Visualizing Living Streets in North St. Paul: A Visual Preference Survey in the Casey Lake Neighborhood

A Plan B Paper
In Partial Fulfillment of the MPlan Degree Requirements
The Hubert H. Humphrey School of Public Affairs
The University of Minnesota
By Sean A. Rahn
May 19, 2014

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PREFACE

This final paper, along with a Capstone Report entitled, "Building Support for Living Streets-Visual Preference Survey in Casey Lake Neighborhood," co-written with Emily Goellner and Cadence Peterson fulfills the Masters MPlan degree requirements for Sean Rahn. Portions of this paper can also be found in the cited Capstone Report.

Goellner, Emily; Peterson, Cadence; and Rahn, Sean (2014). "Building Support for Living Streets-Visual Preference Survey in Casey Lake Neighborhood." Completed for the City of North St. Paul, MN in partnership with the Resilient Communities Project. PA 8081 Capstone Project Report, Hubert H. Humphrey School of Public Affairs, Minneapolis, MN.

EXECUTIVE SUMMARY

The City of North St. Paul, working in conjunction with the University of Minnesota, seeks new ideas and strategies on how best to reengage the community in a discussion that would ideally lead to successful implementation of its approved living streets design policy and plan.

This paper provides the overall context as to why North St. Paul ultimately rejected its own planning efforts regarding living streets in 2011. Understanding this context helps define the need to develop a better community engagement approach in the city. The visual preference survey process is a tool planners use to help citizens envision changes to their built environment while garnering their preferences for or against streetscape design. Combing the visual preference survey with living streets design elements is the engagement approach taken in our capstone work with North St. Paul.

The visual preference survey as a planning tool is discussed as well as the methodology and implementation strategies used to limit survey biases and errors in a visualized format. Strategies associated with selecting the sample frame (the neighborhood surrounding Casey Lake) as well as the design and implementation of the survey questionnaire are highlighted. The establishment of image selection rationale and protocol is also a main focus of this paper.

General survey findings show neighborhood preference and support for the incorporation of certain elements of living streets in North St. Paul (namely raingardens, street narrowing and enhanced intersections) over the existing as-built environment. Elements such as street medians and off-street bike lanes as replacements for sidewalks were not as popular.

Recommendations for future action include establishing stronger community engagement efforts (through the use of additional visual preference surveys and other mechanisms) early in the planning process. Focusing engagement on a demonstration site, fostering living streets redesign "champions," and remaining flexible in element design and incorporation are all keys to successful implementation.

OVERVIEW

What is a living street? In terms of streetscape redesign in a metropolitan setting, living street projects in the United States incorporate eco-friendly elements and community-building aesthetics into overall street improvement. Living streets build on the overall "complete streets" redesign concept. This concept asks planners and engineers to redesign and build road networks that enhance the walkability and interconnectedness of neighborhoods and communities by creating a safe transportation infrastructure for pedestrians, bicyclists and the motoring public.

The City of North St. Paul, Minnesota was one of the first cities in the Twin Cities metropolitan area to adopt a complete streets and living streets policy and redesign manual. As in most communities, the city is undertaking a multi-year, phased-in approach to roadway resurfacing. As part of its overall capital improvement plan, living streets design elements were intended to be incorporated into the neighborhood streetscape redevelopment efforts. However, despite the city's relatively early adoption of living streets policies, North St. Paul has fallen behind other metropolitan communities in terms of implementation and has yet to incorporate living streets concepts and design elements in its redesign efforts.

In partnership with the Resilient Communities Project, the City of North St. Paul and the University of Minnesota, three teams of students were assigned to develop overall recommendations for reengaging decision makers and the public in the implementation of the living streets policies. The group I was assigned to conducted a literature review, a case study analysis of the successful implementation of living streets in various communities throughout Minnesota, as well a life-cycle costing analysis of living street design elements. We narrowed the scope of the project to a particular neighborhood of North St. Paul, and we developed and implemented a prototype community engagement visual preference survey process. Based on our overall findings, a set of recommendations was developed to further neighborhood engagement while highlighting the living streets design element preferences of North St. Paul residents.

Overall, this paper is broken into four parts. First, I will provide an overview of our capstone project which includes defining living streets design concepts and elements, the historical context of the living streets work in North St. Paul, and the challenges the capstone work is intended to help address. Second, I will outline the visual preference survey as tool used by planners to engage the public and help decision-makers understand design aesthetics and the desires of their constituencies. Third, I will focus on the development and implementation of the visual preference survey for North St. Paul, discussing the methodology including efforts to categorize findings and limit biases. Fourth, I will analyze and draw conclusions based on the survey findings. I will conclude by outlining strategy recommendations designed to assist North St. Paul decision-makers in the incorporation of living street/complete street design elements into neighborhood streetscape redesign efforts.

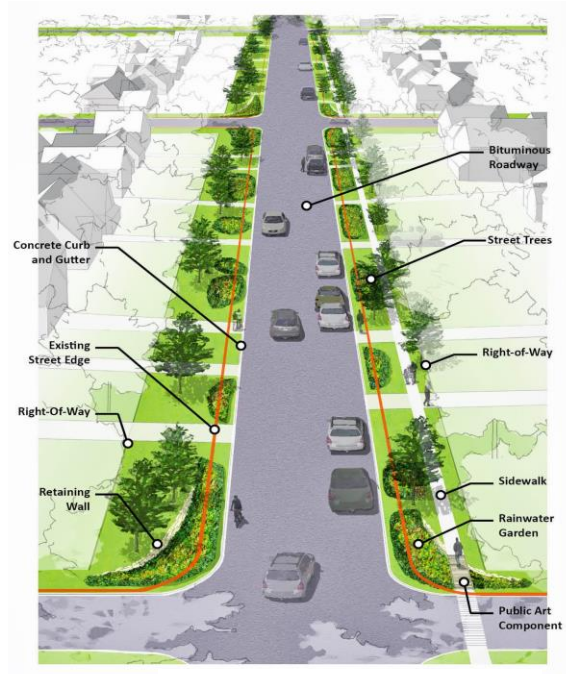
CAPSTONE OVERVIEW—DEFINING COMPLETE AND LIVING STREETS

Living street design elements have their foundation in the complete streets movement which began in 1971. The desire to create a safer environment for pedestrians and bicyclists utilizing community streets prompted the Oregon legislature to enact the nation's first complete streets policy which states,

> "*Footlanes and bicycle trails, including curb cuts or ramps as part of the project, shall be provided wherever a highway, road or street is being constructed, reconstructed or relocated.*"
> *(Oregon Statute 366.514)*

Since then, at least 27 states, 42 regional planning organizations, 38 counties, and 379 municipalities across the United States have adopted complete streets policies either in the form of laws, resolutions, executive orders and/or comprehensive plan ordinances (Seskin and Gordon-Coven, 2013). The complete streets approach to street design breaks down the traditional barriers separating highways, transit, biking and walking and instead focuses on the, "desired outcome of a transportation system that supports the safe use of the roadway for everyone." (Seskin and Gordon-Coven, 2013) These policies help guide planners, engineers and community leaders in prioritizing the construction of streetscape design elements that create a more comprehensive transportation network and promote use by all. These elements include sidewalks, cross-walks, dedicated bike and bus lanes, crossing islands, transit stops, enhanced pedestrian signage and other traffic calming safety elements such as road-narrowing, curb bump-outs, speed bumps, and short medians. The term "living streets" or "green streets" as it is known in other parts of the country, builds on the complete street concept of creating an interconnected transportation network that promotes use by all with the incorporation and enhancement of the natural environment.

The city of North St. Paul called its visioning plan for future street redevelopment "Living Streets" because, "The name connotes a street where people are active and nature is accommodated." (North St. Paul Living Street Plan, 2010) Design elements prominent in living street plans include residential and boulevard raingardens, vegetated swales and catch basins, tree plantings and older tree retention, permeable/porous pavement, and sidewalk designs intended to meander through the natural environment. Living street plans seek to enhance the functionality of the public corridor by preserving traffic and parking uses while accommodating safe pedestrian use, bicyclists and nature.



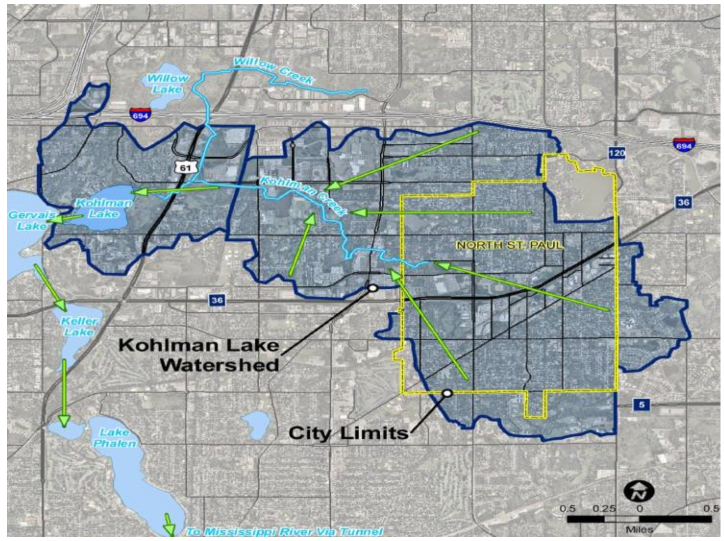
North St. Paul Living Streets Design Manual

One primary goal of incorporating living street design elements into street reconstruction is to infiltrate more rainwater on site and reduce runoff. For example, the Washington-Ramsey Watershed District estimates that the average residential lot in North St. Paul will generate nearly 49,000 gallons of storm water runoff yearly. They estimate that a 100 square foot raingarden will capture and infiltrate 9,000 gallons and will prevent 94% of sediment, up to 87% of phosphorous (which can initiate large algae blooms in lakes) and 49% of nitrates from entering the watershed with each rain event (Washington-Ramsey Watershed District Raingarden II Plan and NDPES data). In addition, cities such as North St. Paul in conjunction with the local watershed have set a goal to infiltrate at least the first inch of rainfall onsite (Aichinger and Rozumulski, 2010). Raingardens, swales, trees and permeable surfaces not only assist with helping meet this goal, but they bring a new aesthetic into a typical urban residential environment.

CAPSTONE OVERVIEW—LIVING STREETS IN NORTH ST PAUL

The challenge of implementing living and complete street policies does not typically lie with the design elements themselves, but rather with the political and cultural make-up of an individual community (McCann, 2013). The problem of how to implement complete and living street design in North St. Paul is the primary focus of our capstone project. Therefore, it is valuable to analyze the overall background and context which led North St. Paul to reject living street implementation in 2011.

Living Streets in North St. Paul had their origin in neighboring Maplewood. In 2009, the Washington-Ramsey Watershed district realized that decreasing water quality of Kohlmen Lake (now on the state's impaired waters list) in Maplewood was destroying fish and wildlife habitat. They traced the cause of the impairments to polluted storm runoff from North St. Paul's storm sewer system, which empties into Kohlmen Lake. Officials from the watershed began working with North St. Paul on a street reconstruction plan that would incorporate design elements intended to infiltrate as much water as close to where it falls as possible. (Trump, 2011). Raingardens would become a major feature of the plan.



At the same time, North St. Paul was finalizing the plan for its 20 year street reconstruction capital improvement strategy (see Appendix A, NSP Capital Improvement Plan). City staff realized that street enhancements similar to those being developed in alignment with Rochester and Richfield's complete streets efforts could fit within the overall street improvement process in North St. Paul as well. An engineering firm was contracted, a citizen led taskforce was appointed and a North St. Paul Living Streets design guide and planning document was created which incorporated raingardens, bike lanes, parking areas, curb extensions, street narrowing and sidewalks into an overall street redesign strategy for the city (North St. Paul Living Street Plan, 2010).

