

Appraisal Study

The Impact of Deep Tunnels on Property Value

*A Study of the Lake City Tunnel
Seattle, Washington*



Synopsis

This appraisal study is performed to determine whether or not the presence of a deep tunnel (indiscernible at ground level) lowers the value of a property. The study is empirical, founded on observation and experimentation and is performed on a sample of transactions of houses in Seattle, all located on city blocks situated over a deep tunnel.

Overview - The Lake City Tunnel

Constructed between 1964 and 1967, the Lake City Tunnel was part of an overall plan to alleviate pollution of Seattle area lakes and rivers. Prior to the construction of the wastewater system, local sewage treatment plants had been discharging effluent into Lake Washington from local sewage treatment plants, creating a serious algae problem in the lake. In addition, raw sewage was being dumped into Elliott Bay and Puget Sound, creating a health hazard and resulted in the closure of many beaches. In 1958, Seattle area citizens created Metro (Municipality of Metropolitan Seattle) to deal with transportation and sewage treatment problems. Their plan included building a regional wastewater system.

The Lake City Tunnel is part of the wastewater conveyance system between the Matthews Park pump station and the West Point treatment plant on Puget Sound. Beginning at Matthews Park pump station in north Seattle, which is located about five miles south of the proposed Brightwater tunnel, the Lake City Tunnel segment extends southwest about three miles to the University District. The average wastewater flow from the Matthews Park pump station through the tunnel is about 48 million gallons a day. Within the study area the tunnel varies in depth below the ground surface between 50' and 300', with an average of about 200'. The 8'-wide (interior diameter) sewer tunnel was constructed with steel reinforced concrete. The tunnel was completed around 1967.

Perpetual easements were acquired by Metro from individual property owners in the early 1960s, for the purpose of "constructing, operating, maintaining, repairing and replacing" a sewer tunnel. The easements are 20 feet wide. There is no perceptible ground level impact from the presence of the tunnel.

Study Design

The study examines the premise that the presence of a deep tunnel easement impacts the value of house properties. The initial study was prepared in 2004 and included a comparison of 497 house transactions occurring in Seattle between 1983 and 2004, 126 of which had deep tunnel easements, and the other 371 of which were on the same blocks but did not have deep tunnel easements. The analysis includes backwards stepwise multiple regression analysis, and t-tests of population means. The study was updated in 2008 to include all sales through 2007, and also incorporate sales from 1962-1972 (the period in and around original acquisition and construction, when the market may have been most aware of the tunnel easement) and the results of both the original and updated study are reported, analyzing a total of 907 sales.

Data Gathering and Conditioning

The initial study includes all property data that meets the following conditions:

- Situated in Seattle along the alignment of the Lake City Tunnel
- Between NE 85th Street to the north, and NE 50th Street to the south (about 2 miles)
- On the same block as an underground easement property
- Used as a single family house
- Bona fide transaction (sale) occurred between 1983 and 2007.

The initial research was performed using King County records. The properties were field inspected from the street. Data screening and conditioning included the removal of transactions of vacant land or improvements demolished subsequent to sale, the removal of related party sales, and removal of three sales with anomalous transaction prices of less than \$28,000 (anomalous in terms of nature of house, with the next lowest transaction price at \$59,000.) All other transactions were analyzed.

Description of the Properties and Transactions

Please refer to the following tabulated descriptive statistics for 1983 - 7/26/04 initial study data. The location is a fully established, stable and uniform neighborhood in Seattle. The sub-neighborhoods are broadly named University, Ravenna, Bryant, Wedgwood, and View Ridge. Throughout the study period the entire neighborhood has been considered a desirable location, with full occupancy and steadily escalating property values. The neighborhood is quiet in character, with houses typically of 2-stories with partially finished basements, in average to good condition, situated on entirely residential streets with curbs and sidewalks, and with nearby neighborhood commercial services. In the period 2004-2007, the average sale price of a transaction meeting the criteria was about \$513,000.

Because of the comparability of neighborhood situation and the nature of this investigation, there appears no need to have any separate variable for sub-location within the neighborhood. None of the properties have a significant view, other than territorial. The 497 transactions for 1983 to 7/26/04 indicate the following variables:

Variable	Mean
Sale Price	\$238,119
Days Since 7/26/04	2969
1st Floor Area	1034 sf
2nd Floor Area	316 sf
Fin. Bsmt. Area	297 sf
Unfin. Bsmt. Area	471 sf
Garage Area	118 sf
Condition Flag (See note below)	2.53
Year Built	1935
Lot Area	5051 sf
Easmt. Flag (1=Yes, 0=No)	0.25

The Condition variable is from the Assessor, with values of 1=Fair, 2=Average, 3=Good, and 4=Very Good. The Easement Flag is a dummy variable assigned as 1 for a house with a deep sewer easement, and 0 for a house without.

Derived Variable - The Ratio of (Sale Price)/(Assessed Value)

Real property within King County is assessed annually to 100% of market value, in conjunction with property tax collection. We analyzed the assessment process in conjunction with this appraisal study including personal interview. The assessment process includes detailed consideration of a wide range of information, including location, age, grade, condition, size, view, neighborhood, and land value. The assessor generally relies upon sale comparison analysis, with supplementary analysis of cost or income data if appropriate. Sales data are tabulated from isolated neighborhood groups. A fairly rigorous multiple regression analysis is developed, including log and other transforms to significant variables, and on this basis the market value is estimated for each property.

