but more important, always the intimate threat of uncontrolled release. Consequently, in dealing with disposal of these materials there is consistently the atmosphere of urgency and the temptation to employ expedients in disposal methods. Such an approach can only lead to further and possibly more complex problems. Timely and safe disposal of these materials mandates thorough assessment of the hazardous material, destruction alternatives and surveillance requirements.

Identification and Nature of Material. The need to identify and characterize the divergent quantities and location of excess munitions and chemical material is a matter of constant concern. The never-ending inventory for such materials continues. Pursuit of appropriate installation and commodity manager representatives who deal with such material for timely identification of stocks is most important. To illustrate this point let's briefly consider explosive waste, which one would assume are the most completely categorized hazardous materials. A recent inventory of air pollution sources at Army installations in the continental U.S.A. indicates that over 27,000 tons of explosive materials are open burned per year. However, no distinction has been made between the materials truly explosive in nature (small arms cartridges, ball power, TNT, etc) and material that can only be safety disposed by detonation (artillery rounds and bombs) or contaminated dunnage, building materials and wrapping.

Finally, no discussion of identification is complete without mentioning the problem of distinguishing which materials are to be considered hazardous. A good example here is CS grenades, a riot control agent. In their case, the chemical structure reveals the cyanide group, the concentration of which would not be of concern in limited quantity, but ominous in large scale destruction programs.

EIA Considerations. A rational methodology has been developed to define problems of hazardous material demilitarization, as well as evaluating the viability of disposal alternatives. Namely, the environmental impact assessment (EIA). Appropriately applied the EIA provides an exceptional tool to evaluate disposal alternatives and discern inherent limitations. In considering alternatives and data necessary to support EIA's the following fundamentals should be observed:

Insure the extent of the problem is completely defined, quantitatively and spatially.

Do not ignore the alternative "status quo".

Evaluate marketing option.

Consider availability of equipment to support collecting piloting data, as opposed to relying on empirical data.

Whether supporting data is pilot or empirical, be humble and insure multidiscipline review of proposals.

Acknowledge data gaps and define rationale used to establish residual or emission standards.

Essential Elements of Alternatives. Regardless of the number or characteristics of alternatives there are elements that must be common to each destructive process considered. Normally such processes either employ chemical reaction principles or thermal degradation properties. Common to either is a need to establish guidelines of the allowable quantity of the hazardous material in the remaining residue, or any air emissions or waste water discharges associated with the process. The mechanism used to establish emission criteria must be founded in a careful literature search on the nature of the hazardous material. Frequently, a proportional relationship to the TLV for a material is used as an expedient to derive emission criteria. This approach must be thorougly qualified and the need for standards development work identified.

In addition to emission criteria, methods of analytical detection, and surveillance programs in general, must be carefully researched and documented. Impact of process interferences as well as analytical precision and accuracy, and quality assurance in surveillance program management must be integrated.

Task Force Management. Synthesis of the previous information leads one to the conclusion that disposal alternatives for hazardous materials evolve into multiple environmental interfaces; air, waste water and solid waste. Each of which will certainly have an occupational, as well as public health dimension. Consequently, no one professional discipline can hope to be truly expert in dealing with the implications of all medias; or the physics and biology of emissions. Rather, an integrated team of professionals in the engineering, medical, physical science fields, working under a single manager is required to thoroughly evaluate the impact of disposal alternatives.

CASE STUDIES. Limitations imposed on ocean disposal, as well as the constraints on land disposal alternatives, has prompted significant efforts in developing process and controls for safe disposal of hazardous materials. One of the more successful operations recently developed, and currently in operation, is the disposal of obsolete munitions and unarmed stockpiles of toxic war gases by the US Army at Rocky Mountain Arsenal, Denver, Colorado. Not only are the materials for destruction and processes designed for this project unique, but the rigidity of surveillance for such a hazardous disposal operation stands alone in sophistication and thoroughness relative to existing technology. Further challenge to insure safe destruction of such toxic materials is the close proximity of urban Denver, Colorado, to the disposal site. In dealing with the destruction of war gases not only is worker safety paramount but protection of the general populations' health assumes greater significance in terms of insuring finite process control and approaching absolute quantification in detection of the contaminant(s).

