DESCRIPTION AND APPLICATION OF A COMPREHENSIVE PLANNING PROCEDURE FOR URBAN RAILROAD RELOCATION

Albert E. Moon, Stanford Research Institute

Relocation for consolidation of railroad facilities in urban areas offers a potential for achieving significant benefits from eliminating delays and accidents at grade crossings, environmental degradation near the railroad, and social and economic barriers and from improving the efficiency of railroad operations. However, the impacts of railroad relocation are distributed widely throughout a community, and any real improvement in the community and railroad system will require careful and comprehensive planning. This paper describes a planning procedure and guidebook developed to help community leaders organize and manage the planning process and to provide a consistent framework for developing and analyzing the costs and benefits of alternatives. The project team found that the analytical procedure was effective when used at the proper level of detail to support the decisions to be made as a result of the current study. They also found that the evaluation of projects with significant nonmonetary benefits is difficult, despite the organization of the benefits that can be valued or measured. This paper illustrates the application of these procedures and the guidebook to the problem of railroad relocation in the city of Lafayette, Indiana.

•A NUMBER of cities are considering relocation of railroads to improve the quality of life for their communities. Railroad relocation has the potential to eliminate delays and accidents at grade crossings, improve the urban environment, and increase the efficiency of railroad operations. Because of widespread interest in the potential benefits of railroad relocation, the Federal Railroad Administration and the Federal Highway Administration embarked on a study of railroad relocation in 1972 to determine the nature and magnitude of the urban railroad problem and to develop a method for planning to alleviate the problem. A team of contractors went to 6 cities where they studied railroad operations and interviewed local governmental officials, community leaders, and railroad personnel. Less detailed studies of railroad operations were conducted in 11 other cities, and proposals to relocate railroads in 50 communities were reviewed.

From this study, the project team developed a comprehensive guidebook that brings together recommendations designed to assist community leaders in conducting railroad relocation planning studies. Technical guidance also is provided for developing and evaluating alternative proposals to alleviate the problem. Such comprehensive planning seems necessary to realize the potential benefits of railroad relocation.

After preparing a draft of the guidebook, the project team applied its procedures to the railroad-community conflict in Lafayette, Indiana. This application enabled the team to revise the guidebook for easier use, and further improvements may be expected as others use the guidebook.

Publication of this paper sponsored by Committee on Railroad-Highway Grade Crossings.

DESCRIPTION OF THE PLANNING GUIDEBOOK

The guidebook was designed to

1. Facilitate the organization and management of planning by community leaders and
2. Provide a uniform framework for developing and evaluating alternative solutions to the railroad relocation problem.

The project team feels that the first of these objectives arises from the diversity of stakeholders who potentially are affected by a railroad relocation project. Thus planning includes all aspects of urban land use planning, urban transportation system planning, and railroad system planning. The review of many project proposals led to the realization of the need for the second objective, a uniform measuring technique.

Organization and Management of Planning

Experiences of communities that have prepared relocation plans indicate the desirability of forming a steering committee that can draw together the many interests affected by the railroad into a forum and policymaking group. Local government, businesses, railroads, other governmental agencies such as transportation planning organizations, and citizens are among those who have been represented. Experience also has shown that strong leadership must be exerted to accomplish the planning, and usually the leadership emanates from the steering committee. In addition, it is important for the involved railroads to participate actively throughout the planning process.

The guidebook recommends that a preliminary assessment of the potential for alleviating the problem be made in which alternatives are developed in a relatively shallow level of detail and an approximate cost of the potential solution is estimated. This step will allow the community to decide whether the continuation of the planning process is justified and whether the leadership and financial resources that the community must provide for the planning can be committed. (The preliminary assessment part of the guidebook will be published separately.)

The steering committee generally guides the plan development and acts as a focal point for communicating progress to the community. When the assessment of the alternatives is completed, the steering committee receives the response of the community and provides leadership for adoption of the most favorable alternative.

After a plan is adopted, the committee usually will be restructured with much broader powers to implement the chosen plan.

Special consideration should be given to the commitment of the community to the solution of the problem in terms of its ability to provide both leadership for the detailed planning process and money for implementation. Special consideration also should be given to the management of the technical aspects of the plan development to ensure that the activities of the many different specialists are coordinated properly.

