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PERCEPTION & ROLE OF 3-D VISUALIZATIONS IN PLANNING: A CASE STUDY OF THE NORTHWEST PASSAGE SCENIC BYWAY'S VIEWSHED PROTECTION & VISUALIZATION PROJECT

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ABSTRACT

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Perception & Role of 3-D Visualizations in Planning: A Case Study of the Northwest Passage Scenic Byway's Viewshed Protection & Visualization

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The use of sophisticated visualization tools and methods, in particular 3-D modeling, has seen a considerable rise in planning throughout the last decade due to continued advancements in 3-D technology, computer hardware, and the internet. The rapid increase in the use of 3-D visualization is supported by the belief that visualizations which imitate human experience help relieve many of the communication problems that exist between experts and lay persons during the planning process and help engage a broader cross-section of the public. However, little understanding exists to support these claims. This research provides a comprehensive investigation of stakeholder perceptions concerning the use of 3-D visualizations in the Northwest Passage Scenic Byway's (NWPSB) Viewshed Protection and Visualization project. This project, which was conducted by the NWPSB Commission and Advisory Team, provided the perfect opportunity to study the use of several 3-D visualizations including digitally altered photographs and fully interactive 3-D models. Comparisons were made between these types of visualizations which are increasingly being used in the planning process. As the use of 3-D visualization in planning continues to rise in popularity around the world, it is imperative that its utility and appropriateness be understood. Interviews were conducted with stakeholders participating in the NWPSB project to assess the perceptions that individuals held in regard to the use of 3-D visualization. The results of this research show that 3-D visualization is an important component of the planning process that can ultimately enhance an individual's comprehension of a project and provide an improved means of communication between experts and stakeholders. The majority of stakeholders felt that the digitally altered photographs provided the best means of communication. Project size and scale, the level of realism, and demographic makeup of the communities were identified as influential factors affecting this opinion. This is not to say that the 3-D models do not have any utility in the planning process, in fact the opposite is true. However, in the context of this study where age, technical ability, and the rural character of the communities played an influential role, the use of 3-D was not appropriate.

With unending love I dedicate this thesis to my family:
My wife Karin and daughter Ella "Bean"

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INTRODUCTION

Planning in the United States has a long and storied history marked by a continuous evolution of ideas, concepts, and paradigms. Generally it has been characterized as beginning during the mid-19th century as the second industrial revolution and its accompanying wave of immigration were full swing. Major U.S. cities grew unchecked and were marked by often deplorable and unsanitary living conditions. In response, plans began to take form that focused on scientific efficiency, civic beauty, and social equality. These three independent ideas began to coalesce and resulted in the first form of city planning in Chicago, Illinois (Krueckberg 1983).

As the 19^{th} century came to a close, professional planning began to take hold in the United States as evidenced by the first National Conference on City Planning in 1911, the formation of the American City Planning Institute in 1917, and the first courses in planning at Harvard (Krueckberg 1983; Kaiser and Godschalk 1995). During the 1920s the United States Department of Commerce published the Standard State Zoning Enabling Act and the Standard City Planning Enabling Act, together they provided the basis for planning and zoning in the United States (American Planning Association 2009). In 1926 the United States Supreme Court upheld the constitutionality of a zoning ordinance in the case of the Village of Euclid, Ohio v. Ambler Reality Company (Cullingworth 1997). This ruling gave state legislatures the legal precedent upon which zoning legislation and planning could be justified. The Act was tremendously popular and became the model for a significant number of zoning ordinances and enabling acts throughout the United States (Cullingworth 1997).

The 1950s saw a surge in local development planning as World War II came to an end. Four influential factors marked this surge including a postwar population boom and urban growth that resulted in a need for capital improvements in infrastructure, a shift of planning responsibility from the independent commission to local government, the Housing Act of 1954 in particular Section 701 that required local government entities to adopt a long range general plan in order to qualify for federal grant monies, and the Highway Act of 1956 that significantly altered patterns of transportation and land uses (Krueckberg 1983; Kaiser and Goldschalk 1995).

Thus the first half of the 20th century experienced an evolution of ideas, from the "City Beautiful" effort and Burnham's Chicago plan to the Standard City Enabling Act and a consensus among planners that focused on the long term physical development plan of a city. However a major shift in planning occurred during the 1960's in large part due to the changing consciousness of the American mind. Race and class disparities addressed by the civil rights movement led to a greater focus on public participation; in particular, requirements for public notices and public hearings were established during this period (Cole and Caputo 1984). Furthermore, the large scale computer models popularized by the quantitative revolution of the 1950s and 1960s failed in providing a value and politically neutral planning process. Planners discovered that public policy decision making was fundamentally different from that of personal or corporate decision making. Collective goals and objectives were nearly impossible to define and planning was found to be heavily entrenched in politics making the aforementioned difficult to achieve (Brail and Klosterman 2001). The 1970s also marked the end of the modernist movement as planners began to realize that the cheap uniform block buildings of the

1950s and 1960s lacked a human scale and resulted in increased urban crime and social problems in many planned neighborhoods; enter the post-modern era and a shift in focus to individualism, expert driven planning, increased public participation and diversity in society (Morris 1997).