The assessment is typically dated. For instance the 2004 assessment process is based on an analysis of transactions that occurred in 2002-2003 prior to the process. Sale date is not used as a variable in the assessment analysis. In a real estate market where values have been generally increasing over time, analysis of these dated sales leads to assessed values that are usually less than current market value (by the time of an average 2004 transaction, the data used to derive the assessed value are based on transactions averaging about 2 years prior). Another factor that may lower the assessed value relative to market value is presumed conservatism in the assessed values; lower assessments avoid appeal and a perception of unfair policy. The average ratio of sale price to assessed value in the study is about 1.3, and has been fairly consistent over time.

The assessment process is tested and rigorous, and the assessed values are fairly reliable and stable as a basis for comparing value differences between residential properties. The process considers the most relevant valuation variables, including location, floor area and type for all

improvements, grade, condition, year built, view, nuisances, and land value. One variable that is not considered is the presence or lack of presence of a deep tunnel easement.

This ratio variable provides a good basis for studying the effect of a deep easement on property value. Any significant negative effect should result in a lower ratio of sale price to assessed value.

Other Relevant Variables

Two other relevant variables are studied. The variable of Sale Price/sf is derived by dividing the sale price by the finished living area in square feet (including above ground and finished basement). This ratio is often examined by appraisers because it applies a major adjustment to the result (accounting for different size of houses, with larger houses usually selling for more than smaller houses). It does not account for many other factors that are likely relevant to the value of a property. Sale Price is another important variable, representing a gross transaction amount without regard to other factors. In King County, excise tax is due on real estate transactions based on the price, and buyers and sellers must attest to the accuracy of recorded sale prices.

Linear Regression Analysis

Backward stepwise linear regression was performed, with sale price as the dependent variable, and all 10 other variables indicated in the table above as independent variables. In this type of analysis, a number of potentially significant independent variables are examined, and those that are not significant are dropped from the final linear model. The results are presented on the following page. 7 variables remain as regression coefficients in the final model (at a .05 probability for variable removal), and 3 variables are found to be not significantly correlated to the sale price. The 3 insignificant variables are garage area ($p=.30$), year built ($p=.85$), and the presence of a deep easement ($p=.48$). The analysis appears significant, with both R^2 and Adjusted R^2 (the coefficient of determination) at .78, indicating that about 78% of the variation in sale price is explained by the 7 remaining variables.

The results are examined for reasonableness. The remaining model makes the following predictions for the initial study data from 1983 to 7/26/04:

- Base sale price of \$202,920
- Minus \$46 for each day prior to 7/26/04
- Plus \$63/sf for each square foot of ground floor area
- Plus \$90/sf for each square foot of second floor area
- Plus \$43/sf for each square foot of finished basement area
- Plus \$30/sf for each square foot of unfinished basement area
- Plus \$12,420 for each increment of the condition variable
- Plus \$3.82/sf for each square foot of lot area

These results appear to be logical and reasonable, accounting for differences in a manner and magnitude that is consistent with the perception of appraisers and home buyers and sellers. The detailed results are presented on the following tables.

Variable Analysis Using T-tests

T-tests (or Student's T-tests) are performed for the purpose of comparing the value characteristic variables. Three variables are examined for comparison of means between transactions of properties without easements and transactions of properties with easements. The rationale for this testing is that any significant effect from the presence of a deep easement on the value of a property will be evident from an analysis of transactions of properties with easements, compared to transactions of properties without easements.

The results are presented on the following pages, including descriptive statistics, graphical comparisons indicating mean and confidence interval, and a tabulation of the p-values from the comparison of various samples of properties without easements (371 transactions between 1983-2004) and with easements (126 transactions between 1983-2004). Considering the relatively large magnitude of the transaction date variable (resulting from a real estate market with significantly increasing values over a 22-year study period), sub-samples are also tested. These include 11 independent two-year intervals, and the most recent five-year interval 2000-2004.

Hypothesis testing is preformed. In the more relevant 1-tailed t-test, the question examined is whether the presence of a deep easement has a negative impact on property value. The null hypothesis is that a house with a deep easement does not have a lower sale price. If the null hypothesis is rejected based on statistical testing, then the alternative hypothesis that a deep easement negatively impacts the value is supported.

Using the entire population sample (1983-2004) as an example, the 1-tailed t-test results are as follows:

	Houses Without Easements	Houses With Easements	t-test Probability Value
Number of Transactions	371	126	
Sale Price/Assessed Value	1.29	1.35	0.98
Sale Price/sf	\$151.69	\$152.99	0.57
Sale Price	\$237,739	\$239,241	0.55

Using the variable (Sale Price/ Assessed Value) as an example, the houses without easements sold at an average price of 1.29 times assessed value, while the houses with easements sold at an average price of 1.35 times assessed value. Referring to the following graph, the actual ratio for houses without easements is in the range 1.27 - 1.31 with 80% confidence, while the actual ratio for houses with easements is in the range 1.32 - 1.39 with 80% confidence. Clearly it does not

appear that the presence of a deep easement has a negative effect on this variable. The t-test indicates a 98% probability of being incorrect if the null hypothesis (value is not lower) is rejected in support of the alternative hypothesis (value is lower). At a critical rejection value of .2, the .98 figure leads to a conclusion that the null hypothesis is not rejected.