Framework for Developing and Evaluating Alternative Solutions

Developing a plan for alleviating the problems associated with railroads in urban areas consists of (a) definition of the problem, (b) identification of alternative solutions, (c) description of alternatives, (d) measurement of costs and benefits, and (e) comparison of alternatives. A number of iterations through these steps usually will be required before a satisfactory plan is developed. The project team has found that failure to consider many alternatives in modest detail sometimes results in community or railroad rejection of a plan that is developed in some detail, and another plan must be developed at consequent increased cost and loss of time.

Not all of the steps can be assisted effectively by a guidebook. For example, problem definition is critical but requires imagination and cannot be done routinely. Iden-

tification of alternatives relates to definition of the problem and hinges on the ingenuity of the study team.

Description of the alternatives may be accomplished at many levels from moderately detailed to very detailed designs of the new system and its components. The guidebook emphasizes the need to match the level of description to the problem; that is, the description must not be too detailed too early.

Measurements of Costs and Benefits

Most of the guidebook is devoted to the analysis of benefits and costs of proposed alternatives. The guidebook lists the following 8 groups that should be considered in the analysis:

1. Railroad operating companies,
2. Railroad employees,
3. Highway users,
4. Residents and tenants of property adjacent to existing or new railroad facilities,
5. Railroad users,
6. Owners of property adjacent to existing or proposed railroad facilities,
7. Community at large, and
8. Remainder of the state and nation.

The guidebook provides worksheets to aid the user in his or her analysis of costs and benefits. The text also discusses the issues involved and presents charts and tables that provide data and computational guides. The items that are considered in the analysis of costs and benefits (as compiled from the entries on the worksheets) are as follows:

1. Railroad design criteria (number of tracks required, clearance requirements, horizontal alignment, vertical alignment, drainage requirements, type of ballast and section, type of crosstie, crosstie size and spacing, rail and turnouts, signaling, crossing protection, and bridges);
2. Approximate railroad construction costs (property acquisition and related items, site preparation, track work and track structure, right-of-way protection, railroad buildings and facilities, signals and communication systems, highway crossing and warning devices, engineering, contingencies, railroad removal, and track salvage);
3. Approximate annual railroad operating costs (train delay or running time, route length or distance, grade-crossing maintenance, manned signal or interlocking, gradient, speed reduction, traffic lost, income tax, line-haul, terminal, freight cars, joint facility, "fixed" plant, grade-crossing maintenance, administration, traffic revenue lost, interest, 1-time tax, accidents, and total);
4. Railroad user cost (moving and disruption, additional transport, net to landowner, community land value loss, community payroll loss, and community jobs lost);
5. Impact of highway users on neighborhoods (change in daily vehicle operating cost, change in daily vehicle time cost, change in daily vehicle accident cost, change in daily emissions and amount of carbon monoxide and hydrocarbons);
6. Inventory of conditions around railroad;
7. Impact of land removal on abutting property (land use, right-of-way, abutting property, economic impacts on land value and business, physical impacts, social impacts, plans to mitigate unfavorable impacts, and key issues in neighborhood);
8. Impact of railroad removal on nonabutting property (physical and social impacts);
9. Inventory of land on and near proposed railroad alignment (data on railroad, right-of-way acquisitions, and descriptions of damages to property);
10. Relocations of families and businesses;
11. Impact of right-of-way acquisition on neighborhoods (value of land improvements taken, value of damages to property, relocation costs for households and busi-

nesses, number of households moved, number of businesses moved, community impacts on land values and jobs);

12. Neighborhood disruption (physical impact of project, number of families affected, characteristics of neighborhood, estimated disruptive impact, and plans to mitigate unfavorable impacts);
13. Impact of increased rail traffic on neighborhoods (railroad operation, physical impact, social impact, economic impact, and plans to mitigate unfavorable impacts);
14. Initial financial analysis for community (project costs, estimated financial contributions by federal and state governments, and local government share of project cost);
15. Bond service requirements for local share of project costs (total local share, bond issue requirements, and total annual revenue to be raised);
16. Community land value change (railroad user moves, right-of-way acquisition, neighborhood land value, and net land value change);
17. Community tax changes required (tax source, amount of taxes, tax rate, and other tax information);
18. Other impacts on community (air pollution, employment, other jobs lost or gained, services, and other community issues); and
19. Impacts on state and nation (impact on natural resources, impact on highway improvement funds, impact on national goals, and impact on institutions).