The awareness that came about in the 1970s that planning was not merely about providing data and facts but was also deeply entrenched in politics continued into the 1980s. It was understood that planners prepare plans and conduct analyses, but that this was only one aspect of their duties. Planners also communicated information to the public, negotiated with stakeholders, and offered advice. As a result, planning during this period was recognized both as a political and social process; the way planners communicated information was found to be as, if not more, important than what they were actually saying (Brail and Klosterman 2001). The planning process in the 1980s moved toward an increasingly interactive, open, and on-going process of collective design and collaboration.

Unfortunately planning proved to be a complex process for non-professionals, one that included a wide range of non-visual components that were often laden with expert knowledge, procedures, difficult language, and complicated numbers or formulas. This often led to miscommunication, confusion, and frustration among the public. With non-professionals now in the mix, the need to communicate information effectively became a primary focus for the planner. Planners began to search for ways to improve communication between stakeholders and planning officials (Brail and Klosterman 2001). Traditional communication tools (i.e., charts, graphs, engineering plans, and cross sections) were found to be insufficient in engaging a broad cross-section of the public due the complexity of the information provided (Appleton and Lovett 2005).

The use of more sophisticated visualization tools and products was found to be a viable solution to this problem (it is important to note that the term "visualization" refers to the process concerned with the tools, techniques, and software used to develop the "visualizations" or visualization products). This was based on the idea that through the use of visualizations, large amounts of abstract information can be reduced to comprehensible information (Al-Kodmany 2001). The use of two-dimensional (2-D) maps had long been a part of the planning process and provided an important visualization tool for planners, however, it became apparent that the public generally struggles to turn 2-D plans into 3-D mental images (Appleton and Lovett 2005). Sanoff (1990) argues that traditional planning tools (e.g., written text, statistics, plans, sections, sketches, perspective drawings, and maps) do not provide planners with the appropriate visualization tools to generate significant public input. Through this it is evident that the communication of relevant information to all stakeholders in an understandable and meaningful way continues to be a problem within planning (Wissen et al. 2008).

However, visualizations that imitate human experience (i.e., interactive 3-D models) have been shown to relieve many of the communication problems that exist between experts and lay persons during the planning process (Kwartler 2005; Lange 2005). Significant improvements in computer hardware, software, data, and the internet during the last 20 years have acted as the catalyst for the rapid evolution of three-dimensional (3-D) visualization software. Planners recently discovered that the use of these types of visualizations might provide stakeholders with an improved means of comprehension of a proposed plan. Hearnshaw explains that "our capacity for generating mental images of three dimensional objects [from 2-D schematics], let alone their relationships, is limited" (1994, 20). The use of 3-D visualizations in planning is intended to bridge this mental gap by providing a concrete image of a proposed project or action. Researchers have established that the use of 3-D visualizations in the planning process can improve communication between stakeholders and experts, provide a high level of conceptualization of a project, and act as a more natural way in which to view a proposal (Appleton and Lovett 2005; Lange and Bishop 2005; Lange 2006). However, concerns over the level of realism used in visualizations, the lack of multiple viewpoints, user control of a model, and the potential for bias have been voiced. Furthermore, much of the existing research has neglected to study the use of 3-D visualizations in a fully interactive 3-D environment.

Purpose Statement

This research provides a comprehensive investigation of stakeholder perceptions concerning the use of 3-D visualizations in the Northwest Passage Scenic Byway's (NWPSB) Viewshed Protection and Visualization project. This project, which was conducted by the NWPSB Commission and Advisory Team to understand the potential degradation of viewsheds and enhancement of economic and recreational opportunities along the NWPB, provided the perfect opportunity to study the use of several 3-D visualizations including digitally altered photographs and fully interactive 3-D models. Comparisons were made between these two types of visualizations which are increasingly being used in the planning process. As the use of 3-D visualization in planning continues to rise in popularity around the world, it is imperative that its utility and appropriateness be understood. The purpose of this research is to bring further understanding of the different aspects and role of 3-D visualizations in planning.

