III. SITING AND DESIGN CONSIDERATIONS

The siting of utility facilities depends upon factors related to engineering feasibility, technical, environmental, and economic considerations, such as the location of load centers, and system reliability. These factors, in varying degrees, are used to determine whether separate or joint utility corridors should be developed, and to identify the location of future utility corridor routes.

1. ENGINEERING CONSIDERATIONS

Ideal routes for both electrical transmission lines and gas pipelines are straight lines. Such ideal routes save materials and reduce construction costs. Moreover, these routes minimize power losses for electrical lines and pumping costs for pipelines. However, actual corridor routes frequently depart from this ideal. Further, considerations of engineering compatibility must be assessed when utility systems are placed in joint use corridors.

Electrical transmission lines are often built in mountainous terrain, across ravines and rivers, in marked departure from an ideal route. This can be done only when the transmission line towers are located on stable ground and are designed to withstand climatic extremes.

Pipeline corridors require a graded right-of-way as a construction area for the entire distance. Thus, rocky soils, faults, landslide areas, canyons, and rivers which can be bridged by electrical transmission lines are generally avoided for pipelines. These requirements can mean that parallel joint use corridors are not feasible if the engineering conflicts are severe enough. Because of the more restrictive siting requirements of pipeline corridors, pipeline engineering is the first consideration in joint use electrical transmission line/pipeline corridors.

2. TECHNICAL CONSIDERATIONS

High-voltage electric transmission lines have the greatest effect on other utility systems, and hence pose the greatest problems for joint right-of-way usage. As illustrated in Table 3-1, the number of hazards (e.g., shock and fire/explosion), potential construction damage, nuisance (e.g., radio interference and noise), and degree of system reliability is more adverse when other systems are influenced by powerlines. Though gas pipelines and highways produce problems for other systems, the effect is not as great as it is for powerlines. Also, system effects are not reversible. Placing an electric transmission line in a corridor along an existing gas pipeline presents greater problems and hazards than placing a pipeline along an already existing powerline due to possible pipeline damage from the installation of tower footings.

Powerlines can induce currents in metallic objects adjacent to the line. This effect is particularly prominent in corridors with long parallels. In addition to causing communication interference, audible crackling noise, and shock hazards, electric transmission lines can contribute to the corrosion of buried pipelines and cable sheaths under certain conditions. Finally, "fault currents" can flow to the ground from the powerlines (e.g., through lightning strikes) and move along the pipeline or buried cable, resulting in equipment damage and possible pipeline rupture which can lead to ignition and shock hazard (Department of the Interior, 1975). Other authorities feel that these severe effects are very rare or may not occur at all given the relatively low-voltage electric transmission lines employed in Anchorage.

TABLE 3-1

SYSTEM INTERACTIONS WITHIN JOINT RIGHTS-OF-WAY

System Effects Upon	Elec. Tran.	Gas Pipeline	Highways
Electrical Transmission	R H-S	H-M	R
Gas Pipelines	D H-G	H-G	H-S
Highways	N H-M	H-S N	H-S N

Legend:

Type of Influence
H- Safety Hazard
- S Small
- M Medium
- G Great

D- Potential Construction Damage
N- Nuisance
R- System Reliability

SOURCE: U.S. Department of the Interior, 1975, The Need for a National System of Transportation and Utility Corridors.

As seen from Table 3-1, utility compatibility from one system to another, aside from electric transmission lines, is adequate. As reported in the Department of the Interior's 1975 report:

> "The type and degree of incompatibility depends on such variables as the design characteristics of each system, the separation between systems, the length of parallel, the resistance of the soil to the flow of electricity, and climatic conditions."

Normal practice in joint use corridors has been to simply provide enough space to avoid any adverse impact such as powerline-induced currents in an underlying gas pipeline. In flat rural land with suitable soils, a minimum corridor width for an electric transmission line, four-lane highway, communication line, pipeline, and a mainline railroad is 1,925 feet, given no mitigation measures. With a number of feasible mitigation measures employed to optimize technical compatibility, this corridor width can be reduced to 745 feet for the same utilities and transportation modes under the same conditions.

