Electricity Transmission Lines and Land Development in the Pacific Northwest

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Abstract

Multiple national-scale electricity transmission studies have pointed out that expanding transmission network significantly is the most cost-effective way to serve the rapidly increasing electricity demand in the long run while supporting more clean energy resources to generate electricity. Yet, it is extremely difficult to build a new transmission line. Landowner resistance to granting a transmission line right-of-way (ROW) can slow down or kill a transmission project. In this paper, I study the build out of electricity transmission lines in the Pacific Northwest by Bonneville Power Administration from 1938 to the early 1940s. I provide the first-of-its-kind estimate on the impact of ROW resulted from building a new transmission line after 60 years up to the present day. Combining public records of ROW tracts, newly digitized historical property assessment records, contemporary parcel assessment data, and newly geo-referenced parcel ownership maps, I find that having a ROW on a parcel reduces parcel value per acre by 15% to 21% relative to what it would have been if absent a ROW. The mechanism lies in the differences in land development between parcels from which ROWs were and were not acquired, with the former having a lower share of single-family residential land use and a higher share of low-value vacant land. The impact varies across lines, driven by lines' locations and whether the ROWs were acquired through an easement or title ownership. Comparing the estimated impact of ROW with the average ROW compensation, the implied annual rate of return that could fully compensate for the long-run losses in parcel value ranges from 6% to 10%, which suggests that at the time of ROW acquisition, there was considerable uncertainty regarding possible future returns from supporting transmission infrastructure. The wealth impact could be a net positive depending on how compensation monies were invested.

JEL Codes: L94, R14, Q48.
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1 Introduction

A robust electricity transmission system with sufficient transmission capacity is critical to serve rapidly growing electricity demand, support clean energy resources, and meet that demand with clean energy resources (U.S. DOE, 2023). Such a huge increase in transmission needs cannot be met solely by deploying alternative solutions without seeking to build more transmission lines. Multiple national-scale electricity transmission studies have pointed out that expanding transmission significantly is the most cost-effective way to serve long-run increasing electricity demand (Brown and Botterud, 2021; Denholm et al., 2022; EPRI, 2022; Jenkins et al., 2021; Mai et al., 2026; U.S. DOE, 2023). In addition, building new transmission lines is still the principal approach to increasing transmission capacity, as recognized by recent orders from the Federal Energy Regulatory Commission (FERC).[1]

Despite the urgent need for a substantial increase in transmission capacity, it has only increased 27% from 2005 to 2020 (Davis et al., 2023). It's costly and time-consuming to acquire rights-of-way (ROWs) for the construction of lines, which is a big reason why the transmission build-out has been slow in recent decades (The National Council on Electricity Policy, 2004, 2022). Of all the factors leading to delays or even failures in right-of-way (ROW) acquisition, local obstruction to siting is a significant one. The concerns of resistant landowners mainly center around potential negative impacts on property values from having transmission lines sit on their land. The magnitude of these impacts may not turn out to be what is ex-ante expected, but empirical research on this topic is limited. There is a lack of economic evidence on the impact of building a new transmission line on the parties directly affected - landowners and their properties holding ROWs and towers.

There are two challenges to studying this research question in a contemporary setting. First, the location of a transmission line may be endogenous due to the rise of NIMBYism and the reluctance to use eminent domain when feasible. As a result, the final location of a line could be different from that proposed by the electric utility, thus crossing a different set of parcels from what the utility initially decided to acquire ROWs from.[2] Second, it's difficult to get data such as maps of planned routes at early stages before public outreach, ROW acquisition records, and detailed project timelines for completed transmission projects because these data don't always exist. Even if they do, they are hard to obtain because most of the transmission lines built in recent decades are usually scattered in different states (or crossing different sets of states), and were built by private utilities. In addition, relatively few transmission lines have been built in recent decades.

In this paper, I study the build-out of transmission lines in the Pacific Northwest by Bonneville

[1] Order No. 1920 requires transmission providers to do long-term regional transmission planning. More than one cost allocation methodology should be considered in case states cannot reach an agreement. When this happens, the default cost allocation method proposed by the transmission planner can be implemented. Order No. 1977 outlines how FERC plans to implement its "backstop siting authority", which allows it to permit the construction of vital transmission projects provided it's in the "public interest".

[2] Endogeneity could also show up before a route is proposed. Some jurisdictions require multiple routes to be studied for a specific line before proposing a determined route. These studies, especially the environmental impact studies required by NEPA and/or state laws, take a long time to finish. It's not clear if these studies are completely unaffected by landowners when they are conducted.

Power Administration (BPA) from 1938 to the early 1940s. Specifically, I study four major transmission projects in Washington State: the Bonneville Dam-Vancouver line (B-V) and Vancouver-Kelso line (V-K) in Clark County, and Covington-Tacoma line (C-T) and Covington-Seattle line (C-SE) in King County. I estimate the impact of ROW on the assessed parcel value per acre 60 years after the ROW acquisition up to the present day using these lines. My setting mitigates the endogeneity concern for three reasons. First, an initial map of BPA's transmission system planned in 1938 looks largely identical to the lines that were eventually built. Second, BPA frequently exercised eminent domain in those years to enforce ROW acquisition along its preferred routes. In addition, the average time from planning to the completion of construction was less than two years, a large contrast to modern processes that span decades.

To estimate the impact of ROW, I first argue for a conditional exogeneity assumption: the route for ROW acquisition was largely exogenous to parcel value per acre in a local area, conditional on the pre-acquisition value of improvements (e.g., buildings) and parcel size. This assumption holds for two reasons. First, when a line is to be built through areas close to a city, some of the parcels in these areas might be carefully avoided for ROW acquisition because they are quite developed, i.e., having small size and/or high value of improvements. Second, when the lowest-valued parcels in an area are adjacent to each other and 'lined up' geographically, it is often the case that ROWs would be acquired from these parcels, which in my setting are usually big and have large proportions of unimproved land.

Next, I define the local area of a line to be a block of approximately one square mile where the ROW is at the center. This block is constructed in two steps: I draw a half mile on each side of the edge of the ROW to create a one-mile buffer surrounding the ROW, then I cut the line into segments of approximately one mile.[3] My research design is to compare in each block, parcels where a ROW was acquired (denoted as 'treated parcels') and the rest of the parcels that didn't have a ROW acquired (denoted as 'controlled parcels'), before and after the ROW acquisition.

To identify the locations, i.e., geographic boundaries, of treated and controlled parcels, I rely on three data sources: BPA transmission line ROW tract data, Washington State property assessment records that contain values and sizes of assessed parcels, and Washington State parcel ownership maps from times before ROW acquisition. I match the BPA data with the parcel ownership maps primarily by ROW length and ROW size to locate treated parcels, while the locations of controlled parcels are determined by the boundaries of one-square-mile blocks and the locations of parcels that remain on the parcel ownership maps after treated parcels are excluded. In addition, I verify these matches by checking whether the name of a ROW owner is matched with the name of a landowner who owned this treated parcel according to property assessment records.

The pre-acquisition parcel values are based on the property assessment conducted before and closest to the time of ROW acquisition, which was in 1938 for B-V, in 1939 for V-K, and in 1940 for C-T and C-SE. Regarding the contemporary values of these 1938, 1939, and 1940 parcels ('his-

[3] An exact one mile is not practical because the sum of lengths of ROWs over a few parcels may not add up to exactly one mile.

torical parcels'), I geo-reference the parcel ownership maps in these years in ArcGIS, map them onto a 2025 parcel map that illustrates the locations of all the parcels that existed in 2025 ('current parcels'), and obtain the proportion that a current parcel overlaps with a historical parcel. Then, I collect the assessed values of current parcels that are mapped, and sum up the values of current parcels that are fully contained and the proportionate values of those partially overlapped to be the values of a historical parcel in the contemporary years.

I use a two-way fixed effects difference-in-differences (DID) model for my estimation and I consider two specifications when pooling all lines together, one assuming common effect across lines and the other allowing heterogeneous effect by line. I regress parcel value per acre on a dummy variable that equals one for a treated parcel in a post-acquisition year. I add a block-by-year fixed effect to reflect that treatment and control are defined in a block. Parcel size and pre-acquisition value of improvements are controlled due to the conditional exogeneity assumption, and I allow their impacts to vary across relative years. I also control for the proportion of ROW on a treated parcel because it can affect how a treated parcel is developed. For instance, a smaller ROW proportion means a larger proportion not taken by the ROW, which has the potential to be developed into usage with higher values, especially on the side away from the ROW. Moreover, I also control for the distance from a parcel to the transmission line to capture the possible spillover - assuming linear in distance - from ROWs to nearby controlled parcels without ROWs, and to improve the prevision of my estimates.

I find that having a ROW on a parcel resulted from building a transmission line reduces parcel value per acre on average by $135,673 to $194,583 in 2020 dollars 60 years after the ROW acquisition over many regression specifications. The decreases are between 15% and 21% when translating to the percentages relative to the post-acquisition per acre value of treated parcels had they not had a ROW. Using event study to decompose the average impact to each relative year, I show that the negative impact of ROW from King County lines keeps increasing over years, peaks at 82 years after ROW acquisition, which is in calendar year 2022, and remains stable since then. The negative impact from Clark County lines barely varies across years and is statistically insignificant. The impact estimates from all lines largely mirrors the trend of King County lines.

The negative impact of ROW is not caused by visual dis-amenity of the transmission lines, but by the differences in land development, i.e., the land use types developed, between treated and controlled parcels. Collecting land use descriptions among current parcels and calculating the differences in the share of parcel area of 13 categories of land use types, I find that treated parcels on average have a higher share of low-value vacant land and a lower share of land used for single-family residential housing. Meanwhile, there is heterogeneity across lines, and the main drivers are lines' locations and the type by which ROWs were acquired - an easement or title ownership. Easement creates the opportunities to develop the ROW lands and provides more flexibility for the development of adjacent non-ROW areas, while the location of a line determines whether it could attract high-value land usages (e.g., commercial and industrial activities) to locate on these ROW lands and adjacent non-ROW areas.

I also investigate two types of heterogeneity across controlled parcels. First, a controlled parcel that shares boundaries with ROWs may get spillover from the ROWs, such that excluding them would increase the estimated negative impact of ROW. I show that such spillover exists, but effect of this spillover on the ROW impact estimates is very modest. Second, different controlled parcels, near or far from the transmission line, might contribute differently to the impact of ROW. I examine three more buffer widths that would change the width of a block where treatment and control are defined to a half mile, a quarter mile, and a half-quarter mile. I find that when the buffer width narrows to a half mile, the negative impact decreases because parcels of higher post-acquisition values are dropped for being out of the buffer, but such decreases are not detected when the width gets even smaller, as the number of controlled parcels substantially decreases. These findings suggest that the impact of ROW is not driven by the differences among controlled parcels, but by how ROWs have shaped the treated parcels over years.

Finally, I compare my ROW impact estimates with the average ROW compensation per acre of ROW. The implied annual rate of return that could fully compensate for the long-run losses in per acre parcel values from having a ROW is between 6% and 10%, which is arguably higher than the long-term interest rate in the U.S. This wide range and the large numbers suggest that at the time of ROW acquisition, uncertainty about what the losses or the gains would be from having a ROW was big. If the compensation monies were invested upon receiving them, it would need a long-run return that is higher than the implied rate of return to achieve a positive wealth on net. Whether landowners were over or under compensated depends on the long-run rate of return to compare.

This paper relates to the literature on the property value impact of energy infrastructure. Existing research has studied wind turbines (Guo et al., 2024; Jarvis, 2025; Quentel, 2025), natural gas pipelines (Herrnstadt and Sweeney, 2024), and overhead power lines (Tang and Gibbons, 2024), exploring variations in the distance to infrastructure and the timing of events, such as turbine technology improvement, pipeline explosion, and housing construction. In these studies, infrastructure existed prior to the events, and the estimated impacts reflect the hedonic preference for certain distances to the existing infrastructure.[4] This paper contrasts with this literature on two aspects. First, my "event" is ROW acquisition, which is an inevitable step in the processes of building a new transmission line. Second, changes in land values reflect not only preference for locations away from ROWs, but also the restrictions of land development on parcels with ROWs.

This paper also adds to the literature on the impact of infrastructure on economic development. Improvements in local productivity and labor market outcomes have been linked to electricity grid investment and electrification (Dinkelman, 2011; Kline and Moretti, 2013; Lipscomb et al., 2013). For non-power infrastructure, interstate highways caused a decline in central-city population (Baum-Snow, 2007), induced suburbanization (Baum-Snow, 2010), and caused economic growth to be concentrated toward cities (Duranton and Turner, 2012; Faber, 2014). Similarly, railroads have been found to reduce trade costs and induce welfare gains (Donaldson and Hornbeck,

[4]The conventional approach to studying the impact of existing infrastructure is to compare places where such infrastructure is located versus places that are not inside the 'inner' part of the doughnut (assuming the infrastructure is a point), but outside of that, because we worry about the spillover to the inner part that is neighboring to the treated places.

2016; Donaldson, 2018). Unlike this county- or state-level evidence, this paper explains the economic growth through parcel-level land use responses to electricity infrastructure build-outs. I document spatial spillover across and within parcels by demonstrating that parcels with and without ROWs have been developed into different mixes of land uses.

This paper also contributes to the discussion of how to incentivize grid investment and address electric power infrastructure shortage (Brooks and Liscow, 2023; Davis et al., 2023; Ham et al., 2026; Hausman, 2025; Johnston et al., 2023). I provide the first empirical evidence on the implied rate of return that could fully compensate for landowners' losses of having a ROW on their properties. My findings have important implications for the design of electricity transmission policies. While regional transmission organizations are required to do long-term transmission planning, this process is dominated by engineers' considerations. Practical strategies on how to accelerate transmission build-out and facilitate ROW acquisition in the field remain understudied and less understood. My results show that the uncertainty of potential future losses can be big at the time when ROWs were acquired. More information on existing projects' long-lasting impacts is needed to reduce this uncertainty, and better estimates of the losses in parcel values could improve settlement of ROW compensation.

Of course, how empirically relevant my findings and their implications are hinges on two predictions about the future: which places where a new transmission line is built today will be suburbanized in the future, and how much of people's underlying preference for risks associated with investment in transmission infrastructure has changed compared to what it was 85 years ago. While this paper can't answer the second question, I provide examples of a few possible scenarios for the first one. It's true that many miles of the transmission lines built in the past are still crossing farmland, rural places, and forests today. However, for the segments that are approaching a substation that's located in between two growing cities, or at least in a region that has huge economic growth potential, we can expect to see suburbanization in areas where these segments go through. This is the story of the Puget Sound region and the Vancouver urban growth area studied in this paper. While only specific segments - not an entire line - will have a possibility of being suburbanized in the future, whether the areas will actually be suburbanized depends on the interaction and pro-active coordination between transmission planning and urban/regional planning. There is therefore no definitive answer to the first question, but discussions on this question should be given attention in future transmission planning.

The rest of the paper is organized as follows. Section 2 explains the setting, including the early history of BPA's transmission system, BPA's ROW acquisition practice, and the lines studied in this paper. Section 3 explains the research design to estimate the impact of ROW. Section 4 describes the data sources and the methods used to construct the data for estimation. Section 5 presents the empirical strategy for estimation. Section 6 discusses results and mechanisms and explores the heterogeneity among controlled parcels regarding their locations and their distances to the line. Section 7 briefly discusses two questions relevant to a long-run impact: the difference between a historical setting and today, and one example of a short-run impact. Section 8 concludes the paper.

2 Setting

This section first provides the history of BPA's transmission system, focusing on the design and early construction. Specifically, I discuss why there was originally a need for this transmission system in the first place, and why the locations of power lines on this system were largely exogenous. Then, I discuss BPA's ROW acquisition practice and policy. Finally, I introduce the specific lines that I study in my empirical analysis.

2.1 History of BPA's Transmission System

Preceding the establishment of the Bonneville Power Administration (BPA) in 1937, discussions on how to develop the Columbia River had been going on for more than a century. Water has long been harnessed to power mills and factories, but it was not until the late 19th century when the United States turned its page to the age of electricity, that hydroelectric power grew to become the pillar of the Pacific Northwest economy. Small hydro power plants and dams were built on Columbia's tributary rivers as big dams for the main stem were expensive to build. In addition, a lack of demand for the large amount of power that big dams could generate deterred local and private investment for these big projects. At the same time, however, the desire to develop the Columbia for navigation, irrigation, and flood control proceeded.[5] In 1932, the Army Corps of Engineers, directed by the River and Harbor Act of 1927, published a report that called for an integrated development of ten multi-purpose dams on the Columbia River starting from Grand Coulee and ending east of Portland, where the Bonneville Dam would sit. Aware of the potential benefits of bringing thousands of jobs to the region through investment in these large hydro projects, Franklin D. Roosevelt, the future president, declared in 1932 in his campaign speech in Oregon that "the next great hydro-electric development to be undertaken by the Federal Government must be that on the Columbia River".

> "This vast water power can be of incalculable value to this whole section of the country. It means cheap manufacturing production, economy and comfort on the farm and in the household. $\cdots$ Here you have the clear picture of four great Government power developments in the United States - the St. Lawrence River in the Northeast, Muscle Shoals in the Southeast, the Boulder Dam project in the Southwest, and finally, but by no means the least of them, the Columbia River in the Northwest. Each one of these, in each of the four quarters of the United States, will be forever a national yardstick to prevent extortion against the public and to encourage the wider use of that servant of the people - electric power" (The Oregonian, 1932).

In March 1933, the Bonneville Dam and the Grand Coulee Dam were authorized as Public Works Administration projects under the National Industrial Recovery Act, with the Army Corps of Engineers in charge of constructing the Bonneville Dam and the Bureau of Reclamation constructing the Grand Coulee Dam.

[5] Debates in Washington centered on what system would work best for irrigation purposes. On the Oregon side, the focus was on the flood control.

As the construction went on, long-established concerns about the economic feasibility of the dams fueled debates about who should market the power. Oregon proposed a bill that suggested that the two dams be operated and marketed separately, with a lower price for power sales at the dam site that would favor industrial customers who wanted to build factories near Portland. Under this bill, there were essentially no incentives for the Army Corps to build long-distance transmission lines to sell power to places far away from the Bonneville Dam. Washington, where the Grand Coulee Dam would not be finished until 1941, did not support this bill as it could have impeded the public utility district movement in its state (Springer, 1976).

Should the Pacific Northwest have an extensive transmission system so that all customers in the region could benefit from the federally generated power? Requested by President Roosevelt to study this issue, the Pacific Northwest Regional Planning Commission released a 1936 report recommending a master grid that would link the major demand centers (Portland, Puget Sound, and Spokane areas) and existing and future power generation with high voltage transmission lines. The report also came with recommendations that the rates charged for transmitting energy should be as nearly uniform as possible throughout the transmission areas,[6] and an independent commission should be the marketing agency. A compromise was eventually reached between the states and the agencies. With the passage of the Bonneville Project Act in 1937, both the Army Corps and the Bureau of Reclamation could still operate their own dams, but the authority to build and operate transmission lines and to market the power would go to a new bureau, the Bonneville Project (later changed to BPA in 1940), within the Department of the Interior (Norwood and Burghardt, 1964; Norwood, 1980).

In 1938, the proposed locations of the system that were planned to be eventually built were released in a map known as the master grid (see Figure B1). It was based on the 1936 study conducted by the Regional Planning Commission (see Figure B2) and illustrated results from surveying the territory. The master grid indicates very rough locations of the substations to-be-built, the approximate places a line connecting two substations would go through, and the general direction of such a line. These survey results were then followed by land surveyors to determine the proposed route for ROW acquisition. The master grid is an engineering and economic solution to maximize the use of the network to transmit power from hydro resources to electricity demand ('load') centers,[7] a system design that was largely unknown to many people in the Pacific Northwest before ROWs were acquired and lines started breaking ground for construction. In addition, there weren't any distributions of this map to the public except a coarse one published in the Oregonian in November 1938 after its release (see Figure B3). Therefore, any anticipation by landowners about where a

[6] BPA's rate remained from 1938 to 1965 at $17.50/kilowatt-year (0.2 cents/kWh) for places beyond 15 miles of the dam and $14.50/kilowatt-year for those within 15 miles of the dam.

[7] In its 1938 annual report to the Department of the Interior, BPA explained "the type of transmission system selected for the present basic design for Bonneville is one which can become a part, without fundamental changes, of an advanced synchronized-at-the load master system." Some major advantages of such a system are that it provides stable operation, minimizes the effect of disturbances at individual generating plants to the system, and maximizes the use of connected lines while minimizing the unused transmission investment in anticipation of load growth. In BPA's own words from its 1939 report, "the aim has been to program a system not only to supply the initial power markets but also to provide for the expansion of service to meet growing power loads with the maximum economy of investment and operating costs." (BPA, 1938, 1939)

proposed route for ROW acquisition might be was unlikely.

2.2 BPA ROW Acquisition

The BPA undertook massive condemnation in the first two years (1938 and 1939) due to the urgent need to start constructing transmission lines as the Bonneville Dam was already generating power from its first powerhouse. Once a condemnation proceeding was initiated, BPA immediately secured the ownership and had possession over the ROW lands. While BPA would deposit an "estimated just compensation" to the federal district courts, the ROW payment could not be "withdrawn" by the landowners before certain settlement was reached. This initial policy took a long time not only because it's harder to purchase by title in fee than to purchase just an easement on the ROW lands, but also because once a settlement with a landowner was reached, a petition for deposit withdrawal needed to be signed and each petition required a separate court hearing. It was during such a hearing that the official transfer of the title would happen and the final ROW payment would be decided. To acquire ROW at lower costs and difficulty, BPA changed its policy - effective December 7, 1939 - from condemnation to direct voluntary purchase. Since then, judicial proceedings would only happen when it was "unable to agree with a landowner as to the amount of damages to be paid him, or when satisfactory title to a tract cannot be obtained without court action" (BPA, 1940).

2.3 Lines Studied in This Paper

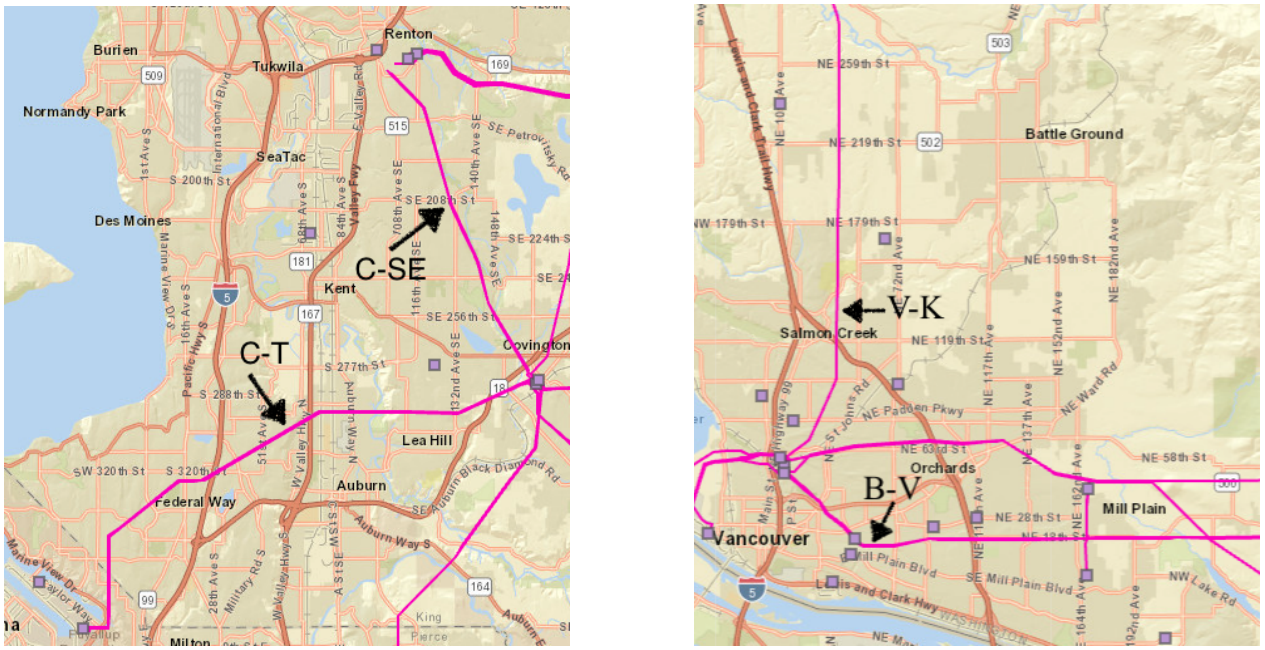
In this paper, I study four segments of transmission lines in Washington State: the Bonneville Dam-Vancouver (B-V) and Vancouver-Kelso (V-K) in Clark County, and Covington-Tacoma (C-T) and Covington-Seattle (C-SE) in King County. Specifically, for B-V and V-K, I study their segments within the urban growth area of Vancouver, WA.[8] Figure 1 shows their location.

The construction of a transmission line involves four steps: survey of territory, design of line, acquisition of ROWs, and actually building the power line. In practice, the exact timing of design and ROW acquisition can be hard to separate as the design and ROW acquisition may proceed together. Table 1 summarizes the dates of these steps for each line. While survey end dates, or design start dates, were not recorded by BPA, ROW acquisition as well as line design should start in between the start of survey and the start of construction. I conjecture the start of ROW acquisition based on when ROW compensation payments were made.

Although not listed in the 1938 master grid, C-T and C-SE went through the same processes as the earlier lines did, as suggested in BPA's annual reports. The survey results of these two lines were therefore not known by the people in the region before BPA started acquiring ROWs in the field.[9]

[8] See Figure B11 for the Vancouver urban growth area.

[9] BPA explained its transmission planning in the 1940 annual report: "This transmission system consists of a main interconnecting, high capacity, high voltage transmission network extending from the Grand Coulee plant to the Bonneville plant to Vancouver, Washington, thence north to Covington and east to Grand Coulee, and extending eastward from Grand Coulee through Spokane. This high capacity bus is designed for 230,000 volt operation and will form the main power supply system of the region. From the main substations located at Spokane, Vernita, Vancouver and Covington radiate 115,000-volt and lower voltage transmission lines to supply power to the various load centers and to



(a) C-T&C-SE

(b) V-K&B-V

Figure 1: Line Location. Source: BPA Transmission Assets.

Table 1: Line Data

	Survey Began	Construction Started	ROW Acquisition Started*	Notes
B-V	April 4, 1938	March 13, 1939	Late 1938/Early 1939	Line placed in service on December 1, 1939
V-K	September 1, 1938	September 21, 1939	Early 1939	Line placed in service on October 30, 1940
C-T	February 25, 1940	–	Mid 1940	Line under design by June 1940; placed in service on March 9, 1941
C-SE	August 23, 1939	–	Mid/Late 1940	Line under design by June 1940; placed in service on May 25, 1941

Source: BPA 1939, 1940, and 1941 annual report and BPA ROW data. Notes: 'ROW Acquisition Started' column is my estimation. ROW acquisition for B-V approximately started around late 1938/early 1939 because almost all of the ROWs for this line had their compensation payment deposited on January 5, 1939. For V-K, ROW acquisition approximately started around early 1939 because almost all of the ROWs for this line had their compensation payment deposited on February 28, 1939, and there were no records in Clark County showing that ROWs had already been acquired up to January 1939 for V-K. For C-T, the earliest payment date among ROWs was September 11, 1940, so the ROW acquisition likely started around mid 1940. For C-SE, the earliest payment date among ROWs was January 8, 1941. There is a possibility that some ROWs of this line had their ROW acquisition finished as of mid 1940 since the survey of C-SE began very early. I can't rule out this possibility, but it's likely to be small.

interconnect the federal transmission system with the existing generating and transmission facilities." (BPA, 1940)

There are two reasons to study these four transmission line segments. First, their design objectives reflect two primary reasons for building transmission lines that remain relevant today: connecting remote generation sources (e.g., solar and wind farms), to major load centers like cities, and extending the existing grid infrastructure to serve growing electricity demand (e.g., data centers). B-V and V-K were built to transmit hydropower from the Bonneville Dam to major load centers, whereas C-T and C-SE served as feeder lines to deliver electricity from an integrated grid to the load centers. Table 2 presents a summary of the main design objectives of each line. Second, these lines cross suburban landscapes rather than farmland and forests, thus are located near places with high-density economic activities. Studying these lines could offer a closer look at how transmission lines affect economic development and provide valuable guidance on how to build more transmission lines while supporting future economic growth.

Table 2: Line Objectives

Line	Design Objectives
B-V	Transmit Bonneville and Grand Coulee power to the Portland area.
	To be a link in interconnection of the Portland load area with the Spokane load area.
V-K	Transmit Bonneville power northward into western Washington.
	To be a link in interconnection of the Portland load area with the Puget Sound load area.
C-T	Provide facilities for supplying large blocks of power to the Puget Sound area.
	Interchange power between the city of Tacoma and the Bonneville system.
C-SE	Provide facilities for supplying large blocks of power to the Puget Sound area.
	Interchange power between the city of Seattle and the Bonneville system.