The North St. Paul's Living Street Plan laid out policy rationales and benefits for the various design elements under consideration. Pedestrian safety, environmental protection, health and economic benefits were all discussed in order to provide a rationale for the incorporation of living street design elements into the existing built environment. In addition, as North St. Paul used assessments to fund a majority of its street improvements, sources of grant funding were identified to assist in off-setting any additional costs that could be attributed to the elements. The guide and overall living streets policy was approved by the Council in the fall of 2010.

The city was poised to implement its newly approved living streets policy and vision on a section of 15th Avenue from McKnight Road to Margaret Street. This section of road was identified for reconstruction due to the age and condition of the street and utilities, which were over 80 years old. The city council directed staff to prepare a feasibility study for the avenue that incorporated design elements laid out in the Living Streets Plan (NSP press release, 2011). In addition to bike lanes and sidewalks (see Appendix B, NSP Bike and Sidewalk Plan), another major feature of the plan consisted of street narrowing (from 30 feet to 22 feet), which would eliminate parking on one side of the street. Reducing asphalt saved funds that would have been used to pay for raingarden and sidewalk construction. Overall the estimated cost of the project was $1.9 million. The watershed secured $700,000 in Clean Water Fund grants, and the remaining funds would be paid using North St. Paul utility funds (Trump, 2011). The intent was to prevent adjacent residents from incurring any additional assessments for the incorporation of the living street elements (Aichinger Interview, 2014).

The reconstruction of 15^{th} Avenue was intended to be a demonstration project that would showcase living streets design elements to the entire community. It was hoped that living street elements would then be incorporated in further street reconstruction efforts in alignment with the capital improvement plan. However, nine months later, the City Council rejected the demonstration project on 15^{th} avenue and has yet to realize any of its living street policy goals.

Vocal citizen opposition at the city council level scuttled the plan. Throughout the spring and summer of 2011, the Wastershed Commission and the citizen taskforce that developed the living streets plan held outreach workshops for the impacted residents. Door-knocking and information sharing were conducted among the 66 homes adjacent to 15^{th} Avenue. Redevelopment plans were presented and some residents were identified as early supporters of street narrowing that would lead to a reduction of speed on the roadway. However that outreach appeared to be too late in the process and too limited in scope. Only thirty-nine homeowners chose to participate in the discussion, and of those thirty-nine, only twenty-five actively attended the townhall meetings. Six households were strongly opposed and actively lobbied the city council and the mayor to reject the plan. The opposition focused on the perceived costs and maintenance (snow removal) of building new sidewalks where none currently exist (Horner, 2011). Ultimately, the plan was defeated at the City Council, and the resources designated for North St. Paul went to neighboring Maplewood and were used to build their version of living streets.

Watershed officials acknowledge that the outcome was influenced by the political realities of the situation and not the benefits of the living streets design elements themselves. Successful implementation efforts around the county have found it essential to build confidence and more generalized support for living/complete streets before it gets to the project level. Also, identifying, engaging and mobilizing key project champions to provide positive reinforcement and turn out when opposition arises help provide a counter to a typical vocal minority who will always remain opposed (McCann, 2013).

15^{th} Ave as it existed in 2011

Proposed 15^{th} Ave street redesign

[Case studies illustrate the role that effective engagement can play in living street implementation. While not a formal part of this paper, Appendix C includes a case study analysis conducted in Richfield that is illustrative of a successful, context sensitive approach taken to implement the city's first complete streets project in 2011.]

THE VISUAL PREFERENCE SURVEY AS A PLANNING TOOL

Our capstone seeks to reinvigorate the living and complete street discussion among city leaders and residents of North St. Paul. We ultimately chose to use an "organic" or bottom-up process to restart the citizen outreach efforts. Rather than attempt to convince residents of the benefits of living street design elements through door to door discussions or townhall meetings, we sought an approach that let residents envision living street design elements in a standard streetscape while also allowing them to show their preferences for each element tested. Such visualization and resident engagement were accomplished through the use of a visual preference survey.

The U.S. Department of Transportation defines a visual preference survey as a technique that assists the community or neighborhood in determining which components of a plan or project environment contribute positively to a community's overall image or features (USDOT, 2002). The technique is based on the development of one or more visual concepts or design elements of a proposed plan or project. Once the design elements are developed in a visual format, they are shown in a public setting, gathering, or door-to-door.

The visual preference survey (VPS) process was developed by Anton Nelessen, an architect and planner at Rutgers University in the late 1970s. In one of his earliest incarnations of the survey, he was contracted by the City of Metuchen, New Jersey, to assist in the redevelopment of the downtown and surrounding suburban residential infrastructure (DePalma, 1989). He developed the tool as a visioning technique enabling residents to articulate their impression of the present community image and to help build consensus for its future character (Nelessen, 1994). Nelessen felt that too often, comprehensive planning and land use design efforts focused on desired fiscal benefits and cost analysis with little attention paid to the physical, visual, psychological and ecological considerations of the residents. The VPS was designed to provide a balance between financial considerations and design aesthetics.

As originally conceived, the VPS process asked residents to literally give a thumbs up or down to images shown at a townhall meeting (Nelessen, 1994). The process has been refined using a Likert Scale, to give residents the ability to rate a series of images as acceptable or unacceptable for the community. The degree to which an image is positive or negative is reflected in an assigned value (e.g. +3 versus +2 or -1). Images that people do not feel strongly about can be rated as neutral or 0. Once the sums, averages and standard deviations are calculated and analyzed, it is determined which images are positively or negatively rated. As a result, participants can express judgments and possibly reach a consensus about visual design features, which may be incorporated in the goals, objectives, and design guidelines for a plan or project. This consensus, which Nelessen calls the "common vision", also provides planners with an understanding of what a particular community wants and is willing to accept in the built environment. (Nelessen and Constantine, 1993).

The images used should depict the functional characteristics of the community as reflected in local zoning requirements, however they should not consist entirely of images that strongly contrast. Nelessen determined images that appear closely related can reveal subtle variations that distinguish a positive image from a negative one (Nelessen, 1994). As a comprehensive community visioning tool, Nelessen sought public input on all manner of community design elements from building style and materials to setbacks, signing, streetscape and landscape designs. The VPS visioning process provides a starting point for community stakeholders to begin the planning process for the future design of their communities.

> *"In the years since the Metuchen project, working with many different communities, we have found that the VPS enables citizens, government officials and developers to participate in creating a common vision — for either a large development project, a part of the community or, even, the entire community." (Nelessen and Constantine, 1994)*

However, does a survey based on visual cues accurately capture the true perceptions of the participant? Visualization is increasingly used by professionals in interactive design and planning work (Tyrvainen, 2006). Successful communication often depends on presenting understandable information to all participants. Aesthetic perception and evaluation of the environment occurs mainly through the sense of sight and no specialized training or education is needed for the public to participate in a visualization process (Tyrvainen, 2006). In addition, one suggested benefit of using a visual survey is that it may decrease conceptual misunderstandings in relation to participatory planning processes (Tahvanainen, et. al. 2001). For example, negative preconceptions of raingarden design may be ameliorated through the use of accurate imagery as opposed to verbal cues alone.

Video imaging or photomontage visualization (photo manipulations), which is used in our North St. Paul visual preference survey, uses computer software to manipulate digital images to create the design element under consideration. Studies on visual imagining techniques have shown that the pictures produced are open to inaccuracy and perspective distortion. S.R.J. Shepard, <u>Guidance for Crystal Ball Gazers, developing a Code of Ethics for Landscape Visualization,</u> advocates for robustness in image depictions that present accuracy, representativeness, visual clarity, interest and legitimacy in order to provide imageries useful in the decision making process (Shephard, 2001). The visual preference survey is a perception-based assessment tool, the product of which, "…is a combination of the features of the visual image interacting with the psychological (perceptual, cognitive, emotional) processes of the observer." (Daniel, 2001) Representational validity studies using high resolution, high realistic visualizations have supported aesthetic quality assessments that correlate highly with the direct observation of landscape components (e.g. Bishop and Hull, 1991, Bishop and Leahy, 1989, Daniel and Meitner, 2001, Orland, 1993, Vining and Orland, 1989). Viewing a high quality image of a landscape design approximates direct observation of the element under review. Hence the perceptions and rankings of the visual aesthetic of the image in question would not radically differ if the item were viewed directly.

In the context of collaborative planning, "in order to evaluate the effect of any particular change…it is important that the visualization medium allows only one aspect of the landscape to change at a time." (Tyrvainen, 2006) In the case of North St. Paul, creating "before" and "after" imagery allows participants to evaluate a single streetscape design element holding all other variables in the image (lighting, color, infrastructure) constant. As in every survey, strategies to limit biases are also are employed and will be discussed in more depth in the methodology section.

Building on the visual preference survey as an instrument, multivariate regression (ordinary least squares) can be used to help further explain differences in image content in a statistical sense. Using statistical techniques to determine the mathematical relationships that exist between image components and the scenic preferences of observers may help explain why certain image elements engender positive or negative preferences (Arriaza, et. al. 2004). In such analysis, the dependent variable tends to be the average score for a given image, while independent variables based on image content/components are determined. Correlations between variables are analyzed and statistically significant results may help explain the relationship between an image component and the overall reaction and rating of the survey participant.

Furthering a planner's ability to explain data received through a visual preference survey, a methodology was recently developed using relatively new statistical software that estimates a cross-classified random effects model, which is a form of a hierarchical model (Ewing, et. al. 2007). Such a model works well when an outcome varies systematically in two dimensions; in the case of a visual preference survey, the scenes and the viewers are the two dimensions. The model seeks to better explain the relationship between a viewer and their "nested" scores for all the images. The variances between viewers and scenes are analyzed, and rather than focus on viewer preferences for street characteristics, the model operationally defines the elements (tree canopy, curb extensions, sidewalk width, parking, commercial uses) that constitute what viewers consider constitute a "mainstreet". Based on a calculated "mainstreet" score, the authors of the methodology devised a formula that when applied to city streets, could guide planners in the development or redevelopment of streets to be more in line with aesthetics associated with "mainstreets".

Since its inception, the VPS process has been used by numerous municipalities and planning functions around the world that seek to better understand residents' perceptions of the built environment as well as help set development goals for the future. The VPS is an effective tool used to initially engage citizens in the community planning process while also helping foster an understanding of design choices available (Steiner and Butler, 2010). It helps create a format for an eventual discussion over the cost and benefits of highly rated design preferences. It can also be used to build support for projects while explaining how design elements can work and fit within a typical streetscape.

VISUAL PREFERENCE SURVEY IN NORTH ST PAUL METHODOLOGY---DEFINING THE SURVEY SAMPLE FRAME

Based on a case study analysis of successful living streets implementation efforts in other Minnesota communities, our capstone group concluded that focusing implementation efforts on one to two streets within a relatively compact neighborhood was a key to success. It was important to designate a residential street as a showplace or prototype to demonstrate how living street design elements can be accommodated and potentially expanded throughout the community.

The residents of four residential streets in the Casey Lake neighborhood makeup the sample frame for the North St. Paul visual preference survey. This area of focus for our survey was chosen based on the timing of street improvements from the city's capital improvement plan, a demographic analysis of residents, and the overall existing built environment. This sample frame meets the standard frame criteria in that it is all inclusive—potentially including every member of the population to be surveyed; and exclusive--in the sense that only those in the population are included (Alreck and Settle, 2004).

If the intent is to encourage developing living street design elements on a prototype residential street in the near-term, we first needed to examine the city's timeline for street redevelopment (see Appendix A, CIP-Capital Improvement Plan). We focused on designated redevelopment areas in 2016, 2018 and 2020. We also examined the current built environment of those streets, noting areas that already have curb and gutter and/or sidewalks as well as how compact and walkable the areas are in order to facilitate the ease of survey delivery. Finding an area already connected to the Gateway Trail System was a consideration because it provides for added interconnectedness and ease in pedestrian and bike recreation.

