Transport and the Environment

David C. Hothersall
Richard J. Salter

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CHAPTER 1

Impact assessment for transport proposals

1.1 Introduction

Major transport proposals require much more than an engineering and economic appraisal; it is now accepted that consideration needs to be given to the environmental effects of projects. In addition, the increasing necessity for public consultation during the initial planning stage of transport schemes, and the emphasis placed on environmental issues by protest and pressure groups, has focused attention on the assessment of environmental impact.

In the United States, as a result of the Environmental Policy Act of 1969, which required that unquantified environmental amenities and values be given appropriate consideration in decision making, specialised techniques which attempt to assess environmental impact have been developed.

Considerable discussion has taken place on the value of these formalised methods. One point of view is that, because of the number of proposals which require assessment on environment impact grounds, it will be necessary to establish standard procedures so as to reduce the time required for their examination.

It is considered that a formal technique would direct attention to relevant issues, and with such a system it would be possible for an intelligent layman to understand and check the assessment, so avoiding argument during the public discussion stage.

On the other hand there are those who state that there are two stages in the process, analysis and evaluation. Analysis makes use of techniques for measuring such environmental effects as air pollution, noise and visual intrusion. It is the evaluation of these effects which is more difficult. It is frequently necessary to make decisions as to the trade-off between increasing air pollution, noise, visual intrusion and increasing employment opportunities. It is said that the purpose of impact analysis is to forecast for the decision makers the consequences of their decisions.

1.2 The Leopold matrix

If a formalised technique is to be employed then it has been suggested that use be made of a modification of the procedure suggested by Leopold *et al.*,[1.1] who state that the evaluation of the impact of a

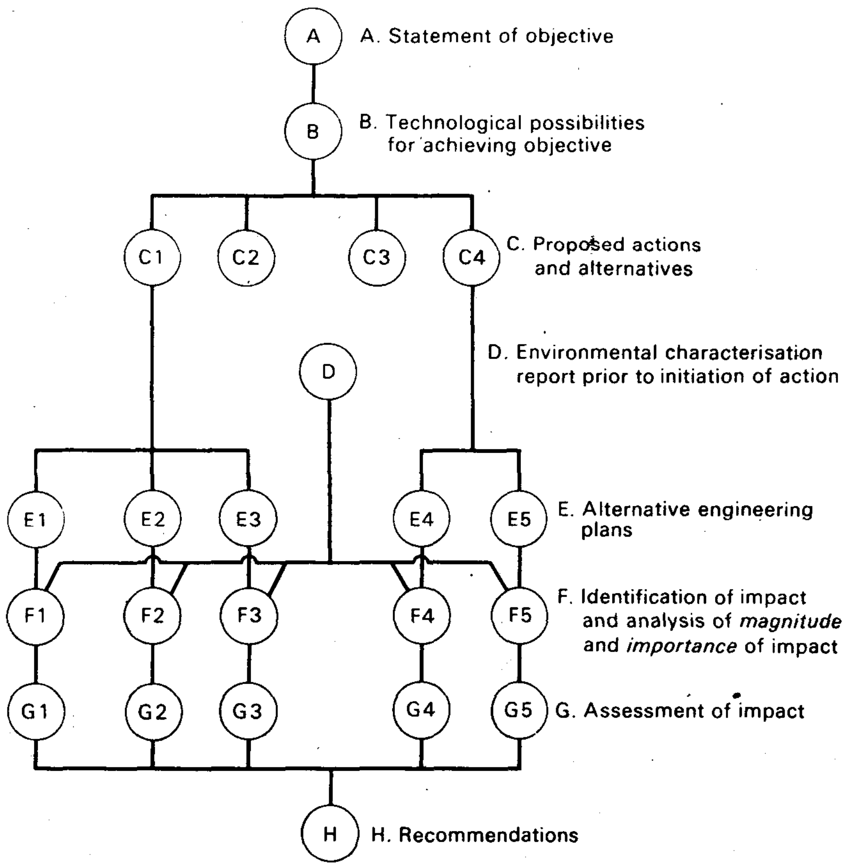

Fig. 1.1 Flow chart for development of action programmes (adapted from Leopold *et al.*[1.1])