Significant research relative to analytical detection and toxicology had already been affected by DA prior to initiating demilitarization of toxic war gases. The occupational and general population exposure standards derived by DA and approved by The Surgeon General of the US Public Health Service are summarized in Table 1. In essence the surveillance scheme involved a concentric ring approach; detection for occupational exposure, process emissions and ambient air surveillance on the perimeter of RMA. Further, key parameters relative to process and environmental control were interlocked with set point alarms (i.e. pH of emission scrubbing liquor, negative pressure in known controlled hot areas, temperature ranges on contaminated waste incinerators). The philosophy of system design and operation was one of total containment of any agent in the event of accidental upset or release. A quality assurance program to assess laboratory efficiency in handling over 100 impingers samples daily for analysis of nerve gas was also implemented.

TABLE 1

EXPOSURE STANDARDS

Agent	Application		Standard (mg/cum)
GB Nerve	General Population	1 hr	0.0001
		72 hr	0.000003
	Unmasked Worker	1 hr	0.001
		8 hr	0.0003
	8 hr Average Over Ten Consecutive Work Periods		0.0001
	Emission - Maximum		0.0003
HD Mustard	Unmasked Worker	8 hr	0.001
	Emission - Maximum		0.03

The disposal of nerve gas entailed demilitarization of 21,115 M-34 GB nerve agent cluster bombs (each cluster contained 76 bomblets filled with 2.6 pounds of GB and 0.55 lb tetryl burster); 378,000 pounds of bulk GB in hardened underground storage; and 3.63 million pounds of GB stored in steel ton containers. A flow diagram illustrating the demilitarization process for the M34 bomb is shown in Figure 1. Disposal alternatives for the residual salts from the process are under study.

FIGURE 1

PROCESS FLOW DIAGRAM M34 DEMILITARIZATION

TRANSPORT FROM STORAGE ↓				
Remote Declustering Operation	→	Inert parts to Decon furnace No. 1	→	Inert parts Disposal
Defusing, punch and drain	→	Contaminated parts and tetryl burster to deactivation furnace	→	Inert Decon Furnace No. 2
↓				
Agent Hydrolysis	→	Spray Dry Liquid Waste	→	Store Residual Salts