Comparison and Evaluation of Alternatives

The project team found that formal benefit-cost studies were not usually a part of the decision-making process in many communities. Such studies are used widely by state and federal agencies, particularly those dealing with transportation. A dual evaluation system is described in the guidebook to conform to current practice in communities, encourage quantitative evaluation, and meet the needs of higher levels of government. The first part of the evaluation provides the community with a comprehensive description of the impacts on all stakeholders, regardless of the duplication that occurs in such a description. The total impact of an improved railroad system cannot be deduced from the addition of the parts, but members of the community can recognize the impact on their individual lives and economic situation from this analysis. Guidance for computing a benefit-cost analysis of the alternatives for use by state and federal agencies is provided as the second part of the evaluation.

APPLICATION OF THE GUIDEBOOK

Problem

The procedures previously set forth were used to analyze the urban railroad problem in Lafayette, Indiana, and to develop potential solutions. Every day, as many as 62 freight trains pass through Lafayette and delay vehicles at the grade crossings. Slowing and stopping the more than 150,000 vehicles that daily cross the tracks are estimated to consume more than 500 h/day. The delays, cost, and potential for accidents are major irritants as well as an expense to the motorist.

The railroads contribute environmental problems such as noise, vibration, and traffic obstruction. Warning devices (gates and flashing lights) guard almost every railroad crossing, contribute to the noise, and are a railroad maintenance expense. The reduced speed of trains passing through the city increases the cost to the railroad.

Lafayette's interrelated problems in railroad, highway, and land use began in the 1960s. A 1969 plan recommended relocation of the railroads to the east of the city to increase accessibility to the central business district (CBD) and alleviate the railroad-highway conflict. A preliminary study of railroad relocation, completed in 1970, considered corridors along the riverfront (the riverfront plan), along the existing rights-of-way, and around the city and concluded that a depressed route along the Norfolk and

Western right-of-way (the C-3 plan) was the best corridor of those studied. This route required relocation of a significant number of homes and businesses, and the city hesitated to undertake such a disruptive action.

Proposed Solutions

Proposed solutions were alternative 1, the riverfront plan, and alternative 2, the C-3 plan.

Figure 1 shows the riverfront plan. The 2 railroads traversing the central portion of the city are joined in a common, 3-track corridor that follows a depressed route near the river; the corridor is shown by the dashed line. Grade separation structures carry all highway traffic over the corridor, and all of the old railroad lines (dotted lines) are removed. This eliminates virtually all railroad-highway grade crossings in the city.

The C-3 plan combines the 2 railroads that traverse the central portion of the city but in a new common corridor follows the existing route that runs diagonally from points 3 to 17 in Figure 1. The new corridor is partly depressed to allow construction of grade separation structures over the corridor. Grade crossings remain in the southwestern part of Lafayette (points 4 and 5 in Figure 1) near the Wabash River.

Conduct of the Analysis

The project team was charged with the following 3 tasks:

1. Perform an initial feasibility study of the riverfront plan;
2. Develop the riverfront plan and estimate the costs and benefits of both the riverfront and the C-3 plans from earlier studies; and
3. Compare the riverfront and C-3 plans with the alternative of taking no action.

Initial Feasibility

The initial feasibility step illustrates the iterative nature of plan development. At the beginning of the project, 3 critical questions were raised. A negative response to any of them would render the riverfront corridor unfeasible. Can a riverfront corridor be designed to offer adequate protection from flooding by the Wabash River? Can a riverfront route be found that will accommodate approaches to the relatively new Harrison Bridge across the Wabash River? Can suitable environmental adjustments be made to prevent the riverfront corridor from adversely affecting the use or appearance of the Wabash riverfront?

Preliminary work on layout of a corridor and analysis by a land use planner gave affirmative answers to all 3 questions, and the project proceeded.