The null hypothesis is never rejected for the 26 samples tested for the variables (Sale Price/Assessed Value) and (Sale Price), and is rejected at a critical value of .2 in 2 out of 13 samples tested for the variable (Sale Price/sf). Thus the null hypothesis is supported in 37 out of 39 samples. Considering the small subsample sizes, the questionable validity of the variable of sale price per square foot of finished area, and the relatively high p-value for the rejected samples (.10 and .19), the isolated rejections are not surprising, unanticipated, or inconsistent with the overall result supporting the null hypothesis.

It should be noted that a high rejection criteria of $p=.2$ is used in an attempt to ensure that the “power” of the testing and results is high. In many statistical tests, a p-value of .05 might be used. This would cause the probability of a Type-I Error of incorrectly rejecting the null hypothesis to be low, and the hypothesis would rarely be rejected. In this instance, considering the reason for the test (for the purpose of ensuring fair compensation for property owners who grant a deep easement), it is important to ensure that the null hypothesis is easily rejected. A high rejection value lowers the chance of a Type-II Error of not rejecting the null hypothesis when it is actually false. The “power” (1 minus β , β being the probability of a Type II Error) of the whole sample study is fairly high under this design, increasing the probability that any negative effect of deep easements on value is detected.

The 2-tail test is similar but does not test for direction, with a null hypothesis that the presence of a deep easement does not impact the value, and an alternative hypothesis that the value is impacted (either higher or lower, unlike the 1-tail test). In this test, the null hypothesis is rejected more frequently, 6 times out of the 39 tests shown at a rejection level of .2. However, in 5 out of the 6 rejections the mean variable for houses with easements is actually higher than the corresponding variable for houses without, leading to a rejection because of an apparent positive impact of easement presence on value. This is not logical, and illustrates the fact that the 1-tail test is a more relevant test for the question at hand.

Interpretation of Results

The samples of properties without easements and properties with deep easements are exceptionally comparable. Please refer to the descriptive statistics, which indicate great similarity in all significant aspects, including size, nature and age of house, condition, and lot area. This is not surprising, considering the fact that the easement cuts diagonally and uniformly randomly across north-south oriented blocks, through neighborhoods with comparable histories and characteristics. As an example, the subsamples have comparable proportions of corner influence, territorial outlook, and proximity to commercial arterials. This provides a strong population basis for the statistical testing.

In the linear regression test, the presence of a deep easement is not found to be a relevant variable for sale price. The seven variables found to be relevant are logical, with reasonable

coefficients. The premise of a linear relationship between independent and dependent variables may not be correct for each variable, and no variable transformation has been attempted (unlike the assessor regression model). The overall model has a high explanatory power. The excellent uniformity of the population in terms of type, style and age of house, and similarity of location appears to lead to a strong model that does not indicate that the presence of a deep easement is relevant.

In the t-tests, the presence of a deep easement is not found to negatively influence sale price, price/sf, or the ratio of sale price to assessed value. Each of these variables has relevance to the investigation of potential change of market value, or the problem at hand. The variable of the ratio of sale price to assessed value appears to be particularly relevant, given the strong attempts and generally good results of measuring market value by the assessor. Since the assessor's prediction does not account for the deep easements, any significant variation of this variable should be a good indication of impact on value. Conversely, if anything this variable appears to indicate that a deep easement has a positive effect on value, a potential conclusion that is rejected as not logical. The results of the t-tests clearly support the premise that deep easements do not have a permanent negative impact on value. Not rejecting the null hypothesis in 37 out of 39 subsamples at a high rejection p-value of .2 is a significantly clear result.

Please refer also to the attached table summarizing these statistics for 352 sales between 1962 and 1972, and also incorporating the additional 58 sales from 7/27/04 through 2007. Similar findings result from analysis of these other data sets, with a total analysis of 907 sales.

Conclusion

Any negative impact of a deep sewer easement on the value of a residential property is immeasurably small.

Appraisal Study – Owner Survey

Synopsis

This appraisal study includes an interview of owners who purchased residential properties that have sewer tunnel easements for the Lake City Tunnel. The survey was conducted by direct interview of property owners, asking them if they were aware of the presence of the tunnel; if they could perceive any ground level impact from the tunnel; and whether the presence of the tunnel had any influence on the transaction price or value of the property. Of the 36 owners successfully interviewed, some were aware of the presence of the tunnel and easement; none could perceive the presence of the tunnel, and none felt that the tunnel easement negatively impacted the price of the property.

Study Design

The study examines the premise that the presence of a deep tunnel easement impacts the value of house properties, and the premise that a deep sewer tunnel will not have a perceptible ground-level impact (such as noise, vibration or settlement). The method is direct interview with property owners, who were contacted by telephone or in person. The interviews were conducted using a standardized survey form, and included an explanation of the reason for and nature of the study. The design is intended to ensure a full and unbiased thought process for the property owner, and so that positive responses (that the easement was known about, impacted value, or could be perceived) are more likely.