proposal is the last step in a series of events which are outlined in Fig. 1.1. Initially there must be a statement of the major objective sought by the proposed scheme. Then comes a consideration of the technological possibilities of achieving the objective, from which one or more actions may be proposed for reaching the objective. It is then necessary to detail the characteristics and conditions of the existing environment before any action is taken. The principal engineering proposals are then examined in detail and cost–benefit analyses undertaken. Identification of the environmental impact of the actions involved in these alternative schemes and an analysis of the magnitude and importance of these impacts follow. Using the results of the analysis of magnitude and importance, an assessment of impact is made leading to a recommendation on how the objective is to be achieved.

Leopold states that an assessment of the probable impacts of the variety of specific aspects of the proposed action upon the variety of existing environmental elements and factors should consist of three basic elements:

(1) a listing of the effects on the environment which would be caused by the proposed development and an estimate of the magnitude of each;
(2) an evaluation of the importance of each of these effects;
(3) the combining of magnitude and importance estimates in terms of a summary evaluation.

For each scheme these three elements are analysed using a matrix, on one axis of which are the actions which cause environmental impact and on the other axis are existing environmental conditions which might be affected. It is stated that this form of approach helps planners to remember the variety of interactions which are involved in environmental impact and to identify alternatives which might lessen the impact.

A total of 100 actions are listed horizontally and there are 88 environmental characteristics listed vertically. Table 1.1 lists the proposed actions which may cause environmental impact, while Table 1.2 gives the existing characteristics and conditions of the environment. For each action which is expected to have a significant interaction with an environmental condition the relevant square in the matrix is divided by a diagonal which runs from upper right to lower left. As there is a total of 88 000 possible interactions, only a few are likely to involve impacts of any magnitude and importance.

After all anticipated actions have been checked with possible environmental effects, consideration should be given to weighting the magnitude and the significance of the interaction. Within each box representing a significant interaction, a weighting factor is introduced

Table 1.1 Proposed actions which may cause environmental impact (Based on Leopold et al.[1.1])

A	**Modification of regime**
a	Exotic flora or 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	Canalisation
i	Irrigation
j	Weather modification
k	Burning
l	Surface or paving
m	Noise and vibration
B	**Land transformation and construction**
a	Urbanisation
b	Industrial sites and buildings
c	Airports
d	Highways and bridges
e	Roads and trails
f	Railroads
g	Cables and lifts
h	Transmission lines, pipelines and corridors
i	Barriers including fencing
j	Channel dredging and straightening
k	Channel revetments
l	Canals
m	Dams and impoundments
n	Piers, seawalls, marinas and sea terminals
o	Offshore structures
p	Recreational structures
q	Blasting and drilling
r	Cut and fill
s	Tunnels and underground structures
C	**Resource extraction**
a	Blasting and drilling
b	Surface excavation
c	Subsurface excavation and retorting
d	Well drilling and fluid removal
e	Dredging
f	Clear cutting and other lumbering
g	Commercial fishing and hunting

Table 1.1—contd.

D	**Processing**
a	Farming
b	Ranching and grazing
c	Feed lots
d	Dairying
e	Energy generation
f	Mineral processing
g	Metallurgical industry
h	Chemical industry
i	Textile industry
j	Automobile and aircraft
k	Oil refining
l	Food
m	Lumbering
n	Pulp and paper
o	Product storage
E	**Land alteration**
a	Erosion control and terracing
b	Mine sealing and waste control
c	Strip mining rehabilitation
d	Landscaping
e	Harbour dredging
f	Marsh fill and drainage
F	**Resource renewal**
a	Reforestation
b	Wildlife stocking and management
c	Ground water recharge
d	Fertilisation application
e	Waste recycling
G	**Changes in traffic**
a	Railway
b	Automobile
c	Trucking
d	Shipping
e	Aircraft
f	River and canal traffic
g	Pleasure boating
h	Trails
i	Cables and lifts
j	Communication
k	Pipeline

Table 1.1—contd.