Description of Alternatives

After considering several approaches, the project team decided that concept-level engineering would be an appropriate level of detail for design and cost of the riverfront alternative. The concept level of engineering produces neither details of structures nor such things as specific quantities of concrete or steel. But it does show horizontal and vertical alignment with sufficient detail to determine whether the proposal will work, and costs are based on past experience with similar kinds of projects in terms of dollars per structure or dollars per track mile (kilometer). An operable alignment was developed, and costs were estimated at $37.7 million in 1974 prices. Completion of property acquisition and construction is estimated to require 4 years.

Figure 1. Proposed riverfront rail corridor.

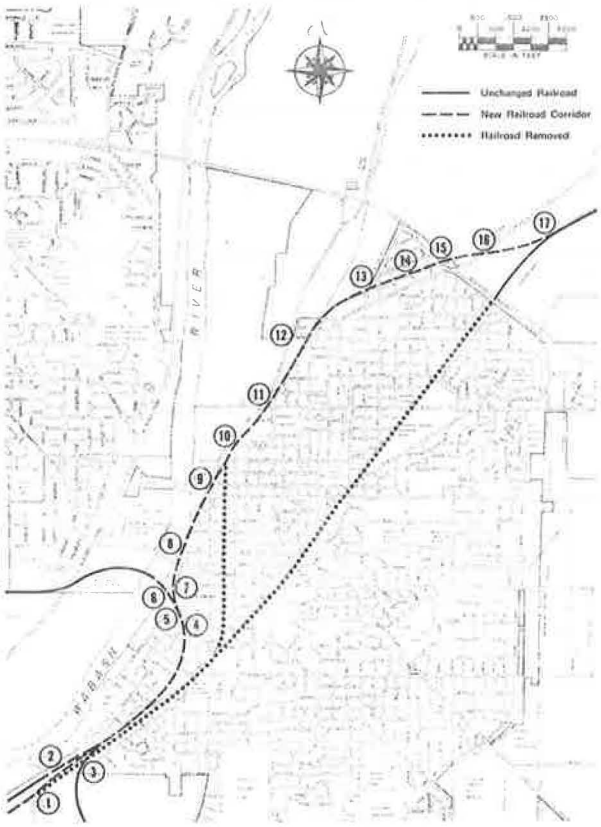

Table 1. Grade-crossing characteristics under existing condition.

Year	Number of Vehicle Crossings	Total Users' Delay Time (min/day)	Vehicle Operating Cost (dollars/day)	Accidents/Year	Cost of Accidents/Day (dollars)	Air Pollution (lb/day)	
						CO	Hydrocarbons
1973	153,000	30,300	731	3.2	220	4.2	2,630
1980	162,000	32,200	776	3.4	234	1.3	798
2004	208,000	41,200	996	4.4	300	0.14	85

Note: 1 lb = 0.45 kg.

Table 2. Highway user impacts in dollars/day.

Savings	Riverfront Plan		C-3 Plan	
	1980	2004	1980	2004
Occupant time	1,092	1,491	1,081	1,387
Operating cost	776	996	761	475
Accident cost	234	300	224	288
Total	2,102	2,697	2,066	2,650
Annual	767,000	984,000	754,000	967,000

Highway Users

Construction of the riverfront corridor will eliminate all of the grade crossings in the city of Lafayette and thus will eliminate delays to occupants of automobiles and trucks. It also will eliminate the vehicle operating costs due to slowing and stopping for the grade crossings. Potential for train-vehicle accidents also will be eliminated.

Data for vehicular crossings of the railroads in Lafayette are given in Table 1 for 1973, 1980, and 2004. Most of the operating cost and time delay associated with these crossings will be eliminated by either plan, as shown by the data given in Table 2.

The values in Table 2 include an assumed value of time for vehicle occupants. The value that people place on avoiding delay varies with their purpose in traveling, the time saved (5 min are more important per minute than 1 min is), and the economic status of the occupants (value placed on time increases with income). After consideration of these factors, the study team assumed an average value of $2.04/h. Thus eliminating the delay in 1980 by the riverfront alternative will be worth a daily total of $1,092 to the travelers. The savings under the C-3 plan are similar to those under the riverfront plan. However, under the C-3 plan, several streets still cross the Norfolk and Western and Nickel Plate-Penn Central tracks on grade; hence the cost saving is slightly smaller. The C-3 plan also closes several streets. Traffic on these streets (25,200 trips daily in 1973) would have to detour, but the added delay and cost cannot be estimated from current data. Additional overpasses, not included in the cost estimates, would eliminate some of the delay.

