

Natural Gas Pipeline Impact on Residential Property Values: An Empirical Study of Two Market Areas¹

by William N. Kinnard, Jr., Sue Ann Dickey and Mary Beth Geckler

The lack of published market research studies on the effects that proximity to high-pressure natural gas transmission pipelines (GTPs) has on the value of nearby single-family residences is both notable and surprising. With the emergence of fear-based "stigma" as an alleged source of diminished property values "near" sources of perceived hazards to human health and safety, sponsored research investigating such negative price impacts on residences "proximate to" GTPs would have been expected. Significant publicity is given to natural gas leaks and pipeline explosions, particularly when there is off-line property damage, personal injury or loss of life as a direct result.²

We had extensive bibliographic searches conducted to identify publications dealing with any price or value effects on single-family residential properties from proximity to GTPs. No reports on any such studies were found.

Transferable Results from High-Voltage Transmission Line Impact Studies

There is, however, a substantial body of literature dealing with the impact on single-family residential property prices from proximity to high-voltage electricity transmission lines (HVTLs).³ HVTL studies suggest that changing

patterns of information about health and safety hazards, real or imagined, tend to produce different market reactions by would-be buyers of residences close to HVTLs. Yet there is a remarkably consistent pattern of market responses by actual and potential purchasers. The reasons for the responses may vary, but the general findings are stable:

1. Price declines, if any, generally fall in a range of zero to 10 percent, compared with prices of non-impacted, non-proximate, otherwise competitive properties;
2. Any negative price impacts that are felt tend to diminish over time; and
3. Any negative price impacts tend to diminish as distance from the HVTL right of way increases, rarely extending beyond 200-300 feet.

Systematic HVTL market studies emphasize that even if only a small percentage of potential purchasers actually buy properties within the "impact zone," as indicated by survey research or opinion polling, there is a sufficient market for the properties to sell competitively and readily. Further, HVTL proximity impact studies demonstrate that a negative impact on value need not take the form of price reductions. Increased marketing time is commonly an indicator of decreases in value; so is a decrease in sales volume, relative to the turnover rates for more

distant competitive properties.

Market research to identify and measure any price/value impacts associated with HVTL proximity compares prices, timing and volume of sales within hypothesized "impact areas" with those same indicators for otherwise similar properties in more distant "control areas." The major tool utilized in most recent studies of HVTL proximity impact is Multiple Regression Analysis (MRA) in the Hedonic Pricing Model format.⁴

The research reported in this paper was designed to fill the void in published literature about value effects on single-family residential properties from proximity to high-pressure GTPs. The consistent pattern of HVTL proximity research findings was the starting point for our research design.

Background to the Research Assignments

In two unrelated market research assignments, we were retained to test claims that proposed GTPs would result in substantial decreases in the market value of single-family residential properties "near" the proposed pipelines and their rights of way. These assertions were based on the alleged "stigma" effect of fear from living close to the hazards posed by such pipelines.

One assignment addressed

widespread concerns of property owners along the right of way of a high-pressure interstate GTP proposed to traverse a series of suburban and urban communities in Connecticut. The other assignment was to test similar (but more rigorously stated) claims of property damages from fear of proximity to an interstate GTP near a major city in a Southwestern state. The Connecticut study was conducted during the spring and summer of 1991; the Southwestern study was conducted during the late Fall and Winter of 1991-1992.

In both assignments, the research hypothesis to be tested was that reduced prices are associated with proximity to GTPs. We also tested the hypothesis that any negative price effect associated with proximity to GTPs increases as distance from the pipeline decreases.

In each study, 100 percent of all recorded single-family residential property sales was obtained from public sources, over the period covered by the research. Those sales transaction files were screened: non-arm's-length transactions were removed, as were sales of properties that were miscoded as single-family residences. Any data file missing information about sales price, square feet of living area, lot size, age of house at time of sale or date of sale was eliminated; so were all duplicates. All sales transactions in which the house size, lot size or inflation-adjusted sales price per square foot were more than three standard deviations from the mean for that characteristic were also eliminated.