Data Gathering and Conditioning

The study includes all data that meet the following conditions:

- Property located in Seattle along the alignment of the Lake City Tunnel
- Between NE 85th Street to the north, and NE 50th Street to the south (about 2 miles)
- The property has an underground easement from the Lake City Tunnel
- Property use is single family house
- Bona fide transaction (sale) occurred between 1983 and 2007
- Interview is with buyer from most recent transaction (current owner)

139 transactions were found in the time period 1983-2007. Some properties transacted more than once and we limited the survey to the most recent buyer (current owner). The remaining 100 transactions formed the initial survey population, meeting all criteria. From these transactions 36 owners were successfully contacted and interviewed via telephone. The following survey form and script was used:

<u>LAKE CITY TUNNEL SURVEY FORM</u>	
Owner Name:	
Phone Number:	
House Address:	
Date Contacted:	
Date of House Purchase, Purchase Price:	
Are you the owner?	
My name is (insert name). I am a commercial real estate appraiser and I work for McKee and Schalka in Seattle. {"Agency"} is planning to build a {"Project"} deep underground in {"Location"}. We have been hired to study the value or impact of the underground {"Project"}.	This project does not affect your property and I am not appraising your property. I'm calling you because there is a similar easement beneath your property about (insert depth) feet underground.
1. I am interested to know if you know the sewer is there? Do you ever hear it or feel it? (There's no reason to think you would.)	
2. Were you aware that there is an easement beneath your property?	
<u>IF YES to #2</u>	
3. Were you aware of the Tunnel Easement when you bought your home?	
4. How did you become aware?	
5. Did you see it on a deed, title report or disclosure statement, did someone report it to you?	
<u>IF YES to #2</u>	
8. Did the easement affect the transaction?	
<u>IF YES to #2</u>	
9. How did the easement affect the transaction, or how much?	
<u>IF NO to #2 or #3</u>	
6. Did anyone else know (such as your spouse)?	
7. Did you see a deed, title report or disclosure statement?	

The interview was intended to be conversational in tone to create a comfortable interview process and elicit more insightful and complete responses. Each owner was qualified, then asked if they knew of the presence of the sewer tunnel and easement. If they knew about the tunnel, they were then asked if they knew about it when they bought the house property. If they knew about the sewer tunnel easement when they bought the house, they were then asked if they thought the easement affected the transaction. All owners were asked either how they had become aware of the sewer tunnel easement, or, if they had no knowledge of the easement, whether they had seen typical property documents such as a title report when the property transacted. All owners were asked if they had ever heard or felt the tunnel. Many of the property owners made comments that were supplementary to the main focus of the questions, and these comments were recorded on the interview forms.

Description of the Properties and Easements

Properties with easements were determined from “As Constructed” drawings (dated April 1971) made by Metropolitan Engineers: Brown and Caldwell, Hill and Ingman, Carey and Kramer, and R.W. Beck and Associates. The drawings show the location of the sewer tunnel and the easement area on a parcel map, and the location of buildings based on aerial surveys from 1958. The affected area of each property varies; for some, the easement area crosses a small corner of the property, and for others the drawings indicate the tunnel directly below the house. The average property today has a 5,600 sf lot and a three-bedroom house averaging 1,639 square feet of finished living area. All but three of the houses were constructed prior to the construction of the Lake City Tunnel, between 1906 and 1956.

The easements are recorded in King County records (recorded as “Sewer Tunnel Easement”) and are therefore typically available to a property buyer. For instance, a title report or deed will normally indicate the easement. Washington State has a mandatory seller disclosure law that results in a document disclosing known conditions from the seller, and it is possible that a buyer may also become aware of the easement through this means.

Results

Number of Owners Interviewed	36	100%
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Owners unaware of the sewer and the easement	25	69%
Owners aware of the sewer and the easement	11	31%

Owners aware of sewer easement at the time of transaction	7	19%
Owners stating that the sewer easement affected the transaction	0	0%
Owners stating they have ever heard or felt the sewer	0	0%

69% of surveyed owners were unaware their property was encumbered by the sewer tunnel easement. In general, these owners responded with surprise to learn of the sewer tunnel and furthermore, that it went underneath their property near or under their house. One owner reported being in the real estate industry for twenty years and said she would likely have paid close attention to easements, but did not recall seeing the sewer tunnel easement on any of her property documents. Most owners surveyed reported they only vaguely recalled reviewing their property documents at the time of purchase.

Eleven of those surveyed, or 31%, reported they were aware of the Lake City Tunnel and the easement. Of this group, 64% were aware of the tunnel easement at the time of the transaction and 36% became aware of the easement sometime after the transaction. Of this latter group, two became aware of the easement two weeks prior to being interviewed. One of them was researching his property in preparation for sale and learned of the sewer line on a City of Seattle website. He in turn informed the other party who is his neighbor. Another owner became aware of the easement when a friend informed her, but she did not know how the friend learned of the easement. In general, this group had a vague recollection of having seen property documents such as their title report or deed, and one reported they thought they saw a reference to the sewer tunnel easement "on a title report or something."

Seven of those surveyed, or 19%, were aware of the easement at the time of the transaction. Each of these owners became aware of the sewer tunnel easement during the transaction of their property and reported seeing the easement on a title report, purchase agreement, or plat map. One of these owners had forgotten about the easement and initially reported that she was unaware of the easement. She was surprised to hear of the easement because she reported that she always thoroughly reads legal documents and had carefully read all the property documents at the signing. During her interview, this owner took out her property file, read the title report, and found the sewer tunnel easement. She then stated that she would have read the easement at the time of the signing as well and would have been aware of it.

All of the seven owners who were aware of the easement at the time of the transaction reported that the sewer tunnel easement had no effect on the transaction.

None of the owners we interviewed reported ever having heard or felt the workings of the sewer tunnel. They tended to be intrigued by the thought of a tunnel that deep below their property and many wondered how the tunnel was constructed. A few owners wondered what might happen if the tunnel leaked, but most were unconcerned upon learning about it and commented they thought such easements were just a part of living in a city and that, in any case, something that deep below their property had no impact on them.