Source: BPA 1939 and 1940 annual report.

3 Research Design

This section explains the research design to estimate the impact of ROW resulted from building a new transmission line on the per acre parcel value. Specifically, I explain how I identify the impact of ROW, and I illustrate this identification strategy with maps.

3.1 Research Design and Identification Strategy

To estimate the impact of ROW, I argue that ROW acquisition is exogenous to pre-acquisition parcel value per acre in a local area. In some areas, this exogeneity will be relaxed through a conditional exogeneity.

As explained in Section 2, the survey results for lines indicate the rough locations where the substations would be built and the approximate route a line between two cities would take. This route identifies the areas the line would likely cross and the line's general direction. These results were then followed by BPA's land surveyors who narrowed down a route of specific parcels they wanted to acquire ROWs from. From BPA's perspective, the decision to pick parcels is again driven

by a mix of factors, such as topography and ground conditions (stream, swamps, etc.) (Lundquist, 1912), as well as conjectured ROW acquisition costs, construction costs, etc. There are no open documents discussing how each factor weighs into the determination of a route, but any cost estimates of ROW acquisition would only be one of the factors considered, such that the correlation between the choice of parcels and parcels' pre-acquisition values may be weak. In addition, these transmission lines follow a straight route; they don't zig-zag in order to go through parcels that have the lowest values in a given area, except when the lowest-valued parcels were already 'lined up'. Below, I will argue for a conditional exogeneity for my empirical analysis because there is suggestive evidence that a route likely correlates with pre-acquisition parcel value per acre in some areas.

There is a potential identification concern that certain parcels may have been difficult to acquire ROWs from due to landowner resistance. If true, ROW acquisition is not entirely exogenous to parcel values as these landowners may have convinced BPA to choose a different route. This is not likely to be true in my setting because BPA could use eminent domain. For B-V and V-K, this is not a concern because their ROWs were acquired before the end of 1939 when eminent domain was exercised on a large scale. For C-T and C-SE, this may be a concern, but as these lines were finished in less than two years after their survey started, this suggests that their ROWs were also acquired quickly and met little resistance. If there was any, it's possible it was eventually resolved through condemnation.[10] However, preliminary searches over the judgment docket and index of the U.S. District Court for the Western District of Washington that are associated with federal land condemnation cases in the period of the early 1940s suggest that there might not be such a case in the areas of C-T and C-SE studied in this paper because no relevant cases were found.[11]

In which local areas will ROW acquisition be exogenous? For a given line, I define such a local area to be a block of approximately one square mile where the ROW is at the center. Specifically, I draw a half mile on each side of the ROW to create a one-mile buffer where the ROW is at the center of the buffer.[12] Then I cut the line into segments of approximately one mile so that each block would contain a few parcels, each of which had a ROW acquired. This ensures there is variation within a block across these ROW parcels. My empirical design is to compare parcels from which a ROW was acquired, which I denote as treated parcels, and parcels in the same block but with no ROW acquisition, which I denote as controlled parcels, before and after the ROW acquisition. This design comes from hypothesizing that there were other routes within the one-mile buffer that could also be the route of the built line, and these routes would cross some of the parcels next to or near the actual treated parcels.

[10] Taking a step back, the existence of a land condemnation case about an easement ROW doesn't sufficiently prove that the landowner had changed BPA's mind in terms of route because the exact reasons why a condemnation case was brought to court could vary. The landowner may simply have been dissatisfied with the amount of compensation, or he may have been resistant to granting a ROW regardless of how much compensation was offered.

[11] There was one case, however, that related to parcels where the Covington substation was built and the case was dated in June 1940. Nevertheless, as I will mention in the Data section, I do not study the parcels where substations were built, or the parcels sharing boundaries with them in this paper, because ROW acquisition for a substation may be different from that for a line, as the ROW of a substation is usually a big piece of land instead of a slim strip.

[12] Except for Covington-Seattle, for which I also include a half mile on the east side of Covington-Renton, which is a line also built by BPA and located very close to Covington-Seattle.

However, no two parcels are identical. A controlled parcel within the same block is not completely identical to a treated parcel other than the absence of a ROW. But, half a mile is sufficiently short such that treated and controlled parcels are likely similar in many unobservable characteristics, and I assume that, on average, there are no differences in unobservable characteristics between the two groups. Still, observable differences between the two groups could have caused the treated parcels to be chosen for ROW acquisition endogenously, which is why I argue for a conditional exogeneity for my estimation.

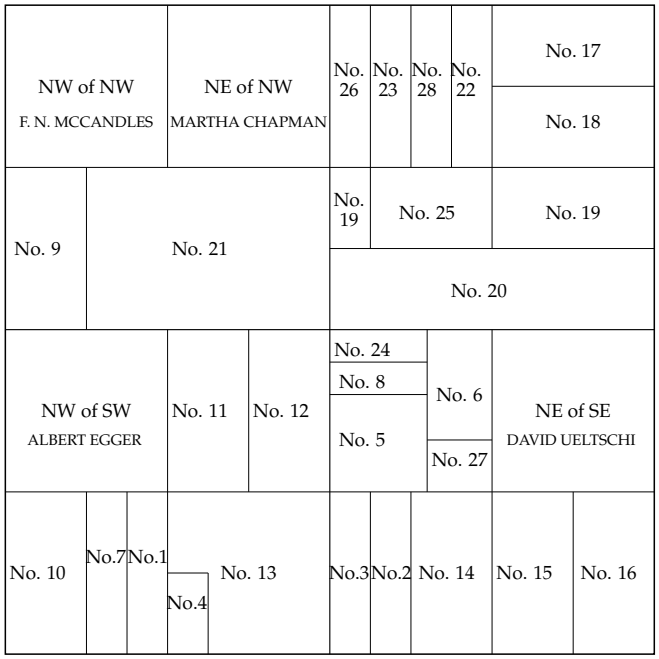
In practice, the exogeneity of ROW acquisition to parcel values may not hold in areas that are close to a city, because some places in these areas are already quite developed, leaving fewer parcels from which to acquire ROWs. Endogeneity could also exist in an area far away from a city where there are only a few parcels that have expensive improvements, or the opposite - where there are many low value parcels adjacent to or 'lined up' with each other geographically. In the first scenario, these parcels with high improvements value could be avoided in the acquisition by careful design; in the second scenario, these low value parcels could provide an obvious solution to the acquisition problem. Therefore, I argue for a conditional exogeneity of ROW acquisition to parcel value per acre, conditional on the pre-acquisition value of improvements and parcel size.[13] This argument is supported by a conditional balance in the pre-acquisition value per acre between treated and controlled parcels, which will be discussed in the Estimation section of this paper.

3.2 Map Illustration of the Identification Strategy

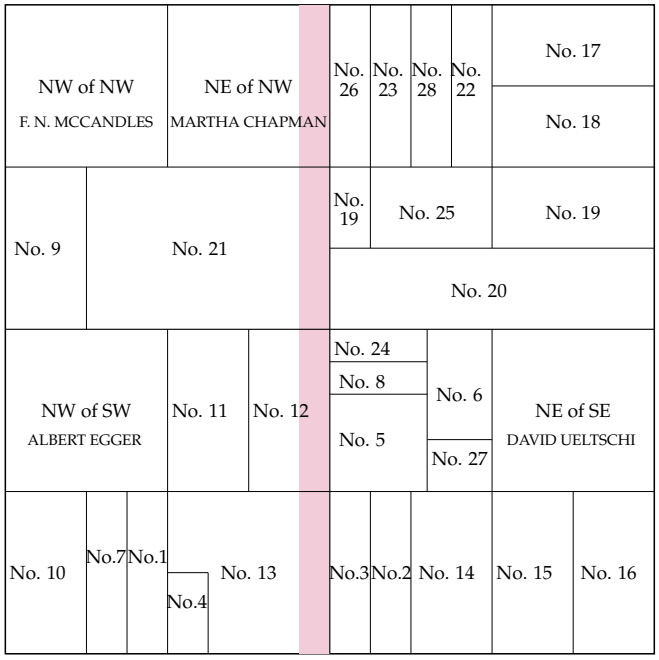
Figures 2 and 3 illustrate my identification strategy with a segment of V-K in Section 36 of Township 3 North, Range 1 East of the Willamette Meridian. This section is a one mile by one mile square according to the Public Land Survey System (PLSS).[14] ROWs were acquired from four parcels: No. 13, No. 12, No. 21 and NE of NW. The length of the one-square-mile block is determined by the length of Section 36. The width of the block is established by drawing a half mile from the right edge of the ROW and a half mile from the left edge of the ROW, which goes slightly beyond the left edge of Section 36 into Section 35. Together, the block is illustrated by the purple shade. Controlled parcels are the rest of the parcels in this shade, including those that partially overlap with the shade. Visually, a route for V-K could cross No. 14, No. 27, No. 6, No. 20, No. 25, and No. 22, or No. 10, NW of SW, No. 9, and NW of NW, or some other parcels. But, a possible route that I use to compare with the actually built line should not cross any treated parcels, such as the one that would go through No. 1, NW of SW, **No. 21**, and NW of NW. This is to ensure that the comparison between treated and control parcels provides (conditionally) exogenous variation.

[13]The parcel size is used to approximate the proportion of land that is unimproved because this variable doesn't exist for data from King County.

[14]PLSS, which is a way of subdividing and describing land, defines a township-range as a piece of land that is six mile by six mile relative to a point at the intersection of a meridian and a baseline. For example, Township 21 North, Range 4 East of the Willamette Meridian is a 36-square-mile piece of land in Washington State. Its north boundary is 126 miles north of the Willamette baseline and its east boundary is 24 miles east of the Willamette meridian. Each township-range has 36 sections, each of which is a one mile by one mile square which equals 640 acres. Sections can be further divided into quarter sections, quarter-quarter sections, or irregular lots.

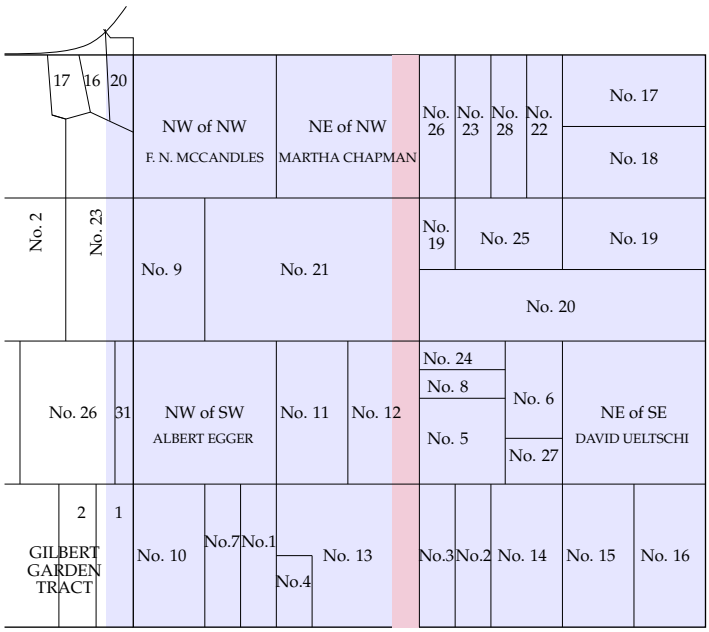


(a) The map of Section 36 of T3N R1E in Clark County, WA in 1939 before ROW acquisition. Notes: See Figure B4 for the original map.



(b) Section 36 T3N R1E, Clark County, WA after ROW acquisition. Notes: Pink shade indicates the ROW of V-K, 250 ft wide. ROWs were acquired from No. 13, No. 12, No. 21, and NE of NW, which are denoted as treated parcels.

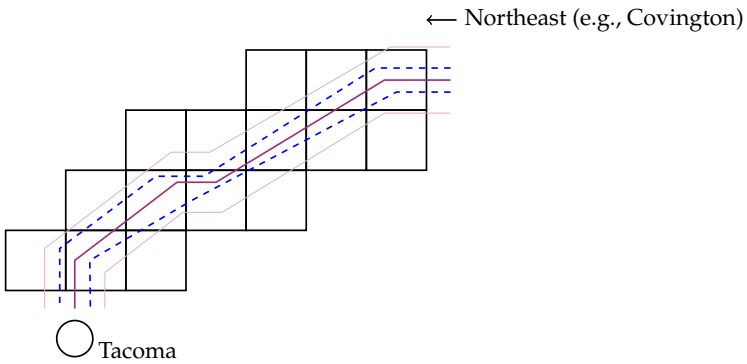
Figure 2: Example of ROW Acquisition for V-K in Clark County, WA.



Notes: This picture shows Section 36 and part of Section 35 of T3N R1E, Clark County, WA. Purple shade indicates the one-square-mile block. Parcels without a ROW but fully or partially in this block are defined as controlled parcels.

Figure 3: Identification Strategy Illustration Using a South-North Line (Based on V-K).

My identification strategy doesn't require the direction of a possible route to be the same as that of the built line as long as it's within the one-mile buffer. Figure 4 explains this idea in a more general setting where a line doesn't go south-north or east-west, for instance, C-T. Each square in this figure is a section in the PLSS. Dashed lines illustrate possible routes that don't have the same direction as the solid line.



Notes: The dark solid line indicates C-T. Light solid lines establish the boundaries of the one-mile buffer (ROW width is ignored here for simplification). Dashed lines illustrate possible routes in the buffer.

Figure 4: Identification Strategy Illustration Using a Southwestward Line (Based on C-T).

Figure 5 further illustrates this idea by magnifying two sections in Figure 4. Figures 5b and 5c present the parcel landscape in 1940 for a segment of C-T before ROW acquisition. Yellow polygons are parcels. The blue shade indicates the one-mile buffer. As the line goes towards southwest, the one-square-mile blocks are created by cutting the line into segments of approximately one mile. Figure 5c shows a one-square-mile block whose boundaries are established by buffer boundaries and two dashed lines perpendicular to C-T. The treated parcels in this block are colored in red. The controlled parcels are the rest of the parcels in this block - either fully inside or partially overlapping, and their locations are indicated by the red lines.

4 Data

In this section, I describe my data sources and explain how I construct the dataset that can be used to estimate the impact of ROW.

4.1 Bonneville Power Administration Transmission Line Right-of-way (ROW) Data

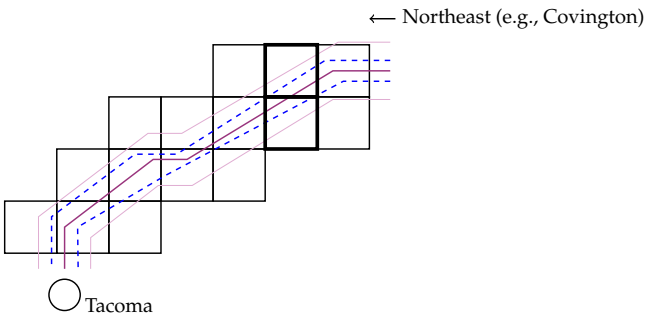
This data contains records of BPA's transmission line right-of-way (ROW) tracts. For each ROW tract, I can see its size in acres, its width and length in feet, the township-range-section in which it's located, its owner's name, the ROW compensation payment(s) to its owner, the date(s) paid, the reasons for the payment(s), and information of the line for which it was acquired, including the line's name, corridor, voltage, and total miles.

In general, a transmission line ROW is a piece of land on a parcel which an electric utility must acquire either by title or by easement to build and maintain a transmission line. Title purchase in fee transfers the ownership from the original landowner to the utility, while easement only grants the utility the right to access the ROW. In this paper, B-V and V-K were acquired by title in fee, C-T and C-SE were acquired by easement.

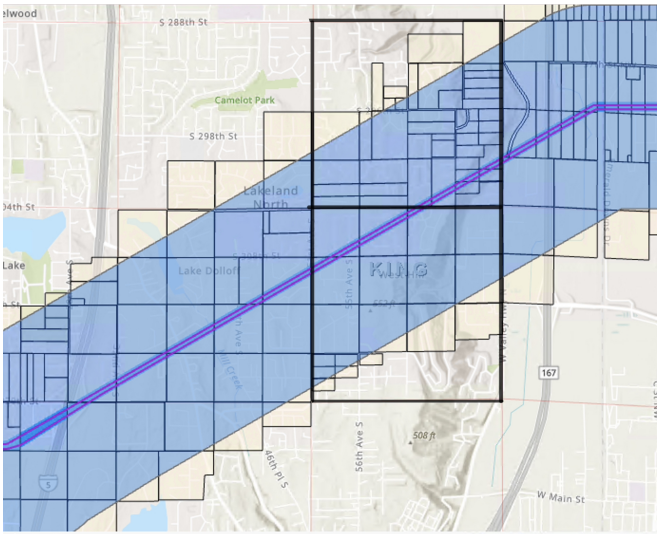
Due to protection of the Personally Identifiable Information, this data doesn't contain the locations, i.e., geographic boundaries, of parcels from which ROWs were acquired. To get this information, historical parcel ownership maps ideally right before ROW acquisition are needed. More details will be discussed later on how to identify the locations of these parcels.

In summary, for the lines studied in this paper, there are a total of 302 ROW tracts in the BPA raw data, forming 243 ROWs[15] on 243 historical parcels. These parcels are denoted as treated parcels because ROWs were acquired from them. However, the number of treated parcels used in the empirical estimation is bigger. Matching the size and length of ROW with parcel geometries established from parcel ownership maps, I find that in the BPA raw data, there are 1.1 miles of ROWs missing for C-T that should have been acquired from five parcels, 0.2 miles of ROWs on

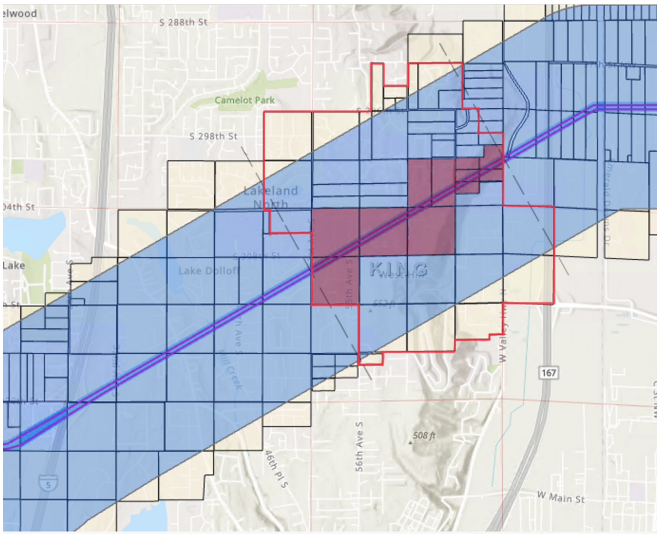
[15]This number is smaller than the total number of tracts because the ROW on every treated parcel of C-T was acquired under two separate acquisitions that happened successively within a year. Each time the width acquired was 100 ft. As a result, the width of C-T's ROWs was 200 ft. In 1958, C-T was upgraded as part of the Tacoma–Grand Coulee line, and the ROWs were extended to 262.5 ft, a width still used today. These extensions stayed within the boundaries of all the 1940 treated parcels, with the exception of one parcel. I exclude this parcel from the set of controlled parcels used in my analysis because ROW acquisition seemed to happen in 1958 on this parcel.



(a) Figure 4 with two highlighted sections



(b) The 1940 parcel landscape for a segment of C-T. Note: Blue shade illustrates the one-mile buffer.



(c) The 1940 parcel landscape for a segment of C-T. Notes: Treated parcels are colored in red. Dashed lines and buffer boundaries together establish a tilted one-square-mile block. Parcels not colored in red inside the red lines are defined as controlled parcels.

Figure 5: Identification Strategy Illustration Using a Southwestward Line (Based on C-T).

three parcels missing for C-SE, 0.56 miles of ROWs on four parcels missing for V-K, and 0.57 miles of ROWs on five parcels missing for B-V. I use these 16 parcels as treated parcels, except one whose pre-acquisition parcel value can't be found from any existing historical records. Table 3 shows the summary statistics of ROWs on their sizes, the size of treated parcels, the proportion of a ROW on a treated parcel, and the ROW compensation.[16]

Table 3: Summary Statistics of Rights-of-way

	mean	sd	min	max
ROW Size (acres)	4.04	4.14	0.010	25.60
Treated Parcel Size (acres)	27.80	30.56	0.480	197.27
Proportion of ROW	0.20	0.15	0.001	0.88
ROW Compensation ($)	536.94	797.09	9.500	4698.52
N	243			

Notes: ROW compensations are in 1940 dollars for C-T and C-SE, 1938 dollars for B-V, and 1939 dollars for V-K. I do not deflate or inflate them into the same year, because the 'deflation then inflation' from 1938 to 1940 was very little.

Whether a ROW was acquired through voluntary agreement or condemnation that involved BPA first depositing an estimated just compensation to the federal courts, the total compensation for a ROW reflected at least two things: BPA's estimation and the landowner's judgment and perhaps bargaining power, and a third thing when condemnation happened - judges' decisions, which may or may not lead to extra monies. Figure 6a plots the ROW compensation and the proportionate parcel value of ROW before acquisition. Figure 6b plots the ROW compensation and the value of the entire parcel. Together, these figures show that ROW compensation was on average above the proportionate parcel value, but below the full parcel value.

4.2 Washington State Real Property Assessment Records

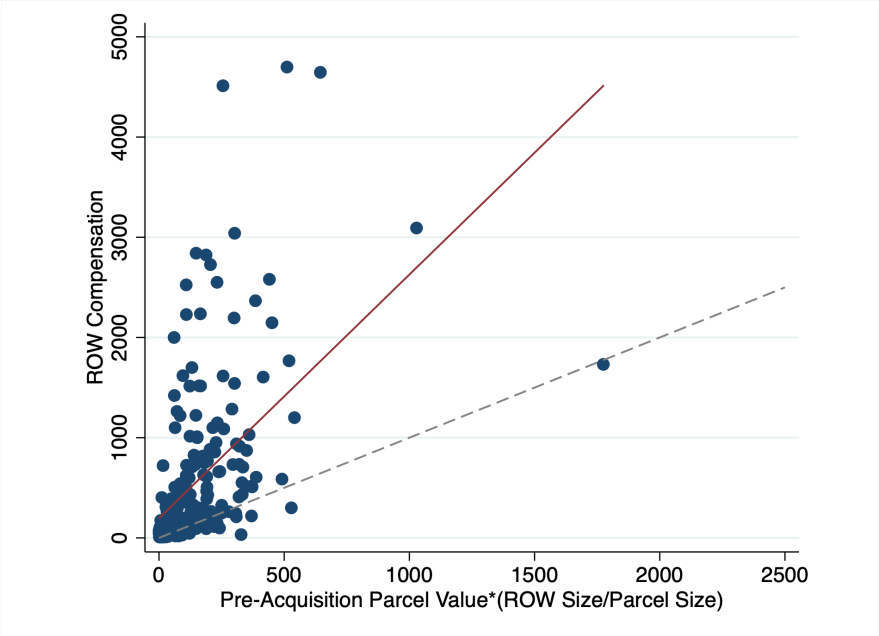
4.2.1 King County, Washington

Because C-T and C-SE started ROW acquisition no earlier than mid 1940, I need maps and values of parcels no later than early 1940.

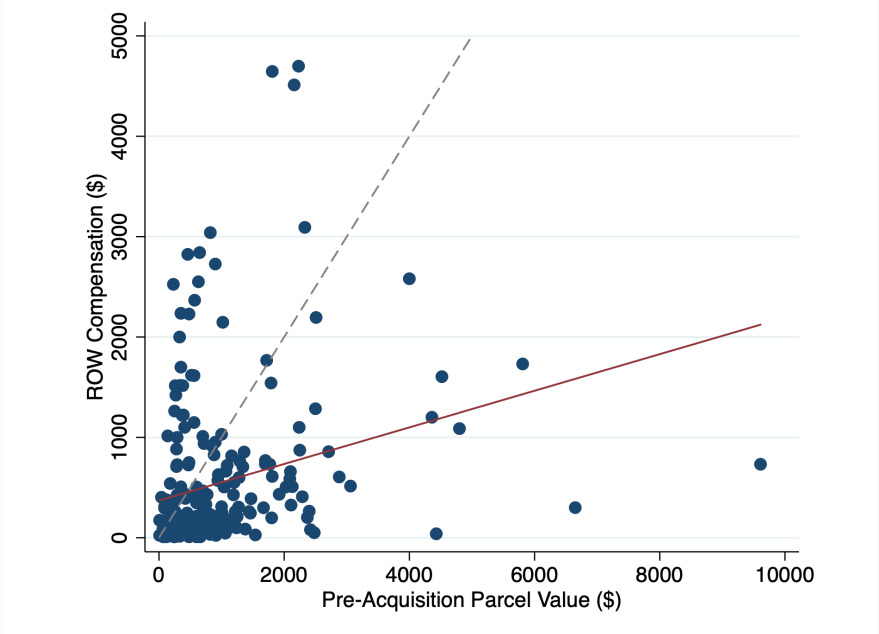
To get parcels' values before ROW acquisition, I obtain the King County tax roll for the year 1941, which was the only year except 1935 that King County assessor's office created a county-wide tax roll. The 1941 tax roll contains for each assessed parcel, the real property values assessed in 1940, the taxes paid in 1941, the parcel location described in legal descriptions, the size in acres, and the landowner's name.[17] The real property values include land value, improvements value, and the sum of these two values as the parcel value. For parcels that were exempt from taxes, their

[16] For some ROWs, this number is the sum of multiple compensations discounted to the year when the ROW was acquired (i.e., 1938 for B-V, 1939 for V-K, 1940 for C-T and C-SE). These ROWs were paid multiple times for a combination of reasons such as 'deficiency', 'timber, danger trees', 'interests', and 'taxes' after their first payment.

[17] According to Washington state laws, the assessed value of property for tax purposes is determined on January 1 of the assessment year. This was the standard practice during 1940 and continues today.



(a) ROW compensation vs. proportionate parcel value



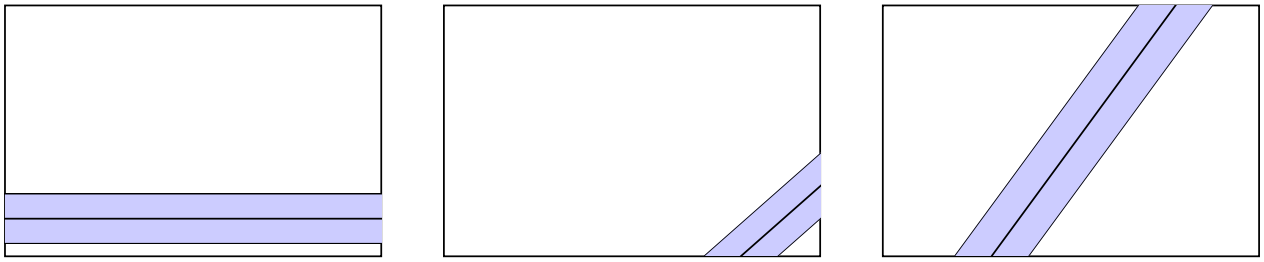
(b) ROW compensation vs. full parcel value

Figure 6: ROW Compensation vs. Proportionate Parcel Value and Full Parcel Value.

1940 values are collected from their property record cards.

To visualize the 1940 locations of parcels described in the tax roll, I obtain the King County parcel ownership maps in 1936, which was the only year that existed prior to 1940. I then create some 1940 parcel ownership maps on top of the 1936 maps by manually drawing parcel boundaries from translating legal descriptions.[18] Using 1936 maps as base maps improves the accuracy of locating a parcel based on the legal descriptions of its location, especially if there were no big changes from 1936 to 1940. Figures B5 and B6, and Figure 8a each provide an example of the 1936 base map, the 1941 tax roll, and the 1940 map created by myself.

I then match BPA's ROW data with the 1940 maps and the tax roll by ROW length and ROW owner's name to verify the locations of treated parcels. ROW length allows me to confirm the location of a treated parcel in a specific section given the line's location, the ROW width of this line, and the locations of all the other parcels in this section. A good matching result will signal that the boundaries of treated parcels are correctly established through my self-created 1940 maps, and that the boundaries of controlled parcels are also very likely to be correctly established. In the process of matching, it's obvious to locate a ROW using its length when it's a rectangle or a parallelogram; when it's a trapezoid, I treat the ROW length as if it could refer to the either base (see Figure 7 for illustration). After locating a parcel using ROW length, I check if the name on the tax roll is matched with the name of the ROW owner in BPA's data. A mismatch could occur if a parcel's owner changed between when the parcel was assessed (e.g., January 1940) and when the ROW was acquired (mid to late 1940).



(a) Border ROW (b) Corner ROW (c) Central ROW

Figure 7: Illustration of Different ROW Positions.