To measure "proximity" to the GTP, several "distance zones" were established. They identified the location of each sales transaction property relative to the pipeline. The distance zones used in both studies were:

- Zone T: Lot is Traversed by Pipeline Right of Way
- Zone O: Lot Abuts Pipeline Right of Way
- Zone A: Lot is 200 Feet or Less from Right of Way
- Zone B: Lot is 201-400 Feet from Right of Way

Zone C: Lot is 401-800 Feet from Right of Way

Zone D: Lot is 801-1300 Feet from Right of Way

Zone E: Lot is 1301-2600 Feet from Right of Way

Zone F: Lot is 2600-5280 Feet from Right of Way

In the Connecticut study, Zone E was the control area, while Zone F was the control area in the Southwestern study. All sales prices (and sales prices per square foot of living area) were **adjusted** to December 1990 price levels, using the applicable Consumer Price Index for All Urban Households. The price indicators or "dependent variables" used in both studies, therefore, were Adjusted Sales Price (ADJSP) and Adjusted Sales Price per Square Foot (ADJSPSF).

Both descriptive statistics and Multiple Regression (MRA) models were employed to identify and measure whatever effects proximity to the GTP had on ADJSP and ADJSPSF.

Specifics of Individual Study Areas and Associated Pipelines

1. Connecticut Study

In the Connecticut study, the construction and installation of the pipeline was underway during the period of the study. The pipeline was a 24-inch diameter line operating at a pressure of 1440 psi in a right of way 60 feet wide.

The study area consisted of nine towns through which existing GTPs had been in place since the mid-1960s. Four of the towns were traversed by two Algonquin pipelines with 26-inch and 30-inch diameters, operating at 650 psi and 750 psi, respectively, in the same 60-foot wide right of way.

The other five Connecticut towns contained a Tennessee GTP within a right of way that varied from 50 to 60 feet in width. The Tennessee line was 16 inches in diameter, with product transported under pressures of 780 psi.

The study period was Jan. 1, 1986 through Feb. 28, 1991. All deed recordings during this period were included in the initial data set of 1,306 sales. The screening criteria enumerated above reduced the usable data set to 1,171 sales.

2. Southwestern Study Area Characteristics

The new interstate GTP at issue in the Southwestern study abutted the developed area of a major city. It was a 36-inch diameter line in a right of way 50 feet wide, operating at 1000/1200 psi. The line was placed in planned street and road rights of way whenever possible.

RECGC conducted the study in November and December, 1991. The period covered by the sales transaction data was Jan. 1, 1988 through Nov. 15, 1991. The usable data set included 2,202 sales transactions data up to one mile from the pipeline.

The Southwestern study concentrated on one master planned community. The total study area was two square miles: one mile along the western boundary bordered the street within which the GTP had been buried. Pipeline construction was completed by the time RECGC conducted the study. The closest lots in the study area were 65 feet away from the pipeline.

Results of Descriptive Statistics Analysis: Comparisons of Averages

Exhibits 1 and 2 show the mean (average) ADJSPSF, by distance zone and by year of sale, for each of the study areas.

1. Connecticut Study Area

In Connecticut, the ADJSPSF in each distance zone generally followed the same patterns over time (Exhibit 1). By 1991, when there was particularly heavy publicity about the new GTP in the area, Zone T sales showed a slightly lower average ADJSPSF. At the same time, ADJSPSF in Zone A declined less in 1990 and 1991 than did unit prices in Zones D and E (the control area).

When separate averages are calculated for sales along the Algonquin and Tennessee lines (Exhibits 1-A and 1-T), similar patterns emerge. A wider spread among distance zones is found in 1991, but the results are essentially inconclusive. It is clear that univariate analysis (comparisons of simple averages of prices) cannot capture the effects of other forces that influence ADJSPSF within the Connecticut study area.

2. Southwestern Study Area

The time period covered in the Southwestern study is much shorter, so market trends are not nearly as evident. Nevertheless, intense publicity about the impending pipeline construction during 1990 and 1991 appears not to have had any adverse effect on mean ADJSPSF for the closest properties (Zone A). This is shown in Exhibit 2. At the same time, the decline from 1990 to 1991 was greatest in Zone B, although ADJSPSF was still considerably higher in Zone B in 1991 than it was in 1988. Once again, the results are inconclusive. Accordingly, major reliance had to be placed on the results of Multiple Regression (MRA) models in the Hedonic Pricing Model format.