Interpretation of Results

The results of this study indicate that the sewer tunnel and easement has had little if any impact on the transaction price of properties transacted since 1983. By then the tunnel and easement had been in place for 15-20 years. Few owners remember being aware of the easement at the time of the transaction, none of them thought the easement influenced the transaction, and none of them indicated they had any accurate knowledge of the dimensions of the tunnel or the

depth of the tunnel below their property. No owner interviewed had ever noticed the sewer tunnel in any physical way.

The fact that few owners were aware of the tunnel or easement, and that those who were aware did not feel that the tunnel had affected the price, suggests that the presence of a sewer tunnel and easement with no ground level manifestation does not significantly influence the value of similar properties.

In the modern transaction environment for similar properties, buyers are very well informed via a variety of means, including title reports, deeds, seller disclosure, real estate agents, attorneys, and escrow agents. Much of the information is readily and publicly available online. The study includes a number of modern-era transactions, and some from years ago when information may have been somewhat less readily available. The real estate environment for this location and market, however, has been consistent throughout the study period, with well-informed buyers who would have had the information available as needed. It appears that the presence of a non-impacting tunnel and easement was simply not important enough to come to the forefront at the time of transaction.

The prioritization of relevant information during the course of a house transaction is likely affected by the perceived importance of such information relative to a buyer's desire, and relative to the legal motivations of the seller and various agents. For instance, it is well known that a leaky roof will cause a diminution in the value of a property. A buyer is interested in understanding the condition of the roof, since the buyer wishes to pay no more than a market value price for the property. The real estate agents and seller are normally motivated to disseminate this information as a means of not being liable to the buyer for non-disclosure. Because the information is economically important, it is prioritized, and a roof inspection or assessment is often considered. Likewise, a surface driveway easement that gives another party use of part of a driveway would limit the utility and diminish the value of the property. The buyer, agents, and seller would all typically prioritize this information at the time of transaction, because the information is economically important. Considering the results of the study, the available information about the sewer easement was not important enough to normally come to the forefront in the course of these transactions.

Conclusion

This substantial sewer tunnel cannot be heard or felt at the ground level during normal operation. The presence of the deep sewer tunnel easement is not perceived by buyers as important enough to be significantly prioritized in the course of a sale of a house property. The reason it is not important relative to other information has an economic basis, in that it is not perceived to significantly influence value or utility. The presence of a deep tunnel easement that cannot be heard or felt, therefore, does not appear to significantly influence the value of a house property after it has been present for a number of years.

In the period 1962-1972, in the immediate time period of the easement acquisition and tunnel construction, the market awareness would have been heightened. The data indicates a similar finding during this period (no measureable influence). As of the date of this study (2008), it is

possible that the market perception or attitude towards an underground easement and tunnel structure could be different than in 1962-1972, possibly because of changes to disclosure regulations or because of consumer preference. The Lake City study indicates that there is no long-term decrease in value that is measureable, and that the reason is that the presence of an indiscernible encumbrance and tunnel is not important to the pricing of a house compared to other more important factors.

Appraisal Study - Lake City Tunnel
Potential Impact of Deep Sewer Easements on Property Value
Comparison of House Sales in Seattle

Description: Probability testing of whether the presence of a deep sewer easement under a house property in Seattle has an effect on the value of the property

Method: t-test (Student's t-test), based on analysis of 907 sales.

Samples: Comparing sales of house properties with deep sewer easements underneath the property, to sales of properties on the same block without deep sewer easements.

Variables: 3 variables are tested: The ratio of sale price to assessed value, the sale price per square foot of finished living area, and the sale price.

1-tailed test: Null Hypothesis: A house with a deep sewer easement does not have a lower sale price than a house without.

Alternative Hypothesis: A house with a deep sewer easement has a lower sale price than a house without.

2-tailed test: Null Hypothesis: The presence of a deep sewer easement does not impact the sale price of a house

Alternative Hypothesis: The presence of a deep sewer easement impacts the sale price of a house

Year of Sale	<u>No. of Sales</u>		<u>Sale Price/Assessed Value</u>					<u>Sale Price/sf</u>					<u>Mean Sale Price</u>				
	Houses Without Easmts.	Houses With Easmts.	Houses Without Easmts.	Houses With Easmts.	Diff.	p-value 1-tailed test	p-value 2-tailed test	Houses Without Easmts.	Houses With Easmts.	Diff.	p-value 1-tailed test	p-value 2-tailed test	Houses Without Easmts.	Houses With Easmts.	Diff.	p-value 1-tailed test	p-value 2-tailed test
1983-2007	416	139	1.29	1.35	5%	0.96	0.07	\$169.24	\$169.36	0%	0.51	0.99	\$269,244	\$259,203	-4%	0.22	0.44
1962-1972	265	87	6.61	6.30	-5%	0.10	0.21	\$11.86	\$11.83	0%	0.47	0.94	\$17,682	\$18,420	4%	0.78	0.44

Conclusions: The Null Hypotheses are not rejected.

Interpretation: There is insufficient evidence to support the hypothesis that the presence of a deep easement has an effect on the sale price of a house property.