The present (1974) value of annual savings for the riverfront plan is $4,330,000. For the C-3 plan, it is $4,256,000.

Operating Impacts on Railroads

Table 3 gives a description of the operating impacts of the riverfront and C-3 plans on the Norfolk and Western and Louisville and Nashville railroads. The impacts are negligible on the Penn Central Railroad. Table 4 gives a summary of costs and benefits for the Norfolk and Western Railroad, and Table 5 gives a summary of costs and benefits for the Louisville and Nashville Railroad. Annual savings will begin about 1980 at the end of the construction period and will extend for the remainder of the study period.

In addition to the items tabulated, possible savings might accrue with the elimination of the need to raise the Louisville and Nashville Railroad Fifth Street tracks to pavement level pending relocations; small additional expense might occur in shuttling yard crews between the Monon yard and any new yard facility. In the analysis, tax impact is the net operating savings taxable at corporate tax rate. Retirements of track work result in 1-time benefit.

Neighborhood Impacts

The riverfront and C-3 plans will affect the CBD and neighborhoods along the present and proposed railroad corridors. Figure 2 shows areas of significant impact that will result from each plan. Table 6 gives a list of the nature and significance of the impacts on these areas by the proposed relocation plans.

Perhaps a key issue in the riverfront corridor assessment is the creation of opportunities and problems by the corridor construction at the riverfront edge of the CBD. Construction activity will focus attention on the riverfront; and the new bridge, site clearing and preparation, and corridor construction will provide both opportunities and problems. The problems arise because the corridor location requires special provisions to ensure clearances and ventilation and minimize visual intrusion and vibration. The riverfront may be developed without railroad relocation, but the development may not occur as rapidly nor will it be as well integrated.

Table 3. Impacts on the Norfolk and Western and Louisville and Nashville railroads.

Characteristic	Norfolk and Western		Louisville and Nashville	
	Riverfront Plan	C-3 Plan	Riverfront Plan	C-3 Plan
Percentage increase in railroad line distance	65	None	8	32
Increase in distance-related annual operating costs	Significant	None	Small	Substantial
Change in gradient-related costs	Some increase	Some increase	Some savings	Small increase
Increase in track maintenance costs	Some	Some	Some	Some
Savings from higher operating speeds on corridor	Some	Some	Some	Some
Cost if track is flooded	Substantial			
Savings from elimination of crossings	Substantial	Substantial	Substantial	Substantial
Savings from elimination of interlocking and use of more favorable interchange locations	Some	Substantial	Some	Some

Table 4. Summary of operation impacts on Norfolk and Western Railroad.

Item	Annual Costs (dollars)	
	Riverfront Plan Versus Existing Plan	C-3 Plan Versus Existing Plan
Train running time[a]	-7,160	-11,904
Route length or distance and route depression[a]	89,165	7,500
Crossing maintenance	-35,850	-35,850
Manned signal or interlocking	-40,000	-40,000
Gradients[a]	116,105	13,351
Traffic	18,600	18,600
Speed reduction	-62,050	-62,050
Total before tax	78,810	-110,353
Income tax expense[b]	-37,828	52,969
Total after tax	40,981	-57,384

[a]Does not include effect of operations over shoofly tracks or recurring switching costs.
[b]Excludes a 1-time tax savings from track retirements that approximates $128,280 for each alternative.

Table 5. Summary of operation impacts on Louisville and Nashville Railroad.