The only data that have a more comprehensive list of historical ownership changes at the parcel level are King County's property record cards, which include years from 1937 to 1973. However, it's not guaranteed that each year, or even the full history of ownership changes, was recorded for every parcel. Regarding the mismatches, some of them can be solved with a re-match as I am able to find the ROW owners on the property record cards of these parcels. Overall, there are four ROW parcels for C-SE and 13 ROW parcels for C-T whose owner names cannot be matched from either the tax roll or the property record card.[19] For these parcels, I still regard them as valid ROW

[18]For instance, 'NE $\frac{1}{4}$ of NE $\frac{1}{4}$ of SE $\frac{1}{4}$ less S 165' of E 263' ' indicates a polygon that equals a square of 660 ft by 660 ft (the northeast quarter of the northeast quarter of the southeast quarter of a section) less a rectangle of 165 ft by 263 ft.

[19]Given that C-T's ROWs were acquired in two batches, the second person recorded as the ROW owner of a ROW

parcels, but I can't verify that the ROW owners - who received payment from BPA, were landowners of these parcels. Table 4 presents a summary of King County's parcels.

Table 4: Summary Statistics of 1940 King County Parcels

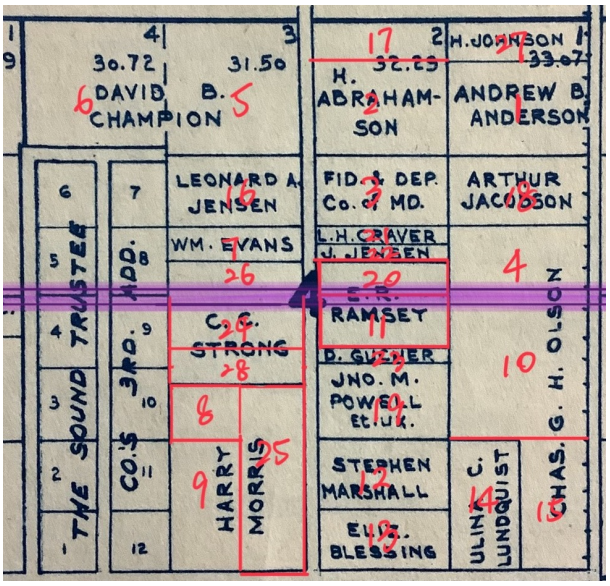
	Treated Parcels				Controlled Parcels			
	mean	sd	min	max	mean	sd	min	max
Size (Acres)	30.66	30.43	0.48	197.27	15.45	13.28	0.12	72.08
Land Value ($)	672.54	876.86	10.00	5500.00	408.82	598.05	10.00	7350.00
Improvements Value ($)	141.31	214.80	0.00	1150.00	169.34	373.00	0.00	5410.00
Parcel Value ($)	813.85	992.36	10.00	6650.00	578.16	803.71	10.00	10180.00
N	130				816			

To determine the contemporary values of these 1940 parcels, the first step is to identify what they have become today. Over 85 years of development, from a vast amount of rural land east of Tacoma and south of Renton, to a weave of residential subdivisions, industrial parks, and commercial centers, with Interstate-5 and state highways crossing through, this area of the Puget Sound region has become one of the most economically developed places in the U.S. A parcel in 1940 is almost certain to have been divided into many smaller parcels up to today (Glaeser and Kahn, 2004). Therefore, I geo-reference the 1940 parcel ownership maps in ArcGIS and overlay them on a base map of King County's current parcels in 2025. Figure 8b presents an example of this mapping of parcel landscape from history to today. To find out which 1940 parcel a current parcel falls inside or partially overlaps with, I compare the geometries (i.e. real earth coordinates) of all the current parcels with those of each 1940 parcel. The current value of a 1940 parcel is thus the sum of full values of current parcels that are fully contained and proportionate values of those that partially overlap. All current parcels' values come from King County Department of Assessment, which include three parts: land value, improvements value, and the sum of the two as the parcel value. Overall, there are **11,724** current parcels mapped to **518** historical parcels in 1940 for C-T, and **12,658** current parcels mapped to **428** historical parcels in 1940 for C-SE.

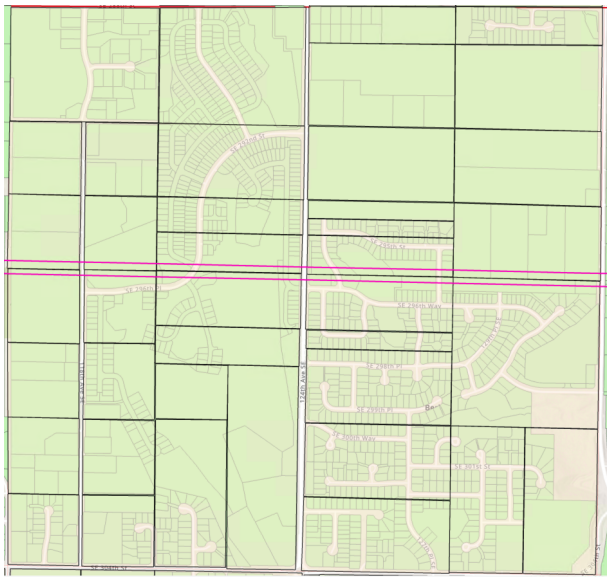
Naturally, of all the parcels that can be found on King County's 2025 parcel ownership map, many parcels were created before 2025. Open data from King County Assessment, which contain parcel values from 1998 to the present day, thus include the values of these parcels since the first year they were created as long as they hadn't been divided into more parcels or merged with other parcels over the years up to 2025. This created a unique feature in my parcel data - the contemporary values of a 1940 parcel do not reflect the same sub-areas inside it over years, because different sub-areas could be 'created' into parcels at different times.

Figure B7 explains this feature using Lot 13 in Section 4 of T21N R5E of King County. Figure B7b zooms in at the current landscape that Lot 13 is mapped onto, which contains three subdivisions highlighted in blocks. The yellow block has values since 1998, but the blue block on the left

could be different from the first person recorded as the ROW owner, and thus can't be found in the 1941 tax roll which indicates only the 1940 ownership. For eight of the 13 parcels, I am able to find their first ROW owners but not the second ROW owners. For the other five parcels, neither ROW owners can be found on their property record cards.



(a) The 1940 parcel ownership map for Section 4 T21N R5E.



(b) The present-day parcel ownership landscape of Section 4 T21N R5E.

Figure 8: Example of Geo-referencing in ArcGIS, Section 4 T21N R5E, King County, WA.

wasn't created until 2015, and the blue block in the middle was created after 2015. So, the value of Lot 13 before 2015 is just the value of the yellow block, and the value per acre of Lot 13 equals the value per acre of the yellow block. Unfortunately, I didn't find any parcel ownership maps before 2025 to figure out which 'vintage' (before 2025 and after 1998) parcel a parcel once belonged to before it was created, as well as the value of this 'vintage' parcel. In other words, in this example, I don't know which 'vintage' parcel the blue block on the left in Figure B7b once belonged to before 2015. Finally, I don't know how this feature may affect the estimation results, but it will likely lead to an underestimation of the ROW impact if I only use data from the recent few years such that the composition of sub-areas for each historical parcel is stable over these years.[20]

In an extreme case, a 1940 parcel may have no assessed values for many years if none of the current parcels inside were created in those years. I call this the 'zero value issue'. The data of Clark County's current parcels, which will be discussed below, share the same feature: the only parcels that can be traced back for their values of multiple years before 2025 are those that hadn't been divided since they were created. The two counties together have 64 parcels that have this issue, and I drop the years that these parcels have no values in all of my results. For the robustness checks, I drop these parcels entirely.

[20] As I will discuss in the Results section, the event study regression shows that from 2020 to 2025, i.e., relative years 82 to 86, the impact of ROW - almost the same over these years - peaks in the contemporary period and is statistically significant. This finding implies that if I only use the recent five years of data, my estimated ROW impact would be bigger.

4.2.2 Clark County, Washington

To get pre-acquisition maps and values for Clark County parcels, I rely on Clark County real property assessment yearbooks from 1938 to 1941. A yearbook contains the parcel ownership maps and the assessed parcel values and parcel sizes in that year by section or donation land claim (DLC).[21] Although the parcel ownership maps don't include a legal description for every parcel, for parcels that are small and usually not a common proportion of a section (e.g., a quarter-quarter section), the map does indicate the length and width for those that have a regular shape. For the remaining few parcels that are small and have irregular shapes, I obtain their locations by geo-referencing the parcel ownership maps.[22] The property values include the value of improved land, the value of unimproved land, and the value of improvements. This separation of the value of land is unique to Clark County.

Because ROW acquisition started in late 1938 for B-V and in early 1939 for V-K, I use the parcel ownership maps from the 1938 yearbook for B-V and the maps from the 1939 yearbook for V-K to identify the locations of treated and controlled parcels. For each line, similar to what I have done for King County, I match the parcel ownership maps and the property assessment yearbook with BPA's ROW data to confirm that the maps can correctly establish the boundaries of parcels. But here, I match by ROW size instead of ROW length. Since the ROWs for B-V and V-K were acquired by title, there is a change in parcel size before and right after acquisition. For B-V, I calculate the change in acres from 1938 to 1939. For V-K, I calculate the change in acres from 1939 to 1941 because the 1940 yearbook is missing. Matching with ROW length is less desirable for Clark County because some ROWs are recorded as having zero ROW length in BPA's data, likely because they are small so it's difficult to measure such lengths.

I also match by ROW owner's name to verify that Clark County parcel ownership maps are able to establish a parcel landscape consistent with BPA's records. Regarding the matching results, for V-K, there are three ROWs where names in the BPA data don't match with those on the assessment records. For B-V, there are seven ROWs having this issue. Unfortunately, the earliest set of property record cards that exists for Clark County is from 1940 to 1956. It doesn't necessarily contain cards for all the parcels, and for those that do have cards, the assessed values may not date back to 1940, so I couldn't resolve the name mismatch issues as I have done for some of the parcels in King County. But I'm certain that these parcels are located correctly because the change in parcel size is matched with the ROW size for each parcel. Table 5 presents a summary of Clark County parcels.

To get the contemporary values of the 1938 and 1939 parcels, I use the same method of geo-referencing. Overall, there are **12,136** current parcels mapped to **379** historical parcels in 1938 for B-V, **9,562** current parcels mapped to **372** historical parcels in 1939 for V-K.

[21] The Greater Vancouver area and rural Clark County have many land claims, each of which could cover multiple sections (as in a township-range in PLSS) in geography. Figure B8 shows an example of a DLC.

[22] I use the measurement tools in ArcGIS to confirm that my geo-referenced parcels are located correctly, specifically by checking whether their sizes are approximately the same as those listed in the assessment yearbook.

Table 5: Summary Statistics of 1938 and 1939 Clark County Parcels

	Treated Parcels				Controlled Parcels			
	mean	sd	min	max	mean	sd	min	max
Size (Acres)	24.78	29.19	1.20	160.00	12.10	16.51	0.08	149.00
Land Value ($)	857.33	1104.37	15.00	8990.00	436.98	527.72	5.00	4560.00
Improvements Value ($)	134.19	190.97	0.00	1000.00	146.24	220.37	0.00	1800.00
Parcel Value ($)	991.51	1180.01	90.00	9610.00	583.22	611.58	5.00	4830.00
N	129				622			

To conclude the Data section, Figure 9 and Figure 10 present the geo-referenced locations of all the historical parcels studied in this paper.

5 Estimation

This section first discusses the conditional balance between treatment and control that supports the conditional exogeneity assumption. Next, I describe the empirical method to estimate the impact of ROW. I use a difference-in-differences model, where treatment is defined as having a ROW; event is when the ROW was acquired. The estimated treatment effect is therefore the average effect of having a ROW on parcels from which it was acquired.

5.1 Conditional Balance Between Treatment and Control Before Acquisition

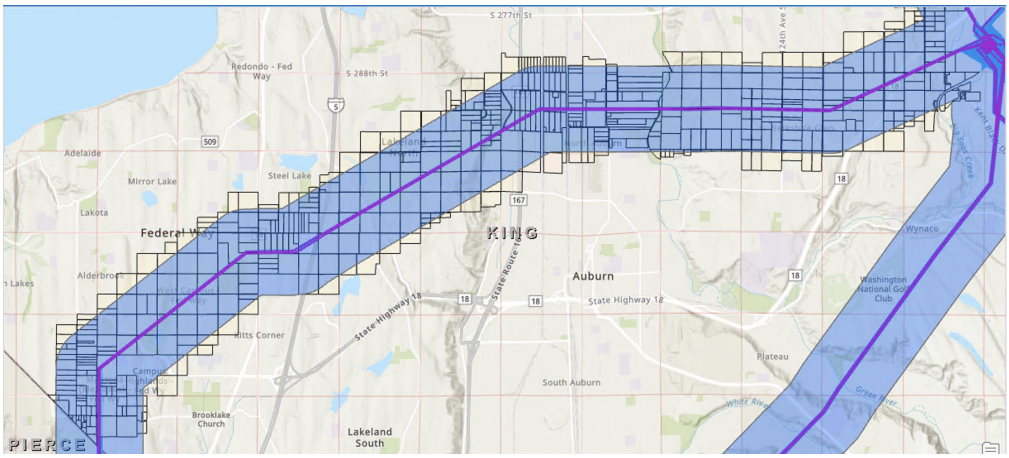
The ideal data to test the conditional balance, or pre-trends, between treatment and control group on the assessed parcel value per acre would contain a few more years of parcel data before ROW acquisition because treated and controlled parcels may have followed different development paths up to the time of acquisition.[23] However, there are many constraints on collecting more years of data.[24] In addition, even if multiple years of pre-acquisition data exist, there may not be much variation over those years in parcel values for the purpose of estimation because land values usually do not change much over just a few years, especially on land that's already improved. There may be changes in the value of improvements that are not small, but such changes usually occur to only a handful of parcels, while other parcels just carry their improvements value from previous years. Therefore, with only one year of pre-acquisition data, I conduct a one-period balance test to argue for a conditional parallel pre-trend between treatment and control. Specifically, I run the following regression for each block.

$$V_i = \alpha + \beta Treat_i + \theta Impvts_i + \mu Acre_i + \epsilon_i \tag{1}$$

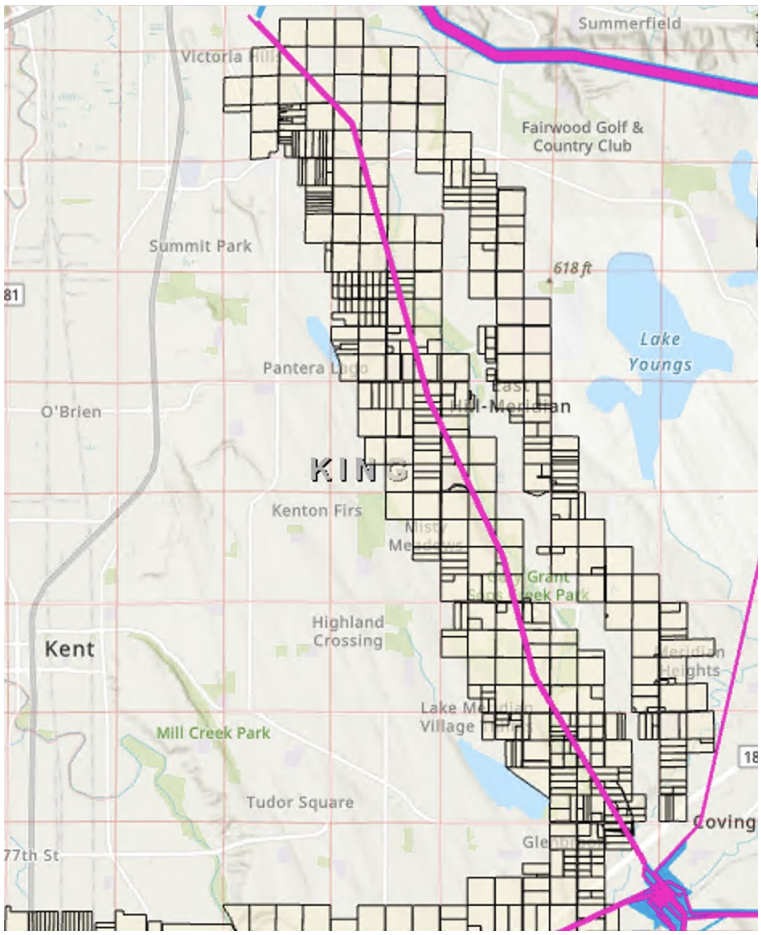
where V_i is the one-year pre-acquisition parcel value per acre for parcel i, $Impvts_i$ is the pre-acquisition improvements value, $Acre_i$ is the parcel size, and standard errors are robust. A statis-

[23] Nevertheless, this period should not start too early, otherwise the parcel ownership landscape would be too different from the one right before ROW acquisition, as there are always new parcels created over time.

[24] Clark County property assessment yearbooks start from 1937, so for B-V, there's only one year before 1938, for V-K, there are two years before 1939. As explained in the Data section, King County doesn't have tax rolls between 1936-1940, and King County's property record cards in reality don't have the 1937-1939 values for many parcels either.

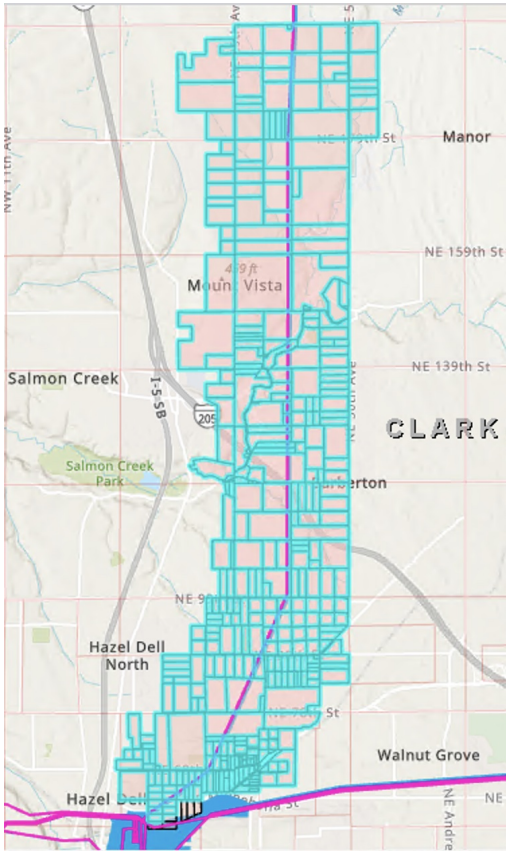


(a) C-T. Notes: Yellow polygons are geo-referenced 1940 parcels for C-T. Blue shade is the one-mile buffer.

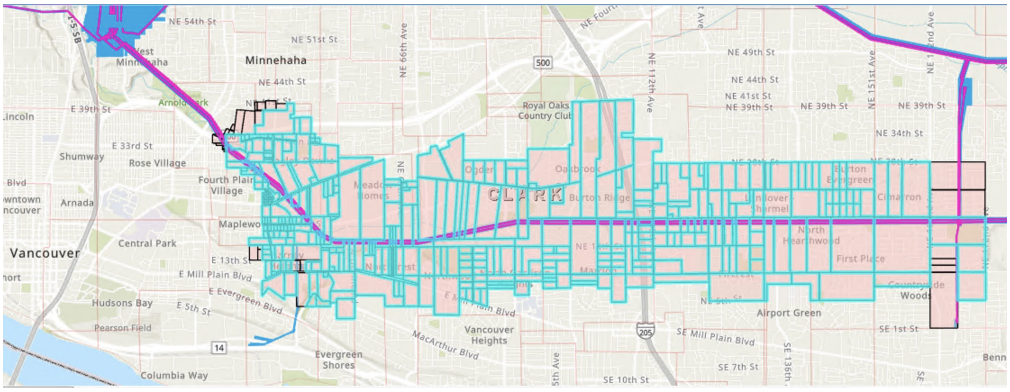


(b) C-SE. Notes: Yellow polygons are geo-referenced 1940 parcels for C-SE, including parcels in a half mile on the east of Covington-Renton, which goes through the 'gap' between polygons in this picture, until the last mile when it's located next and parallel to C-SE.

Figure 9: Geo-referenced Historical Parcels for C-T and C-SE.



(a) V-K. Notes: Highlighted polygons are geo-referenced 1939 parcels used for estimating the impact of ROW for V-K.



(b) B-V. Notes: Highlighted polygons are geo-referenced 1938 parcels used for estimating the impact of ROW for B-V. Parcels that have ROWs for lines other than B-V are excluded. Areas inside the edge of the historical Greater Vancouver are not geo-referenced or included in the block closest to the Vancouver substation (Ross). See the location of this edge in Figure B9. The actual last mile to the Ross substation is not studied in this paper or geo-referenced in this picture because the pre-acquisition parcel maps for this area are complicated to geo-reference.

Figure 10: Geo-referenced Historical Parcels for V-K and B-V.

tically insignificant β would imply that conditional on parcel size and improvements value, there are no statistically significant differences on average in the baseline outcome between the treated and the controlled parcels in a one-square-mile block.

Tables 6, 7, and 8 present the results for each block. Column (1) comes from estimating the full equation. Except for the one-square-mile block with id=4 in the area of B-V that shows a statistically significant difference between treatment and control and is thus excluded from my empirical analysis,[25] there are no statistically significant differences by treatment in other blocks.

As a comparison, column (2) shows the unconditional balance test results from not controlling for parcel size and improvements value. When there is a statistically significant coefficient in column (2), there is usually a statistically significant difference in parcel size and/or improvements value by treatment in columns (3) and/or (4), corresponding to the two scenarios that require the assumption of conditional exogeneity explained in the identification strategy. To reiterate, first, sub-areas that are more developed than elsewhere in places close to a city tend to be less favorable to site a transmission. Examples of such places include block 12 of C-T, block 7 of C-SE, blocks 1 and 2 of V-K. Second, in places far away from a city, there may be a few parcels with large proportions of unimproved land 'lining up' together, creating a favorable condition for transmission line siting. Examples of such areas include block 6 of C-SE, blocks 4 and 5 of V-K, and blocks 6 and 7 of B-V.

5.2 Empirical Estimation

5.2.1 DID Regressions

I consider a difference-in-differences model with the following specification.

$$V_{ioy} = \beta D_{iy} + \eta_i + \sum_{r \neq 0} \theta_r Impvts_i \mathbf{1}(r_{iy} = r) + \sum_{r \neq 0} \mu_r Acre_i \mathbf{1}(r_{iy} = r) + \alpha Dist_{iy} + \phi Prop_{iy} + \delta_{oy} + \epsilon_{ioy} \tag{2}$$

where $D_{iy} = Treat_i \times Post_y$. y includes one year before the ROW acquisition ('the baseline year') and many years in recent decades. The baseline year is 1940 for C-T and C-SE, 1938 for B-V, and 1939 for V-K. The post-acquisition period contains 1998 to 2025 for C-T and C-SE, and 2008 to 2025 for B-V and V-K. $D_{iy} = 1$ for a treated parcel i in a year y in the post period. V_{ioy} is parcel value per acre, η_i denotes parcel fixed effects. I control for one square mile by year fixed effects (δ_{oy}) to compare parcels within a one-square-mile block across years as treated and controlled parcels are defined in a block. A year fixed effect would be redundant as it's absorbed in δ_{oy}. I also control for the improvements value ($Impvts_i$) in the baseline year and parcel size ($Acre_i$), and I allow their impacts to vary across relative years r_{iy} as parcels with different initial improvements values and sizes may have different development patterns over the post-acquisition years. $r_{iy} = y - b_i$, where b_i is the baseline year. Standard errors are clustered at the one-square-mile block.

I also control for two parcel-level characteristics: the distance from a parcel to the transmission line ($Dist_i$) and the proportion of ROW on a treated parcel ($Prop_i$) by interacting each of them

[25] For this area, parcel size doesn't seem to be a good proxy for the proportion of unimproved land. When directly controlling for the proportion of unimproved land, there is no more significant difference between treatment and control.

One square mile block id	(1) parcel value per acre on treat, Acres, ImprovementsValue	(2) parcel value per acre on treat	(3) Acres on treat	(4) ImprovementsValue on treat	(5) N
1	-72.217 (65.102)	-28.707 (24.197)	12.649*** (3.974)	183.958* (101.167)	54
2	-3.269 (2.514)	0.592 (5.887)	-8.484** (4.006)	30.455 (72.760)	30
3	43.286 (52.713)	-38.394 (27.957)	12.374* (7.131)	-75.512 (86.452)	46
4	-13.809 (13.410)	-22.741** (10.913)	47.823 (29.351)	62.241 (114.353)	33
5	91.709 (58.227)	-65.987** (27.504)	20.945** (7.930)	97.843 (142.840)	37
6	0.628 (25.456)	-47.883* (28.400)	19.411** (8.106)	34.946 (189.142)	68
7	-10.095 (6.272)	-18.245* (9.240)	10.801 (13.261)	-48.872 (62.852)	49
8	12.175 (11.879)	-2.894 (5.059)	37.634*** (8.437)	-80.000 (50.375)	31
9	-0.387 (9.541)	-22.034 (13.225)	7.505 (4.935)	-267.951 (169.766)	41
10	5.519 (11.769)	-12.634 (10.036)	27.385*** (9.668)	-31.667 (28.378)	30
11	-0.581 (0.354)	-1.894* (0.968)	11.843*** (2.870)	-12.500 (7.586)	25
12	39.845 (30.109)	-80.676** (39.836)	16.301** (7.529)	-80.833*** (19.282)	74

Notes: Each coefficient is the coefficient on treat from the indicated regression, with robust standard errors in parentheses. N is the sample size, the number of parcels in that one-square-mile block. Block 1 (id=1) is the one-square-mile block closest to Covington substation. Block 12 (id=12) is the block farthest from Covington, closest to Tacoma. Column (1) shows results of conditional balance. Column (2) shows results of unconditional balance. Columns (3) and (4) show that there could be differences in improvements value and/or parcel size prior to acquisition, and these observable differences need to be controlled for in the regression to support the argument that ROW acquisition is conditionally exogenous to parcel value per acre. Significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 6: Balance Table for Covington-Tacoma (C-T)

with the event dummy $Post_y$. This prevents them from being absorbed by the parcel fixed effects. Because $Post_y$ is absorbed by δ_{oy}, α is the average effect of distance over the post-acquisition years, and ϕ is the average effect of ROW proportion on the treated parcels in the post-acquisition period.

Not controlling for distance will not bias the estimated treatment effect because distance is independent of the treatment. However, distance may be correlated with the post-acquisition parcel value per acre. For instance, properties on parcels that are further away from a transmission line may have higher values, possibly due to various reasons such as fear of electromagnetic field ex-

One square block mile id	(1) parcel value per acre on treat, Acres, ImprovementsValue	(2) parcel value per acre on treat	(3) Acres on treat	(4) ImprovementsValue on treat	(5) N
1	-19.678 (20.329)	-34.880 (26.221)	-0.684 (2.069)	-49.007 (62.354)	103
2	20.171 (22.545)	-59.727** (24.430)	18.113** (7.828)	-122.480 (95.097)	60
3	14.959 (9.613)	-7.919 (14.625)	23.646** (9.221)	136.282 (105.436)	45
4	2.263 (4.177)	4.258 (4.916)	0.762 (3.811)	55.874 (62.150)	57
5	-0.343 (4.799)	3.015 (7.461)	4.072 (4.024)	54.639 (47.310)	71
6	33.506 (23.941)	-20.963*** (3.869)	121.360*** (42.772)	-107.273*** (31.244)	46
7	35.623 (22.741)	-71.660** (27.557)	62.511*** (20.142)	-124.286*** (33.527)	46

Notes: Each coefficient is the coefficient on treat from the indicated regression, with robust standard errors in parentheses. N is the sample size, the number of parcels in that one-square-mile block. Block 1 (id=1) is the block closest to Covington substation. Block 7 (id=7) is the one farthest from Covington, closest to Renton/Seattle. Column (1) shows results of conditional balance. Column (2) shows results of unconditional balance. Columns (3) and (4) show that there could be differences in improvements value and/or parcel size prior to acquisition, and these observable differences need to be controlled for in the regression to support the argument that ROW acquisition is conditionally exogenous to parcel value per acre. Significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 7: Balance Table for Covington-Seattle (C-SE)

posure, restrictions on land development, visual dis-amenity, etc. Therefore, I add the distance as a control variable, which may help improve the precision of my estimates. In addition, there may be a concern that spillover from ROWs to controlled parcels that share boundaries with ROWs might exist, which I will discuss in the Results section. Controlling for distance in the regression allows me to capture this potential spillover assuming its effect varies linearly with the distance. I then calculate six measures of distance between each parcel and the transmission line: the distances from either the parcel centroid or the parcel boundary to the edge of the ROW, to the nearest tower, and to the transmission line itself.

The proportion of ROW on a treated parcel indicates what percentage of the parcel's area is taken by the ROW, and thus what is left untouched by the ROW. A hypothesis is that this percentage may be correlated with the usage and thus the value of land developed on a treated parcel in the post-acquisition period. The bigger the non-ROW portion of a treated parcel is, the more likely this area will be developed into high value usage (e.g., single-family housing). Of course, the ROW's position also matters, and is partially captured by the distance ($Dist_i$) for treated parcels.[26] If the ROW is along the edge, rather than at the center, it leaves a bigger complete space to be devel-

[26]For a treated parcel, the distance captures to some extent the relative position of the ROW on this parcel, e.g., along the edge vs. at the center. If the distance from the parcel centroid to the line is 0 ft, it means the line exactly crosses the parcel center. If this distance is big, the ROW might be along the edge of the parcel.