H	Waste emplacement and treatment
a	Ocean dumping
b	Landfill
c	Emplacement of tailings, spoil and overburden
d	Underground storage
e	Junk disposal
f	Oil well flooding
g	Deep well emplacement
h	Cooling water discharge
i	Municipal waste discharge including spray irrigation
j	Liquid effluent discharge
k	Stabilisation and oxidation ponds
l	Septic tanks, commercial and domestic
m	Stack and exhaust emission
n	Spent lubricants
I	Chemical treatment
a	Fertilisation
b	Chemical de-icing of highways etc.
c	Chemical stabilisation of soil
d	Weed control
e	Insect control (pesticides)
J	Accidents
a	Explosions
b	Spills and leaks
c	Operational failure

ranging from 1 to 10. The number is placed in the upper left-hand corner to indicate the relative magnitude of the interaction and in the lower right-hand corner to indicate the relative importance of the interaction. A weighting of 10 indicates the greatest effect and 1 the least interaction.

For an example, the circular[1.1] considers the case of an engineering proposal which requires the construction of a highway and a bridge. The action will have environmental effects which may be classified under erosion, deposition and sedimentation. It may be that, due to poor consolidation of the soil in the region of the bridge, erosion is likely to be considerable and so the magnitude of the impact will be weighted with a factor of 6 or more. If, however, the river already carries large sediment loads and further erosion will not have undesirable effects, then the weighting of the importance of the interaction may be 2 or less.

Table 1.2 Existing characteristics and conditions of the environment (*Based on Leopold et al.*[1.1])

A	**Physical and chemical characteristics**
1	Earth
a	Mineral resources
b	Constructional 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	Rechange
g	Snow, ice and permafrost
3	Atmosphere
a	Quality (gases, particulates)
b	Climate (micro, macro)
c	Temperature
4	Process
a	Floods
b	Erosions
c	Deposition (sedimentation, precipitation)
d	Solution
e	Sorption (ion exchange, complexing)
f	Compaction and settling
g	Stability (slides, slumps)
h	Stress strain (earthquakes)
i	Air movements

Table 1.2—contd.

B	**Biological conditions**
1	Flora
a	Trees
b	Shrubs
c	Grass
d	Crops
e	Microflora
f	Aquatic plants
g	Endangered species
h	Barriers
i	Corridors

2	Fauna
a	Birds
b	Land animals including reptiles
c	Fish and shellfish
d	Benthic organisms
e	Insects
f	Microfauna
g	Endangered species
h	Barriers
i	Corridors

C	**Cultural factors**
1	Land use
a	Wilderness and open spaces
b	Wet lands
c	Forestry
d	Grazing
e	Agriculture
f	Residential
g	Commercial
h	Industrial
i	Mining and quarrying

Table 1.2—contd.

2	Recreation
a	Hunting
b	Fishing
c	Boating
d	Swimming
e	Camping and hiking
f	Picknicking
g	Resorts
3	Aesthetics and human interest
a	Scenic views and vistas
b	Wilderness qualities
c	Open space qualities
d	Landscape design
e	Unique physical features
f	Parks and reserves
g	Monuments
h	Rare and unique species or ecosystems
i	Historical or archaeological sites and objects
j	Presence of misfits
4	Cultural status
a	Cultural patterns (life style)
b	Health and safety
c	Employment
d	Population density
5	Man-made facilities and activities
a	Structures
b	Transportation network (movement access)
c	Utility networks
d	Waste disposal
e	Barriers
f	Corridors
D	Ecological relationships, such as
a	Salinisation of water resources
b	Eutrophication
c	Disease insect vectors
d	Food chains
e	Salinisation of surficial material
f	Brush encroachment
g	Other