Item	Annual Costs (dollars)	
	Riverfront Plan Versus Existing Plan	C-3 Plan Versus Existing Plan
Line haul	242	12,669
Terminal	-9,100	-7,700
Freight car	-2,890	2,024
Grade crossing maintenance	-25,415	-25,415
Other "fixed" plant expenses[a]	2,700	4,254
Loss (or profit) from traffic	—	—
Interest	-3,570	-3,570
Total before tax	-38,003	-17,738
Income tax expense[b]	18,256	8,514
Total after tax	-19,777	-9,224

[a]Both the Riverfront and C-3 alternatives will save the Louisville and Nashville Railroad an additional $175,000 if the city does not require it to raise its Fifth Street tracks to the current pavement level pending relocation.
[b]Excludes a 1-time tax savings from track retirements that approximates $50,000 for each alternative.

Figure 2. Impact areas.

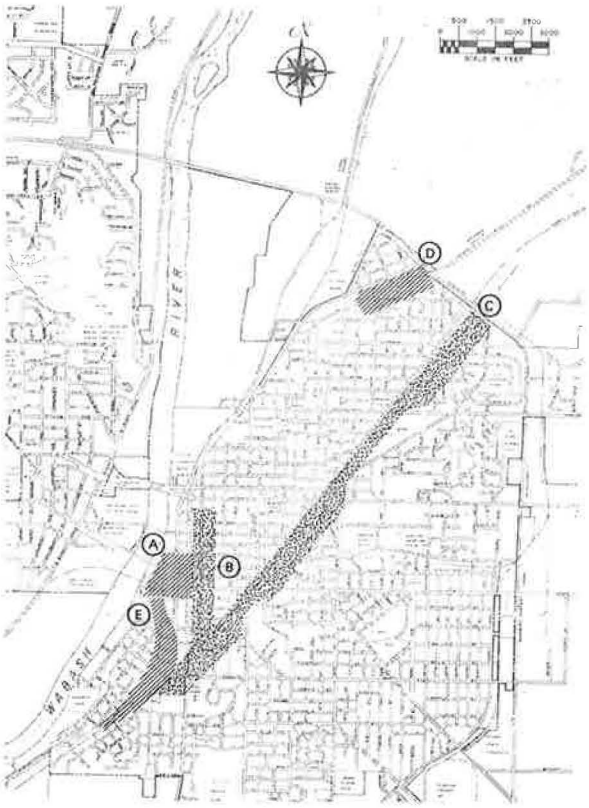

Table 6. Nature and significance of impacts of relocation plans on areas shown in Figure 2.

Area	Item	Riverfront Plan	C-3 Plan
A (CBD)	Improved accessibility	Significant	Slightly less than riverfront plan
	Construction focus attracted	Significant opportunity created	No change
B	Property value change	+$194,000	+$194,000
C	Property value change	+$1.4 million[a]	Probably unfavorable because of increased traffic and track depression
D	Noise, limited accessibility, and visual intrusion[b]	Unfavorable	Not unfavorable
E	Noise, vibration, and other environmental problems[c]	Minimal[d]	Not unfavorable

[a]Track removal causes increase.
[b]Railroad is introduced into established neighborhood.
[c]Increased train traffic causes impact.
[d]Impact is minimal because few residents are in the area.

Table 7. Benefit-cost summary of impacts measured in dollars.

Item	Adjusted Present Values (thousands of dollars)	
	Riverfront Plan Versus Existing Condition	C-3 Plan Versus Existing Condition
Highway user savings	4,330	4,256
Railroad company savings	-209	656
Railroad user cost	-6	-6
Community land value increase	710	96
Relocation cost	-23	-59
Total benefits	4,802	4,943
Capital cost (net of residual)	-23,166	-17,875
Net present value of cost	-18,364	-12,932

Property Accessibility and Values

The residential property in areas B and C probably will become more valuable if the railroad is removed. A portion of the increase reflects values taken from other parts of the community because of the increased competitive position of these suddenly more attractive properties. The remainder of the increase represents a true increase in value resulting from opportunities for residential developments that are more accessible to the CBD and Purdue University (the major trip attractors) than are other areas available for development. The distribution of the new and transferred values is estimated from the relative accessibility of the competing locations.