One square mile block id	(1) parcel value per acre on treat, Acres, ImprovementsValue	(2) parcel value per acre on treat	(3) Acres on treat	(4) ImprovementsValue on treat	(5) N
V-K					
1	-11.996 (9.274)	-64.611*** (14.478)	3.626 (3.616)	-88.272*** (24.658)	100
2	5.130 (6.937)	-17.868*** (5.925)	7.574 (5.078)	-67.820** (27.226)	88
3	-3.162 (4.207)	-8.358 (6.209)	21.890*** (7.591)	147.353 (138.600)	38
4	-20.485 (12.311)	-48.871** (18.587)	5.880 (5.654)	-85.022* (45.944)	53
5	-10.340 (11.246)	-24.295** (10.841)	37.437 (25.897)	37.333 (60.606)	35
6	-3.593 (3.974)	-0.241 (6.759)	3.412 (8.880)	107.719 (179.317)	25
7	-3.737 (3.616)	-3.873 (5.362)	13.582 (10.039)	50.350 (90.938)	33
B-V					
1	-205.241 (459.456)	-1278.013*** (283.512)	8.337*** (2.755)	-69.606 (90.542)	94
2	-1.574 (21.237)	5.847 (19.425)	16.659* (9.516)	142.179** (66.985)	64
3	-0.694 (5.184)	6.190 (5.021)	20.319*** (4.827)	108.547** (46.534)	55
4	-9.559*** (3.189)	-17.017*** (3.110)	18.868 (13.180)	-113.347*** (38.808)	54
5	-5.139 (5.765)	1.022 (5.355)	-5.988** (2.684)	19.359 (20.593)	51
6	-2.371 (2.325)	-10.258*** (1.963)	48.132*** (15.824)	-37.143*** (10.929)	33
7	-2.891 (5.985)	-13.792*** (3.177)	73.333* (33.407)	-216.667* (108.446)	8

Notes: Each coefficient is the coefficient on treat from the indicated regression, with robust standard errors in parentheses. N is the sample size, the number of parcels in that one-square-mile block. Block 1 (id=1) is the block closest to Vancouver substation. Block 7 (id=7) is the one farthest from Vancouver. Column (1) shows results of conditional balance. Column (2) shows results of unconditional balance. Columns (3) and (4) show that there could be differences in improvements value and/or parcel size prior to acquisition, and these observable differences need to be controlled for in the regression to support the argument that ROW acquisition is conditionally exogenous to parcel value per acre. Significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 8: Balance Table for the Bonneville Dam-Vancouver (B-V) and Vancouver-Kelso (V-K)

oped rather than two segregated spaces, which could possibly increase the value of this entire area.

Since by definition that $Prop_i = 0$ for a controlled parcel, $Prop_i \times Post_y$ essentially equals to

$Treat_i \times Prop_i \times Post_y$. Therefore, the treatment effect on a treated parcel i with a ROW proportion $Prop_i$ is not β, but $\beta + \phi Prop_i$. Denote $\overline{Prop}_T$ as the average of ROW proportion over treated parcels, then the treatment effect on a treated parcel with the average ROW proportion is $\beta + \phi\overline{Prop}_T$.

To estimate $\beta + \phi\overline{Prop}_T$, I estimate the following equation equivalent to equation (2).

$$V_{ioy} = \beta^c D_{iy} + \phi Prop^c_{iy} + \eta_i + \sum_{r\neq 0} \theta_r Impvts_i \mathbf{1}(r_{iy} = r) + \sum_{r\neq 0} \mu_r Acre_i \mathbf{1}(r_{iy} = r) + \alpha Dist_{iy} + \delta_{oy} + \epsilon_{ioy} \tag{3}$$

where $\beta^c = \beta + \phi\overline{Prop}_T$ and $Prop^c_{iy} = Treat_i \times Post_y \times (Prop_i - \overline{Prop}_T)$. $Prop_i - \overline{Prop}_T$ is the centered ROW proportion. Now, the treatment effect on a treated parcel i is $\beta^c + \phi(Prop_i - \overline{Prop}_T)$, which still equals to $\beta + \phi Prop_i$. Noticeably, β^c is also the average treatment effect across all treated parcels, because

$$\frac{1}{N_T}\sum_{i=1}^{N_T}(\beta + \phi Prop_i) = \frac{1}{N_T}\sum_{i=1}^{N_T}(\beta^c + \phi(Prop_i - \overline{Prop}_T)) = \beta^c$$

where N_T is the number of treated parcels.

Note that Equation (3) implicitly assumes the impact of pre-acquisition improvements value and parcel size to be the same across different transmission lines at a given relative year,[27] which may not be true given that lines are in two different counties. Although this assumption doesn't bias the pooled regression estimate which gives the average effect over the post-acquisition years, it will cause a big problem when estimating the heterogeneous treatment effect by relative year (e.g., using an event study), where the counterfactual for treated parcels is estimated using controlled parcels in the **same** relative year, which pools over lines that could have different trajectories in their post-acquisition parcel value per acre (see Figure 11). This can not only bias the estimate for that particular relative year, but also the estimates at other relative years. For instance, the treatment effects from relative year 58 to 67, which would be estimated only from King County lines, would be influenced by the fact that these two lines, C-T and C-SE, are also used for estimating the treatment effect for relative years 68 and beyond.

To reflect that parcel value per acre have different trajectories across lines, I also estimate equation (4), a specification that allows all coefficients in equation (3) to differ by line.

$$V_{ioy} = \sum_{l=1}^{4} \mathbf{1}(L_i = l)\left[\beta^c_l D_{iy} + \phi_l Prop^{cl}_{iy} + \alpha_l Dist_{iy} + \sum_{r\neq 0} \theta_{lr} Impvts_i \mathbf{1}(r_{iy} = r) + \sum_{r\neq 0} \mu_{lr} Acre_i \mathbf{1}(r_{iy} = r)\right] + \eta_i + \kappa_{l(i)} + \delta_{l(i)oy} + \epsilon_{ioy} \tag{4}$$

In this regression, L_i is the line l parcel i belongs to. l takes a value from {1=C-T, 2=C-SE, 3=B-V, 4=V-K}. ROW proportion is centered at the mean within each line, i.e., $Prop^{cl}_{iy} = Treat_i \times Post_y \times$

[27] For instance, at relative year 70, the pooled regression contains King County lines in calendar year 2010, B-V in 2008, and V-K in 2009.

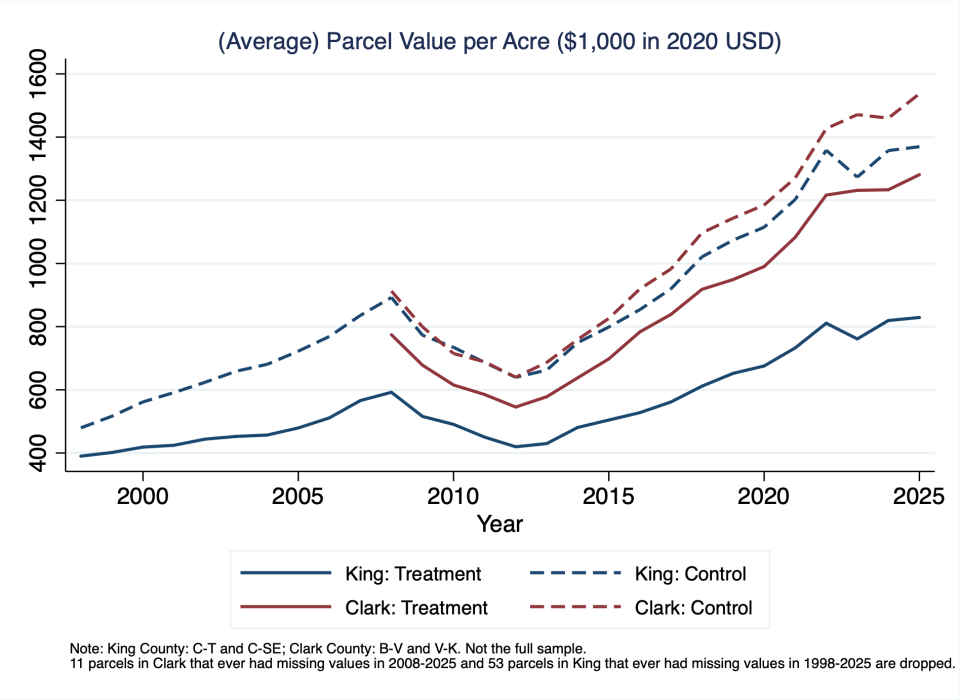


Figure 11: Average Parcel Value per Acre by County in the Post-Acquisition Period.

$(Prop_i - \overline{Prop}_{T,l})$. $\kappa_l(i)$ denotes line fixed effects, which are absorbed by parcel fixed effects η_i. $\delta_{l(i)oy}$ is line-by-block-by-year fixed effect, equivalent to a block-by-year fixed effect. Similar to β^c in equation (3), I can calculate a weighted-average impact of ROW across different lines, using the proportionate number of unique treated parcels of each line as weights. Denote ω_l as the weight for line l, then the weighted average is $\sum_{l=1}^{4} \omega_l \hat{\beta}_l^c$, a linear combination of each line's average impact of ROW across its treated parcels. The weights take the form of

$$\omega_l = \frac{N_{T,l}}{\sum_{j \in \text{Set}} N_{T,j}}$$

where the 'Set' is the set of lines pooled together in the regression. $N_{T,l}$ is the number of unique treated parcels that belongs to line l.

5.2.2 Event Study Regression

To estimate the impact of ROW at each relative year, I estimate an event study version of equation (4), which allows each line to have its own impact at a given relative year, such that when multiple lines are pooled together when estimating for a specific relative year, lines whose data are available in that relative year would not be affected by those whose data are not available at the same relative year. The average impact of ROW would then be a weighted average of impacts across lines that contribute to the estimation of that year. Specifically, the event study uses the following

specification.

$$V_{ioy} = \sum_{l=1}^{4} \sum_{r \neq 0} \mathbf{1}(L_i = l)\mathbf{1}(r_{iy} = r)\left[\beta_{lr}^{c} Treat_i + \phi_{lr} Prop_i^{cl} + \theta_{lr} Impvts_i + \mu_{lr} Acre_i\right] + \sum_{l=1}^{4} \alpha_l \mathbf{1}(L_i = l) Dist_{iy} + \eta_i + \kappa_{l(i)} + \delta_{l(i)oy} + \epsilon_{ioy} \tag{5}$$

where $Prop_i^{cl}$ follows the same definition as before. β_{lr}^{c} gives the average impact of ROW across all treated parcels for line l at relative year r. For different relative years, the 'set' used to determine the denominator of weights include different lines. From relative years 58 to 68, there are only C-T and C-SE. Relative year 69 starts to contain V-K. Relative years 70 to 85 consist data from all the lines, while relative year 87 only contains B-V.

6 Results

In this section, I start with analyzing the results from estimating equations (3), (4) and (5). I then explore potential mechanisms that explain what causes ROWs to have impact on parcel values, and I discuss the differences across lines that may contribute to heterogeneous ROW impacts across lines. Next, I explore whether spillover from ROWs to controlled parcels that share boundaries with ROWs exists and how much of a concern this poses for the ROW impact estimates. In addition, I discuss the robustness of the one-mile buffer by exploring the heterogeneity in controlled parcels' distances to the transmission line. Does it matter which controlled parcels - close to the ROW or not - are used to estimate the impact of ROW? Lastly, I examine the wealth impact from ROW compensation and discuss the returns that could lead to a positive wealth on net in the long-run.

6.1 The Impact of ROW

6.1.1 DID Estimates

Table 9 shows the results from estimating equation (3) assuming a common effect across lines and controlling for the distance from parcel centroid to ROW edge, which I choose as the preferred distance. Column (4) shows that having a ROW on a parcel, resulted from building a new transmission line, has caused an average decrease in the per acre value of $138,211 (in 2020 dollars) 60 years after ROW acquisition up to the present day, although this result is only significant at 10%. This translates to a 15.1% decrease relative to the per acre values of treated parcels over the past nearly 30 years if they hadn't had a ROW acquired in history. Results using other distance measures are shown in Table A1. Overall, across six distance measures, the decrease is, on average, between $135,673 and $156,578 (in 2020 dollars), which translates to a decrease of 14.9% to 16.8%.[28]

[28] Results from the robustness check that drops the parcels that ever had a zero value are presented in Appendix Tables A2 and A3. Treatment effect estimates become larger by around two to four percentage points across distance measures, while the statistical significance does not change.

Table 9: The Impact of ROW (Common Effect Across Lines)

	Dependent variable: parcel value per acre (in 2020 dollars)			
	(1)	(2)	(3)	(4)
Treat × Post	-156273.7**	-139476.6*	-154385.8**	-138210.6*
	(59958.4)	(76004.9)	(59073.1)	(75171.9)
Distance × Post		11.81		11.40
		(34.57)		(34.46)
Centered ROW Proportion × Treat × Post			-217208.7	-213503.8
			(243766.6)	(240489.7)
Constant	922015.3***	904020.6***	923933.7***	906538.0***
	(23542.9)	(62792.4)	(23864.9)	(62366.5)
Observations	40000	40000	40000	40000
Ycf (treated post, no ROW cf.)	933680.415	916904.006	931781.728	915626.703
% effect vs Ycf	-16.74	-15.21	-16.57	-15.09

Notes: This regression pools all lines and all post-acquisition years. Distance is from parcel centroid to ROW edge. ROW proportion is centered at the average among treated parcels. Block 4 in the area of B-V is excluded. Treat x Post in column (4) is the effect of ROW at the average ROW proportion, and is also the average treatment effect of ROW on the treated parcels. Parcel fixed effect and block-by-year fixed effect are included. Pre-acquisition value of improvements and parcel size are controlled, with their impacts varying by relative year and relative year zero is omitted. Ycf (treated post, no ROW cf.) is calculated by first averaging the estimated counterfactual outcomes across post-period years within each parcel, then averaging across unique treated parcels, so that each parcel receives equal weight. % effect vs Ycf is the ratio of Treat x Post to Ycf. Standard errors in parentheses. SEs clustered at a block of (approx.) one square mile. Significance: * p<0.10, ** p<0.05, *** p<0.01.

The coefficient in front of 'Treat × Post' in column (4) is bigger than that in column (2) because excluding ROW proportion, despite centered at the average, causes negative bias to the estimation: ROW proportion is positively correlated with the treatment (both ROW proportion and 'Treat' are zero for a controlled parcel), and is usually negatively correlated with the outcome (less space left to be developed into potentially high value usage). The coefficient in front of 'Treat × Centered ROW proportion × Post' is statistically insignificant but large, suggesting that ROW proportion may have a big impact on the changes in the per acre value.

Table 10 shows the results from estimating equation (4) allowing each line to have a different impact from ROW. There, the impact of ROW is a weighted average of each line's ROW impact, where the weights are proportional to the number of unique treated parcels crossed by each line. On average, having a ROW decreases the per acre value by $148,790 in 2020 dollars, a decrease of 16.1% relative to what this value would have been if a ROW had not been acquired. Together with Table A4 that shows results from controlling for other distance measures, the weighted average impact of ROW across six distances ranges from a decrease of $142,038 to $161,125, equivalent to a decrease of 15.4% to 17.2%.[29]

To conclude, two pooled DID models give similar estimates on the impact of ROW - allowing heterogeneity across lines shifts the range of the negative impact by a negative 0.5 percentage points (or around $6,500). In addition to the weighted average impact, Table 10 reveals interesting heterogeneity across lines. The most noticeable one is the slope coefficient in front of centered ROW

[29]Results from dropping the 64 parcels that ever had a zero value are shown in Appendix Tables A5 and A6.

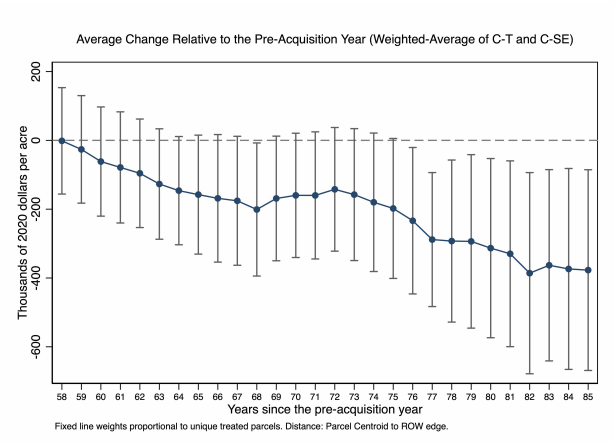
Table 10: The Impact of ROW (Allowing Heterogeneity Across Lines)

	Dependent variable: parcel value per acre (2020 dollars)			
	(1)	(2)	(3)	(4)
Treat x Post: C-T	-154589.6**	-250991.4**	-160315.1**	-256339.7**
	(69661.5)	(99286.5)	(59409.8)	(95267.1)
Treat x Post: C-SE	-278335.7	-156497.5	-274064.4*	-153269.3
	(184295.8)	(202101.8)	(160914.7)	(180583.9)
Treat x Post: B-V	-60715.6	-41945.4	-65268.8	-45162.9
	(47155.0)	(103402.9)	(52679.9)	(109143.1)
Treat x Post: V-K	-146221.6*	-124921.1	-141892.8*	-123312.2
	(76509.8)	(162083.3)	(79496.6)	(161770.3)
Centered ROW Proportion x Treat x Post: C-T			573652.1	567638.2
			(785454.3)	(796316.9)
Centered ROW Proportion x Treat x Post: C-SE			-1040929.3**	-1027697.2**
			(403651.3)	(388920.5)
Centered ROW Proportion x Treat x Post: B-V			256873.5	264984.1
			(343662.9)	(332620.8)
Centered ROW Proportion x Treat x Post: V-K			-600377.1***	-595593.0**
			(214464.3)	(223397.8)
Distance x Post: C-T		-57.46		-57.27
		(51.52)		(51.68)
Distance x Post: C-SE		86.30		85.60
		(55.22)		(55.49)
Distance x Post: B-V		16.58		17.88
		(57.22)		(55.75)
Distance x Post: V-K		14.98		13.09
		(79.72)		(80.25)
Weighted average ROW effect	-159643.2***	-147702.7*	-160235.7***	-148790.0**
	(52728.4)	(72611.8)	(47750.3)	(69342.3)
Observations	40000	40000	40000	40000
Ycf (treated post, no ROW cf.)	937892.446	925951.731	938446.731	927002.133
% effect vs Ycf	-17.02	-15.95	-17.07	-16.05

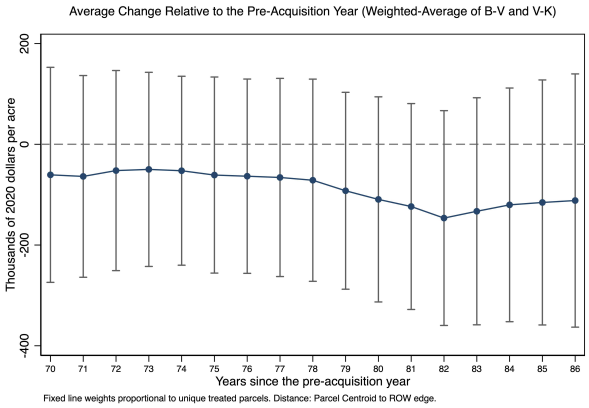
Notes: Treatment, centered ROW proportion, and distance slopes vary by line and pool all post-acquisition years. This regression pools all lines. Pre-acquisition improvements value and parcel size slopes vary by line and relative year; relative year zero is omitted. Distance is from parcel centroid to ROW edge. ROW proportion is centered at the average among each line's treated parcels. Parcel fixed effect and line-by-block-by-year fixed effect are included. Line-by-block-by-year fixed effects are equivalent to block-by-year fixed effects. Block 4 in the area of B-V is excluded. Ycf (treated post, no ROW cf.) is a weighted-average of each line's Ycf, using fixed line weights proportional to unique treated parcels. Each line's Ycf is calculated by first averaging the estimated counterfactual outcomes across post-period years within each treated parcel, then averaging across unique treated parcels of this line. % effect vs Ycf is the ratio of Weighted-average Impact of ROW to Ycf. Standard errors in parentheses. SEs clustered at a block of (approx.) one square mile. Significance: * p<0.10, ** p<0.05, *** p<0.01.

proportion for C-T and B-V, which are positive numbers yet statistically insignificant, hinting on the possibility that a bigger ROW portion may not necessarily cause the rest of the area of a treated parcel to be less valuable. I will discuss a few reasons that could potentially explain and support this hypothesis.

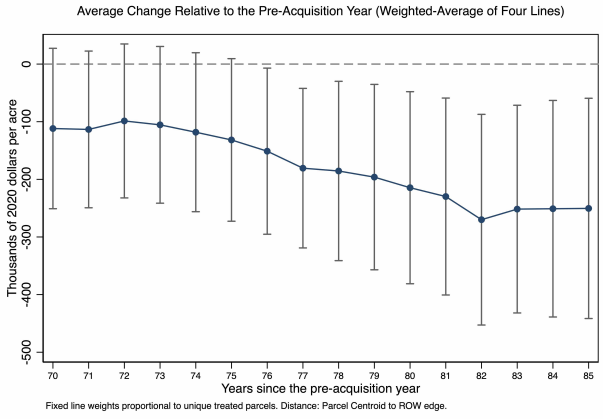
6.1.2 Event Study Estimates



(a) Weighted average of ROW impacts from C-T and C-SE.



(b) Weighted average of ROW impacts from B-V and V-K.



(c) Weighted average of ROW impacts from all lines.

Figure 12: The Dynamic Impact of ROW Across Years Since ROW Acquisition.

Figure 12 plots different subsets of coefficients from estimating equation (5) under different weighting schemes. For instance, Figure 12a plots

$$\frac{N_{T,CT}}{N_{T,CT}+N_{T,CSE}} \times \hat{\beta}^{c}_{CT,r} + \frac{N_{T,CSE}}{N_{T,CT}+N_{T,CSE}} \times \hat{\beta}^{c}_{CSE,r}$$

where r is from 58 to 85 and $N_{T,l}$ is the number of unique treated parcels crossed by line l. Since all lines have data from relative year 70 to 85, Figure 12c plots

$$\sum_{\substack{l\in\{CT,CSE,BV,VK\}\\ r\in[70,85]}} \frac{N_{T,l}\hat{\beta}^{c}_{l,r}}{N_{T,CT}+N_{T,CSE}+N_{T,BV}+N_{T,VK}}$$

Figure 12a shows that the weighted average impact of ROW from the two lines in the Puget Sound

region increases over time and starts to become statistically significant since relative year 76, which is 2016 in calendar year, corresponding to the diverging trends in parcel value per acre between treated and controlled parcels illustrated in Figure 11 after around 2015. The ROW impacts from the two Clark County lines are not statistically significant and remain flat over years according to Figure 12b. As a consequence, the weighted average impact from all lines - both the trend and the statistical significance - mirror the results from King County lines, with the magnitude reaches its maximum at relative year 82 and barely changes from relative years 82 to 85, i.e., from 2022 to 2025 in calendar time. Figure 13 overlays all panels in Figure 12 to compare their estimates' magnitudes, where the blue line comes from Figure 12a, the red line comes from Figure 12b, and the green line comes from Figure 12c.

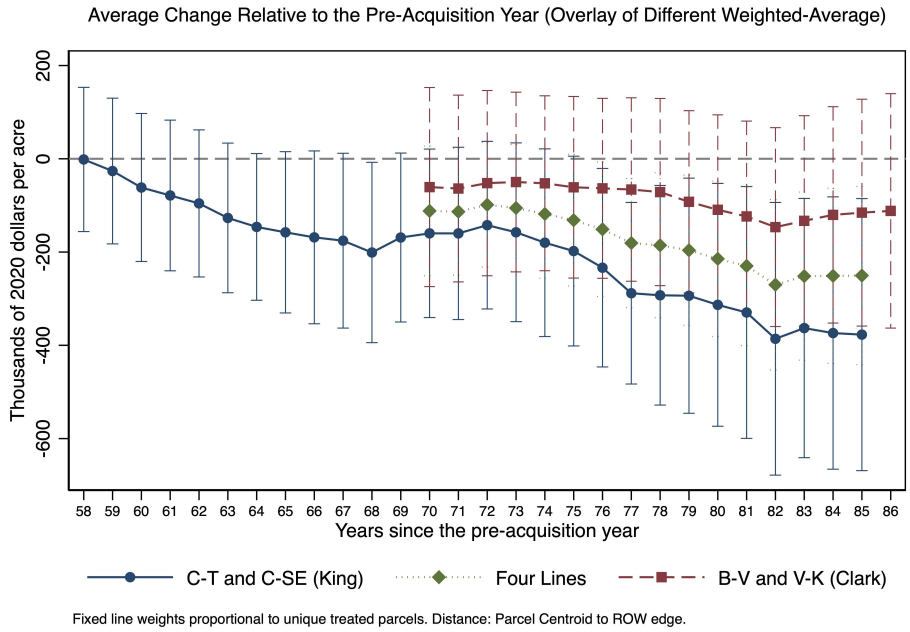


Figure 13: The Dynamic Impact of ROW Across Years Since ROW Acquisition.

6.1.3 Mechanism

The slope coefficients in front of distance in Table 10 are statistically insignificant, suggesting that proximity to ROW is not the cause of ROWs' negative impact on per acre parcel value. A more plausible explanation is the differences in land development, i.e., the land use types developed on a parcel, between treated and controlled parcels. Intuitively, due to the existence of a ROW and the transmission towers on it, areas next to or very close to it can be less preferred for development due to potential restrictions from county- and state-level land use regulation and people's concerns on transmission line's health impact, according to anecdotal evidence. As a result, a treated parcel is more likely to be developed into a mix of different land uses, e.g., an aggregation of commercial, industrial, residential and vacant land; while a controlled parcel is likely to be entirely developed for residential uses.

I categorize land use descriptions of current parcels collected from county assessor's office into 13 types of land uses as shown in the y-axis of Figure 14. The first five of them are different types of residential housing. A special note is that in both counties, a parcel that's currently vacant could have a non-zero assessed value. At the same time, there also exist parcels that may not be vacant but for various reasons have zero assessed values, or they don't have any assessment information at all. The former is a feature unique to parcels in Clark County while the latter is a feature unique to King County.[30] I group them together into one category 'Property with zero value/no value', and these parcels are excluded from the construction of the per acre value for a historical parcel.

Figure 14 plots the difference in the share of a historical parcel's area that is developed as a certain land use type between treated and controlled parcels.[31] Two prominent findings from this picture: the acre share of single-family residential usage is significantly lower by 10% on a parcel where a ROW was historically acquired, while the acre share of vacant land is significantly higher by 6.5% on parcels acquired a ROW. With single-family residential houses normally having the highest or one of the highest per acre value among all land use types, and vacant land tending to have a fairly low per acre value, the negative impact of ROW comes from the cumulative land development in the region over 85 years.

From both Figure 13 and Table 10, it's clear that ROWs of King County lines have a lot bigger impact than those of Clark County lines. As is reflected in the raw data in Figure 11, King County's treated parcels have much lower values over the contemporary years. There do exist some differences in land development on either treated or controlled parcels between the two counties that could shed some light on the differences in their ROW impacts. Figure 15 draws the share of each land use type for each county separately for treated and controlled parcels, which suggests that a much higher share of low-value vacant land on King County's treated parcels, relative to that on King County's controlled parcels and also Clark County's treated parcels, is the main contributor to the low values of King County's treated parcels. As to how vacant land is assessed in practice, why it could get a non-zero value, and whether this value truly represents (maybe) its value of best use if occupied, these are interesting and important questions central to understanding the magnitude of the ROW impact as well as the differences in ROW impacts between two counties. While not discussed in this paper, county differences in property value assessment does matter, and should be paid closer attention to in other similar research.

6.1.4 If Properties with Zero or No Assessed Value Could Have Values

So far the outcome variable, the per acre value of a historical parcel, has not included in its calculation either the size or the value (which would be zero) of current parcels that are fully or partially

[30] Unfortunately, the exact details of the various reasons why a Clark County parcel has zero assessed values are not disclosed on their assessor's website, but according to some other existing information, some of these parcels are used as "bio-filtration swales/pond", "dedicated unimproved street", "parks with playground, ball fields, picnic area", "rivers/sloughs/streams/ditches/waterway", some of which can be found an equivalent type in King County's parcels that have no assessment information. More about these King County parcels see Appendix C.

[31] For instance, a historical parcel is calculated as having 100% share of its area used for 'Single-family residential' if all the current parcels inside or partially overlap with it are developed for 'Single-family residential' land use.