Multiple Regression Model Results

Exhibits 4, 5 and 6 summarize the MRA modeling results. They show that there is generally a negative effect on both ADJSP and ADJSPSF for Zone T properties (in Connecticut only); however, any negative price impact is typically non-significant. Moreover, the effects vary from line to line, and from town to town. There is actually a net positive price effect along the Algonquin line (Exhibit 5).

All of the models consisted of statistically significant variables only, except for the distance zone and town variables, which were forced into the models. Alternative Models 1 and 2 were used in both studies. In each case, Model 2 removed an independent variable that was statistically significant, but whose correlation with size led to multicollinearity and potentially nonsensical results. In Connecticut, the variable "basement-finished" was removed, while in the Southwestern study it was "number of baths".

The coefficient of multiple determination (R^2) was acceptably high in both studies, when ADJSP was the dependent variable: approximately .74 in the Connecticut study and .86 in the Southwestern study. When ADJSPSF was the dependent variable, R^2 dropped significantly. This is a common occurrence.

F-ratios were exceptionally high in all models. The figures were considerably higher in the Southwestern study. In every case, the models were emphatically not random nor chance occurrences; they represented systematic, significant patterns of market behavior.

1. Connecticut Study Findings

Overall, Zone T showed negative impacts from the existence of portions of pipeline rights of way on the properties, but those effects were non-significant (Exhibit 4) except in Trumbull. Moreover, the net effect along the Algonquin line was positive (but non-significant). The price effect along the Tennessee line was negative and statistically significant (Exhibit 5). This is entirely the result findings within one town, however: Trumbull.

Curiously, Zone O (abutting properties) prices showed a positive effect relative to those in Zone E. Generally speaking, all the other zones showed negative price impacts relative to Zone E, except in Zone A when ADJSP was the dependent variable. All those distance zone impacts were non-significant and non-systematic, however. (See Exhibit 4). There were substantial differences between the Algonquin line results and the Tennessee line findings, as indicated in Exhibit 5. There was no systematic pattern beyond Zone T, however.

2. Southwestern Study Findings

Exhibit 6 shows that there is also no systematic pattern of price differences or statistical significance of findings as distance from the pipeline increases, in the Southwestern study area. Until Zone E is reached, there are no statistically significant distance zone coefficients. Moreover, any price differences are relatively minor. Coefficients for all distance variables were calculated in comparison with price levels in Zone F, the control area.

The Zone E results provide further substantiation for the general finding that no systematic pattern of price effects is associated with distance from or proximity to the GTP abutting the study area.

Conclusions

The conclusions from the findings in both the Connecticut and the Southwestern pipeline proximity impact studies are essentially the same. Both market research studies were based entirely on the actual recorded behavior of buyers in the respective single-family residential property markets. These conclusions are:

1. No systematic pattern of measurable and significant negative impacts on sales prices of residential properties close to an existing or proposed high-pressure GTP was observed. None should be expected in future, similar situations.

2. No systematic pattern of variations in sales price effects was observed. None should be expected in future, similar situations. No correlation was observed between price levels (total or per square foot) and distance from the pipeline.

3. As the size of the data set(s) decreases, greater variability of results and less reliability of results are encountered. Relatively large numbers of sales transactions data are required to produce stable, supportable, systematic results.

4. The non-systematic, generally non-significant pattern of proximity effects (impacts) on sales prices was found in all data sets and sub-sets that were developed and analyzed. These results were consistent with one another, stable and statistically robust.

5. The findings based on ADJSPSF are fully supported by, and consistent with, those based on ADJSP.

6. Greatest reliance can (and should) be placed on the findings from MRA analysis, using the Hedonic Pricing Model format. Any incremental effect of distance (proximity) on price is explicitly separated, measured and tested.

7. It is highly likely that the research findings and conclusions developed for the Connecticut and Southwestern studies are transferable to other market situations in other areas. This conclusion stems from the generally consistent, stable and statistically robust results from the two geographically separated study areas. □

References

¹ Adapted from a paper presented at the 1993 Conference of the American Real Estate Society in Key West, Florida.

² An interesting artifact of reports of natural gas pipeline accidents is the vocabulary commonly used. The occurrences are "disasters" and the product is most commonly labeled "methane gas" in a pejorative context. Although, nearly all natural gas pipeline accidents, with property damage and/or personal injury occur in urban environments when distribution lines are ruptured by mechanical digging equipment, all pipeline accidents are lumped together in the popular press.