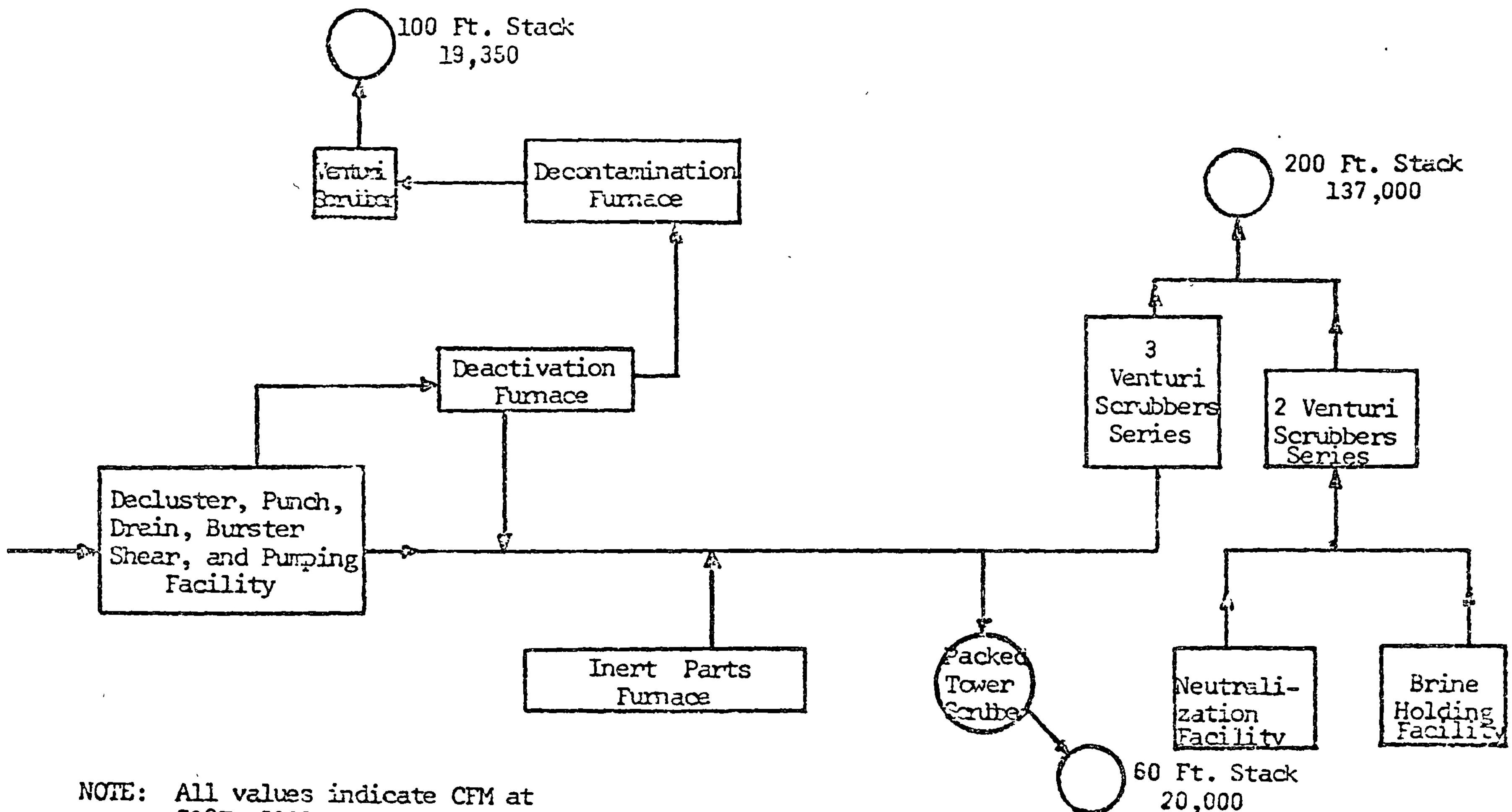
Integral air pollution control devices on the system are depicted in Figure 2. Discharge from venturi scrubber system was exhausted through a 200 foot stack, while exhaust from the decon furnace No. 1 was discharged through a 100 foot stack. Exhaust from the spray dryer was discharged through a 60 foot stack. Figure 3 shows the spatial array of the process stacks relative to location of a nine-station ambient air network. The network, in addition to collecting background data prior to beginning operations, monitored air quality during the M34 system's operation from October 1973 through September 1976. Parameters measured included particulates, ozone, nitrogen dioxide, anticholinesterase activity, wind speed and wind direction.

Similar systems and approaches were applied to disposal of other toxic war gases. HD mustard war gas was disposed of by incineration during the time frame of 1970-1974 at RMA. Demilitarization of nerve gas in the armed configuration of Honest John Warheads has been affected as well as bulk stored GB nerve gas stored at RMA. Facilities for the transfer of phosgene (carbonyl chloride) into hydrostatically tested shipping containers for ultimate sale of this material have been engineered and constructed. Each of these systems, as well as other facilities to demilitarize obsolete chemical muntions were developed and designed following exhaustive bench/pilot testing of processes.

SUMMARY: Technology exists to handle most demilitarization problems associated with hazardous materials. The importance of early identification of potential items, defining the density, scope and characteristics of the materials is most important to permit timely evaluation of disposal alternatives. The EIA approach to evaluating alternatives, to include careful interpretation of emission and analytical constraints within the alternatives by an integrated professional team, will lead to successful problem resolution.