Discussion: The Lake City Tunnel in Seattle houses a deep and large sewer tunnel structure that has no discernable impact at ground level. It was constructed between 1964-1967, and required acquisition of perpetual underground easements from single family residential properties. The first sample (1962-1972) is sales that occurred just before, during construction, and just after the sewer tunnel construction for which the easements were placed (construction was about 1964-1967). The second sample (1983-2007) is more than 15 years after completion of construction, up until the date of this study.

The mean difference in the samples is close to 0% for the houses with easements compared with houses without easements for the 2 samples and 3 different parameters sampled. The difference is not statistically significant. More detailed testing was performed on various sub-samples, with similar results.

Overall, the analysis indicates that the null hypotheses should not be rejected, supporting the premise that the presence of a deep sewer easement under a house property does not significantly impact the value of the property.

Potential Impact of Deep Sewer Easements Linear Regression Analysis of 1983-2004 House Sales in Seattle

Linear Regression Results for:

Y = Linear Regression!\$B\$1:\$B\$498 (Sale Price)

X = Linear Regression!\$F\$1:\$O\$498 (Other Variables)

Independent variable entry method: Backward Stepwise

P to Remove: .05

Descriptive Statistics

Variable	Mean	Std Dev.	N
Sale Price	\$238,119	\$112,420	497
Days Since 7/26/04	2969	2040	497
1st Floor Area	1034	211	497
2nd Floor Area	316	377	497
Fin. Bsmt. Area	297	362	497
Unfin. Bsmt. Area	471	394	497
Garage Area	118	141	497
Condition Flag (See note below)	2.53	0.70	497
Year Built	1935	17	497
Lot Area (sf)	5051	1795	497
Easmt. Flag (1=Yes, 0=No)	0.25	0.44	497

Note on Condition Flag: 1=Fair, 2=Avg., 3=Good, 4=Very Good

Summary Results

R ²	R	Adj. R ²	S.E. of Estimate
0.78	0.88	0.78	52771

ANOVA

Source	Sum Sq.	D.F.	Mean Sq.	F	Prob.
Regression	4.91E+12	7	7.01E+11	251.7	0.00
Residual	1.36E+12	489	2.78E+09		
Total	6.27E+12	496			

Regression Coefficients

Source	Coefficient	Std Error	Std Beta	-95% C.I.	+95% C.I.	t	Prob.
Intercept	\$202,920	\$14,943		\$173,559	\$232,281	13.579	0.00
Days Since 7/26/04	-\$46	\$1	-\$1	-\$48	-\$43	-38.24	0.00
1st Floor Area	\$63	\$13	\$0	\$38	\$88	4.9798	0.00
2nd Floor Area	\$90	\$6	\$0	\$77	\$102	13.804	0.00
Fin. Bsmt. Area	\$43	\$8	\$0	\$28	\$57	5.6493	0.00
Unfin. Bsmt. Area	\$30	\$7	\$0	\$16	\$43	4.3631	0.00
Condition Flag	\$12,420	\$3,455	\$0	\$5,631	\$19,209	3.5945	0.00
Lot Area	\$3.82	\$1.51	\$0.06	\$0.85	\$6.79	2.5302	0.01

Potential Impact of Deep Sewer Easements Comparison of 1983-2004 House Sales in Seattle

Descriptive Statistics

Properties Without Deep Sewer Easements

Descriptive Statistics for:

Input Range = 1983-2004!\$C\$3:\$O\$374

	Sale Price	Price/sf	Sale Price/Assmt.	Sale Date	1st Floor Area	2nd Floor Area	Fin. Bsmt. Area	Unfin. Bsmt. Area	Garage Area	Condition Flag	Year Built	Lot Area	Total Finished Area
Mean	237738.52	151.69	1.29	35249.29	1022.45	335.55	299.95	454.47	113.02	2.49	1935.61	4894.56	1680.70
Median	223000.00	138.30	1.24	35381.00	1010.00	240.00	100.00	460.00	0.00	2.00	1928.00	4758.00	1620.00
Mode	165000.00	100.00	234.69	4485596707813, 5/27/2004	040, 1070	0.00	0.00	0.00	0.00	2.00	1950.00	5000.00	1720.00
Std Error	5880.35	3.94	0.01	106.66	10.00	20.30	19.50	20.92	7.17	0.04	0.91	78.49	30.90
Std Dev.	113263.49	75.89	0.28	2054.35	192.65	390.95	375.68	402.95	138.18	0.69	17.44	1511.82	595.15
Variance	12828618705.39	5759.23	0.08	4220362.32	37114.10	152840.44	141138.92	162369.11	19094.41	0.47	304.19	2285611.61	354202.62
Coeff. Var.	47.64	50.03	21.41	5.83	18.84	116.51	125.25	88.66	122.26	27.56	0.90	30.89	35.41
Lower 80%CL	230189.07	146.63	1.27	35112.36	1009.61	309.49	274.91	427.62	103.81	2.45	1934.44	4793.79	1641.03
Upper 80%CL	245287.97	156.75	1.31	35386.22	1035.29	361.61	324.99	481.33	122.23	2.54	1936.77	4995.33	1720.37
Minimum	60000.00	28.74	0.68	30462.00	560.00	0.00	0.00	0.00	0.00	1.00	1908.00	2500.00	620.00
Maximum	600000.00	432.29	2.39	38194.00	2000.00	1680.00	1330.00	1220.00	480.00	4.00	2001.00	13608.00	3360.00
Count	371.00	371.00	371.00	371.00	371.00	371.00	371.00	371.00	371.00	371.00	371.00	371.00	371.00