³ For example, two published bibliographies provide information on over 75 publicly available research studies conducted since 1970. See Kroll, Cynthia A., and Thomas Priestley, *The Effects of Overhead Transmission Lines on Property Values: A Review and Analysis of the Literature*. Berkeley, CA: Edison Electric Institute, Siting and Environmental Task Force, December

1991; Kinnard, William N. Jr., "The Impact of High Voltage Transmission Lines on Real Estate Values". *Journal of Real Property Tax Management*, Spring 1990.

⁴ See Kroll and Priestley, *op. cit.*; Kinnard, *op. cit.*; see also Kung, Hsiang-te and Charles F. Seegle, "Impact of Power Transmission Lines on Property Values: A Case Study," *Appraisal Journal*, July 1992.

William N. Kinnard, Jr., Ph.D., MAI, SREA, CRE is President of the Real Estate Counseling Group of Connecticut. He is also a Principal in Dickey & Kinnard, Inc. and Professor Emeritus at the University of Connecticut. He has published and testified on proximity impacts from HVTLs, radioactivity, airborne and groundwater pollution, and high-pressure natural gas pipelines.



Sue Ann Dickey, MAI, SREA is President of Dickey & Kinnard, Inc. and Principal of Sue Ann Dickey & Associates. She specializes in market demand and residential development studies, including proximity impact analyses.



Mary Beth Geckler, MPA, is Vice-President of RECGC, Inc. In recent years, she has concentrated on proximity impact studies related to a variety of health and safety hazards. She is co-author of several published reports.

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Natural Gas Pipeline Impact on Residential Property Values: An Empirical Study of Two Market Areas

EXHIBIT 1
CONNECTICUT COMBINED CASES: 1171
AVERAGE ADJSPSE BY ZONE AND YEAR

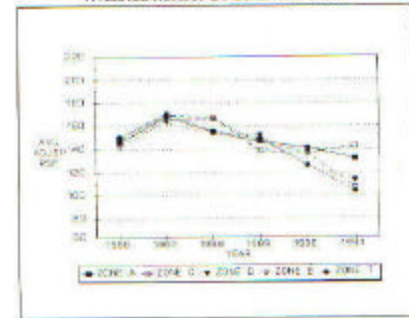


EXHIBIT 4

Summary of Multiple Regression Results
Combined Tennessee and Algonquin Lines in Connecticut
1,171 Sales

	MODEL 1		MODEL 2	
	ADJSP (\$)	ADJSPSE (\$)	ADJSP (\$)	ADJSPSE (\$)
ZONET				
Coefficient	-9407	-4.08	-11924	-5.20
t-Statistic	-1.19	-0.98	-1.53	-1.26
ZONE O				
Coefficient	+11228	+5.41	+1086	+0.80
t-Statistic	0.84	0.77	0.08	0.11
ZONE A				
Coefficient	+996	-0.66	+162	-0.85
t-Statistic	0.16	-0.20	0.02	-0.26
ZONE B				
Coefficient	-5249	-3.23	-8028	-4.47
t-Statistic	-0.87	-1.01	-1.35	-1.42
ZONE C				
Coefficient	-5941	-3.42	-5421	-3.14
t-Statistic	-1.29	-1.41	-1.19	-1.31
ZONE D				
Coefficient	-2890	-2.38	-4004	-2.86
t-Statistic	-0.67	-1.05	-0.93	-1.26
R ² (ADJ)	0.7382	0.3280	0.7462	0.3452
F-RATIO	168.09	29.26	164.34	29.47
SEE (ADJ)	53332	28.09	52397	27.63
NO. SALES	1139	1139	1118	1118
NO. CASES	1171	1171	1171	1171
LOTSIZE				
Coefficient	28001	14.19	30326	15.11
t-Statistic	8.01	7.70	8.56	8.09