FIGURE 2

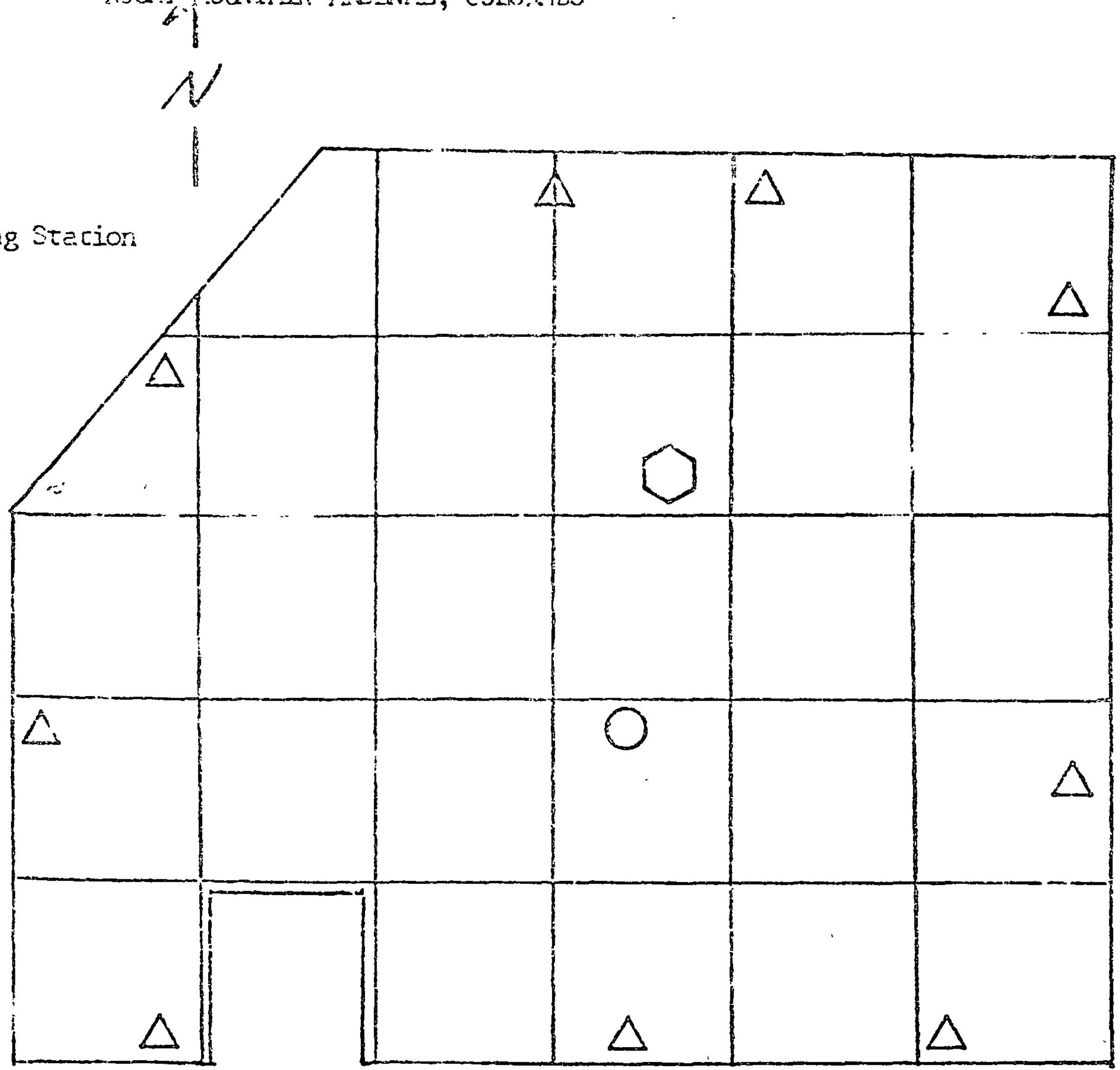
M34 AIR FLOW PATTERNS AND AIR POLLUTION CONTROLS



NOTE: All values indicate CFM at 70°F, 5200 Ft. Elevation

FIGURE 3

SOURCES AND AMBIENT AIR MONITORING LOCATIONS
ROCKY MOUNTAIN ARSENAL, COLORADO



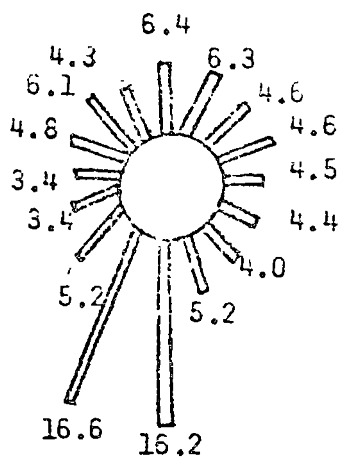
LEGEND. SCALE 1 in = 1 mi

△ Ambient Air Monitoring Station

⬡ GB Nerve Gas Demil Process Stacks

○ HD Mustard Gas Demil Process Stacks

COMPOSITE WIND ROSE



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