In terms of demographic analysis, a meta-analysis of empirical literature on environmental aesthetics (a component of living street design) suggests that there is already a very high degree of aesthetic preference consensus among many demographic distinctions (gender, political affiliation, ethnic affiliation, students and nonstudent adults) (Stamps, 2009). We chose to examine three main criteria in our demographic analysis broken down on the census block level: household income, median resident age and percent of household with children and teens. We combined this information with the CIP data and developed a decision matrix (see Table 1).

We ultimately based our decision of the sample frame study area on three main points of consideration. First, 2018 and 2020 street redevelopment dates were preferable because they provide additional lead time to fully engage the residents on living streets before the technical design process needs to begin. Second, we chose to prioritize areas where the built environment already was relatively connected with sidewalks in order to provide a better chance of avoiding the same resistance that ultimately scuttled the living street project on 15th Avenue. Finally, we prioritized areas with a lower median age and a relatively high percentage of households with children and teens, concluding that walkability (a key living street component) to school and neighborhood parks would be desirable for those younger families.

Key Components of the Casey Lake Neighborhood:

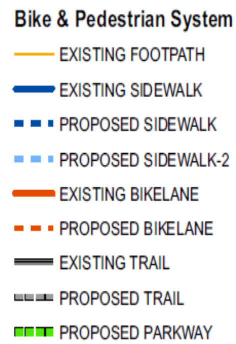
*Relatively compact—123 houses on four residential streets;

*Capital improvement plans calls for street redevelopment in 2020;

*Sidewalks, curb, gutter and boulevards exist on both sides of three out of the four streets;

*Median resident age is 44.5, 3.5 years younger than households in the areas slated for redevelopment in 2018; and

*Neighborhood connected to Gateway Trail System.



VISUAL PREFERENCE SURVEY IN NORTH ST PAUL METHODOLOGY---RANGE EFFECTS BIAS CONTROL AND IMAGE SELECTION

As mentioned previously, the VPS is a technique that allows participants to rate slide images with the purpose of determining the relative desirability of various streetscape design elements.

One challenge in conducting a VPS is selecting a manageable number of design elements to test in a manner that introduces as few outside variables as possible. Limiting the amount of variables (image range) tested will help produce more reliable and usable results. Having too many variables in a single image could bias the results (the range effects bias), as the design element under study will not be isolated and respondents may react to extraneous imagery. If too many extraneous elements are included in the image, the results cannot be relied upon as wholly indicative of the preference for a particular element. "The range effects bias can be prevented by restricting each person to viewing a single stimulus."(Poulton, 1973)

As mentioned previously, this study used photomontage visualization techniques to limit bias and create the design element under study. Working in conjunction with the students from the school of architecture, we took digital images from existing residential streetscapes and used photo imagining software to overlay or remove the alternative design elements under consideration. Weather conditions were manipulated to make all the images appear slightly overcast (neutral) while road surfaces were made identical, removing cracks, blemishes, uneven paving and coloring. The ability to create or adjust digital images helps ensure that viewers stay focused on the design elements under consideration (Steiner and Bulter, 2010).

The quality and composition of the photos show elements from typical perspectives, i.e., the sidewalk or the street of a residential neighborhood. The "after" photos show a convincing image that allows respondents to accurately indicate their preferences, while not being overly artistic in nature or containing extraneous items which could bias the rating with unrelated preferences for

visual graphic design. In total, we developed 24 images including 12 "before" and "after" image pairs.
Living street design elements were chosen based on city approved goals for residential neighborhoods listed in the comprehensive plan and the living streets design plan. Images were chosen based on their fit in one of these categories:

- Healthy Residents and Neighborhood Walkability
  - Meandering sidewalks, bike lanes
- Neighborhood Safety
  - Road narrowing-speed control, medians, crosswalks with curb bump outs
- A Cleaner Environment
  - Raingardens, meander sidewalks around raingarden features, permeable pavement

While not the primary focus of this paper, a discussion of living street design elements would not be complete without briefly mentioning empirical data that supports the positive outcomes of including such elements in street redesign in the context of the city's planning goals and the imagery used in the visual preference survey.

Healthy Residents and Neighborhood Walkability

Creating a pleasing network of sidewalks and bike lanes encourages mobility and can lead to increases in health among neighborhood residents. A recent multilevel study using a national dataset concluded that neighborhood walkability, access to safe biking routes and overall safe neighborhood environments positively correlate with increased exercise and weight control (Doyle and Schlossberg, 2007). Walking and cycling for daily travel offer an affordable, reliable and theoretically feasible way to achieve recommended physical activity levels (Lee, 2013). As an added benefit, an economic study using a hedonic regression technique determined that houses adjoining streets with above-average levels of walkability command a premium of about $4,000 to $34,000 over houses with just average levels of walkability in typical metropolitan areas (Cortright, 2009).

North St. Paul has established walkability as a planning goal:

- *North St. Paul Comprehensive Plan Goals 4 and 9: "Achieve a functional, aesthetic and balanced system which includes pedestrian ways, sidewalks and trails…" and "Establish a climate and an urban pattern for active living to create and sustain changes in land use design, building design, transportation, public policies and project to cultivate, support and integrate physical activity into daily life."*

- *North St. Paul Living Streets Design Objective 2, 4, 5: "Convert some parking lanes for bike & pedestrian circulation. Create bike lanes/trails along major roads," and "Connect schools, parks, etc…with sidewalks and bike routes," and "Meander new sidewalks around existing trees…"*

The North St. Paul VPS tested two different styles of bike lane design as well as straight and meandering sidewalks.

Neighborhood Safety

Creating safer neighborhoods for pedestrians through street redesign that slows traffic, reduces accidents and promotes driver awareness is standard goal for any community. Refocusing street use from a car-centric perspective to incorporate uses by all is a main component of complete/living street redesign.

A 2010 Federal Highway Administration study found that road diets, which narrow roads by reducing the number of traffic lanes, can reduce crash frequencies by an average of 29 percent, an improvement that can be attributed to dedicated turn lanes and reduced overall travel speeds (USDOT, 2010) Additional analysis suggests that increased walkability of neighborhoods, especially for seniors, may lead to more car-pedestrian accidents unless micro-scale design elements (better cross-walks, signage, speed controls) are also incorporated in the overall network (Lee, 2013).

North St. Paul acknowledges the need to slow traffic:

- *North St. Paul Living Streets Design Objective 3 and 6: "Use curb bump outs & other techniques as appropriate to slow traffic," & "Reduce the amount of pavement to maintain and replace in the future."*

The North St. Paul VPS tested several traffic calming and driver awareness devices, including enhanced cross walk features with curb bump outs, street narrowing and a median/pedestrian island.

A Cleaner Environment

A primary source of pollutants in lakes and rivers comes from community storm water runoff. Impermeable surfaces (roofs and roads) encourage rainwater to flow as surface runoff, rather than allowing it to infiltrate into the ground. Lawn chemicals containing nitrates and phosphates as well as automobile pollutants are washed into the watershed from residential lots and streets. Best Management Practices (BMPs) utilize an approach to drainage that uses a variety of techniques to control surface water runoff (and consequent pollution problems) from the urban environment. A common BMP strategy to reduce storm water runoff is to treat or mitigate runoff at its source, or where the rain falls (US EPA, 2012). In a residential context, raingardens and vegetated swales help infiltrate storm water on site. A well-maintained and vegetated raingarden with native plantings will infiltrate more water than bare areas or grass alone (Virahsawmy, et. al., 2013). Permeable pavement treatments also have been shown to reduce surface runoff volume compared to impervious asphalt or concrete by allowing storm water to more readily infiltrate into the ground (US EPA, 2000). Large urban street trees intercept and store rainwater at the source as well as filter pollutants in the canopy and root zone. A typical medium-sized tree can intercept as much as 2380 gallons of rainfall per year (US Forest Service, 2002). Meandering hard surface sidewalks around BMP design features, including raingardens and mature trees, will help infiltration and limit runoff.
North St. Paul has clear environmental protection goals:

- *North St. Paul Comprehensive Plan Goal 7 and 8: "Enhance and expand the park, open space and trail system…" and "Protect and enhance the lakes, wetlands, woods and wildlife and promote actions, practices and developments which tend to sustain the environment."*

- *North St. Paul Living Streets Design Objective 1, 2, 5, 6: "Infiltrate at least the 1st inch of rainfall from city streets near the street edge," and "Convert some parking lanes for water treatment..." and "Protect and retain existing trees; meander new sidewalks around existing trees…" and "Use vegetation and other physical features to create a look unique to the city."*

The North St. Paul VPS tested four raingarden designs that include curb-cuts, which allow street runoff to flow into the garden. A permeable street pavement image was tested as well as meandering sidewalks around raingardens.

VISUAL PREFERENCE SURVEY IN NORTH ST PAUL METHODOLOGY---INSTRUMENT DESIGN AND DATA COLLECTION

Best practices in survey design dictate that in order to maximize the reliability of responses through design, clear and consistent prompts to respondents must be provided. Instructions and questions need to be focused, brief and clear (Alreck and Settle, 2004). The VPS questionnaire used a statement at the beginning outlining the overall intent of the survey which was followed by short-form one sentence ranking criteria reminder near the photos that was value neutral in terms of the images presented.

As previously mentioned, a Likert Scale rating was used to capture the subjective perceptions of the respondents in a quantifiable form. We used a 7 point rating scale (-3 very unattractive to +3 very attractive, with a neutral 0 value) with descriptive labels consistent with survey prompts in terms of value neutrality. Image desirability for North St. Paul was the question under study. As is typical in standard survey design (Alreck and Settle, 2004), we concluded with four numeric and single select demographic (biographic) questions related to number of the persons in the household, status as an owner or renter, age and income.

An attempt was made to minimize the starting point bias and presentation order effects bias through the use of calibration images and randomization. Studies suggest that respondents are generally less favorable towards questions that appear at the beginning of a survey, treating them as an anchor when evaluating later questions in a sequence (Veronesi, et. al., 2010, Tversky and Kahneman, 1974). To minimize the starting point bias, a calibration (or decoy) image was used first that depicted a typical residential streetscape with no enhancements. The image was also meant to help acclimate the viewer to the process (Herzog, 1989), and was not used in the overall calculations of survey findings. The presentation order effects bias presumes that the relative position of an item in an inventory of questions may uniquely influence the way in which a respondent reacts (Landon, 1970, Manning et al, 2002). Respondents may reveal one set of norms if the order in which photographs are presented depicts greater impacts first (i.e. street narrowing), followed by lesser impacts (i.e. raingardens), than if the order were reversed. Viewer routine and fatigue may also set in causing later images to not be viewed as independently as they should be. One method to control for this bias is to vary or randomize the order of the images displayed from one respondent to the next (Alreck and Settle, 2004). Limitations on the software used to conduct the VPS survey prevented us from randomizing images after every completed survey. However, we were able to prepare and conduct multiple versions of the survey where the images appeared in random order varying from one version of the survey to the next (each image was assigned a number and a random number generator was used to select image order). In advance of finalizing the surveys, the surveys were tested for comprehension and ease of use by self-selected individuals known to the members of the capstone group.

In order to ease data collection and prevent certain types of interviewer error (data recording error, scale interpretation error), the survey was administered using an iPad application developed through iSurvey.com. The iSurvey software allows multiple users to simultaneously collect and automatically download survey results to a cloud-based server after the completion of every survey. Data was automatically geo-coded and time-stamped. The data could then be examined at any time and uploaded into Excel or other statistical packages.