EXHIBIT 2
MASTER PLANNED COMMUNITY
SOUTHWESTERN STATE
AVERAGE ADSPSF BY ZONE AND YEAR

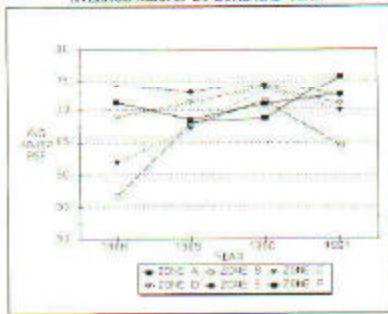


EXHIBIT 1-A
CONNECTICUT ALGONQUIN CASES: 316
AVERAGE ADSPSF BY ZONE AND YEAR

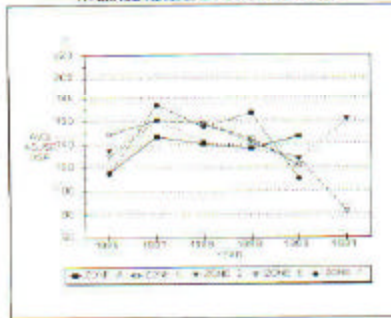


EXHIBIT 1-T
CONNECTICUT TENNESSEE CASES: 855
AVERAGE ADSPSF BY ZONE AND YEAR

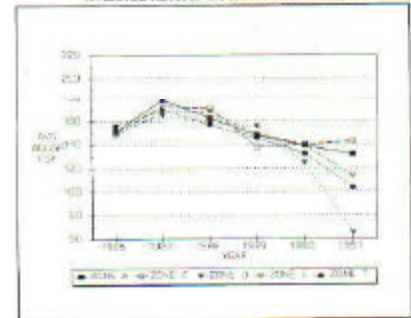


EXHIBIT 5

*Summary of Connecticut MRA Model Results, By Pipeline
Models 1 and 2
Adjusted Sales Price is Dependent Variable*

	ALGONQUIN PIPELINE		TENNESSEE PIPELINE	
	Model 1 (\$)	Model 2 (\$)	Model 1 (\$)	Model 2 (\$)
ZONE T				
Coefficient	+20557	+22098	-21690	-24920
t-Statistic	1.54	1.71	-2.25	-2.61
ZONE O				
Coefficient	NA	NA	4132	-3799
t-Statistic	NA	NA	0.30	-0.28
ZONE A				
Coefficient	+4312	+2255	-1265	-1031
t-Statistic	0.39	0.20	-0.17	-0.14
ZONE B				
Coefficient	+12164	+5134	-12525	-14042
t-Statistic	1.05	0.46	-1.78	-2.02
ZONE C				
Coefficient	+842	- 20	-8640	-7598
t-Statistic	0.10	-0.00	-1.59	-1.41
ZONE D				
Coefficient	+5245	+2258	-6323	-5778
t-Statistic	0.73	0.30	-1.21	-1.12
R ² (ADJ)	.6462	.6445	0.7636	.7701
F-RATIO	41.86	36.51	178.92	172.72
SEE (ADJ)	48253	46562	54366	53783
NO. SALES	312	297	847	842
NO. CASES	316	316	855	855
LOT SIZE				
Coefficient	25210	25446	31268	32924
t-Statistic	6.11	5.99	5.60	5.95

Natural Gas Pipeline Impact on Residential Property Values: An Empirical Study of Two Market Areas

EXHIBIT 6

Summary of Southwestern MRA Model Results
Models 1 and 2
Dependent Variable is ADJSP or ADJSPSF

	ADJSP		ADJSPSF	
	Model 1 (\$)	Model 2 (\$)	Model 1 (\$)	Model 2 (\$)
ZONE A				
Coefficient	+ 1563	+ 1493	- 0.20	- 0.47
t-Statistic	0.81	0.77	- 0.23	- 0.52
ZONE B				
Coefficient	- 120	- 150	- 0.81	- 0.92
t-Statistic	- 0.08	- 0.10	- 1.18	- 1.33
ZONE C				
Coefficient	+ 2083	+ 2024	+ 0.33	+ 0.11
t-Statistic	1.74	1.70	0.60	0.19
ZONE D				
Coefficient	+ 822	+ 754	+ 0.15	- 0.10
t-Statistic	0.69	0.63	0.28	- 0.18
ZONE E				
Coefficient	+ 5740	+ 5648	+ 2.15	+ 1.80
t-Statistic	7.96	7.91	6.50	5.44
R ² (ADJ)	0.8610	0.8609	0.5050	.4931
F-RATIO	1349.75	1499.79	222.27	235.6
SEE (ADJ)	13697	13693	6.28	6.35
NO. SALES	2190	2190	2190	2190
NO. CASES	2202	2202	2202	2202