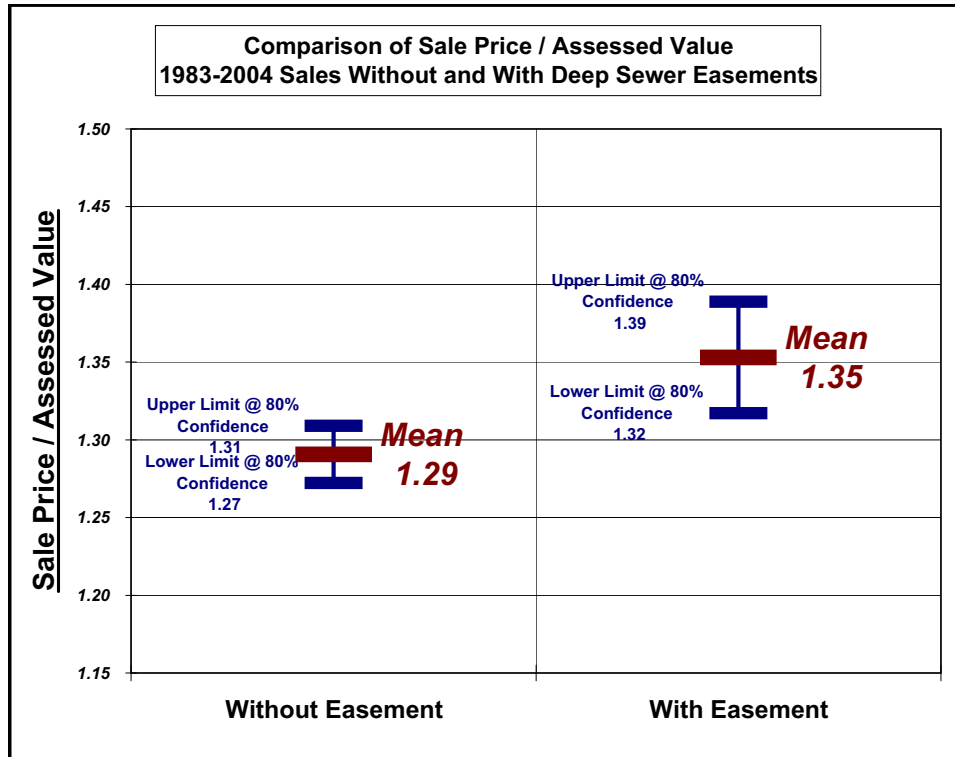
Properties With Deep Sewer Easements

Descriptive Statistics for:

Input Range = 1983-2004!\$C\$378:\$O\$504

	Sale Price	Price/sf	Price/Assd	Sale Date	1st Floor Area	2nd Floor Area	Fin. Bsmt. Area	Unfin. Bsmt. Area	Garage Area	Condition Flag	Year Built	Lot Area	Total Finished Area
Mean	239240.66	152.99	1.35	35154.99	1066.67	260.00	288.02	519.52	132.62	2.65	1933.69	5512.24	1627.06
Median	211500.00	146.80	1.27	35565.00	1000.00	0.00	160.00	590.00	0.00	3.00	1928.00	5000.00	1565.00
Mode	185000, 209000	-	-	1, 11/30/2001	840.00	0.00	0.00	0.00	0.00	2.00	1950.00	5000.00	1680.00
Std Error	9829.43	5.82	0.03	178.45	22.86	29.24	28.50	32.49	13.13	0.07	1.44	213.31	41.91
Std Dev.	110335.07	65.31	0.31	2003.15	256.63	328.22	319.89	364.73	147.35	0.73	16.14	2394.35	470.43
Variance	12173827618.82	4265.00	0.10	4012604.73	65859.20	107729.60	102326.43	133030.17	21712.29	0.53	260.47	5732933.01	221305.71
Coeff. Var.	46.12	42.69	23.08	5.70	24.06	126.24	111.07	70.21	111.11	27.54	0.83	43.44	28.91
Lower 80%CL	226576.81	145.49	1.32	34925.08	1037.21	222.33	251.30	477.66	115.71	2.57	1931.84	5237.42	1573.07
Upper 80%CL	251904.51	160.48	1.39	35384.91	1096.12	297.67	324.73	561.39	149.53	2.73	1935.54	5787.05	1681.06
Minimum	59000.00	30.72	0.89	30384.00	700.00	0.00	0.00	0.00	0.00	1.00	1906.00	2500.00	700.00
Maximum	725000.00	337.21	2.54	38169.00	1990.00	1000.00	1040.00	1350.00	600.00	4.00	2001.00	16301.00	3550.00
Count	126.00	126.00	126.00	126.00	126.00	126.00	126.00	126.00	126.00	126.00	126.00	126.00	126.00

Potential Impact of Deep Sewer Easements Comparison of 1983-2004 House Sales in Seattle



Statistical Hypothesis Testing (1-Tailed t-test)

**Null Hypothesis: A House With a Deep Sewer Easement
Does Not have a Lower Sale Price than a House Without**

t-Test Result for Datasets:
Set 1 Range = 1983-2004!\$E\$3:\$E\$374
Set 2 Range = 1983-2004!\$E\$378:\$E\$504
Unequal variances assumed

1-tailed t-Test (Sale Price/Assmt. > Sale Price/Assmt.)