The door to door survey was conducted April 13-19, 2014, by the three members of our North St. Paul living streets capstone group. Completed surveys were obtained from 80 residents representing 65% of the Casey Lake neighborhood households. The number of individual question responses generated totaled 2240. On average, each survey was completed in ten minutes.

iPad screen shot of visual preference survey

VISUAL PREFERENCE SURVEY IN NORTH ST PAUL FINDINGS

I believe the VPS is an effective tool in initially engaging citizens in the community planning process while also helping foster an understanding of design choices available. As a visioning technique however, the findings do not project a pure statistical representation of a random sampling of all North St. Paul residents. The findings are an approximation of the relative option and preferences of those in the Casey Lake neighborhood who chose to participate in the survey. Reactions and attitudes toward an image are derived from individual life experiences, community norms, and motivations to either maintain or change the built environment of the neighborhood. The neighborhood appears to be fairly homogeneous. In terms of survey result demographics, 52.5% of the participants were fifty one years old or older and 79% had annual incomes above $60,000. Eighty-one percent were homeowners and the average household size totaled 2.91 occupants.

The process of analyzing the data began by uploading the data into excel and aligning the image ratings from the various survey versions used so that all data for each image is aligned in columns. The standard calculation protocol is as follows: the Likert Scale scores for each image are added and the mean or average rating of each image is calculated; the mode and standard deviation from the mean are also calculated. The standard deviation score compared against the average standard deviation of the entire image set is helpful in comparing imagery with similar mean scores. A lower standard deviation than the average is interpreted to mean that there is relatively more consensus among the participants on the rating score for a given image. After comparing the rating score of each image, those images with a higher average rating and relatively low standard deviation are considered to be the most desirable and vice versa for negatively rated images. Calculating differences from the mean in the "before" and "after" image sets is also useful when comparing across sets to determine which "after" image engendered a greater difference from its "before." (See Appendix D, all VPS images and scoring data)

As mentioned previously, seven living streets design elements were tested:

- Designated bike lanes (on and off street)
- Raingardens (in season and out of season)
- Permeable street pavement
- Road narrowing
- Enhanced intersections with curb treatments and bump out
- Undivided long median
- Straight sidewalks and meandering sidewalks around raingardens

Based on a comparison of the mean scores, standard deviations and difference from the mean (see Table 2 for a data comparison chart), the following conclusions can be drawn.

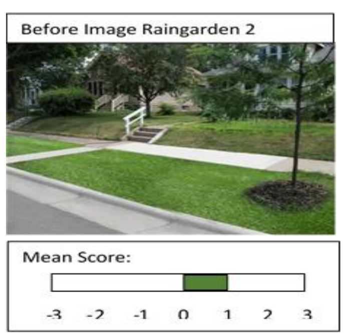
Attractive Raingardens Rated Higher than Standard Lawns Based on Mean Score

Well-maintained raingardens with curb cuts were most desirable to the residents of the Casey Lake neighborhood. The "after" image of the raingarden shown to the right not only had the largest mean score (1.2375) of all the images tested, it also showed the greatest difference from the mean score of the "before" image (.9125). The standard deviation of 1.407 was below the average standard deviation for all the images, demonstrating that the image engendered positive desirability consensus among the residents.

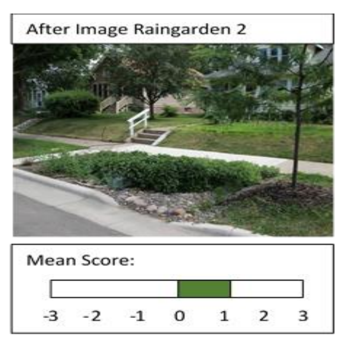
Mean Score	.325
Mode	2
Std. Dev.	1.770
Diff frm Mean	--

Mean Score	1.2375
Mode	2
Std. Dev.	1.407
Diff frm Mean	.9125

Slightly different than above, this raingarden image pair shows a raingarden on a street boulevard, which is not private property, but is typically maintained by the property owner. Consistent with the overall findings on the preference of raingardens, the after image of this raingarden had the 2nd highest mean score (1.1625).



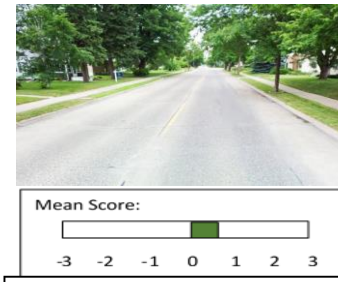
Mean Score	.95
Mode	2
Std. Dev.	1.301
Diff frm Mean	--



Mean Score	1.1625
Mode	2
Std. Dev.	1.444
Diff frm Mean	.2125

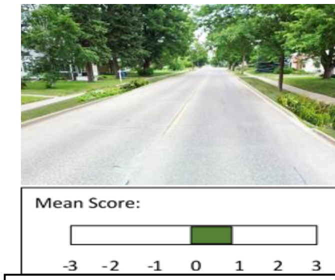
Even though this image pair appears closely related, consistent with Nelessen's summation, even subtle variances in imagery can lead to conclusive outcomes. Although with a slightly lower mean score (.85) than previous images of raingardens, the "after" image demonstrates the second highest increase in the mean score from the "before" (.3125) with even a slightly lower standard deviation than Raingarden 1.

Before Image Street 1



Mean Score	.5375
Mode	0
Std. Dev.	1.113
Diff frm Mean	--

After Image Street 1



Mean Score	.85
Mode	1
Std. Dev.	1.37
Diff frm Mean	.3125

Enhanced Intersections Preferred over Standard Based on Mean Score

As depicted in this image pair, an enhanced intersection with curb bump outs and crosswalk treatments is rated more positively than the "before" image. However, the "after" image had the highest standard deviation score of all the images, which suggests that there is not much consensus—participants rated it either very high or low. A mode score of "2" suggests that the most common score of the image shows moderate desirability, hence our general finding that enhanced intersections are preferred. However more study may be needed to determine the exact configuration which would garner stronger support.

Before Image Intersection

Mean Score	.475
Mode	0
Std. Dev.	1.368
Diff frm Mean	--

After Image Intersection

Mean Score	.65
Mode	2
Std. Dev.	1.987
Diff frm Mean	.175

Narrower Streets Preferred to Wider Streets and to Medians Based on Mean Score

Both "after" images shown here depict traffic calming devices. Narrowing the street (by approximately 33%) rated slightly higher (.0875) than a typical wider street. The narrow street image with wider boulevards

Before Image Street 2

Mean Score	.6375
Mode	0
Std. Dev.	1.265
Diff frm Mean	--

After street 2 (narrow)

Mean Score	.725
Mode	1
Std. Dev.	1.221
Diff frm Mean	.0875

After Image Street 2 (median)

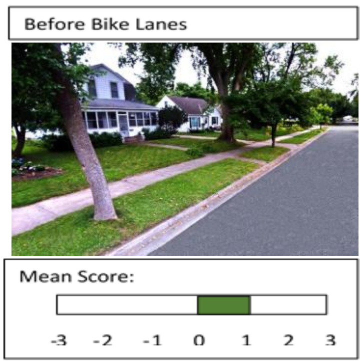
Mean Score	-.8375
Mode	-3
Std. Dev.	1.368
Diff fm Mean	-1.475

more accurately reflects the already relatively narrow streets of the Casey Lake neighborhood.

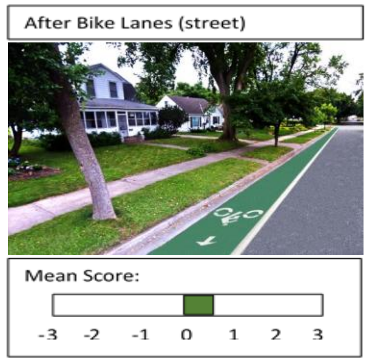
The long median in the second “after” image, however, was not desirable. As depicted, this type of median appears to drastically restrict driving lanes while leaving little room for on-street parking. Anecdotally, more than one participant volunteered that the image reminded them of neighborhoods in St. Paul and Minneapolis and would not be appropriate for North St. Paul. This image had the lowest mean score and the second greatest difference from the mean than all the images. Standard deviations for all the images show general consensus.

<u>On-street Bike Lanes Viewed More Favorably than Off-street Based on Mean Score</u>

“After” images here imply that bike lanes reduce the desirability of the streetscape. In situations where bike lanes are necessary to make crucial connections between destinations like parks, schools and regional trail systems, designated bikes lanes on the street are more desirable than bike lanes on the sidewalk. As depicted, an on-street bike lane still has a positive mean score of .625 (albeit still lower than the “before” image). The off-street bike lane had the greatest difference from the mean than any pair of images tested (-1.825) while having the second lowest mean score of (-.7875). Some of the reaction towards this image may have been because of the pavement type depicted (asphalt) or to the “designating” of a residential sidewalk for biking purposes.



Mean Score	1.037
Mode	2
Std. Dev.	1.247
Diff fm Mean	--



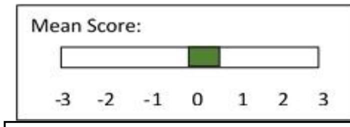
Mean Score	.625
Mode	1
Std. Dev.	1.745
Diff fm Mean	-.4125

Mean Score	-.7875
Mode	-2
Std. Dev.	1.733
Diff fm Mean	-1.825

Permeable Pavement Viewed as Less Desirable than Standard Pavement Based on Mean Score

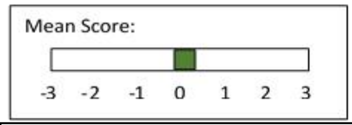
While still slightly positive, the depiction of a permeable street in the "after" image shows that it is less desirable than a standard, well-paved street to residents of the Casey Lake neighborhood based on the mean scores. The higher standard deviation (1.928) indicates that there is not much consensus on permeable pavers, at least at this magnitude of use. Again, anecdotally speaking, a number of participants commented that the street looked "expensive" even if acknowledging the positive aesthetic qualities. In addition, some residents also commented on anticipated high maintenance costs of such a surface during the winter.

Before Permeable Pavement



Mean Score	.525
Mode	0
Std. Dev.	1.475
Diff frm Mean	--

After Permeable Pavement

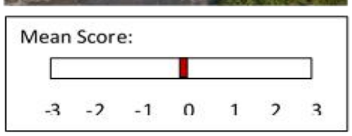


Mean Score	.225
Mode	1
Std. Dev.	1.928
Diff frm Mean	-.3

Inconclusive: Out of Season Raingardens with Meandering Sidewalks Based on Mean Score

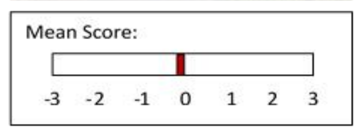
As may be expected, out of season raingardens before bloom appear less aesthetically pleasing and consequently less desirable than during summer peak foliage as reflected in the results on the right. Some participants may have interpreted the raingarden as one that is poorly maintained. Although both images have negative mean scores close to neutral, the "after" image scores slightly lower than the "before".

Before Out of Season Raingarden



Mean Score	-.025
Mode	0
Std. Dev.	1.550
Diff frm Mean	--

After Out of Season Raingarden



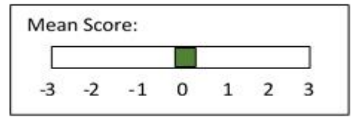
Mean Score	-.0875
Mode	1
Std. Dev.	1.5524
Diff frm Mean	-.0625

However, this image pair of out of season raingardens shows that both images have a positive mean desirability score (.9 and .375) with more consensus than the first out of season raingarden images. Taken together, image perspective and scale may have impacted these results as the first out of season raingarden is depicted to be much closer than viewing out of season raingarden 2 from across the intersection. Taken separately, even though a straight sidewalk with no raingarden rated higher, a meandering sidewalk with an out of season raingarden, at least when viewed from a short distance, still can be desirable.