Research Questions

The primary research question concerns the response stakeholders have to the use of 3-D visualizations in the NWPSB Viewshed Protection and Visualization project. This primary question is approached through a set of more specific questions that include:

1. Has the use of 3-D visualizations in the NWPSB's Viewshed Protection and Visualization project allowed stakeholders to better conceptualize the potential or proposed future developments of the areas within the NWPSB when compared to traditional visualization techniques?
2. How important is the level of realism in a 3-D visualization?
3. How important are the accessibility of visualizations to stakeholders and the ease of use of Google Earth® as a display medium when viewing a 3-D visualization?
4. Has the use of Google Earth® as a display medium for 3-D visualizations addressed many of the problems noted in previous research?
5. What role does 3-D visualization play in planning process?

The answers to these questions will be assessed through participant observations and in-depth interviews with stakeholders from the NWPSB Viewshed Protection and Visualization project which occurred from January 2009 to August 2009.

BACKGROUND AND LITERATURE REVIEW

This section provides a historically and theoretically based review of the literature that is focused on the topic of the role and use of visualization in planning. The first two sections offer historical reviews of visualizations and computer technology in planning, including the development of 3-D visualization software for planning. The third section offers a theoretical background and review of research investigating the use of 3-D visualization for planning and public participation. The final section addresses the role that perception and psychology play in visualization.

History of Visualizations and Computer Technology in Planning

For thousands of years humans have attempted to convey abstract information though various methods of visualization. The earliest known drawings by humans date as far back as 30,000 BC in the Chauvet-Pont-d'Arc Cave in present day southern France (Lange and Bishop 2005). The map, a visual representation of an area of the earth, was thought to have existed nearly 8,000 years ago, with the earliest known example coming from the Catal Hüyük settlement (in present day Turkey) around 6,200 B.C.E (Lange and Bishop 2005). Perspective drawings first began to appear in ancient Greece and were later used in Europe during the Renaissance as a technique for the display of architectural designs (Lange and Bishop 2005). In 1781 Louis Alexandre Berthier utilized a hinged overlay map at the Siege of Yorktown (Foresman 1998). Humphry Repton, an English landscape architect of the early 19th century, pioneered the application of visualization techniques to site design issues at the landscape level. The use of painted panoramas to depict landscape change was also popular at this time (Lange and Bishop 2005).

King et al. (1989) explain that the prominent use of visualizations by humans is based on the idea that they are the common language to which all people can relate, regardless of their background. Lange and Bishop (2005, 23) further this explanation when they state that a visual form is created to help people "better understand the relationship between data or some condition of the environment." Due to the complex nature of the planning process, planners have recognized the importance of visualizations and have utilized them to allow abstract data to be more easily understood by laypersons with the hope of significantly reducing the risk for confusion (Al-Kodmany 2001).

One of the earliest examples of visualization used for planning in the United States can be traced back to 1682 when William Penn utilized a simple plan view map for his plan of Philadelphia. Other early examples include Oglethorpe's 1733 plan for Savannah and L'Enfant's 1791 plan for Washington D.C., both of whom used a similar map form as Penn (Kaiser and Godschalk 1995). During the mid 19^{th} century a process of systematic mapping, inventory, and recording of sanitary conditions was used for individual parcels of land to track and combat the spread of disease in American cities (Krueckberg 1983).

In 1909 the Commercial Club of Chicago published Daniel Burnham's plan for Chicago, arguably the most influential city plan in the last 125 years (Marsh 1983). The plan embraced the "City Beautiful" effort that emerged during the 1893 Chicago Columbian Exposition which was intended to "expand civic consciousness as well as raise standards of public design" (Krueckberg 1983, 4). Burnham's plan employed an inspirational vision for the design of public spaces in Chicago and utilized both a comprehensive plan map and perspective drawings (Krueckberg 1983). During the 1920s the United States Department of Commerce published the Standard State Zoning Enabling Act and the Standard City Planning Enabling Act. The Acts were tremendously popular and became models for a significant number of zoning ordinances and enabling acts throughout the United States, many of which were represented in map form (Cullingworth 1997). Despite a shift in planning philosophy from the general physical plan of a city to a more comprehensive plan during the mid 20th century, visualizations (in map form) continued to play an integral part of the planning process (Krueckberg 1983).

The first application of computers in planning began in the 1960s with the development of large scale metropolitan land use and transportation models that were popularized by the quantitative revolution (Brail and Klosterman 2001). Previously, planners had been focused on the physical design of the city and "professional visions of the desirable future" (Brail and Klosterman 2001, 6). This philosophy was replaced with the idea of "rational" planning that applied science and information technology that sought to achieve a value and politically neutral planning process (Brail and Klosterman 2001).