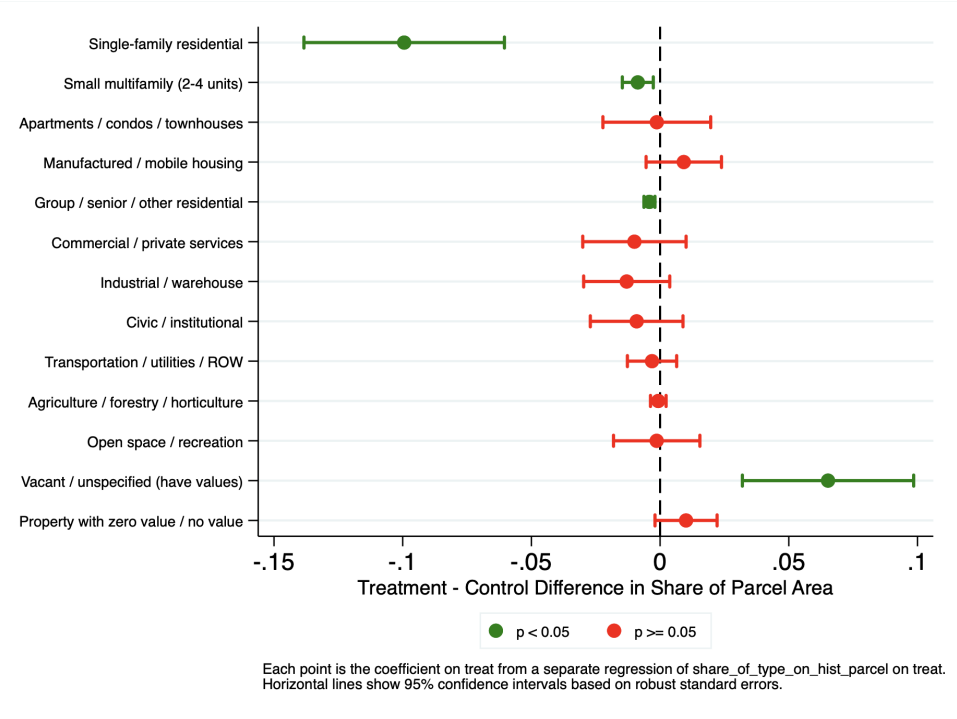
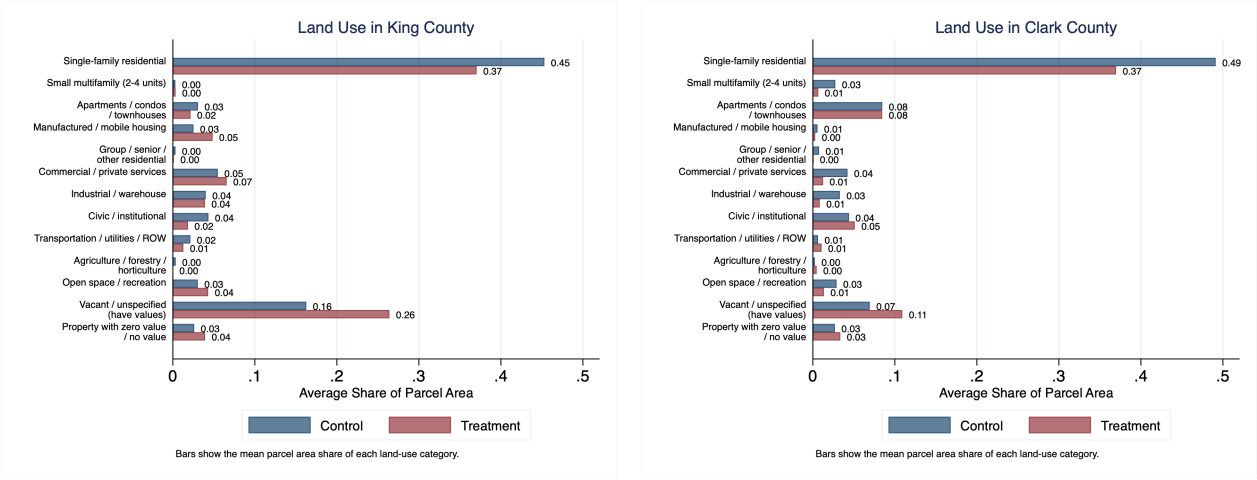


Figure 14: Different Land Use in Share of Parcel Area Between Treated and Controlled Parcels.



(a) King County

(b) Clark County

Figure 15: Land Use in Share of Parcel Area by Treatment and by County.

inside of it. As shown in Figure 14, the share in parcel area of properties with no or zero value is slightly bigger for treated parcels, I may have overestimated the value per acre for all historical parcels, and to a greater extent for the treated than for the controlled, because the subarea with no or zero assessed value potentially could have a value that's just much lower than the rest of the area in that historical parcel, yet not being recorded a non-zero assessed value in reality.

Tables 11 and 12 present the impact of ROW under different assumptions for the hypothetical

per acre value of the zero/no value subarea of a historical parcel. Column (1) assumes that the per acre value of the zero/no value subarea is 25% of that from the rest of a historical parcel which has values. This would adjust downwards the per acre value to the most extent compared to 50%, 75% and 100% in columns (2) to (4). Therefore, the negative ROW impact estimate is the largest in column (1), then decreases as the hypothetical per acre value of the zero/no value area increases. Notice that when the adjustment is 100%, it's equivalent to leaving out the zero/no value areas from the beginning as indicated by results in Tables 9 and 10.

Overall, both common effect and line heterogeneity models show that adding a hypothetical value for the zero/no value areas increases the negative ROW impact by about three percentage points. Similar to previous robustness checks on the main results, ROW impact estimates become bigger by two to three percentage points when dropping the few parcels that ever had a zero value either from 2008 to 2025, or 1998 to 2025. These results can be found in Tables A7 and A8.

Table 11: ROW Impact with Hypothetical Values for Zero/No Value Subarea

	Dependent variable: parcel value per acre (in 2020 dollars)			
	(1) Hyp25	(2) Hyp50	(3) Hyp75	(4) main (Hyp100)
Treat × Post	-163017.8**	-154748.8**	-146479.7*	-138210.6*
	(67870.1)	(70037.1)	(72480.0)	(75171.9)
Distance × Post	12.25	11.96	11.68	11.40
	(33.64)	(33.84)	(34.12)	(34.46)
Centered ROW Proportion × Treat × Post	-297186.1	-269292.0	-241397.9	-213503.8
	(194947.8)	(207281.2)	(222656.0)	(240489.7)
Constant	865050.1***	878879.4***	892708.7***	906538.0***
	(60165.1)	(60798.6)	(61533.6)	(62366.5)
Observations	40000	40000	40000	40000
Ycf (treated post, no ROW cf.)	884315.985	894752.892	905189.797	915626.703
% effect vs Ycf	-18.43	-17.30	-16.18	-15.09

Notes: 'Hyp25', 'Hyp50' and 'Hyp75' each assumes the per acre value of the zero/no value subarea to be 25%, 50%, and 75% of the per acre value from the rest of the historical parcel that has values. Column (4) is the same with Table 9 column (4) that ignores the zero/no value subarea. Notice that this is equivalent to assuming that the zero/no value subarea has the same per acre value with the rest of the areas that have values, i.e., 'Hyp100'. Results in this table come from estimating equation (3) (assuming common effect across lines) by pooling all lines and all post-acquisition years. Distance is from parcel centroid to ROW edge. Standard errors in parentheses. SEs clustered at a block of (approx.) one square mile. Significance: * p<0.10, ** p<0.05, *** p<0.01.

6.1.5 Explanations for Heterogeneity Across Lines

The positive slope coefficients in front of centered ROW proportion for C-T and B-V in Table 10 reflect an interesting observation from the raw data, which is that there exists a positive correlation between the ROW proportion and the post-period parcel value per acre for the treated parcels of these two lines (see Figure 16a and Figure 17a).

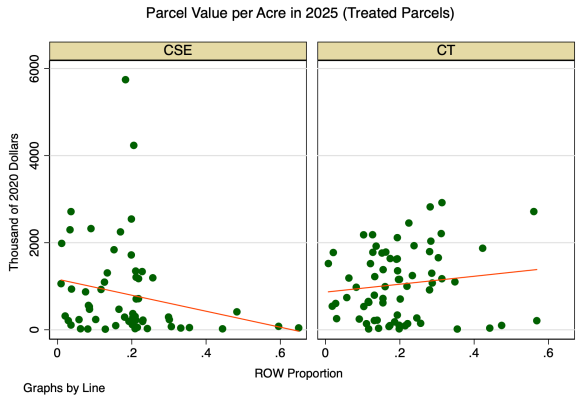
To further explore why these two correlations are positive, as opposed to the negative ones from C-SE and V-K, I look into the distribution of ROW proportion and the distribution of parcel

Table 12: ROW Impact with Hypothetical Values for Zero/No Value Subarea

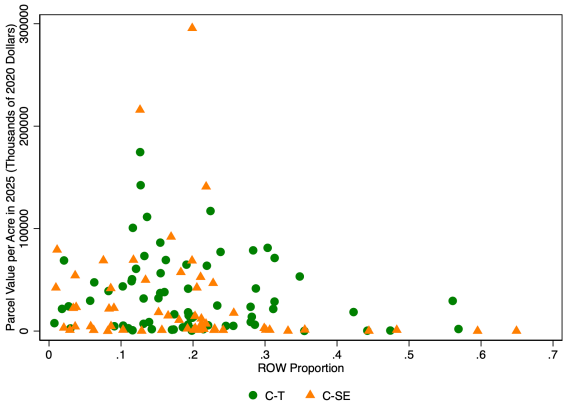
	Dependent variable: parcel value per acre (2020 dollars)			
	(1) Hyp25	(2) Hyp50	(3) Hyp75	(4) main (Hyp100)
Treat x Post: C-T	-274831.0***	-268667.2***	-262503.5***	-256339.7**
	(90652.8)	(91653.8)	(93200.8)	(95267.1)
Treat x Post: C-SE	-171417.1	-165367.9	-159318.6	-153269.3
	(149796.7)	(159815.5)	(170092.6)	(180583.9)
Treat x Post: B-V	-99423.8	-81336.8	-63249.9	-45162.9
	(102894.1)	(103808.5)	(105914.5)	(109143.1)
Treat x Post: V-K	-125443.9	-124733.3	-124022.8	-123312.2
	(149390.5)	(153432.4)	(157561.2)	(161770.3)
Centered ROW Proportion x Treat x Post: C-T	37420.6	214159.8	390899.0	567638.2
	(575119.0)	(635561.0)	(710673.9)	(796316.9)
Centered ROW Proportion x Treat x Post: C-SE	-989353.6**	-1002134.8**	-1014916.0**	-1027697.2**
	(393986.6)	(391768.4)	(390077.4)	(388920.5)
Centered ROW Proportion x Treat x Post: B-V	147683.0	186783.4	225883.8	264984.1
	(247292.6)	(273897.8)	(302513.4)	(332620.8)
Centered ROW Proportion x Treat x Post: V-K	-507976.7**	-537182.1**	-566387.5**	-595593.0**
	(197328.6)	(205494.7)	(214205.6)	(223397.8)
Distance x Post: C-T	-48.77	-51.60	-54.44	-57.27
	(49.85)	(50.39)	(51.00)	(51.68)
Distance x Post: C-SE	91.21*	89.34	87.47	85.60
	(52.85)	(53.66)	(54.54)	(55.49)
Distance x Post: B-V	11.51	13.63	15.76	17.88
	(59.39)	(58.09)	(56.88)	(55.75)
Distance x Post: V-K	4.033	7.053	10.07	13.09
	(77.41)	(78.14)	(79.09)	(80.25)
Weighted average ROW effect	-171691.1***	-164057.4**	-156423.7**	-148790.0**
	(62106.8)	(64280.5)	(66701.0)	(69342.3)
Observations	40000	40000	40000	40000
Ycf (treated post, no ROW cf.)	893879.743	904920.540	915961.337	927002.133
% effect vs Ycf	-19.21	-18.13	-17.08	-16.05

Notes: 'Hyp25', 'Hyp50' and 'Hyp75' each assumes the per acre value of the zero/no value subarea to be 25%, 50%, and 75% of the per acre value from the rest of the historical parcel that has values. Column (4) is the same with Table 10 column (4) that ignores the zero/no value subarea. Notice that this is equivalent to assuming that the zero/no value subarea has the same per acre value with the rest of the areas that have values, i.e., 'Hyp100'. Results in this table come from estimating equation (4) (allowing heterogeneous effect by line). All regressions pool all lines and all post-acquisition years. Distance is from parcel centroid to ROW edge. Standard errors in parentheses. SEs clustered at a block of (approx.) one square mile. Significance: * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

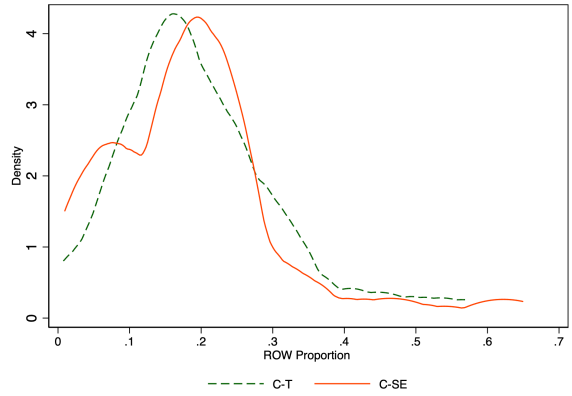
size (Figures 16c, 17c, 16d and 17d), which all seem to suggest that at a given ROW proportion, the size of a treated parcel from the C-T or B-V line is on average bigger than that from the other line from the same county. Figures 16b and 17b confirm this by directly plotting the total parcel value and ROW proportion on the same figure. Indeed, C-T's treated parcels have higher total values on average than C-SE's treated parcels at a given ROW proportion, same is true for B-V's treated parcels when compared to V-K's treated parcels.



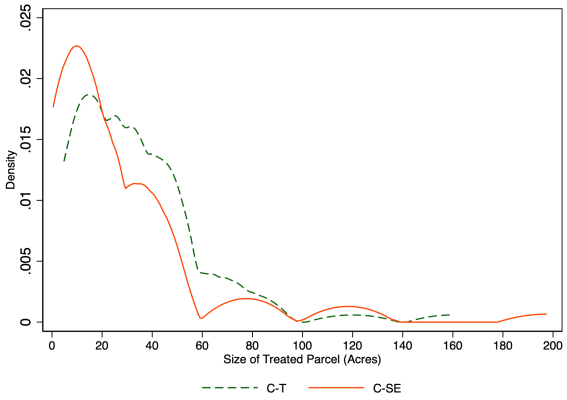
(a) Per Acre Parcel Value (in 2025) vs. ROW Proportion (Treated Parcels)



(b) Total Parcel Value (in 2025) vs. ROW Proportion (Treated Parcels)



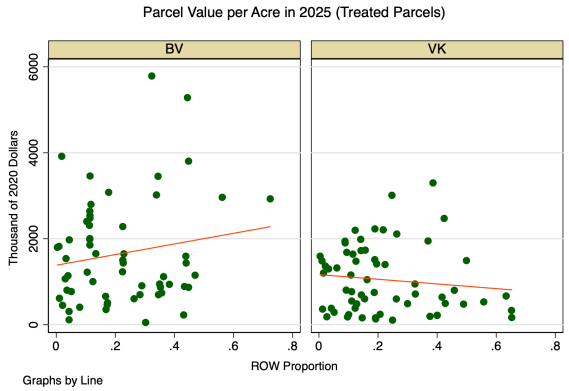
(c) Density of ROW Proportion



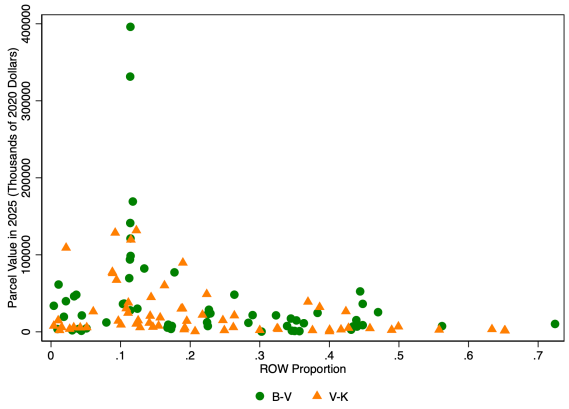
(d) Density of Parcel Size

Figure 16: Parcel Value per Acre vs. ROW Proportion for King County Parcels.

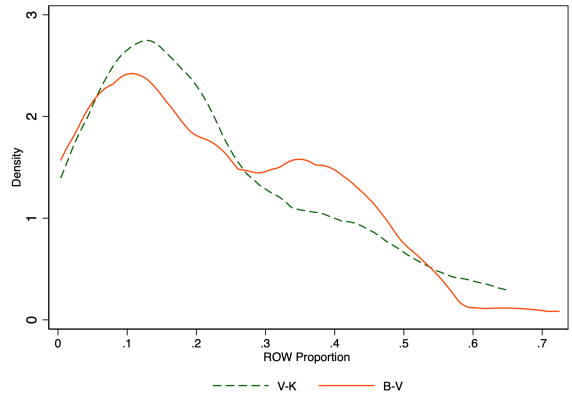
One plausible explanation for why C-T's treated parcels have higher values is that C-T is an easement line, and geographically it crosses two major highways (US Interstate Highway 5 and WA State Route 167) when going southwestward towards Tacoma. Easement means the ownership of the ROW was not transferred to BPA. This allowed more possibility and flexibility to develop the ROW lands and the adjacent non-ROW areas, and provided a prerequisite that helped create various line-specific land usages on parcels that hold ROWs or are located in the adjacent non-ROW areas as the regional economy developed over the past 85 years. Nevertheless, C-SE is also an easement line, easement itself doesn't tell the whole story; the location of C-T, which also



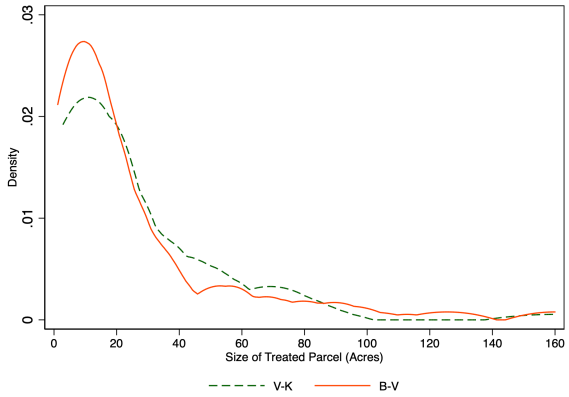
(a) Parcel Value per Acre (in 2025) vs. ROW Proportion (Treated Parcels)



(b) Total Parcel Value (in 2025) vs. ROW Proportion (Treated Parcels)



(c) Density of ROW Proportion



(d) Density of Parcel Size

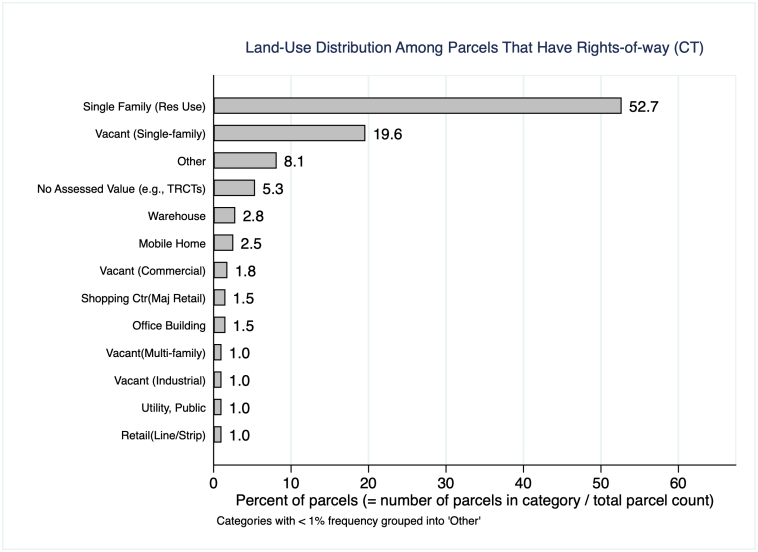
Figure 17: Parcel Value per Acre vs. ROW Proportion for Clark County Parcels.

relates to its land development, matters as well.

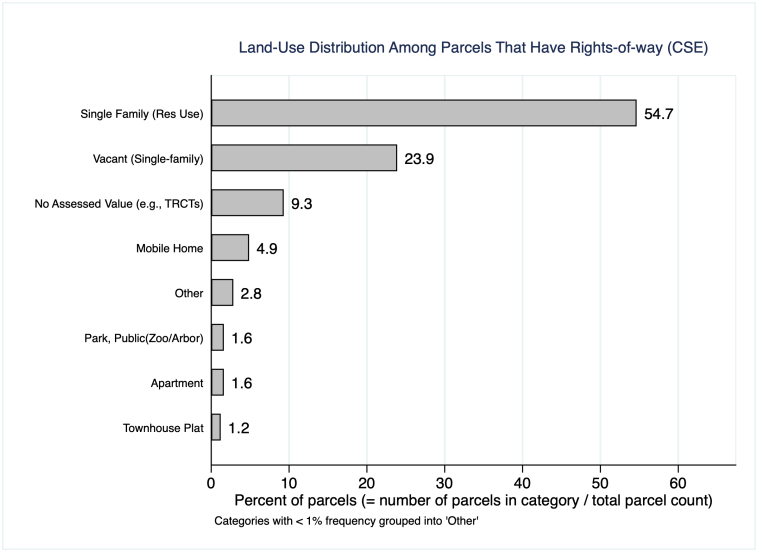
Figure 18 shows the distribution of land usage types among parcels that hold ROWs for C-T and C-SE.[32] C-T crosses parcels that are used as 'Warehouse', 'Shopping Center (Major Retail)', 'Office Building', etc., which have some of the highest assessed values outside of parcels used for residential housing. C-SE, by contrast, rarely crosses parcels used for commercial and industrial (C&I) activities: except those used for single-family residential housing, most of the parcels crossed are public parks or low value mobile homes (or townhouses). Different locations of C-T and C-SE largely contribute to these differences in land development. C-T intersects with two major highways built in the 1960s while C-SE does not. C-T goes through the heartland of the Puget Sound region while C-SE is located close to the inland boundary of King County's urban growth

[32]Types that have a frequency smaller than 1% are categorized into 'Other' and frequency is defined as the number of parcels in a usage type divided by the total number of parcels that have ROWs. More details on the ownership and land usage among current parcels that have ROWs are in Appendix C.

area.[33] Naturally there would not be much C&I use mixed into C-SE's areas, but the highways and being at the center of a region have really created a different environment for C-T's areas that have attracted and bred large-scale C&I development.[34]



(a) Parcels That Have ROWs (C-T)



(b) Parcels That Have ROWs (C-SE)

Figure 18: Land Use Distribution Among Current Parcels in King County.

[33] See Figure B10 for King County's urban growth area.

[34] For B-V versus V-K, it seems like neither easement nor line's location could explain why B-V's treated parcels have higher values on average. Both lines are located close to the Columbia River (although B-V is closer) and both of their ROWs were acquired by title ownership. One possible reason is that B-V's ROWs were 'beautified' extensively with green grass cover according to ariel photos, but this remains an open question to be explored for future research.

6.1.6 Easement vs. Title

Of the two forms of ROW acquisition, neither easement nor title is necessarily better than the other. Because the ROW lands of a title line are usually owned by the electric utility unless partially disposed of, and are vacant in most cases unless partial ownership brings in demand to develop them, there is very little development of these ROW lands into usages other than holding the transmission infrastructure. Therefore, for a title line, the post-acquisition value of a treated parcel reflects only the value of the non-ROW portion. To compare the impact of ROW between easement and title lines, I calculate the value per acre for easement lines' treated parcels only from their non-ROW portions.

Table 13 shows the regression results comparing title lines (V-K and B-V) and easement lines (C-T and C-SE) allowing heterogeneity across lines. Column (3) shows that the impact of ROW for easement lines is smaller (-18.1%) when the per acre value of treated parcels is calculated from the non-ROW portion, but is still bigger than the impact from the title lines as shown in column (1). Neither estimates is statistically significant, which suggests that neither easement nor title is better than the other, even when the long-run decrease in parcel value is the only cost to be minimized.

Column (4) in Table 13 is more striking, showing a substantial decrease of 53.6% in the per acre value of the ROW lands instead of the entire treated parcels. Moreover, the fact that columns (2) and (3) are similar and columns (3) and (4) are drastically different reveals an important finding - comparing treated parcels with controlled parcels is similar to comparing the non-ROW portions of treated parcels to controlled parcels. This suggests that how ROWs have affected the non-ROW portions is an important mechanism behind the impact of ROW.

6.2 Spillover to Controlled Parcels After Acquisition

Controlled parcels that share boundaries with ROWs could be affected by the ROWs. These parcels may be viewed as similar to treated parcels and their values in the post-acquisition period could have been higher if they weren't next to the ROWs. Including these parcels into the control group may underestimate the impact of ROW if such post-period spillover exists from treated to these controlled parcels.

Table 14 Panel A and B's column (2) show the regression results excluding controlled parcels that share boundaries with ROWs, i.e., those that have zero distance from their boundaries to the edge of ROWs.[35] If the spillover doesn't exist, these parcels will have similar value per acre with other controlled parcels not next to ROWs, so that excluding them should result in results close to, if not almost identical to, those obtained when they are not excluded. Comparing columns (2) with columns (1), the drop in value per acre increases by 2.1 and 2.3 percentage points, and an average of 2.2 and 2.8 percentage points across all distance measures, which suggest that spillover does exist but the effect of this spillover on ROW impact is modest.[36]

[35]Tables A9 and A10 shows the results under other five distance measures.

[36]The spillover can't be tested by viewing the 'next-to-ROW' controlled parcels as treated parcels. Whether the spillover exists or not, or how big it is, the 'next-to-ROW' controlled parcels have higher post-acquisition values than treated parcels, such that including them into the treatment group will for sure lower the treatment effect estimate.

Table 13: The Impact of ROW by ROW Acquisition Type (Allowing Line Heterogeneity)

	Dependent variable: parcel value per acre (2020 dollars)			
	Title Lines (V-K and B-V)	Easement Lines (C-T and C-SE)		
	(1) Entire T	(2) Entire T	(3) Non-ROW portion	(4) ROW portion
Weighted average ROW effect	-84878.1	-208768.8**	-154335.9	-445552.1***
	(100635.9)	(98938.6)	(99073.2)	(109060.8)
Treat x Post: C-T		-256339.7**	-179973.9*	-529333.1***
		(96309.6)	(97096.3)	(139191.7)
Treat x Post: C-SE		-153269.3	-124425.0	-347807.6*
		(182559.9)	(182335.3)	(171657.5)
Treat x Post: B-V	-45162.9			
	(111869.9)			
Treat x Post: V-K	-123312.2			
	(165811.9)			
Centered ROW proportion x Treat x Post: C-T		567638.2	803896.3	787293.3
		(805030.4)	(922583.3)	(483590.6)
Centered ROW proportion x Treat x Post: C-SE		-1027697.2**	-1026108.6**	-368105.2
		(393176.2)	(378043.9)	(424140.7)
Centered ROW proportion x Treat x Post: B-V	264984.1			
	(340930.9)			
Centered ROW proportion x Treat x Post: V-K	-595593.0**			
	(228979.1)			
Distance x Post: C-T		-57.27	-57.33	-52.00
		(52.25)	(52.48)	(50.82)
Distance x Post: C-SE		85.60	83.70	92.08
		(56.10)	(55.74)	(56.91)
Distance x Post: B-V	17.88			
	(57.14)			
Distance x Post: V-K	13.09			
	(82.26)			
Observations	13105	26895	26895	26893
Weight: C-T	0.00	0.54	0.54	0.54
Weight: C-SE	0.00	0.46	0.46	0.46
Weight: B-V	0.49	0.00	0.00	0.00
Weight: V-K	0.51	0.00	0.00	0.00
Ycf (treated post, no ROW cf.)	1008102.366	850892.683	854540.833	831394.397
% effect vs Ycf	-8.42	-24.54	-18.06	-53.59

Notes: For treated parcels, the value per acre used behind column (3) is calculated using only the non-ROW portion, and that used behind column (4) is calculated only from the ROW portion. For example, mathematically, the former equals the total value of the non-ROW portion divided by the size of this area. For columns (1) and (2), the value per acre is still calculated from the entire treated parcel. Distance is from parcel centroid to ROW edge. Treatment, centered ROW proportion, and distance slopes to vary by line and pool all post-acquisition years. Pre-acquisition improvements value and parcel size slopes vary by line and relative year. Parcel fixed effect and line-by-block-by-year fixed effect are included. Ycf (treated post, no ROW cf.) is a weighted-average of each line's Ycf, using fixed line weights proportional to unique treated parcels. Each line's Ycf is calculated by giving each parcel equal weight. Standard errors in parentheses. SEs clustered at a block of (approx.) one square mile. Significance: * p<0.10, ** p<0.05, *** p<0.01.