Before Out of Season Raingarden 2

Mean Score	.9
Mode	2
Std. Dev.	1.248
Diff frm Mean	--

After Out of Season Raingarden 2



Mean Score	.375
Mode	1
Std. Dev.	1.495
Diff frm Mean	-.525

<u>Multiple Living Street Elements can be Desirable Together Based on Mean Score</u>

This image was placed at the very end of the survey as a concluding, composite image. It was not paired with a "before" image. Rather than test a specific design element, the image is used as an experiment to test in general, a number of living street design elements at once. The image depicts a reality where a number of elements work together to create a "flow" to the streetscape. Meandering sidewalks, curb cuts, and narrowing of the street present a more "complete" approach to what a living street can look like. Ironically, the image was taken from neighboring Maplewood and the elements depicted in the photo were created using the financial resources rejected when North St. Paul dropped its initial attempt at living street implementation in 2011. Although lacking in consensus, out of the 23 images ranked in the survey, this composite image came in 4th in terms of mean score.

Final Image-Multiple Elements

Mean Score	.95
Mode	2
Std. Dev.	1.720
Diff frm Mean	--

ANALYZING THE RESULTS USING AN OLS REGRESSION TECHNIQUE

An attempt was made to mathematically assess the importance of individual elements in explaining preferences for certain images. Tables 3-5 contain data and outcomes related to an ordinary least squares regression done in Excel. The mean score for all the images is the dependent variable for such a regression, while nine independent living street variables (or predictors) were identified and scored as a "0" not present in the image or a "1" if the image contained the variable (see Table 3). Using Excel to run a correlation analysis (Table 4) determining Pearson's correlation coefficient of the independent variables used in the regression show that many of the variables are not strongly correlated with one another (except for raingardens and curb treatments as all raingardens contained at least one curb cut). Having stand-alone independent variables is desired as strongly correlated independent variables will not add to the explanation of the overall analysis.

Running a regression analysis of the independent variables helps attempt to explain the degree of variability between the mean score differences from one image to the next. After running the regression (Table 5) overall, an adjusted r-square of .52 shows that just over 50% of the mean scores of the images are explained by the independent variables selected, which means a large proportion of the variations is due to factors not included in the study. The very act of calculating the mean score prior to using it as the dependent variable may explain some of variance, and hence a lower adjusted r-squared value in the regression. The f-statistic shows a 1.6% probability that the entire outcome of the regression is merely by chance, which is low, indicating significance at the 95% level. On closer examination of the independent variables, the one variable having the largest effect on the mean score is an image containing a living raingarden. Living raingardens have a positive coefficient of .77 and a p-value of .04, indicating that there is a 96% chance that viewing a living raingarden has a positive effect on the mean score (holding all other independent variables constant). Images depicting street narrowing also are positive but less significant (B=.28; p-value=.26). Conversely, medians (B= -1.8; p-value=.002), bike lanes (B= -.83; p-value=.01), and out of season raingardens (B= -.188 p-value=.67) each have a negative effect on the mean score according to the results.

ANALYZING THE RESULTS USING A T-TEST

A paired, two sample for the means statistical t-test was conducted on the data using Excel (see t-test results for all images in Table 6). The paired t-test determines if the differences in the means (or averages) from the "before" and "after" image pairs is statistically significant. When comparing image pairs, the null hypothesis is that there is <u>no</u> statistically significant difference between the "before" image and the image "after" a treatment (in this case, the living streets design feature) is applied, regardless of the mean score. A statistically significant difference helps better explain that a particular "after" image with the design element in question significantly impacts a viewer's perception and results in a higher or lower rating.

Based on the t-test results, only one "after" image positively impacts the results at the 95% confidence level of significance (α=.05). "After" raingarden 1 had a t-stat of 4.14 which is significantly higher than the t-critical one-tail result of 1.66 and the t-critical two-tail result of 1.99 resulting in a rejection of the null hypothesis that there is no statistically significant difference. This tends to confirm the results of the regression analysis on the positive impact that viewing living raingardens had on the survey participant.

Also, the "after" image of the off-street bike lane (t-stat -8.77; t-critical one tail 1.35; t-critical two tail 1.99) and the long median (t-stat -6.74; t-critical one tail 1.66; t-critical two tail 1.99) shows that at the 95% level of significance, viewing those images led to a negative rating. The remaining "after" imagery showed no significance at the 95% level when compared to the t-critical two tail test results.

SUMMARY OF VPS FINDINGS AND CONCLUSION

Casey Lake Neighborhood residents appear to be are receptive to living street design elements.

Based on our visual preference survey findings and evaluations of the mean scores and standard deviations, the elements with the highest preference rating and best likelihood of gaining acceptance in this neighborhood include:

- Raingardens with curb cuts
- Enhanced Intersections with bump outs
- Narrowed Streets

Residents appear familiar with raingardens, perhaps through the work of the watershed or by visiting neighboring communities where they are more commonplace in a residential setting. Choosing raingardens as a desirable neighborhood feature exemplifies the desire to live in and commute through an aesthetically pleasing variegated landscape. Residents may also be more educated on the function of the raingarden as a filter, preventing pollutants from further harming nearby Casey Lake and other waterways. It should be mentioned however, that raingardens need maintenance and while off season raingardens may be acceptable, poorly maintained gardens may not be tolerated. Narrowed streets and enhanced intersections fit well in this neighborhood. As the residential streets are already fairly narrow, it would appear based on these findings that the residents would also be more accepting of narrowing arterial streets and other "feeder" roadways surrounding the area. Enhanced intersections as depicted in the survey would directly complement the extensive sidewalk network already in place while underscoring safety by slowing traffic and making drivers more aware of pedestrians.

Living street elements that engendered some support, but require more education and visioning work to incorporate include:

- On-street bike lanes
- Permeable surfaces

It stands to reason that biking may be a common activity in this neighborhood considering the ease of access to the Casey Lake Park, existing park bike trails and the neighboring Gateway trail system. However designated bike lanes on the residential streets would be a completely new element to introduce to the community. Such lanes may be more suited to arterial roads to help connect parks, schools and others neighborhoods. Aesthetically, people liked the look of permeable surfaces, but cost and maintenance are strong considerations, especially when contemplating such material for a road surface. More community education as to maintenance and cost of permeable surfaces is needed before it should be attempted on a widespread basis. A limited use of such pavers on sidewalks or intersection bump outs may be more appropriate and acceptable to begin.

Design elements that met with the most resistance include:

- Long street medians
- Off street designated bike lanes

Certain arterial streets may be more suited for short medians that provide pedestrian islands and help slow traffic. The long median depicted in the survey appeared to eliminate on street parking, which was not supported. Off street designated bike lanes also appeared to limit the use of what is typically a considered a pedestrian sidewalk. Different design and imagery surrounding bike lanes may elicit more positive results.

In conclusion, applying the visual preference survey to living street design concepts proved to be a good visioning tool, enabling residents in a particular neighborhood of North St. Paul to rate their preferences and voice their opinion on streetscape redesign for their community. Engaging the citizenry early in the planning process is key to overcoming misinformation and misunderstandings while building support for new design concepts that fall in line with desired goals of healthy residents, neighborhood safety and environmental protection. The VPS was designed for that very purpose, to provide a better understanding of new concepts by using accurate visual imagery to depict design options for the future. Giving residents a choice and a voice early enough in the process helps narrow the focus for decision makers to what may be possible and acceptable.

North St. Paul can now use the visual preference survey developed for the Casey Lake neighborhood as a template to conduct similar outreach and visioning exercises in other parts or the community. If the city chooses to select the neighborhood as a demonstration area for its next attempt at living street implementation, it now has baseline living street design preference responses to use in reengagement efforts.

RECOMMENDATIONS

North St. Paul has taken initial steps toward realizing living streets in their community by approving a living streets policy and design plan. However, tuning policy into practice is often challenging when attempting to implement new concepts and designs. Below are recommendations for continued action based on research and findings from the Casey Lake neighborhood and the visual preference survey.

Promote Design Process over Projects

The watershed and city's joint effort on 15th Avenue identified the project (include living street design in street redevelopment on 15th Avenue); however based on successful living street implementation research, they didn't have enough process in place with the neighborhood to sustain the effort once opposition mounted. Neighborhood outreach can start simply with a visualization survey, and/or a townhall meeting, but one cannot predetermine how the design will take shape prior to this effort. A more organic, (bottom-up) context sensitive approach is needed in order to begin the planning process with the goal of realizing a new vision for the neighborhood streetscape.

Designate Prototype Neighborhood and Street for Implementation

The previous effort in North St. Paul chose 15th Avenue as the prototype. However, beyond the fact that the street was in line for redevelopment, it doesn't appear that any other consideration was given as to whether or not this was the best area to begin implementing living streets. Does the built environment contain elements that may ease additional living street design implementation (e.g. sidewalks, trails, enhanced intersections)? Is there an existing environmentally sensitive amenity nearby that residents may wish to protect or better connect to (e.g. lake, park)? Is the neighborhood compact enough so that residents beyond the impacted street can be involved and help champion the project? Is the demographic make-up of the neighborhood such that younger families or families with children are present and may support a more walkable and pedestrian safe environment? Is there a third party (e.g. utility, watershed, park district) with resources eyeing a potential project in the community who can help offset costs for neighborhood street redevelopment with living street elements? Establishing a prototype or demonstration neighborhood has been shown in other communities to ignite living/complete street interest in other areas.

Identify Champions and Keep Them Involved

Involving members of the neighborhood before the project is designed not only helps foster interest and engagement, is also helps planners identify strong proponents. Champions need to be nurtured through ongoing contact, education and project updates. Such neighborhood champions lend a legitimate voice that can reframe living streets to fit the context of their particular neighborhood. They can help identify others who may be supportive and willing to speak to the objections of opponents. During reconstruction, and even once reconstruction is complete, champions can speak to the positive nature of the process and help ignite the next round of planning discussions in a new neighborhood.

Show Willingness to Compromise in Order to Implement Living Street Design within the Existing Built Environment

Through the use of the North St. Paul visual preference survey, residents of the Casey Lake neighborhood identified raingardens, street narrowing and enhanced intersections as desirable attributes to include in the streetscape while objecting to medians and off street bike lanes. Other neighborhoods may strongly object to sidewalks but may be willing to support raingardens. Flexibility in design is key. Not all living street elements approved in the design plan can or should occur in any given neighborhood at any one particular time. Setback requirements, curb and gutter treatments, sidewalk width, signage etc…all should be up for debate when working with a neighborhood on redesign. Incorporating living streets design elements is transformative work. Remaining flexible and open to change will not only benefit existing residents, but will help North St. Paul rebuild its neighborhoods for future generations.