3. ECONOMIC CONSIDERATIONS

Joint use utility corridors can involve added costs due to a less-than-ideal route, but may be more than offset by the cost savings in corridor acquisition and construction maintenance operations. The mitigation measures necessary to prevent construction and maintenance damage to adjacent systems in the corridor result in higher construction costs than that of a single system corridor. Moreover, special construction costs might be encountered for individual utility systems given the less-than-ideal route for a joint use corridor. These special costs could include solid rock trenching for pipelines, or special footings for transmission towers in wetland areas. These costs may be offset, however, by joint use corridor savings resulting from shared access roads and reduced land area requirements.

4. RELIABILITY

Reliability refers to the probability of system failure. In joint use corridors, system reliability is said to be "degraded" because of the increased probability of system hazard/damage from other parallel and adjacent systems in the corridor. Examples of system disruptions that produce degraded reliability are:

1. Persons and equipment working on one system damaging adjacent facilities;

2. A train derailment or highway accident damaging adjoining systems;

3. Explosion from a gas pipeline rupture damaging adjacent systems; or

4. An accident, sabotage, or natural disaster disrupting all systems in close proximity (Department of the Interior, 1975).

Electric transmission lines must be protected so that the loss of power in a joint use corridor through accident, natural disaster, or sabotage does not lead to widespread outages. Similarly, gas pipelines must be protected so that widespread service disruptions are avoided. Start-up costs after such disruptions are high, particularly for gas service.

All joint use utility corridors are subject to degraded reliability due to necessary construction and periodic maintenance. The spacing and mitigation measures mentioned above, as well as cooperation and communication between utilities, can maximize system reliability, but with a probable increase in costs.

5. ENVIRONMENTAL CRITERIA

Of all the utility services, overhead electric transmission lines have the greatest impact on the environment. They require the most right-of-way and they are, of course, visible. Concealment of transmission towers and lines is virtually impossible, but much can be done to make them less obtrusive and more attractive. Proper corridor site location, landscaping, and screening are needed in both rural and urban settings.

Constraints upon the location of transmission lines are, however, usually greater in urban areas. Existing development, and the lack of sufficient right-of-way, may require less than optimum locations. In rural areas, greater flexibility exists in locating the utility corridor because wider right-of-way easements are usually available. The dissimiliarities between rural and urban areas results in the application of different criteria for siting transmission lines. A joint publication by the U.S. Department of Agriculture and Interior has been used extensively in this section (U.S. Department of Agriculture and Interior, 1970).

Electric Transmission Lines--Rural

1. Rights-of-way should be planned to preserve the landscape and minimize land use conflicts. This means the avoidance of heavily timbered areas, steep slopes, main highways, and scenic areas, including parks or monuments. If the corridor must pass through a recreation area, a thorough evaluation of an undergrounding alternative should be made.

2. Where possible, retirement or upgrading of existing lower voltage transmission circuits should be required to allow

the construction of higher voltage, higher capacity circuits on the existing right-of-way.

3. Joint use utility corridors with properly sited rights-of-way should be encouraged where feasible.

4. Care should be taken to screen corridors from view by the selection of routes that take advantage of natural contours or landscapes. Deflection of right-of-way strips through heavily timbered areas should be made to avoid "tunnel" appearances.

5. Avoid crossing open expanses of water and wetlands. Where this habitat is crossed by the flight lanes of migratory waterfowl and heavily used by other birds, the need for avoidance is particularly great.

6. Any areas of wildlife concentration, such as nesting and rearing areas, should be avoided.

Electric Transmission Lines--Urban

1. In the selection of rights-of-way, care should be exercised to avoid high visibility areas. Where high visibility corridors are unavoidable, screening should be used wherever possible to minimize views of the utility corridor.