Table 14: Effect of Spillover on the Impact of ROW

Panel A: Common Effect Across Lines

	Parcel value per acre (2020 dollars)	
	(1) Full sample	(2) Drop control next to ROW
Treat x Post	-138210.6*	-161311.3**
	(75171.9)	(77294.5)
Distance x Post	11.40	6.191
	(34.46)	(32.54)
Centered ROW Proportion x Treat x Post	-213503.8	-167085.4
	(240489.7)	(239551.9)
Constant	906538.0***	906963.0***
	(62366.5)	(61141.5)
Observations	40000	39149
Ycf (treated post, no ROW cf.)	915626.703	938972.863
% effect vs Ycf	-15.09	-17.18

Panel B: Line Heterogeneity

	Parcel value per acre (2020 dollars)	
	(1) Full sample	(2) Drop control next to ROW
Weighted average ROW effect	-148790.0**	-175728.2**
	(69342.3)	(70907.6)
Treat x Post: C-T	-256339.7**	-261468.6**
	(95267.1)	(112004.4)
Treat x Post: C-SE	-153269.3	-167093.3
	(180583.9)	(192248.8)
Treat x Post: B-V	-45162.9	-54188.8
	(109143.1)	(116078.6)
Treat x Post: V-K	-123312.2	-204899.8
	(161770.3)	(140848.6)
Centered ROW Proportion x Treat x Post: C-T	567638.2	602221.1
	(796316.9)	(807574.0)
Centered ROW Proportion x Treat x Post: C-SE	-1027697.2**	-1053936.5**
	(388920.5)	(389045.0)
Centered ROW Proportion x Treat x Post: B-V	264984.1	269720.9
	(332620.8)	(328120.4)
Centered ROW Proportion x Treat x Post: V-K	-595593.0**	-420138.1**
	(223397.8)	(190471.3)
Distance x Post: C-T	-57.27	-56.04
	(51.68)	(54.87)
Distance x Post: C-SE	85.60	79.59
	(55.49)	(55.04)
Distance x Post: B-V	17.88	12.58
	(55.75)	(60.05)
Distance x Post: V-K	13.09	-8.702
	(80.25)	(61.95)
Observations	40000	39149
Ycf (treated post, no ROW cf.)	927002.133	954197.331
% effect vs Ycf	-16.05	-18.42

Notes: For both panels, column (2) excludes controlled parcels whose distance from parcel boundary to ROW edge is zero (i.e., sharing boundaries with ROWs, or denoted as next to ROWs). Panel A assumes common effect across lines using equation (3). Panel B allows heterogeneous effects across lines estimating equation (4). Both panel use the distance from parcel centroid to ROW edge. Ycf (treated post, no ROW cf.) is first calculated for each line by giving each parcel equal weight, then by taking a weighted-average of each line's Ycf, using fixed line weights proportional to unique treated parcels. Standard errors in parentheses. Standard errors in parentheses. SEs clustered at a block of (approx.) one square mile. Significance: * p<0.10, ** p<0.05, *** p<0.01.

6.3 Discussion on the Robustness of the One-Mile Buffer

According to the four steps to build a transmission line in historical times, I argue that the ROW acquisition is conditionally exogenous in a local area containing the line. Instead of constructing this area by drawing a one-mile wide buffer centering at the ROW, I discuss three other widths: a half mile (2640 ft), a quarter mile (1320 ft), and a half-quarter mile (660 ft). A quarter-quarter mile (330 ft) is not considered because it's too narrow to find a controlled parcel for a treated parcel.[37] The goal of this discussion is twofold. One, to show that the negative impact on treated parcels persists without decreasing much as buffer width narrows. Two, as an implication, to argue that the negative treatment effect is not driven by the differences among controlled parcels - that some are close to and some are far away from the transmission line, but the differences between treated parcels, from which ROWs were acquired to hold the line, and controlled parcels that weren't.

Table 15 shows the regression results allowing line heterogeneity under four buffer widths. Column (1) is the same as column (4) in Table 10. Considering that treated and controlled parcels may not be conditionally balanced before acquisition in blocks set by these new buffer widths (e.g.,

[37] The ROW width is 250 ft for V-K and C-SE, 262.5 ft for C-T, and 300 ft for B-V.

a half-square-mile block set by a half-mile buffer), columns (2) to (5) look at a restricted sample where blocks have conditional balance not only under a one-mile buffer, but also under a half-mile, a quarter-mile, and a half-quarter-mile buffer. Columns (3) to (5) are estimated by dropping controlled parcels that have zero overlap with an indicated buffer. For instance, the regression under a half-mile buffer in column (3) means that controlled parcels that don't overlap with this buffer are dropped from the data used to get column (2).

As the buffer gets narrower, for instance, from one mile to a half mile, the estimated impact decreases (although not for C-T), because the controlled parcels that overlap with the buffer have a lower post-acquisition per acre value on average since they are closer to the transmission line than those out of the buffer. This results in a decrease in the estimated counterfactual for treated parcels, thus a decrease in the estimated treatment effect. However, from a half mile to a quarter mile, there is an interesting increase in the average ROW impact from C-T and C-SE (the King County lines), but no such bounce back from the two Clark County lines. Indicated by the coefficients in front of distance, especially for C-T, it's possible that the per acre value gradient does not go up with the distance away from the transmission line (ROW edge here). A parcel without ROW can have a per acre value quite high and higher than parcels that are even further away from the line if the former holds a shopping mall while the later features mobile homes. Set aside the lines in the Puget Sound, the other two lines in Vancouver still show a decreasing trend as buffer narrows down, and there the negative impacts of ROW largely persist.

Overall, Table 15 suggests that the core factor that drives the magnitude of the ROW impact is not the heterogeneity among controlled parcels regarding their different distances to the transmission line.

6.4 The Wealth Impact of ROW

Figure 19 shows the implied discount rate calculation following equation (6)

$$V_h(1+r)^{t-h} = V_t \tag{6}$$

where h is the year when ROW compensation payment was made. I let t be 2020 because all values are adjusted to 2020 dollars in my regressions. V_h is the average of ROW compensation per acre of ROW, and is presented in Table 16. V_t is the decrease in parcel value per acre estimated from various regressions.[38] The implied discount rate r is the rate of return needed to net out the losses of holding a ROW in the long run. A big r indicates that landowners either viewed the compensation to be too small back in the late 1930s and early 1940s, or felt the losses that they would bear into the future to be too uncertain to predict.

[38] I use the results from estimating equations (3) and (4) that control for centered ROW proportion and distance. Specifically, they are from Table 9 column (4), Table 10 column (4), Table 13 columns (1) and (3), Table 14 Panel A and Panel B column (2), Table 15 columns (2) to (5), Tables A1, A3, A4, A9, A10, and A6's columns (2), (4), (6), (8), and (10), Tables A2 and A3's column (4), and Tables 11, 12, A7, and A8's columns (1) to (3). All of these results except the ones from Table 13 are from pooling all lines. I have also added results from estimating the specification used to get Table 13 but controlling for distances that are not parcel centroid to ROW edge, which are not shown in the appendix.

Table 15: The Impact of ROW Under Different Buffer Widths

	Parcel value per acre (2020 dollars)				
		Restricted Sample			
	(1) one mile	(2) one mile	(3) half mile	(4) quarter mile	(5) half-quarter mile
Weighted average ROW effect	-148790.0**	-197904.6**	-149694.5	-231500.3*	-248959.4**
	(69342.3)	(75421.9)	(93728.6)	(113652.9)	(116658.8)
Treat x Post: C-T	-256339.7**	-262244.5*	-287073.9**	-410748.0	-542594.2**
	(95267.1)	(136713.0)	(124544.5)	(241699.5)	(252813.3)
Treat x Post: C-SE	-153269.3	-177230.4	-69990.0	-269603.9	-201707.8
	(180583.9)	(184776.3)	(236245.9)	(258786.8)	(260775.4)
Treat x Post: B-V	-45162.9	-139909.3**	-93085.3**	-71117.2	-59682.9*
	(109143.1)	(51327.9)	(41200.0)	(72958.1)	(29011.1)
Treat x Post: V-K	-123312.2	-205776.6	-137774.6	-127470.3	-139373.5
	(161770.3)	(184092.5)	(269648.7)	(261885.2)	(280219.8)
Centered ROW Proportion x Treat x Post: C-T	567638.2	-89199.6	8832.3	-245225.6	-503429.5
	(796316.9)	(764155.8)	(822897.0)	(682169.9)	(710438.5)
Centered ROW Proportion x Treat x Post: C-SE	-1027697.2**	-1154321.3**	-991035.8*	-1219445.3**	-1068304.0**
	(388920.5)	(489322.0)	(483857.0)	(502665.8)	(455365.3)
Centered ROW Proportion x Treat x Post: B-V	264984.1	393807.4	435256.3	754610.5	532700.3
	(332620.8)	(325352.6)	(381514.7)	(542172.0)	(449382.2)
Centered ROW Proportion x Treat x Post: V-K	-595593.0**	-690257.2*	-826694.5**	-974992.7**	-1033020.4***
	(223397.8)	(377295.4)	(323394.2)	(362297.7)	(364499.4)
Distance x Post: C-T	-57.27	-19.90	-10.63	-226.2	-554.6
	(51.68)	(68.54)	(75.22)	(305.7)	(428.6)
Distance x Post: C-SE	85.60	69.82	172.8	-280.1	-284.8
	(55.49)	(60.02)	(146.0)	(193.0)	(278.9)
Distance x Post: B-V	17.88	-33.05	-0.272	167.8	-81.08
	(55.75)	(29.67)	(83.25)	(120.9)	(131.1)
Distance x Post: V-K	13.09	-20.27	76.78	-47.57	-144.0
	(80.25)	(89.42)	(182.2)	(132.7)	(157.6)
Observations	40000	31301	20295	12909	9233
Unique treated parcels (total)	252	203	203	203	203
C-T	70	56	56	56	56
C-SE	60	56	56	56	56
B-V	60	48	48	48	48
V-K	62	43	43	43	43
Unique controlled parcels (total)	1389	1080	641	339	185
C-T	448	305	160	71	40
C-SE	368	326	193	111	60
B-V	263	220	159	103	54
V-K	310	229	129	54	31
Ycf (treated post, no ROW cf.)	927002.133	924921.831	876032.552	957639.995	974886.176
% effect vs Ycf	-16.05	-21.40	-17.09	-24.17	-25.54

Notes: Column (1) is the column (4) in Table 10. Columns (2) to (5) use 'blocks' where treated and controlled parcels are conditionally balanced pre-acquisition under four blocks formed by four buffers: the one-square-mile block, the half-square-mile block, the quarter-square-mile block, and the half-quarter-square-mile block. Distance is from parcel centroid to ROW edge. Parcel fixed effect, line-by-block-by-year fixed effect, pre-acquisition value of improvements, and parcel size are controlled in the regressions, with the last two vary both at relative year and by line. Ycf (treated post, no ROW cf.) is first calculated for each line by giving each parcel equal weight, then by taking a weighted-average of each line's Ycf, using fixed line weights proportional to unique treated parcels. SEs clustered at a block of (approx.) one square mile. Significance: * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

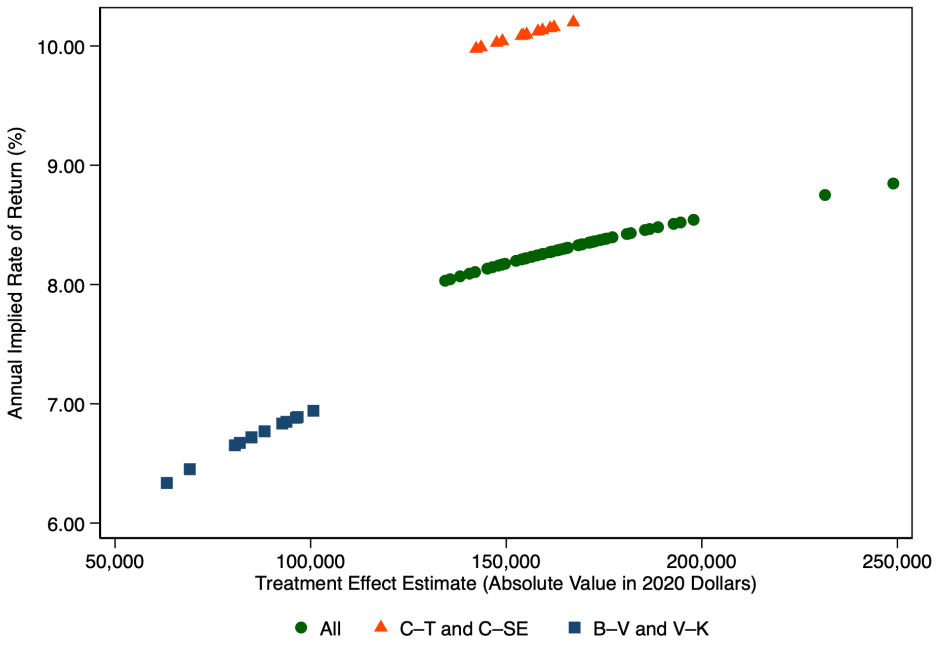


Figure 19: Implied Rate of Return That Fully Compensates for Long-run Losses.

Table 16: Average ROW Compensation per Acre of ROW

	Average (ROW compensation/ROW size) ($ per acre)
All (Four Lines)	238.34 [1938]
C-T	78.24 [1940]
C-SE	61.87 [1940]
C-T and C-SE	70.65 [1940]
B-V	347.92 [1938]
V-K	476.84 [1939]
B-V and V-K	410.23 [1938]

Notes: Each row is the per acre ROW compensation averaged over the treated parcels of the corresponding line (or group of lines). The year in the bracket is the year h used in the rate of return calculation. For a specific line, h is when the ROWs were acquired. When there are multiple lines and their ROWs acquired in different years, I pick h as the earliest year, i.e., 1938.

As shown in the figure, the implied rate of return is in the range from 6% to 10%, with an average of 8.3%. This rate could be higher than the long-run U.S. interest rate (e.g., yield of 10-Year U.S. Treasury note) depending on how the long run interest rate is measured. Nevertheless, some of the high numbers in this range suggest that at the time of ROW acquisition, there was substantial uncertainty for landowners to predict the losses from having ROWs on their land. While the stock market in the long run could generate a return of above 10%, it would require using the ROW compensation monies to invest over a very long horizon to achieve a net positive in wealth.

7 Discussion

In this section, I discuss two questions that may be relevant to a long-run impact of ROW. First, what is different about building a transmission line today? Second, what might a short-run impact be?

7.1 How Building Transmission is Different Today

As explained in the Setting, there were historically four steps to building a transmission line: surveying the territory, designing the line, acquiring ROWs, and actually building the line. In the present day, the process has become more lengthy and slightly different. For example, before coming up with a determined proposed route to acquire ROWs, there would typically be many rounds of open house meetings where relevant landowners could get informed of the project. It's very likely they are able to see some survey results and perhaps design details, depending on the project. These open house meetings are usually part of the processes to carry out an Environmental Impact Study (EIS). In most EISs, in addition to the determined proposed route, you could also see some alternative routes that are considered but not chosen, which was rarely the case historically, especially before the 1970s. These EIS alternative routes are not good "controls". They are not a good comparison to the determined proposed route because they likely have been shaped by landowners' inputs during open houses. If there's a map that is purely the outcome of a utility's own planning and not influenced by any landowners, and also has multiple routes, then we can compare the determined one with the rest of the routes. Unfortunately, it's often the case that when such a map exists, it has only one route, and is very likely only an illustrative sketch.

In the early years of BPA's history, BPA unilaterally set the route for ROW acquisition for B-V and V-K, and faced seemingly very little resistance from landowners in both the design and ROW acquisition for C-T and C-SE. Whereas nowadays, as explained above, the design process of a line will likely involve many rounds of open discussions and consider many alternative routes. As it has always been hard to completely separate the design and the ROW acquisition, these open houses may be designed with the intention of eliminating potential objection that could later show up in the field during ROW acquisition by engaging with landowners early. But, in reality, these open houses cannot iron out all the potential objections that landowners may have. This is why we're still seeing eminent domain cases brought to the courts as a last resort to get ROWs, and why utilities try very hard to get the right to use eminent domain from local and state authorities.

7.2 The Short Run Impact Might be a Different Story

Long term planning is difficult. There is no guarantee of achieving what is planned. Meanwhile, the constantly changing world calls for a change of the plan, and the plan does often change. A long term mindset may be rare, but we often want to know whether short-run outcomes will resemble those that we intend to achieve in the long run. In this section, I estimate the impact after 17 years of ROW acquisition using V-K as an example. My results suggest that in this particular setting, there is no robust evidence of impacts of ROWs in the short run. More importantly, the short run is not a simple scaled-down version of the long run; the stories about how ROWs and the

transmission infrastructure broadly affect land development are likely different in the short run.

Table 17 shows the results from V-K using 1956 as the only post-acquisition year. Panel A column (4) shows that the impact of ROW is positive but statistically insignificant, which also holds when excluding controlled parcels that share boundaries with ROWs as shown in Panel B column (4). Moreover, comparing to the long-run effect from V-K in Table 10 after almost 70 years of ROW acquisition, centered ROW proportion does not have a statistically significant negative impact on parcel value per acre in the short run as it does in the long run.[39]

Table 17: The Impact of ROW in the Short Run Using V-K as an Example

	Dependent variable: parcel value per acre (in 2020 dollars)							
	All Sample				Drop Controlled Parcels with Boundary to ROW = 0			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treat × Post	-26.59	187.0	-32.52	184.6	-39.88	203.2	-48.72	195.4
	(94.70)	(192.0)	(100.6)	(171.7)	(128.2)	(219.6)	(133.4)	(200.9)
Distance × Post		0.151		0.154		0.156		0.157
		(0.168)		(0.169)		(0.163)		(0.164)
Centered ROW Proportion			832.4	887.1			757.1	771.3
× Treat × Post			(1226.1)	(1214.7)			(1253.1)	(1230.9)
Constant	1950.3***	1833.0***	1946.4***	1826.6***	2013.2***	1888.6***	2008.9***	1883.7***
	(113.3)	(115.4)	(109.9)	(112.4)	(117.8)	(126.1)	(113.7)	(124.3)
Observations	740	740	740	740	700	700	700	700
Ycf (treated post, no ROW cf.)	1770.159	1556.614	1776.097	1558.976	1783.450	1540.382	1792.289	1548.223
% effect vs Ycf	-1.50	12.01	-1.83	11.84	-2.24	13.19	-2.72	12.62

Notes: This is a 2x2 DID, the pre-acquisition year is 1939, the post-acquisition year is 1956. Distance is from parcel centroid to ROW edge. Treat x Post in columns (4) and (8) are the effects of ROW at the average ROW proportion and also the average treatment effects of ROW on the treated parcels. Parcel fixed effect, block-by-year fixed effect, pre-acquisition value of improvements, and parcel size are controlled in the regressions. Ycf (treated post, cf.) is calculated by giving each parcel equal weight. % effect vs Ycf is the ratio of Treat x Post to Ycf. Standard errors in parentheses. SEs clustered at a block of (approx.) one square mile. Significance: * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

One possible explanation for these results is that, before the 1960s, treated parcels, especially the non-ROW portions in the case of V-K, and control parcels differed little in the types of properties developed on them. In other words, ROWs didn't seem to have impeded high value properties from being developed on treated parcels in the two decades following ROW acquisition as well as the existence of the transmission line, relative to what would have happened on these parcels in the long run. Meanwhile, the fact that results in Table 17 are sensitive to whether distance is controlled also supports this explanation. Comparing columns (1) and (2), or columns (3) and (4), when distance is controlled, the regression essentially tries to compare treated and controlled parcels that have the same distance within each block. One could visualize that a wider but shorter treated parcel and a narrower but longer controlled parcel could have the same distance from their parcel centroids to ROW edge, but that properties of higher values would be developed on the latter would not necessarily occur in the short run.

[39] In the raw data, the average post-acquisition difference in the outcome between treated and controlled parcels is even smaller than the average pre-acquisition difference, which illustrates why the treatment effect is positive number.

8 Conclusion

This paper studies the long-run impact of ROW resulted from building a new transmission line in a unique setting - the transmission lines studied were built by Bonneville Power Administration in Washington State from 1938 to the early 1940s.

I use a two-way fixed effects DID model where I control for parcel size, value of improvements before acquisition, the proportion of ROW acquired from a parcel, and the distance from a parcel to the transmission line. I also include a block-by-year fixed effect because my treatment and control are defined in a one-square-mile block. I estimate that having a ROW on a parcel reduces its per acre value by 15% to 21% relative to what it would have been if a ROW had not been acquired, 60 years after ROW acquisition. The mechanism lies in the differences in land development between parcels with and without a ROW. In addition, there exists heterogeneity across lines, likely driven by differences in lines' locations and whether the ROWs are acquired by easement or title.

I detect spillover from parcels where ROWs were acquired to parcels from which no ROW was acquired but which shared boundaries with ROWs. However, the effect of spillover on the impact of ROW is very modest. In addition, I find that whether the parcels used in the control group are close to or far from the transmission line doesn't change the estimated impact of ROW much. This means that a key to understanding the impact of a line's ROW is to identify how the ROWs have affected the parcels from which they were originally acquired.

Looking at today, while it's possible that landowners might care about the short run impact more than the long run impact when approached by a utility, there is much evidence that the opposite is true, and is common. Many landowners have emphasized their long-lasting attachment to their land and property, which reflects, to some extent, their wish to stay connected to their land and property into the long run. My calculation of the annual rate of return that could fully compensate for the long-run losses in parcel values provides an important historical benchmark that quantifies the size of the uncertainty of an energy infrastructure project at its planning stage. Along with the long-run impact of transmission line rights-of-way estimated in my setting, this paper can provide valuable insights for future transmission planning.

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Appendix A: Additional Tables

Table A1: The Impact of ROW Using Other Distance Measures (Common Effect)

	Dependent variable: parcel value per acre (in 2020 dollars)									
	Boundary to ROW Edge		Centroid to Line		Boundary to Line		Centroid to Tower		Boundary to Tower	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Treat × Post	-138057.4*	-135672.7*	-149607.1*	-148893.5*	-147242.4**	-145167.5**	-157984.1**	-156578.2**	-156023.5**	-153931.1**
	(71295.4)	(70535.0)	(74864.0)	(73766.8)	(71983.3)	(70966.6)	(71521.2)	(70506.3)	(69913.1)	(68958.7)
Distance × Post	15.90	16.30	4.431	3.663	7.017	7.157	-1.206	-1.548	0.202	0.366
	(34.60)	(34.79)	(32.71)	(32.54)	(33.09)	(33.19)	(33.46)	(33.39)	(33.85)	(33.99)
Centered ROW Proportion × Treat × Post		-221755.0		-214986.8		-217940.1		-217604.0		-217251.0
		(246350.6)		(239483.6)		(244427.9)		(241829.7)		(244704.3)
Constant	903119.3***	904603.6***	914737.1***	917896.8***	912827.4***	914568.4***	924053.1***	926553.3***	921741.8***	923437.4***
	(52039.0)	(51814.7)	(63641.5)	(63291.9)	(53775.8)	(53580.4)	(66242.6)	(65894.1)	(56056.8)	(55903.0)
Observations	40000	40000	40000	40000	40000	40000	40000	40000	40000	40000
Ycf (treated post, no ROW cf.)	915474.107	913078.752	927020.325	926294.931	924650.398	922564.685	935388.620	933971.342	933430.395	931327.448
% effect vs Ycf	-15.08	-14.86	-16.14	-16.07	-15.92	-15.74	-16.89	-16.76	-16.72	-16.53

Notes: This table presents the results of Table 9 columns (2) and (4) using five other distance measures. This regression pools all lines and all post-acquisition years and assumes common effect from ROW across lines. Parcel fixed effect, block-by-year fixed effect, pre-acquisition value of improvements, and parcel size are controlled. Ycf (treated post, no ROW cf.) is calculated by first averaging the estimated counterfactual outcomes across post-period years within each parcel, then averaging across unique treated parcels, so that each parcel receives equal weight. Standard errors in parentheses. SEs clustered at a block of (approx.) one square mile. Significance: * p<0.10, ** p<0.05, *** p<0.01.

Table A2: The Impact of ROW (Common Effect Across Lines, Robustness Check)

	Dependent variable: parcel value per acre (in 2020 dollars)			
	(1)	(2)	(3)	(4)
Treat × Post	-187399.2***	-153972.7**	-185151.1***	-152506.6**
	(52416.0)	(69257.3)	(51948.5)	(68498.8)
Distance × Post		23.50		22.99
		(33.45)		(33.29)
Centered ROW Proportion × Treat × Post			-255297.5	-247633.4
			(240510.4)	(235405.9)
Constant	884511.6***	848396.7***	886827.4***	851415.0***
	(22893.9)	(60595.6)	(23251.6)	(59908.1)
Observations	38912	38912	38912	38912
Ycf (treated post, no ROW cf.)	893583.896	860190.842	891313.577	858702.543
% effect vs Ycf	-20.97	-17.90	-20.77	-17.76

Notes: The 64 parcels that ever had a zero value in the post period are dropped compared to the sample used for estimating Table 9. This regression pools all lines and all post-acquisition year. Distance is parcel centroid to ROW edge. Treat x Post in column (4) is the average effect of ROW on the treated parcels. Parcel fixed effect, block-by-year fixed effect, pre-acquisition value of improvements, and parcel size are controlled. Ycf (treated post, no ROW cf.) is calculated by first averaging the estimated counterfactual outcomes across post-period years within each parcel, then averaging across unique treated parcels, so that each parcel receives equal weight. Standard errors in parentheses. SEs clustered at a block of (approx.) one square mile. Significance: * p<0.10, ** p<0.05, *** p<0.01.

Table A3: The Impact of ROW (Various Distances, Common Effect, Robustness Check)

	Dependent variable: parcel value per acre (in 2020 dollars)									
	Boundary to ROW Edge		Centroid to Line		Boundary to Line		Centroid to Tower		Boundary to Tower	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Treat × Post	-160709.1**	-157863.5**	-162516.2**	-161727.9**	-168215.6**	-165758.4**	-172891.1**	-171268.8**	-175292.7**	-172784.9**
	(66407.7)	(65887.5)	(69715.1)	(68602.0)	(68438.9)	(67612.7)	(67952.4)	(66982.0)	(67522.4)	(66740.3)
Distance × Post	23.29	23.76	16.51	15.60	14.87	15.02	10.18	9.762	9.735	9.935
	(34.36)	(34.58)	(32.91)	(32.66)	(34.13)	(34.24)	(33.61)	(33.48)	(34.38)	(34.54)
Centered ROW Proportion × Treat × Post		-261815.7		-245626.4		-256692.3		-252678.5		-256468.0
		(243977.1)		(233570.5)		(241452.0)		(237232.0)		(241858.4)
Constant	856603.1***	858413.4***	857144.3***	860884.3***	864872.2***	866999.2***	867178.5***	870190.8***	871215.8***	873268.3***
	(51187.0)	(50838.2)	(63163.2)	(62517.0)	(54274.7)	(53930.1)	(65556.6)	(64953.3)	(55790.1)	(55498.6)
Observations	38912	38912	38912	38912	38912	38912	38912	38912	38912	38912
Ycf (treated post, no ROW cf.)	866903.277	864035.224	868716.132	867905.673	874398.259	871918.769	879085.164	877440.628	881476.802	878946.731
% effect vs Ycf	-18.54	-18.27	-18.71	-18.63	-19.24	-19.01	-19.67	-19.52	-19.89	-19.66

Notes: The 64 parcels that ever had a zero value in the post period are dropped as a robustness check. The results here are columns (2) and (4) of Appendix Table A1 using five other distance measures. This regression pools all lines and all post-acquisition year. Parcel fixed effect, block-by-year fixed effect, pre-acquisition value of improvements, and parcel size are controlled. Ycf (treated post, no ROW cf.) is calculated by first averaging the estimated counterfactual outcomes across post-period years within each parcel, then averaging across unique treated parcels, so that each parcel receives equal weight. Standard errors in parentheses. SEs clustered at a block of (approx.) one square mile. Significance: * p<0.10, ** p<0.05, *** p<0.01.