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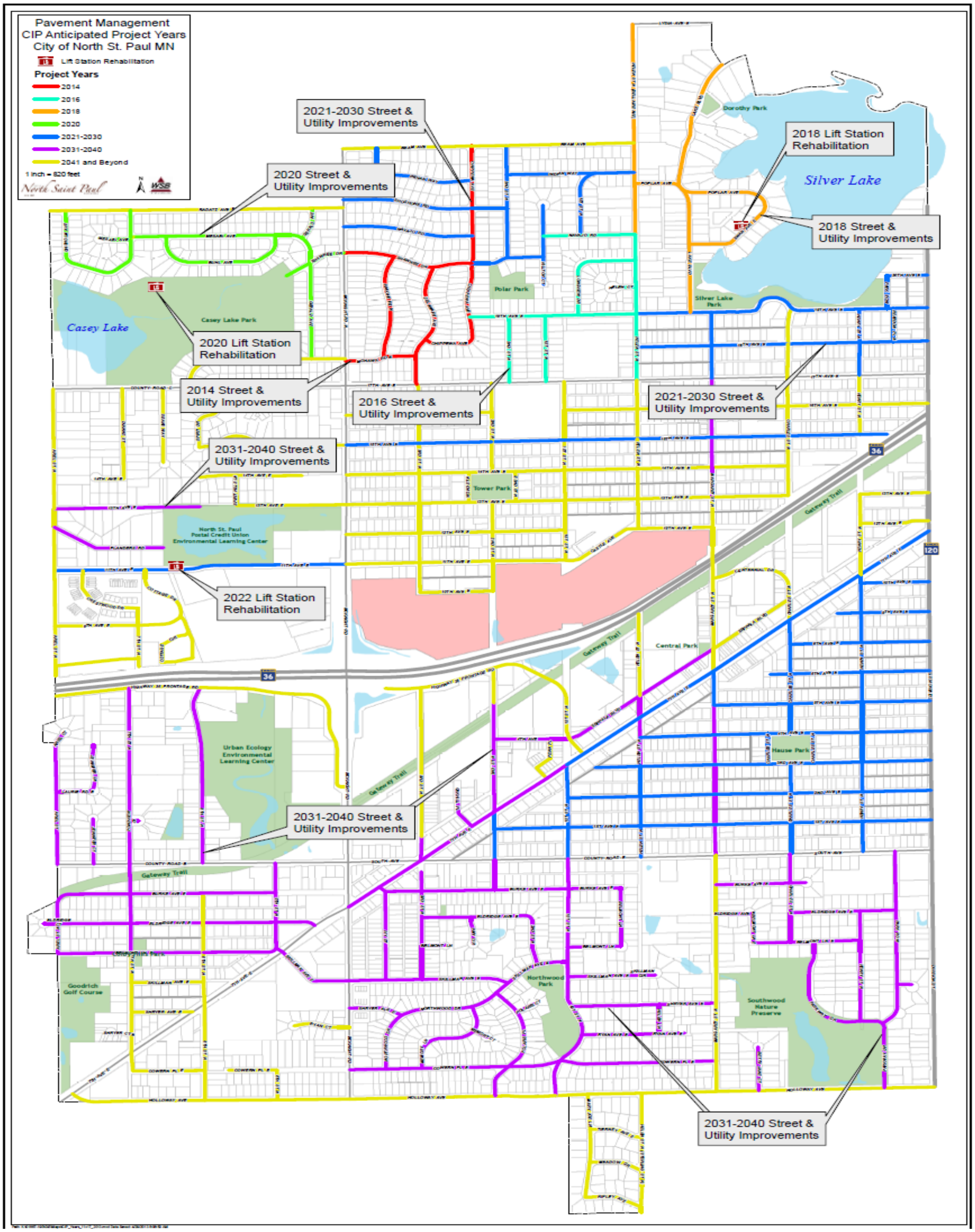
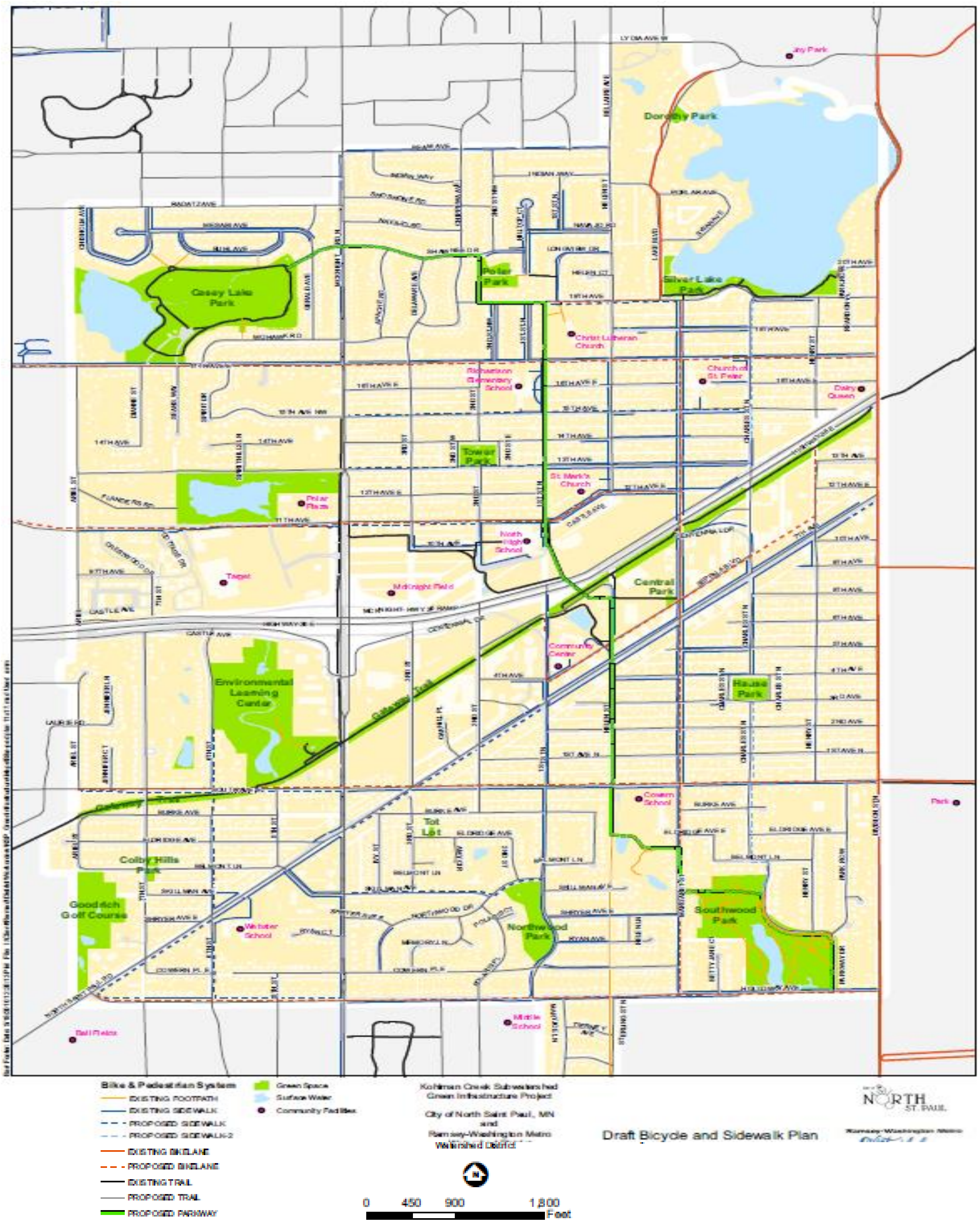
APPENDIX A--NORTH ST. PAUL CAPITAL IMPROVEMENT PLAN



APPENDIX B--NORTH ST. PAUL BICYCLE AND SIDEWALK PLAN



Case Study: 75/76th Street Reconstruction in Richfield, MN

By

A Plan B Paper

BACKGROUND

The City of Richfield took advantage of a sewer reconstruction opportunity to accommodate the city's first street redesign with complete street elements. Richfield, working in conjunction with the Metropolitan Council Environmental Services and the Three Rivers Park District, refocused what started out as a sewer project to meet transportation improvement needs and help fulfill a complete street vision.

In 2008, Hennepin County identified the need to construct a major regional sanitary sewer interceptor that would run across the city of Richfield from east to west. Typically, pipeline projects that necessitate roadway replacement commonly replace the roadway in-kind, meaning that complete street elements may be considered extraneous and the responsibility of the municipality.[i] Richfield was tasked with designating a suitable corridor for construction.

Also on the drawing board at this time was a plan from the Three Rivers Park District to extend the Nine-mile Creek Regional Trail from Edina to Bloomington transecting the City of Richfield. Again, Richfield needed to designate a corridor that could accommodate a regional trail.

Richfield engineers and planners had a corridor to meet both needs. The 75th/76th St. corridor was originally constructed after World War II as a parallel arterial to I-494. However, in the 1990s, a new arterial was developed one block away, leaving 75th/76th street as a flat, under-utilized four lane road with primarily residential housing on both sides. Residents complained of excessive speeding on the roadway as well as a general lack of safety for pedestrians as there were no sidewalks.[ii] As traffic counts typically dipped to 3150 ADT, the planning department knew the roadway could be reduced to two lanes with plenty of space remaining to accommodate a regional trail. In addition, planners envisioned an opportunity to introduce the city to the complete streets concepts by creating sidewalks, bike lanes, boulevard trees and raingardens. However, the challenge faced by Richfield was the same as North St. Paul: how to achieve public support for complete street redesign and actually implement the vision?

COMPLETE STREET IMPLEMENTATION IN RICHFIELD

The City of Richfield began by applying the context sensitive solutions approach (CSS) to street redesign. The principles of CSS promote, "a collaborative, multidisciplinary process that involves all stakeholders in planning and designing transportation facilities."[iii] Using this process, the planner seeks to integrate the community objectives while making decisions based on an understanding of trade-offs that may occur when involving community members with varying concerns and goals. Community members have input at every stage of the planning process as well as during final design and actual construction. The process and final result often yield high constituent/resident satisfaction which can help jumpstart future projects. [iv]

Richfield realized the CSS principles by first assigning a citizen-led transportation and planning advisory commission the task of interacting and leading discussions among the residents who live on 75th/76th and the neighborhood as a whole. Mailings, notices and flyers were used to attract attendance at commission open houses. However, rather than present engineer designed planning schematics, cross-sections or pre-formed design elements, the first meetings consisted of white boards and brain storming work—they made and stuck with the assumption that the residents are the experts of what to include on their street.[v] In between commission meetings, city staff developed working drafts of design elements that engendered consensus for every segment of the roadway. According to the City Engineer, younger residents often challenged older residents over certain elements that encouraged mobility such as sidewalks and bike lanes. The engineer felt that these confrontations were necessary to arrive at consensus and that the commission offered an outlet for resistance to occur at this level without the need to involve the City Council.[vi] Once construction began, contractors met weekly with residents on the corners of intersections to update on progress and incorporate changes where feasible. Flexibility in design, engineering and construction is key. For example, trail, curb and gutter and bike lane dimensions were altered to accommodate more diverse uses of the right-of-way.[vii]

Ultimately, the sewer line was built and utilities were located underground. The regional trail connections were approved, the street was narrowed to two lanes, bike lanes were approved, boulevard trees were added, street parking would occur only in the street segments where the adjoining residents wanted it, and intersection striping as well as pedestrian islands were created. Sidewalks and raingardens, however, were not included despite support from the planning department and younger residents. Those were two of the many trade-offs that were made during the process. The commission made its recommendations on the project to the City Council, and it was approved unanimously.

It should be noted that there were no city assessments on individual property owners for this project and no property takings were needed. There is a city-wide franchise fee in place to pay for the city's portion of the reconstruction. Federally funded street reconstruction bonds were obtained. Narrowing the street to two lanes saved $2 million off the estimated $6 million cost of the sewer work alone.

GOING FORWARD

The City Engineer credits the 75th/76th street reconstruction project for jump starting a complete streets boom in Richfield. Soon after the project was underway in 2009, the City of Richfield approved its complete streets policy and guiding principles. Master bike and sidewalk plans were also approved. As part of its ongoing capital improvement plan, complete street elements are taking shape on other high traffic corridors. 66th avenue was reconstructed to include roundabouts, meandering sidewalks and bike lanes. The city seeks to incorporate "green" wherever possible and not overbuild for cars. Short medians are under consideration for Portland Avenue. Xcel energy needs to rework utility lines on Nicollet, and a similar planning process to the 75th/76th reconstruction is just getting underway.[viii]

LESSONS LEARNED

*Do not be overly ambitious on the first complete street project. Seek to develop a single prototype street that includes complete street elements rather than attempting to transform an entire neighborhood.

*For the prototype, look for opportunities to partner with other groups, (counties, Met Council, utilities, park districts, watersheds etc…) even if a proposed project falls outside the typical capital improvement queuing process.