Ho. Diff	Mean Diff.	SE Diff.	T	DF	P
0.00	-0.06	0.03	-1.99	195.63	0.98

Conclusion: Hypothesis Not Rejected

Statistical Hypothesis Testing (2-Tailed t-test)

**Null Hypothesis: The presence of a Deep Sewer Easement
Does Not Impact the Sale Price of a House**

t-Test Result for Datasets:
Set 1 Range = 1983-2004!\$E\$3:\$E\$374
Set 2 Range = 1983-2004!\$E\$378:\$E\$504
Unequal variances assumed

2-tailed t-Test

Ho. Diff	Mean Diff.	SE Diff.	T	DF	P
0.00	-0.06	0.03	-1.99	195.63	0.05

Conclusion: Hypothesis Rejected

Appraisal Study - Lake City Tunnel
Potential Impact of Deep Sewer Easements
Comparison of House Sales in Seattle

- Description:** Probability testing of whether the presence of a deep sewer easement under a house property in Seattle has an effect on the value of the property
- Method:** t-test (Student's t-test), based on analysis of 497 sales between 3/9/1983 - 7/26/2004
- Samples:** Comparing sales of house properties with deep sewer easements underneath the property, versus sales of properties on the same block without deep sewer easements.
- Variables:** 3 variables are tested: The ratio of sale price to assessed value, the sale price per square foot of finished living area, and the sale price.
- 1-tailed test:** Null Hypothesis: A house with a deep sewer easement does not have a lower sale price than a house without.
Alternative Hypothesis: A house with a deep sewer easement has a lower sale price than a house without.
- 2-tailed test:** Null Hypothesis: The presence of a deep sewer easement does not impact the sale price of a house
Alternative Hypothesis: The presence of a deep sewer easement impacts the sale price of a house

Year of Sale	<u>No. of Sales</u>		<u>Sale Price/Assessed Value</u>				<u>Sale Price/sf</u>				<u>Mean Sale Price</u>			
	Houses Without Easmts.	Houses With Easmts.	Houses Without Easmts.	Houses With Easmts.	Probability Value - 1-tailed test	Probability Value - 2-tailed test	Houses Without Easmts.	Houses With Easmts.	Probability Value - 1-tailed test	Probability Value - 2-tailed test	Houses Without Easmts.	Houses With Easmts.	Probability Value - 1-tailed test	Probability Value - 2-tailed test
2003-2004	55	9	1.19	1.21	0.64	0.71	\$253.54	\$241.59	0.19	0.39	\$375,089	\$359,272	0.23	0.46
2001-2002	49	21	1.22	1.23	0.58	0.84	\$210.45	\$211.57	0.53	0.93	\$322,658	\$358,186	0.91	0.18
1999-2000	48	17	1.44	1.54	0.88	0.25	\$185.03	\$209.83	0.97	0.07	\$315,028	\$319,072	0.57	0.87
1997-1998	31	19	1.42	1.41	0.43	0.86	\$151.36	\$149.42	0.43	0.86	\$238,401	\$235,737	0.44	0.89
1995-1996	49	14	1.24	1.31	0.88	0.24	\$114.71	\$119.27	0.73	0.54	\$192,370	\$196,846	0.66	0.69
1993-1994	33	12	1.18	1.13	0.20	0.40	\$120.44	\$112.50	0.21	0.42	\$181,895	\$171,042	0.22	0.44
1991-1992	32	9	1.14	1.18	0.75	0.50	\$109.51	\$127.28	0.94	0.11	\$168,975	\$159,883	0.21	0.42
1989-1990	25	9	1.73	2.00	0.97	0.06	\$90.53	\$129.38	1.00	0.01	\$149,828	\$178,556	0.88	0.24
1987-1988	22	6	1.30	1.37	0.83	0.33	\$61.60	\$67.47	0.77	0.46	\$105,698	\$111,908	0.68	0.64
1985-1986	19	5	1.27	1.21	0.32	0.63	\$68.07	\$56.01	0.10	0.19	\$88,380	\$93,300	0.67	0.66
1983-1984	8	5	1.11	1.24	0.86	0.28	\$54.49	\$47.72	0.20	0.40	\$82,875	\$98,700	0.79	0.42
1983-2004	371	126	1.29	1.35	0.98	0.05	\$151.69	\$152.99	0.57	0.85	\$237,739	\$239,241	0.55	0.90
2000-2004	126	37	1.23	1.28	0.88	0.24	\$221.69	\$218.20	0.36	0.71	\$342,264	\$349,604	0.66	0.67

Conclusions: The Null Hypotheses are not rejected.

Interpretation: There is insufficient evidence to support the hypothesis that the presence of a deep easement has an effect on the sale price of a house property.

Discussion: The tests examine a variety of different populations, including total sample and sub-samples that are based on ranges of dates of sale. The rationale is that sale prices have changed significantly over time, so sub-sampling allows examination of results where the sale date variable becomes less significant. The results are consistent across the various sub-samples, and are particularly powerful for the more relevant 1-tailed test, and for the most significant variable of the ratio of sale price to assessed value (note: the assessment process is largely based on multiple regression analysis including transform of relevant variables, and the presence of a deep sewer easement is not a variable. Because of the assessment process of analyzing historical sales to derive future values, without time trending, the assessed value tends to be lower than market value in a rising market). The potential rejection of null hypotheses occurs rarely in the 2-tailed test, and only because houses with deep sewer easements appear more valuable than those without, an illogical premise.