Table A4: The Impact of ROW Using Other Distance Measures (Heterogeneous Effect by Line)

	Dependent variable: parcel value per acre (2020 dollars)									
	Boundary to ROW Edge		Centroid to Line		Boundary to Line		Centroid to Tower		Boundary to Tower	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Treat x Post: C-T	-214222.4**	-220161.3**	-253362.0**	-258114.0***	-221891.3**	-227703.4**	-240293.6**	-246478.7***	-218201.5**	-223636.3***
	(89417.3)	(83992.6)	(97088.1)	(92715.8)	(90233.2)	(84890.6)	(90517.1)	(84967.9)	(85622.1)	(80051.9)
Treat x Post: C-SE	-180217.0	-173196.8	-155740.5	-153794.6	-174539.1	-167338.1	-189951.7	-184397.8	-202933.9	-193946.3
	(192022.6)	(170194.0)	(200419.9)	(179545.0)	(191896.2)	(170400.9)	(190337.0)	(170682.5)	(182256.7)	(161984.8)
Treat x Post: B-V	-21817.8	-27813.3	2144.5	-27.34	22254.7	16994.0	-1118.4	-4142.7	19515.7	14331.5
	(102938.7)	(110708.5)	(96156.9)	(102198.0)	(98459.2)	(106166.2)	(99258.6)	(105490.2)	(96266.3)	(103890.9)
Treat x Post: V-K	-139434.3	-134222.2	-188461.0	-189360.9	-202711.8	-198960.6	-195800.6	-194153.0	-207456.7	-204132.9
	(151658.6)	(150859.2)	(145945.0)	(142393.5)	(145415.5)	(140948.9)	(140220.5)	(136330.1)	(146669.0)	(142492.2)
Centered ROW Proportion x Treat x Post: C-T		577145.0		557826.3		575070.2		580628.0		568973.0
		(791280.9)		(796656.4)		(790970.7)		(804071.7)		(792231.6)
Centered ROW Proportion x Treat x Post: C-SE		-1084799.2***		-1011894.9**		-1085188.9***		-1052942.5**		-1093543.1***
		(390970.3)		(392779.0)		(390820.4)		(386909.8)		(388041.6)
Centered ROW Proportion x Treat x Post: B-V		231835.2		297835.3		229768.3		285042.2		231246.9
		(373945.6)		(325529.8)		(363007.6)		(329479.4)		(362698.0)
Centered ROW Proportion x Treat x Post: V-K		-601190.1***		-620328.2**		-603407.6**		-613022.2**		-606538.1**
		(209989.0)		(235941.1)		(221832.9)		(229180.3)		(225090.0)
Distance x Post: C-T	-47.47	-47.61	-58.10	-57.62	-50.18	-50.23	-54.09	-54.34	-49.28	-49.09
	(54.14)	(54.44)	(48.19)	(48.27)	(50.76)	(51.03)	(46.70)	(47.14)	(48.83)	(49.07)
Distance x Post: C-SE	92.76*	95.19*	85.34	83.81	92.41*	94.85*	63.93	64.82	67.99	72.05
	(52.34)	(53.39)	(55.06)	(55.23)	(52.58)	(53.64)	(64.54)	(65.35)	(61.25)	(62.93)
Distance x Post: B-V	37.71	35.88	48.13	50.51	65.99	65.05	48.38	50.03	67.06	66.15
	(56.54)	(57.75)	(46.30)	(44.25)	(45.30)	(45.77)	(50.84)	(49.22)	(45.38)	(45.72)
Distance x Post: V-K	5.543	6.259	-27.47	-30.97	-39.87	-40.29	-34.51	-36.44	-45.20	-45.97
	(82.00)	(82.29)	(67.53)	(68.11)	(71.85)	(71.91)	(68.47)	(68.71)	(75.57)	(75.71)
Weighted average ROW effect	-141915.0**	-142038.4**	-153316.2**	-154911.4**	-147768.2**	-147997.8**	-160414.3**	-161124.7**	-155323.5**	-155109.8**
	(68557.8)	(65259.7)	(69411.1)	(65651.9)	(67419.0)	(63589.5)	(66593.0)	(62963.9)	(65393.0)	(61829.2)
Observations	40000	40000	40000	40000	40000	40000	40000	40000	40000	40000
Ycf (treated post, no ROW cf.)	920181.817	920265.909	931596.444	933157.421	926060.284	926250.850	938719.174	939393.635	933653.543	933400.770
% effect vs Ycf	-15.42	-15.43	-16.46	-16.60	-15.96	-15.98	-17.09	-17.15	-16.64	-16.62

Notes: This table presents the results of Table 10 columns (2) and (4) using other distance measures. Treatment, centered ROW proportion, and distance slopes vary by line and pool all post-acquisition years. Pre-acquisition improvements value and parcel size slopes vary by line and relative year; relative year zero is omitted. ROW proportion is centered at the average among each line's treated parcels. Parcel fixed effect and line-by-block-by-year fixed effect are included. Ycf (treated post, no ROW cf.) is a weighted-average of each line's Ycf, using fixed line weights proportional to unique treated parcels. Each line's Ycf is calculated by first averaging the estimated counterfactual outcomes across post-period years within each treated parcel, then averaging across unique treated parcels of this line. % effect vs Ycf is the ratio of weighted average impact of ROW to Ycf. Standard errors in parentheses. SEs clustered at a block of (approx.) one square mile. Significance: * p<0.10, ** p<0.05, *** p<0.01.

Table A5: The Impact of ROW (Heterogeneous Effect by Line, Robustness Check)

	Dependent variable: parcel value per acre (2020 dollars)			
	(1)	(2)	(3)	(4)
Treat x Post: C-T	-203499.4**	-247020.8**	-210360.3***	-253696.2**
	(79433.2)	(110776.2)	(69017.6)	(105999.6)
Treat x Post: C-SE	-326611.0**	-196123.8	-323520.1***	-194104.2
	(122731.6)	(152474.1)	(106973.0)	(138076.8)
Treat x Post: B-V	-103358.6*	-72435.6	-103099.4*	-72414.3
	(55888.6)	(100072.3)	(53031.2)	(101914.7)
Treat x Post: V-K	-138155.5*	-126229.1	-134075.3*	-124799.0
	(71792.8)	(142210.8)	(74342.5)	(139282.9)
Centered ROW Proportion x Treat x Post: C-T			682093.4	680830.7
			(774336.7)	(779867.1)
Centered ROW Proportion x Treat x Post: C-SE			-928107.1*	-912901.2*
			(518100.2)	(488651.8)
Centered ROW Proportion x Treat x Post: B-V			-13981.6	-1632.9
			(460093.8)	(441248.7)
Centered ROW Proportion x Treat x Post: V-K			-578546.4**	-576154.9**
			(214544.1)	(221090.4)
Distance x Post: C-T		-25.71		-25.61
		(55.27)		(55.31)
Distance x Post: C-SE		92.13*		91.41*
		(49.83)		(49.81)
Distance x Post: B-V		27.30		27.30
		(59.92)		(58.34)
Distance x Post: V-K		8.388		6.536
		(72.57)		(72.83)
Weighted average ROW effect	-192714.7***	-162331.3**	-192714.7***	-163260.7**
	(42813.2)	(63869.1)	(38945.1)	(61086.4)
Observations	38912	38912	38912	38912
Ycf (treated post, no ROW cf.)	899622.443	869239.074	899622.382	870168.402
% effect vs Ycf	-21.42	-18.68	-21.42	-18.76

Notes: The 64 parcels that ever had a zero value in the post period are dropped compared to the sample used for estimating Table 10. Treatment, centered ROW proportion, and distance slopes vary by line and pool all post-acquisition years. Pre-acquisition improvements value and parcel size slopes vary by line and relative year; relative year zero is omitted. Distance is from parcel centroid to ROW edge. ROW proportion is centered at the average among each line's treated parcels. Parcel fixed effect and line-by-block-by-year fixed effect are included. Ycf (treated post, no ROW cf.) is a weighted-average of each line's Ycf, using fixed line weights proportional to unique treated parcels. Each line's Ycf is calculated by first averaging the estimated counterfactual outcomes across post-period years within each treated parcel, then averaging across unique treated parcels of this line. % effect vs Ycf is the ratio of weighted average impact of ROW to Ycf. Standard errors in parentheses. SEs clustered at a block of (approx.) one square mile. Significance: * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

Table A6: The Impact of ROW (Various Distances, Heterogeneous Effect, Robustness Check)

	Dependent variable: parcel value per acre (2020 dollars)									
	Boundary to ROW Edge		Centroid to Line		Boundary to Line		Centroid to Tower		Boundary to Tower	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Treat x Post: C-T	-229422.3**	-236460.1**	-247845.5**	-253914.1**	-234208.2**	-241125.6**	-245903.9**	-253552.7**	-229000.7**	-235655.9**
	(98001.0)	(91975.0)	(109481.6)	(104169.7)	(99304.3)	(93285.4)	(105030.7)	(98616.1)	(94278.3)	(87805.5)
Treat x Post: C-SE	-224757.2	-219014.9	-195873.4	-195059.5	-219884.1	-213968.2	-226554.9	-222168.3	-247609.1	-239913.3*
	(150154.3)	(136912.4)	(152733.2)	(138574.1)	(151760.6)	(138834.9)	(151364.2)	(139622.3)	(150413.7)	(138993.5)
Treat x Post: B-V	-62571.6	-61471.8	-29178.5	-29446.3	-19222.9	-18281.7	-36626.5	-36830.8	-21285.8	-20393.4
	(102008.3)	(105070.4)	(96372.0)	(97958.4)	(101537.3)	(103537.0)	(100136.9)	(101718.8)	(100723.9)	(102403.4)
Treat x Post: V-K	-141542.7	-136585.3	-184727.5	-185753.8	-199671.5	-196124.5	-189257.5	-187794.9	-201605.3	-198467.0
	(135961.4)	(132847.7)	(136912.6)	(130508.4)	(138929.8)	(132334.6)	(131004.8)	(124275.1)	(138779.6)	(132512.1)
Centered ROW Proportion x Treat x Post: C-T		683326.4		676702.4		682502.4		687677.9		680817.5
		(778879.4)		(778411.4)		(778231.2)		(786731.8)		(777591.6)
Centered ROW Proportion x Treat x Post: C-SE		-974030.6*		-896261.2*		-974006.7*		-942581.0*		-985042.2*
		(513069.0)		(489719.6)		(513293.5)		(496919.2)		(516436.0)
Centered ROW Proportion x Treat x Post: B-V		-41528.5		33349.2		-40301.9		18615.5		-38928.3
		(498577.9)		(434758.9)		(487996.6)		(441465.4)		(490404.3)
Centered ROW Proportion x Treat x Post: V-K		-578272.2**		-600300.7**		-581692.0**		-591617.7**		-584707.0**
		(212688.3)		(231215.8)		(221809.1)		(226310.4)		(224142.1)
Distance x Post: C-T	-20.60	-20.74	-25.88	-25.45	-22.83	-22.87	-26.26	-26.72	-19.67	-19.52
	(56.39)	(56.56)	(52.42)	(52.36)	(53.42)	(53.56)	(51.07)	(51.41)	(51.62)	(51.72)
Distance x Post: C-SE	96.19*	98.55*	90.80*	89.29*	94.92*	97.30*	72.57	73.47	71.54	75.54
	(53.88)	(54.77)	(49.85)	(49.66)	(53.67)	(54.57)	(58.51)	(58.96)	(58.27)	(59.59)
Distance x Post: B-V	39.36	39.67	56.63	56.90	66.50	66.66	53.72	53.84	67.91	68.06
	(55.66)	(58.43)	(48.32)	(45.79)	(44.88)	(46.16)	(52.08)	(50.25)	(45.00)	(46.23)
Distance x Post: V-K	-2.765	-2.048	-30.27	-33.69	-43.41	-43.81	-35.61	-37.50	-46.82	-47.55
	(76.43)	(76.54)	(69.14)	(69.38)	(74.66)	(74.62)	(70.61)	(70.46)	(77.24)	(77.27)
Weighted average ROW effect	-166002.7**	-164986.6***	-166661.5**	-168404.4***	-170157.6**	-169458.3***	-176490.9***	-177154.2***	-176451.1***	-175365.8***
	(61341.7)	(58686.5)	(62679.5)	(59313.5)	(62087.1)	(58865.5)	(61488.2)	(58306.4)	(61234.3)	(58193.2)
Observations	38912	38912	38912	38912	38912	38912	38912	38912	38912	38912
Ycf (treated post, no ROW cf.)	872910.460	871894.371	873569.264	875312.170	877065.306	876366.064	883398.674	884061.980	883358.847	882273.504
% effect vs Ycf	-19.02	-18.92	-19.08	-19.24	-19.40	-19.34	-19.98	-20.04	-19.98	-19.88

Notes: The 64 parcels that ever had a zero value in the post period are dropped. The results here are columns (2) and (4) of Appendix Table A4 using five other distance measures. Treatment, centered ROW proportion, and distance slopes vary by line and pool all post-acquisition years. Pre-acquisition improvements value and parcel size slopes vary by line and relative year; relative year zero is omitted. Distance is from parcel centroid to ROW edge. ROW proportion is centered at the average among each line's treated parcels. Parcel fixed effect and line-by-block-by-year fixed effect are included. Ycf (treated post, no ROW cf.) is a weighted-average of each line's Ycf, using fixed line weights proportional to unique treated parcels. Each line's Ycf is calculated by first averaging the estimated counterfactual outcomes across post-period years within each treated parcel, then averaging across unique treated parcels of this line. % effect vs Ycf is the ratio of weighted average impact of ROW to Ycf. Standard errors in parentheses. SEs clustered at a block of (approx.) one square mile. Significance: * p<0.10, ** p<0.05, *** p<0.01.

Table A7: ROW Impact with Hypothetical Values for Zero/No Value Subarea (Robustness Check)

	Dependent variable: parcel value per acre (in 2020 dollars)			
	(1) Hyp25	(2) Hyp50	(3) Hyp75	(4) Hyp100
Treat × Post	-172100.6**	-165569.2**	-159037.9**	-152506.6**
	(64514.7)	(65592.0)	(66925.0)	(68498.8)
Distance × Post	19.93	20.95	21.97	22.99
	(32.89)	(32.97)	(33.10)	(33.29)
Centered ROW Proportion × Treat × Post	-300662.6	-282986.2	-265309.8	-247633.4
	(189605.5)	(202091.9)	(217553.9)	(235405.9)
Constant	822886.0***	832395.7***	841905.3***	851415.0***
	(58936.7)	(59184.0)	(59508.2)	(59908.1)
Observations	38912	38912	38912	38912
Ycf (treated post, no ROW cf.)	839562.765	845942.691	852322.617	858702.543
% effect vs Ycf	-20.50	-19.57	-18.66	-17.76

Notes: The 64 parcels that ever had a zero value in the post period are dropped as robustness check. 'Hyp25', 'Hyp50' and 'Hyp75' each assumes the per acre value of the zero/no value subarea to be 25%, 50%, and 75% of the per acre value from the rest of the historical parcel that has values. Column (4) is the same with Table A2 column (4) that ignores the zero/no value subarea. Notice that this is equivalent to assuming that the zero/no value subarea has the same per acre value with the rest of the areas that have values, i.e., 'Hyp100'. Results in this table come from estimating equation (3) (assuming common effect across lines) by pooling all lines and all post-acquisition years. Distance is from parcel centroid to ROW edge. Standard errors in parentheses. SEs clustered at a block of (approx.) one square mile. Significance: * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

Table A8: ROW Impact with Hypothetical Values for Zero/No Value Subarea (Robustness Check)

	Dependent variable: parcel value per acre (2020 dollars)			
	(1) Hyp25	(2) Hyp50	(3) Hyp75	(4) Hyp100
Treat x Post: C-T	-274991.3**	-267892.9**	-260794.5**	-253696.2**
	(104945.0)	(104757.7)	(105111.0)	(105999.6)
Treat x Post: C-SE	-194401.2	-194302.2	-194203.2	-194104.2
	(124387.4)	(128931.1)	(133494.9)	(138076.8)
Treat x Post: B-V	-118866.7	-103382.6	-87898.4	-72414.3
	(98492.7)	(98403.2)	(99558.0)	(101914.7)
Treat x Post: V-K	-127487.5	-126591.3	-125695.1	-124799.0
	(131574.9)	(134071.7)	(136642.4)	(139282.9)
Centered ROW Proportion x Treat x Post: C-T	214167.8	369722.1	525276.4	680830.7
	(499110.6)	(577460.8)	(673167.7)	(779867.1)
Centered ROW Proportion x Treat x Post: C-SE	-857363.4*	-875876.0*	-894388.6*	-912901.2*
	(467469.9)	(474454.9)	(481516.6)	(488651.8)
Centered ROW Proportion x Treat x Post: B-V	-68439.6	-46170.7	-23901.8	-1632.9
	(374665.9)	(395413.6)	(417684.8)	(441248.7)
Centered ROW Proportion x Treat x Post: V-K	-494067.3**	-521429.9**	-548792.4**	-576154.9**
	(198062.1)	(205273.3)	(212966.2)	(221090.4)
Distance x Post: C-T	-23.48	-24.19	-24.90	-25.61
	(54.78)	(54.92)	(55.10)	(55.31)
Distance x Post: C-SE	91.84*	91.69*	91.55*	91.41*
	(47.12)	(47.93)	(48.83)	(49.81)
Distance x Post: B-V	18.95	21.73	24.51	27.30
	(60.91)	(59.93)	(59.08)	(58.34)
Distance x Post: V-K	-2.338	0.620	3.578	6.536
	(71.49)	(71.73)	(72.18)	(72.83)
Weighted-average ROW effect	-180909.3***	-175026.4***	-169143.5***	-163260.7**
	(57752.5)	(58653.3)	(59768.5)	(61086.4)
Observations	38912	38912	38912	38912
Ycf (treated post, no ROW cf.)	849094.929	856119.421	863143.912	870168.402
% effect vs Ycf	-21.31	-20.44	-19.60	-18.76

Notes: The 64 parcels that ever had a zero value in the post period are dropped as robustness check. 'Hyp25', 'Hyp50' and 'Hyp75' each assumes the per acre value of the zero/no value subarea to be 25%, 50%, and 75% of the per acre value from the rest of the historical parcel that has values. Column (4) is the same with Table A5 column (4) that ignores the zero/no value subarea. Notice that this is equivalent to assuming that the zero/no value subarea has the same per acre value with the rest of the areas that have values, i.e., 'Hyp100'. Results in this table come from estimating equation (4) (allowing heterogeneous effect by line). All regressions pool all lines and all post-acquisition years. Distance is from parcel centroid to ROW edge. Standard errors in parentheses. SEs clustered at a block of (approx.) one square mile. Significance: * p<0.10, ** p<0.05, *** p<0.01.

Table A9: Effect of Spillover on the Impact of ROW (Other Distances, Common Effect)

	Parcel value per acre (2020 dollars)									
	Boundary to ROW		Centroid to Line		Boundary to Line		Centroid to Tower		Boundary to Tower	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Treat × Post	-135672.7*	-159433.6**	-148893.5*	-173975.7**	-145167.5**	-171465.8**	-156578.2**	-181832.6**	-153931.1**	-180830.3**
	(70535.0)	(73414.3)	(73766.8)	(75809.6)	(70966.6)	(73833.8)	(70506.3)	(72224.4)	(68958.7)	(71119.6)
Distance × Post	16.30	9.150	3.663	-2.307	7.157	-0.789	-1.548	-7.818	0.366	-8.087
	(34.79)	(33.28)	(32.54)	(30.83)	(33.19)	(32.06)	(33.39)	(31.50)	(33.99)	(32.40)
Centered ROW Proportion × Treat × Post	-221755.0	-171832.6	-214986.8	-170086.5	-217940.1	-168679.6	-217604.0	-170396.2	-217251.0	-167421.7
	(246350.6)	(246133.9)	(239483.6)	(238244.4)	(244427.9)	(243879.5)	(241829.7)	(240899.0)	(244704.3)	(244113.1)
Constant	904603.6***	905516.8***	917896.8***	920342.0***	914568.4***	917554.8***	926553.3***	929823.3***	923437.4***	927564.6***
	(51814.7)	(51523.6)	(63291.9)	(61832.4)	(53580.4)	(53208.1)	(65894.1)	(64093.5)	(55903.0)	(55072.8)
Observations	40000	39149	40000	39149	40000	39149	40000	39149	40000	39149
Ycf (treated post, no ROW cf.)	913078.752	937088.568	926294.931	951625.868	922564.685	949118.863	933971.342	959473.885	931327.448	958477.497
% effect vs Ycf	-14.86	-17.01	-16.07	-18.28	-15.74	-18.07	-16.76	-18.95	-16.53	-18.87

Notes: Columns (2), (4), (6), (8), and (10) exclude controlled parcels whose distance from parcel boundary to ROW edge is zero (i.e., sharing boundaries with ROWs, or denoted as next to ROWs). All columns assume common effect across lines estimated from equation (3). Ycf (treated post, no ROW cf.) is first calculated for each line by giving each parcel equal weight, then by taking a weighted-average of each line's Ycf, using fixed line weights proportional to unique treated parcels. Standard errors in parentheses. Standard errors in parentheses. SEs clustered at a block of (approx.) one square mile. Significance: * p<0.10, ** p<0.05, *** p<0.01.

Table A10: Effect of Spillover on the Impact of ROW (Other Distances, Heterogeneous Effect)

	Parcel value per acre (2020 dollars)									
	Boundary to ROW		Centroid to line		Boundary to line		Centroid to tower		Boundary to tower	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Weighted average ROW effect	-142038.4**	-171125.0**	-154911.4**	-188800.1***	-147997.8**	-185465.1***	-161124.7**	-194582.7***	-155109.8**	-192798.9***
	(65259.7)	(67335.9)	(65651.9)	(65358.1)	(63589.5)	(63293.7)	(62963.9)	(62573.1)	(61829.2)	(61310.7)
Treat x Post: C-T	-220161.3**	-225964.7**	-258114.0***	-263048.9**	-227703.4**	-233228.9**	-246478.7***	-252557.9**	-223636.3***	-229669.1**
	(83992.6)	(100495.1)	(92715.8)	(109658.3)	(84890.6)	(101484.9)	(84967.9)	(101449.3)	(80051.9)	(96136.4)
Treat x Post: C-SE	-173196.8	-184717.2	-153794.6	-167830.9	-167338.1	-179296.6	-184397.8	-200324.1	-193946.3	-206925.7
	(170194.0)	(180072.0)	(179545.0)	(191214.3)	(170400.9)	(180590.4)	(170682.5)	(181106.7)	(161984.8)	(171690.6)
Treat x Post: B-V	-27813.3	-36757.0	-27.34	-16120.1	16994.0	1827.9	-4142.7	-19786.7	14331.5	441.1
	(110708.5)	(118161.3)	(102198.0)	(109522.9)	(106166.2)	(114353.7)	(105490.2)	(113009.2)	(103890.9)	(111396.2)
Treat x Post: V-K	-134222.2	-226088.9	-189360.9	-292373.3***	-198960.6	-318758.9***	-194153.0	-292728.1***	-204132.9	-324506.6***
	(150859.2)	(136336.9)	(142393.5)	(98818.5)	(140948.9)	(101310.7)	(136330.1)	(94265.3)	(142492.2)	(105311.8)
Centered ROW Proportion x Treat x Post: C-T	577145.0	612259.2	557826.3	592508.0	575070.2	610002.9	580628.0	615068.2	568973.0	604041.0
	(791280.9)	(803438.7)	(796656.4)	(807843.5)	(790970.7)	(802941.7)	(804071.7)	(815411.7)	(792231.6)	(804263.6)
Centered ROW Proportion x Treat x Post: C-SE	-1084799.2***	-1107561.8***	-1011894.9**	-1039369.0**	-1085188.9***	-1107869.9***	-1052942.5**	-1077974.9***	-1093543.1***	-1115340.2***
	(390970.3)	(393168.0)	(392779.0)	(391952.5)	(390820.4)	(393069.0)	(386909.8)	(388950.5)	(388041.6)	(391979.9)
Centered ROW Proportion x Treat x Post: B-V	231835.2	243006.6	297835.3	294903.2	229768.3	238509.0	285042.2	284583.8	231246.9	239486.2
	(373945.6)	(370826.6)	(325529.8)	(323288.0)	(363007.6)	(361341.3)	(329479.4)	(327499.2)	(362698.0)	(361031.0)
Centered ROW Proportion x Treat x Post: V-K	-601190.1***	-409020.5**	-620328.2**	-443214.6**	-603407.6**	-404341.4**	-613022.2**	-425470.3**	-606538.1**	-407962.6**
	(209989.0)	(173638.9)	(235941.1)	(207381.9)	(221832.9)	(189082.8)	(229180.3)	(198583.3)	(225090.0)	(192406.2)
Distance x Post: C-T	-47.61	-46.57	-57.62	-56.29	-50.23	-49.03	-54.34	-53.66	-49.09	-48.25
	(54.44)	(58.60)	(48.27)	(51.51)	(51.03)	(55.04)	(47.14)	(50.38)	(49.07)	(52.93)
Distance x Post: C-SE	95.19*	89.35	83.81	77.77	94.85*	88.95	64.82	57.45	72.05	65.50
	(53.39)	(53.03)	(55.23)	(54.64)	(53.64)	(53.16)	(65.35)	(63.60)	(62.93)	(61.40)
Distance x Post: B-V	35.88	29.78	50.51	40.25	65.05	55.02	50.03	39.56	66.15	56.68
	(57.75)	(63.00)	(44.25)	(48.11)	(45.77)	(50.65)	(49.22)	(53.42)	(45.72)	(50.45)
Distance x Post: V-K	6.259	-25.35	-30.97	-60.56	-40.29	-81.85*	-36.44	-64.62	-45.97	-89.02*
	(82.29)	(62.56)	(68.11)	(43.31)	(71.91)	(44.43)	(68.71)	(44.42)	(75.71)	(49.17)
Observations	40000	39149	40000	39149	40000	39149	40000	39149	40000	39149
Ycf (treated post, no ROW cf.)	920265.909	949609.156	933157.421	967312.542	926250.850	963986.619	939393.635	973118.572	933400.770	971350.942
% effect vs Ycf	-15.43	-18.02	-16.60	-19.52	-15.98	-19.24	-17.15	-20.00	-16.62	-19.85

Notes: Columns (2), (4), (6), (8), and (10) exclude controlled parcels whose distance from parcel boundary to ROW edge is zero (i.e., sharing boundaries with ROWs, or denoted as next to ROWs). All columns assume heterogeneous effect across lines estimated from equation (4). Ycf (treated post, no ROW cf.) is first calculated for each line by giving each parcel equal weight, then by taking a weighted-average of each line's Ycf, using fixed line weights proportional to unique treated parcels. Standard errors in parentheses. Standard errors in parentheses. SEs clustered at a block of (approx.) one square mile. Significance: * p<0.10, ** p<0.05, *** p<0.01.

Appendix B: Additional Figures

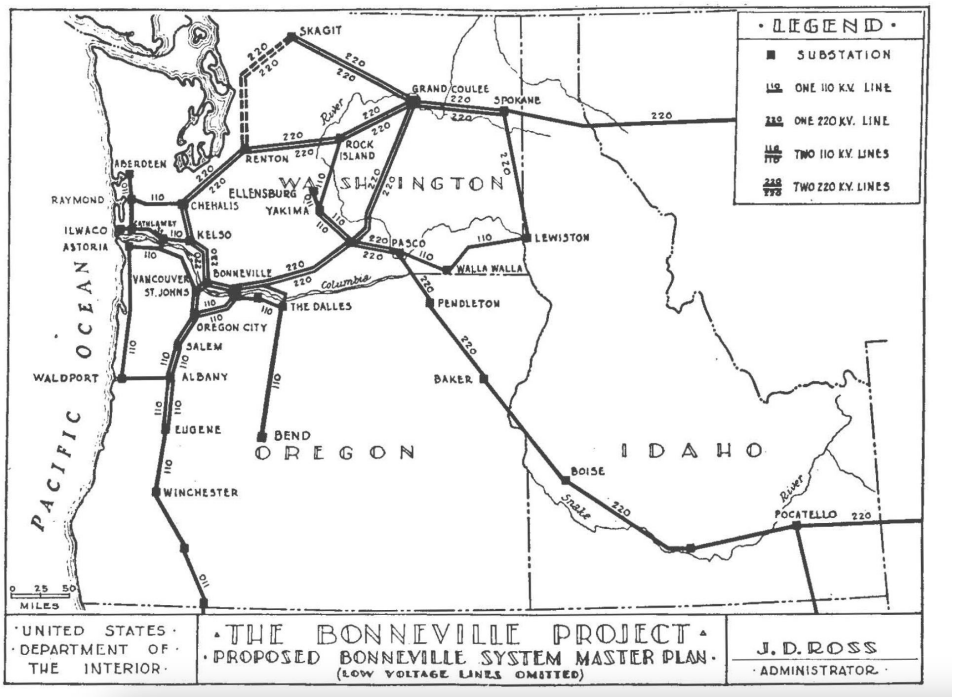


Figure B1: BPA Master Grid, 1938.