*Utilize CSS principles and strategies to involve adjacent and surrounding neighborhood residents; begin with an organic white-board process rather than fully conceptualized designs and elements. Remain flexible in design standards while still fulfilling the functional intent of those standards.

*Empower a citizen led group to call and run townhall meetings focused just on the project under consideration. Provide a structured outlet for disagreement and consensus building. Let the group make recommendations to the City Council.

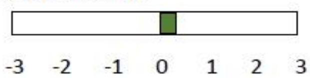
References:
[i] Complete Picture, City of Richfield finds solutions for a Variety of Problems. Roads and Bridges Periodical. August 2012. Page 28.
[ii] A Major Sewer Project with a Complete Street Finish Presentation. City of Richfield. Kristin Asher.
iiiDesigning Walkable Urban Thoroughfares: A Context Sensitive Approach. Institute of Transportation Engineers. 2010. Page 3.
http://www.naturewithin.info/Roadside/ITE%20Walkable%20Urban%20Streets.pdf
[iv] Roads and Bridges. Page 28.

[v]Interview with Kristin Asher, Richfield City Engineer. April, 21, 2014.
[vi] Asher Interview.
[vii] Roads and Bridges. Page 29.
[viii] Asher Interview.

Visual Preference Survey
Living Street Design Elements Rated by North St. Paul Casey Lake Neighborhood Residents

Before Image Raingarden 1

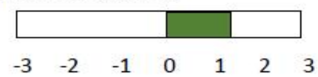
Mean Score: .325



Mean Score	.325
Mode	2
Std. Dev.	1.770
Diff frm Mean	--

After Image Raingarden 1

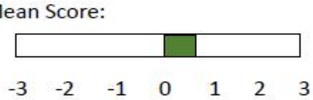
Mean Score: 1.2375



Mean Score	1.2375
Mode	2
Std. Dev.	1.407
Diff frm Mean	.9125

Before Image Street 1

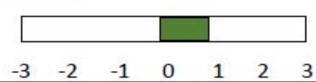
Mean Score:



Mean Score	.5375
Mode	0
Std. Dev.	1.113
Diff frm Mean	--

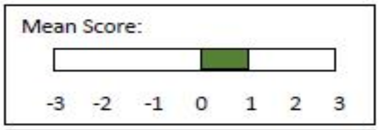
After Image Street 1

Mean Score:



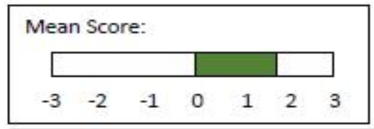
Mean Score	.85
Mode	1
Std. Dev.	1.37
Diff frm Mean	.3125

Before Image Raingarden 2



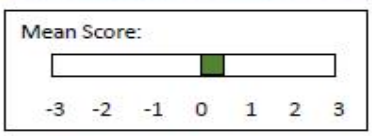
Mean Score	.95
Mode	2
Std. Dev.	1.301
Diff frm Mean	--

After Image Raingarden 2



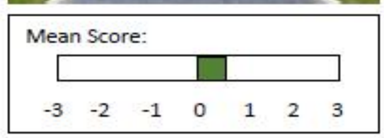
Mean Score	1.1625
Mode	2
Std. Dev.	1.444
Diff frm Mean	.2125

Before Image Intersection



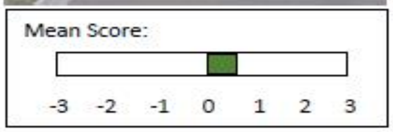
Mean Score	.475
Mode	0
Std. Dev.	1.368
Diff frm Mean	--

After Image Intersection



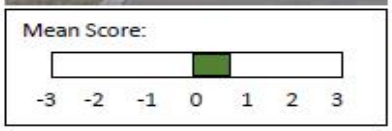
Mean Score	.65
Mode	2
Std. Dev.	1.987
Diff frm Mean	.175

Before Image Street 2



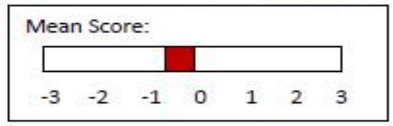
Mean Score	.6375
Mode	0
Std. Dev.	1.265
Diff frm Mean	--

After street 2 (narrow)



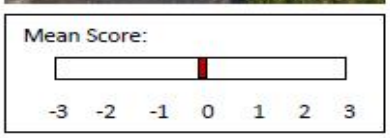
Mean Score	.725
Mode	1
Std. Dev.	1.221
Diff frm Mean	.0875

After Image Street 2 (median)



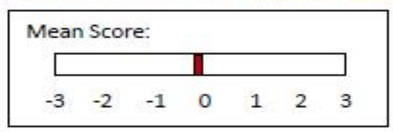
Mean Score	-.8375
Mode	-3
Std. Dev.	1.368
Diff frm Mean	-1.475

Before Out of Season Raingarden



Mean Score	-.025
Mode	0
Std. Dev.	1.550
Diff frm Mean	--

After Out of Season Raingarden



Mean Score	-.0875
Mode	1
Std. Dev.	1.5524
Diff frm Mean	-.0625

Before Raingarden Swale

Mean Score:

-3 -2 -1 0 1 2 3

Mean Score	.825
Mode	1
Std. Dev.	1.394
Diff frm Mean	--

After Raingarden Swale

Mean Score:

-3 -2 -1 0 1 2 3

Mean Score	.625
Mode	3
Std. Dev.	1.851
Diff frm Mean	-.2

Before Permeable Pavement

Mean Score:

-3 -2 -1 0 1 2 3

Mean Score	.525
Mode	0
Std. Dev.	1.475
Diff frm Mean	--

After Permeable Pavement

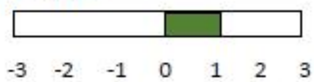
Mean Score:

-3 -2 -1 0 1 2 3

Mean Score	.225
Mode	1
Std. Dev.	1.928
Diff frm Mean	-.3

Before Bike Lanes

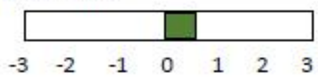
Mean Score:



Mean Score	1.037
Mode	2
Std. Dev.	1.247
Diff frm Mean	--

After Bike Lanes (street)

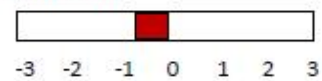
Mean Score:



Mean Score	.625
Mode	1
Std. Dev.	1.745
Diff frm Mean	-.4125

After Bike Lanes (Offstreet)

Mean Score:



Mean Score	-.7875
Mode	-2
Std. Dev.	1.733
Diff frm Mean	-1.825

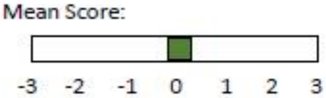
Before Out of Season Raingarden 2

Mean Score:

Mean Score	.9
Mode	2
Std. Dev.	1.248
Diff frm Mean	--

After Out of Season Raingarden 2

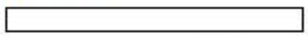
Mean Score:



Mean Score	.375
Mode	1
Std. Dev.	1.495
Diff frm Mean	-.525

Calibration Image

Mean Score:



Mean Score	Not factored
Mode	Not factored
Std. Dev.	Not factored
Diff frm Mean	--

Final Image-Multiple Elements

Mean Score:

Mean Score	.95
Mode	2
Std. Dev.	1.720
Diff frm Mean	--

TABLE 1—NORTH ST. PAUL DEMOGRAPHICS AND DECISION MATRIX

North St. Paul Select Census Block Demographics

Census Block	Median Income of Census Block group	Median House Price of block group	# of HH in block	Average family size	Median age	% children and teens	CIP Improve date	Location
042601-1-014	$83,750	$192,100	27	2.78	39.5	27.5%	2016	Bounded on the north and west by Longview St, Helen st to the east, and 19th Ave to the south
42601-1-012	$83,750	$192,100	16	2.38	54.5	7.89%	2016	Bounded on the north by 19th ave, 2nd st to the west,1st st to the east and 17th Ave to the south *Note both 1st and 2nd streets have sidewalks on both sides of the street
42601-1-013	$83,750	$192,100	18	3.38	36.5	33.34%	2016	Bounded by 19th ave to the north, 1st st to the east, Helen St to the west, and 17th Ave to the south
42602-1-004	$78,355	$225,400	34	2.83	43.8	24.7%	2018	Bounded by E. Poplar Ave to the north, Helen st to the west, Lake Blvd to the east, and 19th ave to the south *Block is designated as an area served by the Gateway Trail
42602-1-003	$78,355	$225,400	18	2.75	50.2	18.7%	2018	Bounded by Lydia Ave to the north, Bellaire Ave to the west, Lake Blvd to the east and E. Poplar Ave to the south *Note streets have C&G, no sidewalks *Block is designated as an area served by the Gateway Trail
42602-1-001	$78,355	$225,400	25	2.80	51.8	22.39%	2018	Bounded by Silver Lake to the east, E. Swan Ave and Lake Blvd to the west and 19th ave to the south *Block fronts Silver Lake and Gateway trail connections
42601-2-005	$55,848	$221,500	22	2.85	41.5	20.37%	2020	Bounded on the north by Mesabi Ave and the south, east and west by Buhl Ave *Note both Mesabi and Buhl Avenues have sidewalks on both sides of the street. *Block is north of Casey Lake and Gateway Trail Connection
42601-2-002	$55,848	$221,500	30	2.96	46.5	22.61%	2020	Bounded on the north by Radatz Ave and the south, east and west by Chisholm Ave
								*Note Chisholm has sidewalks on both side of the street, Radatz has just C&G *Block is northwest of Casey Lake and Gateway Trail Connections
42601-2-006	$55,848	$221,500	28	2.95	45.5	22.37	2020	Bounded on the north by E Shawnee Dr, McKnight on the east, Gerald Ave on the west and E Mohawk Rd on the south *Note McKnight as a sidewalk on western side of the street *Block is east of Casey Lake and Gateway Trail Connections

If one makes the assumption that households with an overall lower median age and with children in the home may be more open to the living streets interconnected concept, then the areas shaded in yellow and orange would be a good area to consider (CIP 2016 and CIP 2018).

If the goal is to create better connections to the Gateway trail system regardless of the current infrastructure, then the green areas should be considered (CIP 2018).

If the goal is to create better connections to the Gateway trail system using existing sidewalk infrastructure, and have enough time to engage the citizens and obtain support for living streets, then the orange areas should be considered (CIP 2020).