Relative accessibility is approximated by the ratio of the squares of the distances from trip origin to destination. Thus, the relative accessibility of 2 origins, 1 of which is twice as far from the common destination, would be 4:1. For area B, the average relative accessibility to Purdue University and downtown Lafayette (weighted by numbers of households along Fifth Street) is 27 times that of the new tracts in the eastern and southern parts of Lafayette. Thus the assumption is that area B is 27 times more attractive than the new tracts, and $^{27}/_{28}$ of the value increase will be a net gain. Therefore, the removal of the railroad contributes $^{27}/_{28} \times \$194{,}000$ or $\$187{,}000$ in new property value. This increase can be applied to either the C-3 or the riverfront alternative.

The riverfront plan similarly affects area C. Removal of the railroad should increase the value of the adjoining property. In consultation with a local appraiser, the research team estimated the increase in value for the block of homes nearest the railroad to be a total of $\$1.4$ million. Again, part of this gain will be a displacement of demand from other parts of the city, particularly in the newer southern and eastern developments. However, by using the accessibility analysis, one determines that the property in this strip is $^{11}/_{13}$ more accessible to the CBD and Purdue University than are the new eastern and southern developments. Thus a factor of $^{11}/_{13} \times \$1.4$ million results in a net land value benefit of $\$1.19$ million for the riverfront plan.

Estimates of relocation payments are used as a measure of the economic cost of family or business displacement. However, there is more to moving a family or business than economic problems—new relationships must be established and new schools for children, new customers for businesses, and other disruptive consequences result.

Under either the C-3 or riverfront alternatives, 4 freight users will lose service and probably will need to relocate. The research team assumed that the net moving cost will approximate $\$2{,}500$ per business for a total of $\$10{,}000$. The C-3 plan identifies 22 other businesses and professional offices to be relocated. Assuming an average of a $\$1{,}500$ moving expense per establishment, the 22 businesses would be due $\$33{,}000$ without allowing for other assistance. The riverfront relocation eliminates 6 commercial businesses and uses part of the property from 7 others. Moving costs are estimated to total $\$20{,}000$. Under either the riverfront or C-3 plans, all of these business establishments can be relocated in the community so that no impact on employment is anticipated.

One of the principal impacts of the C-3 plan is the elimination of 250 residences for the temporary trackage route, the open-cut construction, and the approaches to grade separation structures. A 1971 housing survey indicated about 200 vacant housing units in areas near this route and perhaps only 600 to 700 in the entire Lafayette area. Thus a requirement for 250 homes in this market is significant. The market pressure could be eased by moving some units, but finding vacant land on this scale would be difficult. Moving costs are estimated at $\$200$/family for redevelopment projects. This moving cost would amount to $\$50{,}000$ in direct payments in addition to administrative costs. No other assistance is estimated. The riverfront relocation displaces 30 residential units in area D and 14 others in various locations. Part of the property of 12 other residences is needed. Some units may be moved to lots nearby. The estimated costs for moving all families are $\$11{,}200$.

Cost Comparison of Alternatives

For the benefit-cost analysis, it was assumed that the construction of either project would begin in 1976 and would require 4 years to complete. The construction costs were distributed over that period. The amounts expended each year were discounted at 10 percent to the beginning of 1974. Then, to allow for the usefulness of parts of the facility at the end of the 25-year period, the research team deducted the full value of all land and 50 percent of preparation, track work, and structure after discounting to the beginning of 1974. The following summarizes these operations:

Item	Amount (dollars)	
	Riverfront Plan	C-3 Plan
Present (1974) value of construction cost	24,084,000	18,607,000
Present value of residual	918,000	732,000
Net present value of construction cost	23,166,000	17,875,000

Comparison of Impacts and Costs

The results of the full benefit-cost analysis are summarized in Tables 7 and 8. The table presents current values of costs and benefits and other impacts. The benefits from either of the alternative plans are well above the median expected from relocating railroads in cities of comparable population. The excess of cost over benefits indicates that the topography and development of Lafayette make the solution of its railroad problem extraordinarily difficult.

Moreover, the comparison of monetary and other values should be considered. The following are some of the impacts of the relocation plans that are difficult to quantify:

Plan	Impact
Riverfront	Creates opportunity for riverfront development but adds some problems to this development
	Creates opportunity for Northeast Parkway
	Disrupts neighborhood in area D
C-3	Reinforces railroad barrier by depression
	Disrupts local housing market

The adjusted present values given in Table 7 can best be considered as the cost of the intangible results of the alternatives. This effective cost in the C-3 plan is nearly $13 million. This amount will solve the railroad problem but will disrupt the housing mar-

Table 8. Benefit-cost summary of other measurable impacts.