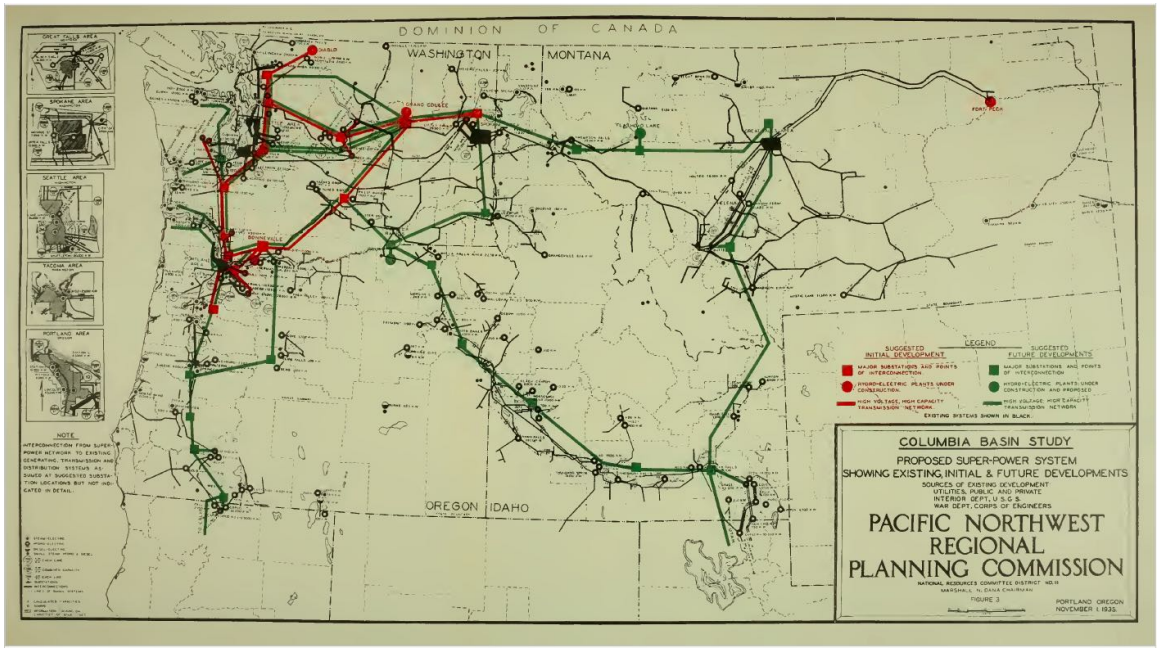


Figure B2: Proposed Power System for the Pacific Northwest, Pacific Northwest Regional Planning Commission, National Resource Committee, 1936.

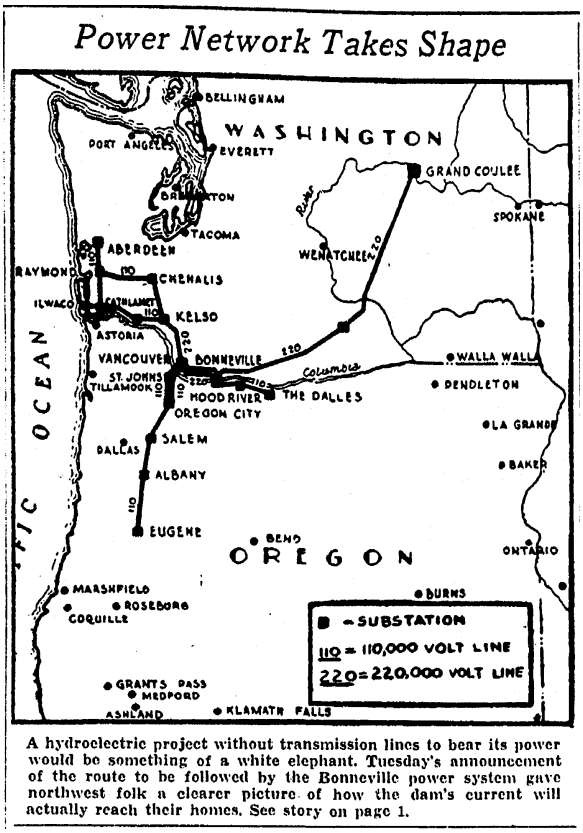


Figure B3: BPA Master Grid published in the Oregonian, November 1938.

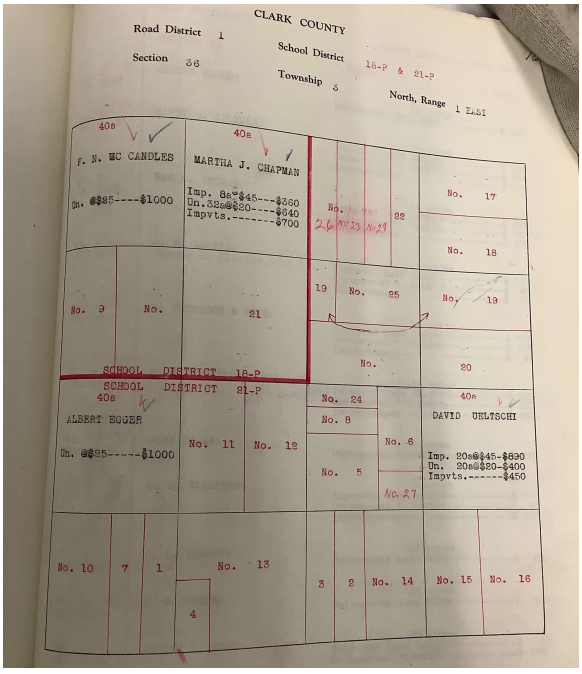


Figure B4: Section 36 of T3N R1E in Clark County, WA in 1939.

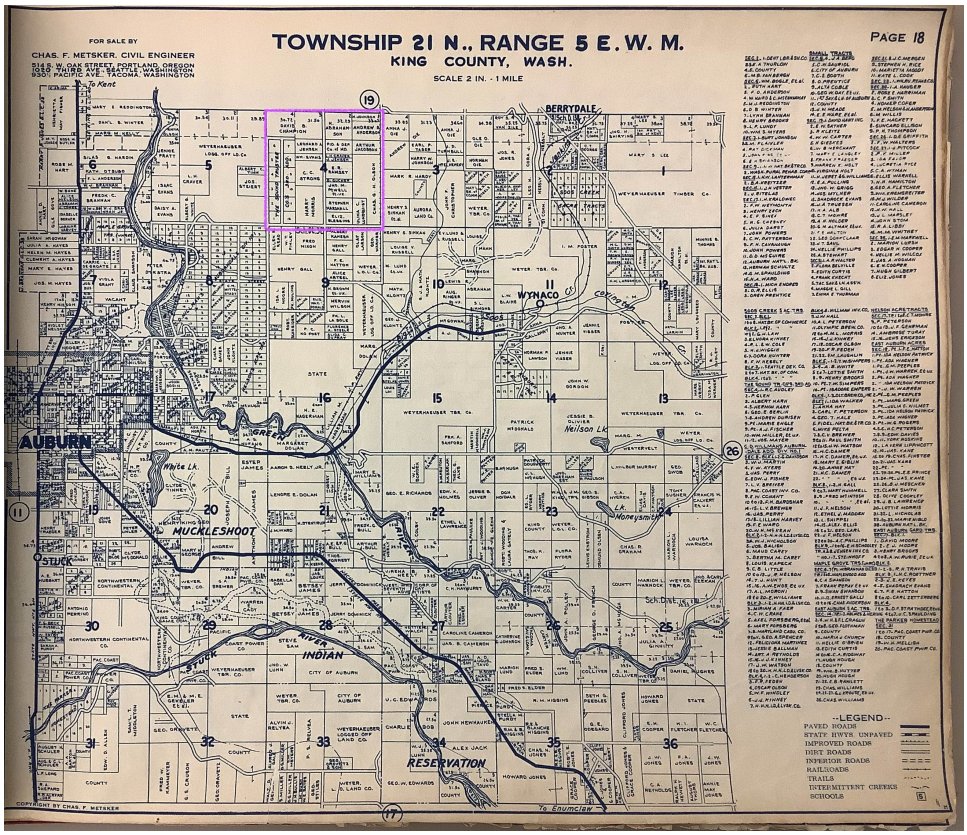


Figure B5: 1936 Parcel Ownership Map for T21N R5E, King County, WA.

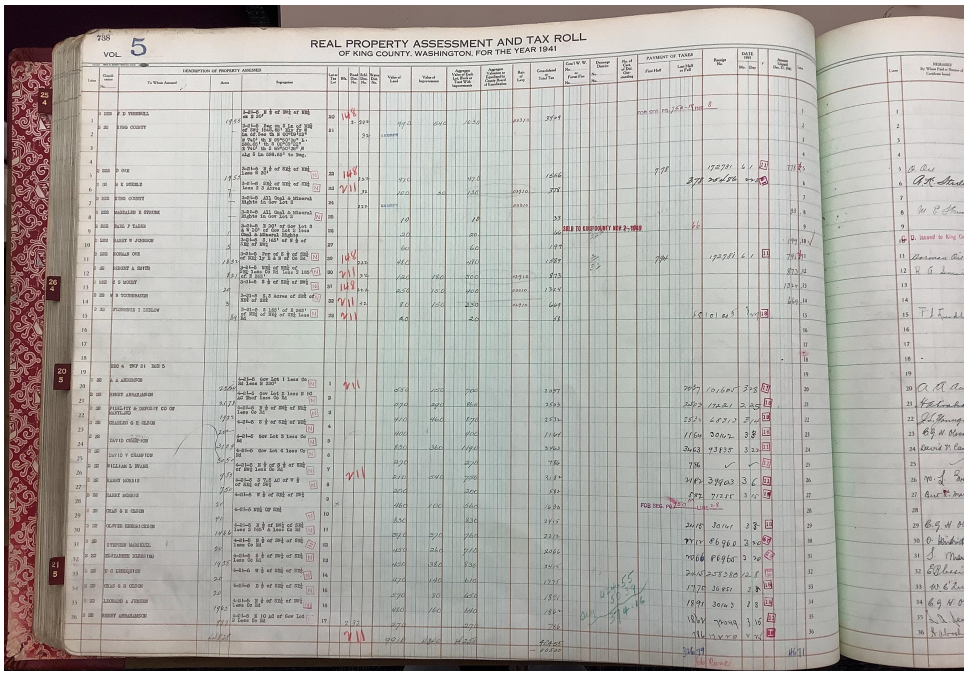
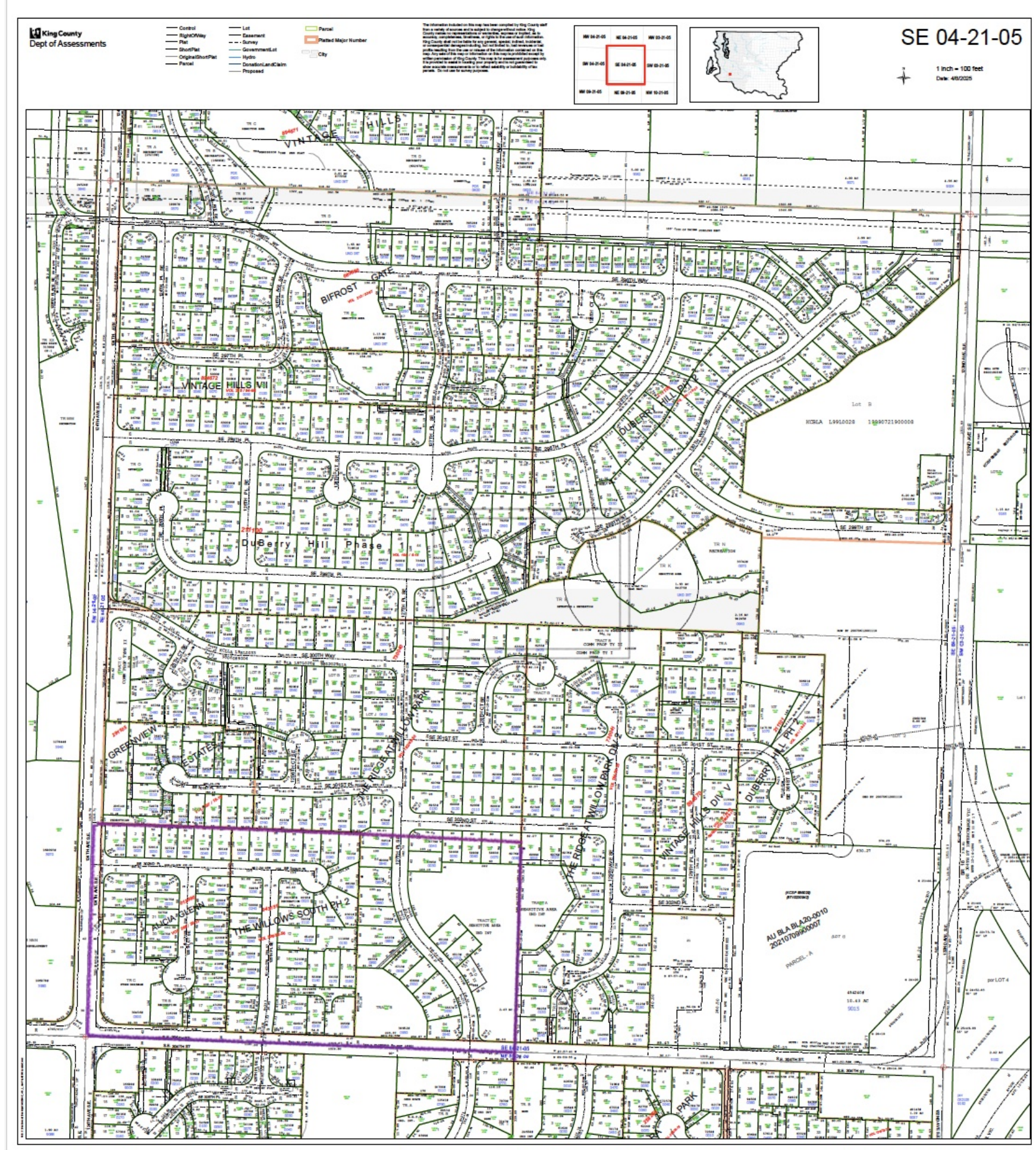
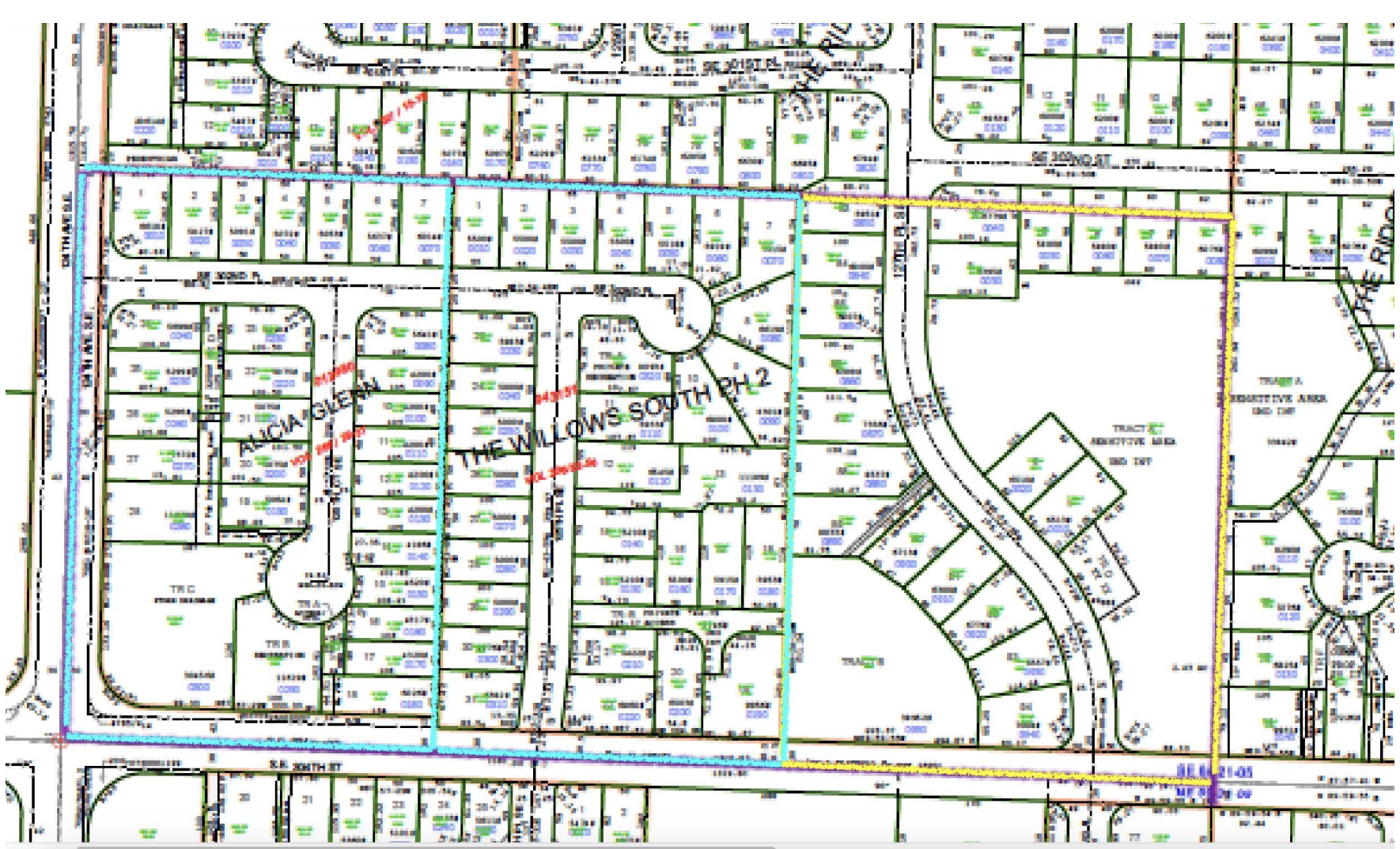


Figure B6: 1941 Tax Roll, King County, WA.



(a)



(b)

Figure B7: Lot 13 of Section 4, T21N R5E, King County in Today.



Figure B8: Post-1938 Parcel Ownership Map for Durgan DLC in Clark County, WA. Notes: The 1938 map is the same for this DLC but without ROWs depicted by the county assessor.

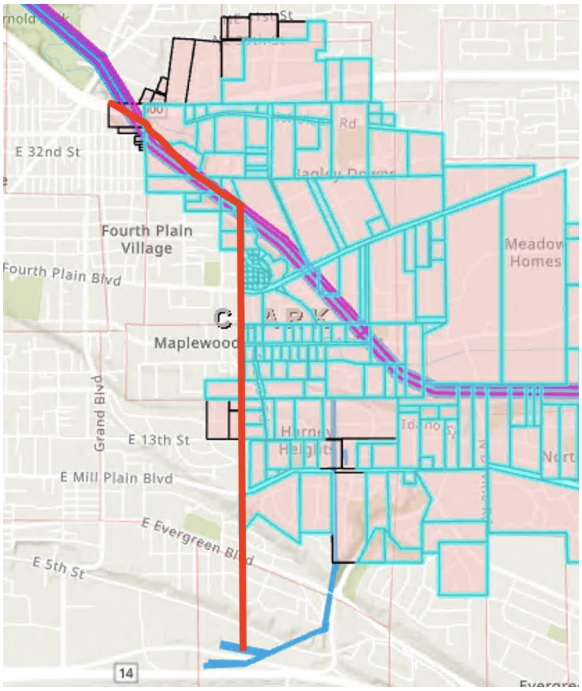


Figure B9: The Edge of the Historical Greater Vancouver. Notes: the red line is the edge. The city of Vancouver was on the left of the red line.

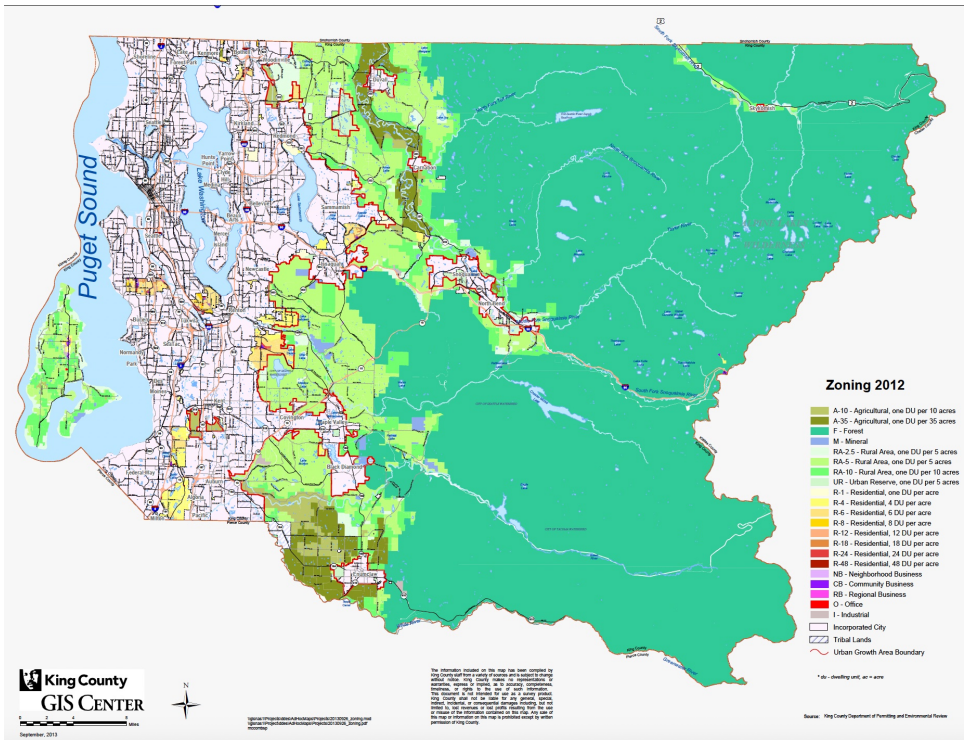


Figure B10: King County Zoning Map.

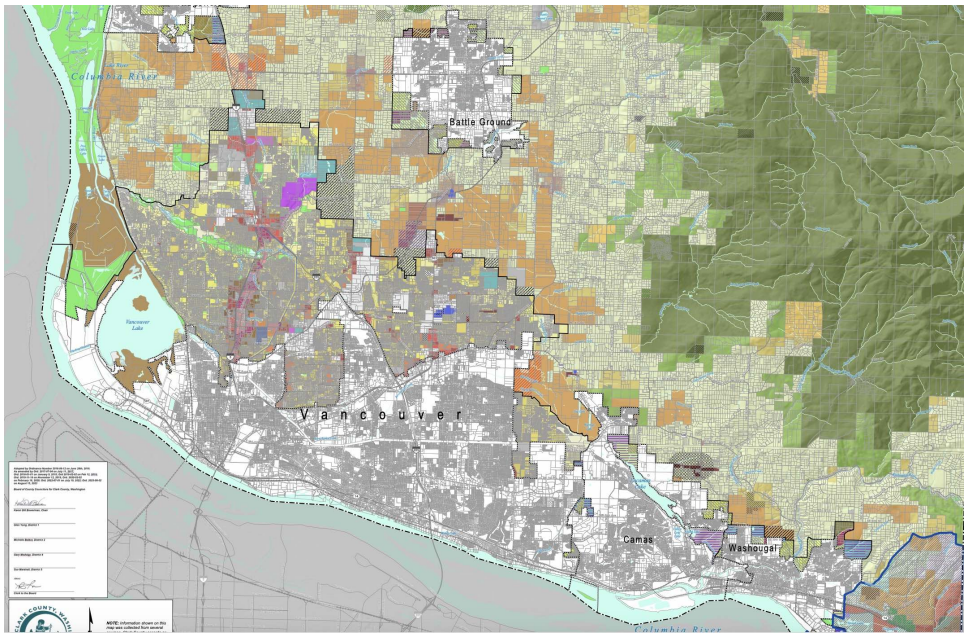


Figure B11: Vancouver Urban Growth Area, Clark County Zoning Map.

Appendix C: Ownership and Land Usage of Current Parcels That Have ROWs

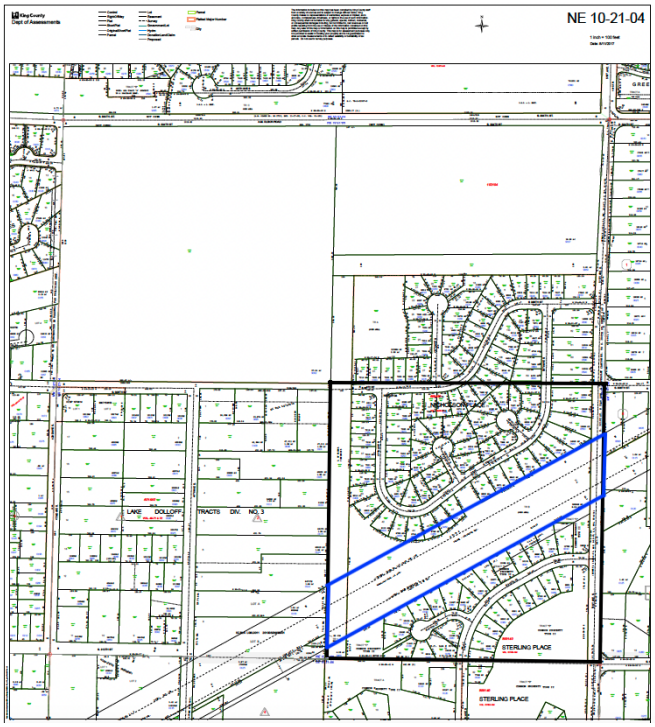
To understand why a treated parcel's contemporary values are much lower than those of a controlled parcel - the main reason why the treatment effect is negative, it's important to know who in modern times owns parcels that hold a ROW and what are those parcels used for.

For B-V and V-K, because their ROWs were acquired by title thus owned by BPA, these ROW lands are exempt from property value assessment unless there's a small parcel located on a ROW land that usually holds a facility house of BPA, which would then have an assessed value. Moreover, these ROWs in most cases are not located on any current parcels, which usually have assessment information, except in a few cases where a ROW is located on a parcel owned by a public entity (e.g., Clark County Public Works), or very rare, by a private real estate developer (e.g., a park developer). Although, these parcels may or may not have a non-zero assessed value depending on what the entire parcel is used for. Notice that these parcels are no longer owned by BPA despite once owned by BPA in history, this is because BPA has disposed some of the ROWs they initially acquired by title.

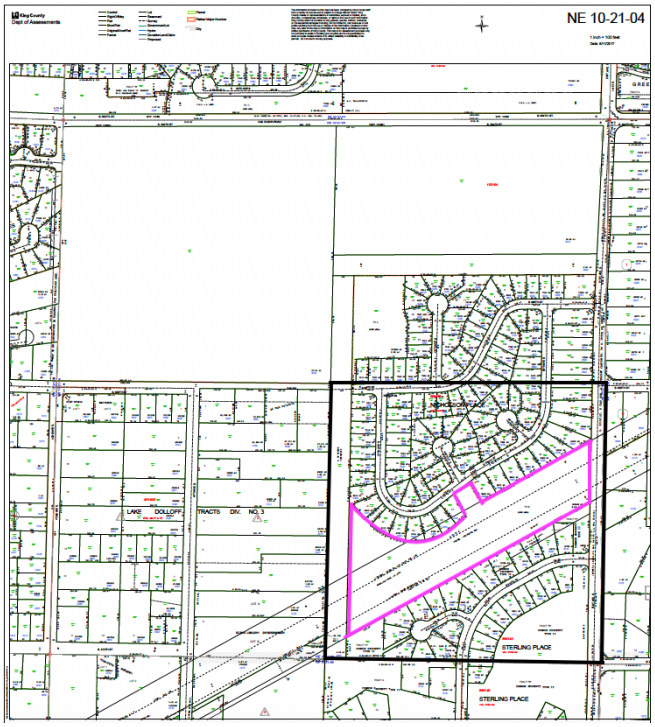
There's more data available to look at C-T and C-SE because their ROWs were acquired by easement. There are 648 out of **24382** (2.6%) current parcels that hold ROWs for C-T and C-SE. Some of these parcels don't have assessed values, and the total size of ROWs on them is about 9.4% - 9.6% of the total size of C-T and C-SE's ROWs.[40] Detailed information of ownership and land usage doesn't exist for parcels with no assessed values. But, based on the 'ids' of these parcels, they are mostly "tract lots"[41] that "represent an undivided interest within the plat and are not considered lots or building sites for purposes of residential dwelling construction". They are owned for the purpose of ingress/egress (e.g., privately-owned access roads), utility facilities, open spaces, or they could be parcels with environmental restrictions (e.g., parcels set aside for native growth protection). Other than being a tract lot, a parcel with no assessed value could also represent a water body within a plat, and is usually owned by a water district. Figure C1 provides an example of a ROW locating on a parcel that doesn't have assessed values. The blue parallelogram indicates the ROW on Lot 4 of Section 10, T21N R4E of King County, which is partially located on a parcel (the pink polygon) that is an open area.

[40] The ratio of a current parcel that overlaps with a line's ROW could be very small when it's not zero. The lower bound 9.4% comes from truncating the lowest ratio to 0.01. This narrows the number of parcels that are considered to have ROWs, but barely affects the land use distribution over these current parcels.

[41] A tract lot doesn't have to be a parcel that holds a ROW. It could be anywhere, such as within a treated parcel but doesn't include areas where a ROW is located, or inside a residential subdivision, e.g., part of a cul-de-sac.



(a)



(b)

Figure C1: The Current Landscape of Lot 4 in Section 10, T21N R4E, King County. Notes: boundaries of Lot 4 are indicated by the black lines. The blue parallelogram in (a) is the ROW on Lot 4. The pink lines in (b) indicate an open area in Lot 4. Source: King County Department of Assessment.