TABLE 2—NORTH ST. PAUL VPS DATA SUMMARY CHART

Image name	Sum	Mode	Average	Standard Dev		Diff from Mean	Rank based on Diff
Before Bike Lane	83	2	1.0375	1.24721208			
After bike lane (street)	50	1	0.625	1.74569996		-0.4125	9
After bike lane (offstreet)	-63	-2	-0.7875	1.7334662		-1.825	12
Before Intersection	38	0	0.475	1.36849728			
After Intersection	52	2	0.65	1.98793831	*	0.175	4
Before Raingarden Swale	66	1	0.825	1.39415598			
After Raingarden Swale	50	3	0.625	1.85127394		-0.2	7
Before Street 2	51	0	0.6375	1.2653488			
After Street 2 (narow)	58	1	0.725	1.22189933	*	0.0875	5
After Street 2 (median)	-67	-3	-0.8375	1.96451914		-1.475	11
Before Raingarden 1	26	2	0.325	1.770182			
After Raingarden 1	99	2	1.2375	1.4074283	*	0.9125	1
Before Street 1	43	0	0.5375	1.11314073			
After Street 1	68	1	0.85	1.37886396	*	0.3125	2
Before Raingarden 2	76	2	0.95	1.30141111			
After Raingarden 2	93	2	1.1625	1.44470881	*	0.2125	3
Before out of season RG	-2	0	-0.025	1.55062258			
After out of season RG	-7	1	-0.0875	1.55240728		-0.0625	6
Before Peremable Pavement	42	0	0.525	1.47532447			
After Permeable Pavement	18	1	0.225	1.92895984		-0.3	8
Before out of season RG 2	72	2	0.9	1.24879689			

After out of season RG 2	30	1	0.375	1.49577464		-0.525	10
Image1 (calibration)	18	0	0.225	1.49238574			
Final-Multiple elements	76	2	0.95	1.7203179			
Average Standard Deviation=	1.5275						
*=denotes "after" image with a higher positive mean average than "before" image							

TABLES 3-5—CORRELATION AND REGRESSION TABLES

Variable Measurement Table 3

Image #	Mean rating	Straight Sidewalk	Living Raingardens	Bike lanes	Curb treatments	Dead Raingardens	Pavement treatments	Meandering Sidewalk	Street Narrowing	Median		Variable	Scoring
Before Bike Lane	1.0375	1	0	0	0	0	0	0	0	0		Straight Sidewalk	No straight sidewalk =0; Straight sidewalk=1
After Intersection	0.65	1	0	0	1	0	1	0	1	0		Living raingarden Present	No living raingarden =0; Living raingarden=1
After Raingarden Swale	0.625	0	1	0	1	0	0	1	0	0		Bike Lanes	No bike =0; bike land=1
After bike lane (street)	0.625	1	0	1	0	0	1	0	1	0		Curb treatment	No curbtreatment =0; curbtreatment including curb cuts=1
Before Intersection	0.475	1	0	0	0	0	0	0	0	0		Dead or out of season raingarden	No dead reaingarden=0; Dead reaingarden present=1
After Street 2 (median)	-0.8375	1	0	0	0	0	0	0	1	1		Pavement treatment	No pavement treatment=0; Pavement treatment including
Before Raingarden 1	0.325	0	0	0	0	0	0	0	0	0		Meandering Sidewalk	No meandering sidewalk= 0; Meandering sidewalk = 1
After out of season RG	-0.0875	1	0	0	1	1	0	1	0	0		Street Narrowing	No narrowing= 0; Street narrowing = 1
After Street 2 (narow)	0.725	1	0	0	0	0	0	0	1	0		Median	No Median= 0; Median = 1
Before Street 1	0.5375	1	0	0	0	0	0	0	0	0			
Before Raingarden 2	0.95	1	0	0	0	0	0	0	0	0			
(offstreet)	-0.7875	0	0	1	0	0	0	0	0	0			
After Street 1	0.85	1	1	0	1	0	0	0	0	0			
Before out of season RG	-0.025	1	0	0	0	0	0	0	0	0			
Before Peremable Pavement	0.525	0	0	0	0	0	0	0	0	0			
Before out of season RG 2	0.9	1	0	0	0	0	0	0	0	0			
After Raingarden 2	1.1625	1	1	0	1	0	0	0	0	0			
Before Street 2	0.6375	1	0	0	0	0	0	0	0	0			
After out of season RG 2	0.375	0	0	0	0	1	0	1	0	0			
After Raingarden 1	1.2375	0	1	0	1	0	0	0	0	0			
After Permeable Pavement	0.225	0	0	0	0	0	1	0	0	0			
Before Raingarden Swale	0.825	0	0	0	0	0	0	1	0	0			
Final Image	0.95	0	1	0	0	0	0	1	0	0			

Correlation Table 4

	Straight Sidewalk	*Living Raingardens*	*Bike lanes*	*Curb treatments*	*Dead Raingardens*	*Pavement treatments*	*Meandering Sidewalk*	*Street Narrowing*	*Median*
Straight Sidewalk	1								
Living Raingardens	-0.225374468	1							
Bike lanes	-0.068732175	-0.16265001	1						
Curb treatments	0.070567483	0.647098434	-0.183339699	1					
Dead Raingardens	-0.068732175	-0.16265001	-0.095238095	0.168061391	1				
Pavement treatments	0.046004371	-0.20412415	0.338648106	0.063913749	-0.119522861	1			
Meandering Sidewalk	-0.441358333	0.233333333	-0.162650012	0.166993144	0.585540044	-0.204124145	1		
Street Narrowing	0.367883604	-0.24182542	0.265497122	-0.011357771	-0.141598465	0.503496546	-0.241825417	1	
Median	0.170940865	-0.11236664	-0.065795169	-0.126660099	-0.065795169	-0.082572282	-0.112366644	0.464660189	1

Regression Table 5

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.84827302							
R Square	0.71956712							
Adjusted R Square	0.52542129							
Standard Error	0.37077994							
Observations	23							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	9	4.585832571	0.509537	3.706323	0.016340259			
Residual	13	1.787210908	0.137478					
Total	22	6.373043478						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.40283874	0.184681018	2.181268	0.048123	0.003859658	0.801818	0.003859658	0.801817823
Straight Sidewalk	0.21679389	0.209944849	1.032623	0.320609	-0.236764379	0.670352	-0.236764379	0.670352165
Living Raingardens	0.77135019	0.341389943	2.25944	0.041674	0.033822057	1.508878	0.033822057	1.508878324
Bike lanes	-0.833886	0.31340943	-2.66069	0.019609	-1.510965882	-0.15681	-1.510965882	-0.15680606
Curb treatments	-0.3736164	0.297299328	-1.2567	0.230974	-1.015892562	0.26866	-1.015892562	0.268659737
Dead Raingardens	-0.1881441	0.431868419	-0.43565	0.670236	-1.12113908	0.744851	-1.12113908	0.744850912
Pavement treatments	0.09979723	0.318941425	0.312901	0.759319	-0.589233825	0.788828	-0.589233825	0.78882829
Meandering Sidewalk	0.0074666	0.296021883	0.025223	0.98026	-0.632049795	0.646983	-0.632049795	0.646983001
Street Narrowing	0.38300334	0.329727094	1.161577	0.266291	-0.329328739	1.095335	-0.329328739	1.095335418
Median	-1.840136	0.485492773	-3.79024	0.002249	-2.888979343	-0.79129	-2.888979343	-0.7912926

TABLE 6—T-TEST TABLES FOR ALL IMAGES

t-Test: Paired Two Sample for Means		
	After Raingarden 1	*Before RainGarden 1*
Mean	1.2375	0.325
Variance	1.98085443	3.133544304
Observations	80	80
Pearson Correlation	0.248068123	
Hypothesized Mean Difference	0	
df	79	
t Stat	4.144344898	
P(T<=t) one-tail	4.24694E-05	
t Critical one-tail	1.664371409	
P(T<=t) two-tail	8.49389E-05	
t Critical two-tail	1.99045021	

t-Test: Paired Two Sample for Means		
	After Intersection	*Before Intersection*
Mean	0.65	0.475
Variance	3.951898734	1.87278481
Observations	80	80
Pearson Correlation	0.164248258	
Hypothesized Mean Difference	0	
df	79	
t Stat	0.704879668	
P(T<=t) one-tail	0.241479068	
t Critical one-tail	1.664371409	
P(T<=t) two-tail	0.482958136	
t Critical two-tail	1.99045021	

t-Test: Paired Two Sample for Means		
	Before Bike Lane	*After Bike Lane (street)*
Mean	1.0375	0.625
Variance	1.555537975	3.047468354
Observations	80	80
Pearson Correlation	0.099561992	
Hypothesized Mean Difference	0	
df	79	
t Stat	1.806878437	
P(T<=t) one-tail	0.037294369	
t Critical one-tail	1.664371409	
P(T<=t) two-tail	0.074588738	
t Critical two-tail	1.99045021	

t-Test: Paired Two Sample for Means		
	Before Bike Lane	*After Bike Lane (offstreet)*
Mean	1.0375	-0.7875
Variance	1.555537975	3.004905063
Observations	80	80
Pearson Correlation	0.25388178	
Hypothesized Mean Difference	0	
df	79	
t Stat	8.772089385	
P(T<=t) one-tail	1.3557E-13	
t Critical one-tail	1.664371409	
P(T<=t) two-tail	2.7114E-13	
t Critical two-tail	1.99045021	

t-Test: Paired Two Sample for Means		
	Before Raingarden Swale	*After Raingarden Swale*
Mean	0.825	0.625
Variance	1.943670886	3.42721519
Observations	80	80
Pearson Correlation	0.018391711	
Hypothesized Mean Difference	0	
df	79	
t Stat	0.778797735	
P(T<=t) one-tail	0.219212734	
t Critical one-tail	1.664371409	
P(T<=t) two-tail	0.438425468	
t Critical two-tail	1.99045021	

t-Test: Paired Two Sample for Means		
	Before Street 2	*After Street 2 (narrow)*
Mean	0.725	0.6375
Variance	1.493037975	1.601107595
Observations	80	80
Pearson Correlation	0.56511084	
Hypothesized Mean Difference	0	
df	79	
t Stat	0.67440579	
P(T<=t) one-tail	0.251011075	
t Critical one-tail	1.664371409	
P(T<=t) two-tail	0.502022149	
t Critical two-tail	1.99045021	

t-Test: Paired Two Sample for Means		
	Before Street 2	*After Street 2 Median*
Mean	0.6375	-0.8375
Variance	1.601107595	3.859335443
Observations	80	80
Pearson Correlation	0.329529701	
Hypothesized Mean Difference	0	
df	79	
t Stat	6.748123815	
P(T<=t) one-tail	1.12794E-09	
t Critical one-tail	1.664371409	
P(T<=t) two-tail	2.25589E-09	
t Critical two-tail	1.99045021	

t-Test: Paired Two Sample for Means		
	Before Out of Season RG	*After out of season RG*
Mean	-0.025	-0.0875
Variance	2.40443038	2.409968354
Observations	80	80
Pearson Correlation	0.262004314	
Hypothesized Mean Difference	0	
df	79	
t Stat	0.296569866	
P(T<=t) one-tail	0.383786609	
t Critical one-tail	1.664371409	
P(T<=t) two-tail	0.767573218	
t Critical two-tail	1.99045021	

t-Test: Paired Two Sample for Means		
	After Street 1	*Before Street 1*
Mean	0.85	0.5375
Variance	1.901265823	1.239082278
Observations	80	80
Pearson Correlation	0.35008952	
Hypothesized Mean Difference	0	
df	79	
t Stat	1.944755983	
P(T<=t) one-tail	0.027681538	
t Critical one-tail	1.664371409	
P(T<=t) two-tail	0.055363076	
t Critical two-tail	1.99045021	

t-Test: Paired Two Sample for Means		
	After Raingarden 2	*Before Raingarden 2*
Mean	1.1625	0.95
Variance	2.087183544	1.693670886
Observations	80	80
Pearson Correlation	0.226549519	
Hypothesized Mean Difference	0	
df	79	
t Stat	1.110574063	
P(T<=t) one-tail	0.13506028	
t Critical one-tail	1.664371409	
P(T<=t) two-tail	0.27012056	
t Critical two-tail	1.99045021	

t-Test: Paired Two Sample for Means		
	Before Permeable Pavement	*After Permeable Pavement*
Mean	0.525	0.225
Variance	2.176582278	3.720886076
Observations	80	80
Pearson Correlation	-0.175472549	
Hypothesized Mean Difference	0	
df	79	
t Stat	1.02178905	
P(T<=t) one-tail	0.154999802	
t Critical one-tail	1.664371409	
P(T<=t) two-tail	0.309999604	
t Critical two-tail	1.99045021	

t-Test: Paired Two Sample for Means		
	Before Out of Season RG 2	*After Out of Season RG 2*
Mean	0.9	0.375
Variance	1.559493671	2.237341772
Observations	80	80
Pearson Correlation	0.169416203	
Hypothesized Mean Difference	0	
df	79	
t Stat	2.639923074	
P(T<=t) one-tail	0.004994341	
t Critical one-tail	1.664371409	
P(T<=t) two-tail	0.009988681	
t Critical two-tail	1.99045021	

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