2. Use of existing rights-of-way should be examined for the potential siting of new transmission lines.

3. Joint use of rights-of-way by two or more utilities, where not in conflict with identified transportation needs, should be encouraged.

4. Aesthetic considerations need to be balanced with land requirements for utility corridors. Ideally, utility lines should be completely screened within a very narrow corridor. Where sufficient right-of-way width is available, consideration should be given to using double pole structures which are shorter and hence more easily screened than the taller single pole structures. (This technique should only be used in rural areas where the necessary right-of-way for double pole structures is usually available.) Alternatively, the height of the pole lines should be minimized through the prohibition of distribution underbuilding on transmission lines.

Underground Transmission Lines

The environmental impact of underground utility location may be minimal compared to overhead electric transmission lines. Whether such facilities should be constructed, however, depends on environmental, cost, and system reliability criteria--and must be evaluated on a case-by-case basis. The following environmental considerations can ensure that these lines will be an unobstructive part of the landscape.

1. The joint use of rights-of-way with other types of utilities should be coordinated in a common corridor whenever utility uses are compatible.

2. Clearing for construction and excavation should be kept to a minimum.

6. SENSITIVE LANDS

Sensitive lands may be defined as those areas where eco-systems are particularly vulnerable, or where development constraints and/or hazards are present. Table 3-2 lists those factors by general category which are sufficient to identify sensitive lands. Single factors alone (e.g., wetlands or the presence of rare and endangered species) may be sufficient to classify an area as sensitive, particularly where state or federal regulation, as in the above two examples, are involved. The clustering of several factors from different problem groups for a given locale is an indicator of the land's sensitivity.

Transmission lines should be diverted around these sensitive areas. However, where no alternatives to proposed corridors across small areas of sensitive lands are available, thorough consideration should be given to undergrounding transmission lines. In earthquake problem areas, however, such undergrounding is not advisable.

7. VISUAL IMPACTS

Major electrical transmission facilities can have a major visual impact, especially within the densely built-up portions of urban areas. These facilities can affect a person's feelings about the quality of life and livability of the area where he works and lives. To the extent that the outline of these facilities can be obscured or obstructed, the compatibility with adjacent sensitive uses can be greatly enhanced. Facilities that must be upgraded or replaced should utilize existing rights-of-way where not in conflict with identified transportation improvements, and careful consideration should be given to the actual type of transmission tower design used in order to provide the least visually obstructive facility. The use of compact construction should be encouraged by the utilities.

TABLE 3-2

SENSITIVE LANDS CRITERIA

Earthquake Problems
- ° ground shaking potential
- ° fault rupture areas
- ° tsunami or seiche potential

Slope Stability Problems
- ° avalanche hazard
- ° landslide hazard
- ° solifluction potential
- ° creep potential

Water Problems
- ° stream flooding frequency
- ° floodplain areas
- ° aquifer recharge areas
- ° wetland areas

Soil Problems
- ° subsidence potential
- ° liquefaction potential
- ° settlement potential
- ° shrink/swell potential
- ° frost heave potential
- ° soil loss potential
- ° sedimentation potential

Ecological Problems
- ° unique habitat areas
- ° wildlife nesting or rearing areas
- ° rare or endangered species present
- ° bird flightway areas

Weather Problems
- ° high wind areas
- ° ice damage potential

Cultural Problems
- ° land use conflict areas
- ° scenic opportunities/landscape vistas
- ° noise (loudness, duration, frequence, and perceived nuisance level)
- ° archeological/historic sites
- ° unique recreation areas (fossil beds, skiing, etc.)

SOURCE: Laird, R.T., et al, 1979, Quantitative Land Compatibility Analysis, USGS, Washington, D.C.
McHarb, Ian, 1971, Design with Nature, Doubleday Press, New York