Item	Riverfront Plan Versus Existing Condition	C-3 Plan Versus Existing Condition
Number of families relocated	56	250
Number of businesses relocated	13	26
Number of employees affected	0	0
Vehicle emissions reduction by 1978		
Hydrocarbons, lb/day	2	2
Co, lb/day	1,250	1,250

ket and many families, leave the depressed right-of-way as a barrier, close street traffic to 25,000 crossings/day, and place a large-scale grade separation structure into residential neighborhoods. There is a $5.2 million difference between the C-3 and the riverfront alternatives. The riverfront plan will reduce the number of families to be moved, eliminate the barrier across town together with all restrictions to pedestrian and automobile traffic, and place a smaller barrier in area D. This $5.2 million might be used to improve the C-3 plan by deeper depression, more grade separations, and contained rather than open cuts.

These issues affect people in various parts of Lafayette in greatly different ways. Although the study team can identify the issues and analyze the quantifiable items, the people of Lafayette must ultimately express their preferences.

The benefits of the Northeast Parkway and the new Ferry Street Bridge as well as the increased costs of closing streets need to be quantified as soon as the Greater Lafayette Area Transportation Study has developed the appropriate analyses. This is very important because the Ferry Street Bridge represents a large portion of the riverfront corridor cost.

After the issue is well understood and a community commitment is made to the project, detailed plans must be drawn up and the cost of the plans must be carefully estimated to determine the level of financing required. Then funds can be assembled and construction can begin.

Significant Findings of the Application Exercise

There are 3 significant findings of the application exercise.

1. Improvements in land value can be judged fairly well by local appraisers and can be adjusted for the effects of relocation values.
2. Neighborhood impacts need to be measured on a scale consistent with the rest of the analysis.
3. Justification of projects with large intangible benefits is going to be difficult.

Improvements in Land Value

Many economists claim that railroad relocation can increase the land value and tax base for a community, but others say that improvements in land value in one location are gained at the expense of losses in other locations. In field investigations, the research team talked to real estate appraisers in several parts of the country. All of them said that they consider proximity to railroad tracks in their evaluation of property. The research team used the estimates of a local appraiser for property adjacent to the tracks. The estimates for areas farther from the tracks, which would be affected by the improved accessibility through grade-crossing elimination, were counted elsewhere. To account for relocation, the research team assumed that value was proportional to accessibility, and they computed accessibility to major activity centers of the new and potential competing parcels as the square of the distance. The major activity centers were the CBD and Purdue University. Competing residential areas were at the eastern and southern boundaries of the urban area. It was assumed that new values resulting from removal of the railroad would be distributed according to the accessibility of these sites relative to sites for new residential units.

Level of Detail

The neighborhood impact analysis procedure in the guide originally recommended the analysis of neighborhoods that are less than census tract size. The project team considered that this level of detail might be necessary to uncover variations in impact among different alternatives that might be needed for environmental impact analysis.

In the Lafayette study, 20 neighborhoods were defined initially. After considerable work, the research team concluded that a detailed analysis of each small neighborhood would produce no more useful information for its purpose than the analysis of the 5 areas shown in Figure 2. As a result, the text of the guidebook has been modified to recommend the use of relatively large neighborhood impact areas in initial comparisons and smaller areas in the detailed design.

Intangible Benefits

The railroads of Lafayette conflict significantly with the community. Yet the high cost of relocating the railroads creates a significant shortfall between the monetary benefits of the alternatives and the costs. The lower cost C-3 plan does not seem to provide an adequate solution to the problem either.

The intangible value of removing the railroads can be measured only in the feelings of the people of Lafayette about their city both with and without railroads. Of particular interest is a study being sponsored by the Lilly Foundation, Inc. This study will prepare materials that will help the citizens visualize the differences that will result from railroad removal; the study will attempt to assess the feelings of the citizens about the value of those improvements. The results of this study will meet with considerable attention.