"Rational" planning came under scrutiny during the 1970s as the large-scale computer models of the 1960s failed as an appropriate method for public planning. The applied science model that defined "rational" planning was discarded and the use of information technology was viewed as "inherently political, reinforcing existing structures of influence, hiding fundamental political choices, and transforming the policy-making process" (Brail and Klosterman 2001, 7). The 1970s saw a shift on the technical side of computer information as well, from data handling to data organization in the form of management information systems including the first geographic information systems (GIS) (Maguire et al. 1991; Brail and Klosterman 2001; Langendorf 2001).

The new "communications" (i.e., communicative) planning that emerged during the 1980s focused on an increasingly interactive, open, and on-going process of collective design and collaboration where computer technology was viewed as another tool in the planner's toolbox (Brail and Klostermann 2001). This philosophy was a guiding factor in the development of decision support systems (DSS) that were designed to facilitate "a decision process which is iterative, integrative, and participative" (Brail and Klosterman 2001, 13). Geographic information systems (GIS) software was the basis upon which most spatial decision support systems (DSS) were built, the results of which were typically shown in map form (Brail and Klosterman 2001).

Planning professionals of the 1990s and early 21st century showed a continued interest in participatory and community based planning efforts (Al-Kodmany 2001). Coupled with the rapid evolution of computer processing power, hardware, software, the internet, and availability of data, the use of computer-based visualizations in planning increased at a rapid rate. Digital photomontages, SDSS, GIS, and 3-D software continue to play an integral role in the planning process in the 21st century (Al-Kodmany 2001; Brail and Klosterman 2001).

History of 3-D Visualizations in Planning

The development of 3-D visualization technology during the mid 20th century was based on several coinciding factors, a perfect storm that included the rise of computer hardware and graphics technology, several creative thinkers, and a belief that 3-D visualizations were the most natural way to represent the “real” world (Al-Kodmany 2002). The first significant example of 3-D visualization technology to aid planning occurred during the early 1970s at UCLA when researchers proposed the creation of an Urban Simulation Laboratory. The goal of the lab was intended to bring together researchers, decision makers, and community representatives to react to alternative visual urban simulations (Jepson et al. 2001). Two pilot projects, INTU-VAL and CITYSCAPE, were developed in conjunction with the General Electric Corporation to exhibit the capabilities of such a system. Unfortunately, high operation costs forced a premature end to the lab and neither project became fully operational. However the vision and work completed at UCLA was a catalyst for future developments in 3-D visualization technology (Jepson et al. 2001).

In 1965 Howard Fisher established the Laboratory for Computer Graphics in the Graduate School of Design at Harvard University with a grant from the Ford Foundation; the lab’s initial goal was to develop computer mapping software. Fisher’s team of programmers was successful in this endeavor when they created SYMAP, one of the first widely distributed computer packages for the handling and display of geographic data (Maguire et al. 1991). Although Fisher left the lab only two years after its establishment, work on computer mapping techniques continued. One primary focus for the laboratory during the late 1970s and early 1980s was the display of 2.5-D (refer to the section on Dimensions and Visualization for a definition) and 3-D spatial data (Chrisman). The 1980s also saw the development and increased popularity of computer-aided drafting (CAD) software. Many of these software packages included the ability to superimpose 3-D vector data over a photograph (Lange and Bishop 2005).

The 1990s continued to see significant increases in computing power and the widespread availability of personal desktop computers. Advances in computer graphics and 3-D modeling driven by the military, video gaming and entertainment industries allowed for the development of 3-D visualization software specific to planning. Several 3-D modeling packages including Environmental Systems Research Institute's (ESRI) ArcView 3-D Analyst®, Bryce®, Autodesk 3ds Max®, and Multi-Gen Paradigm® were all released during this time as well (Langendorf 2001).

In 1996 the Orton Family Foundation, a non-profit organization, whose goal was to help rural communities define their future and shape the growth of their communities, worked with several consultants to develop the CommunityViz® software. CommunityViz® is an extension to ESRI's ArcGIS® that allows non-technical users the ability to test land use scenarios, measure their effects, and perform various sensitivity analyses, the results of which could be viewed as statistics, graphs, 2-D maps, or 3-D simulations (Kwartler and Bernard 2001). The introduction of CommunityViz® to the planning field emphasized the use of DSS, GIS, and 3-D technology in the planning process. It also showed an increased emphasis on stakeholder interaction, participation, and collaboration.

The turn of the century was marked by a proliferation of digital globe and 3-D modeling software programs including Google Earth®, Microsoft Virtual Earth®, ArcGlobe®, NASA's WorldWind®, and Google SketchUp®. Improvements to existing 3-D planning software and DSS (i.e. CommunityViz® and 3-D Analyst®) continued to be a focus (Köbben and Graham 2009). These visualization tools and software packages continued to maintain the focus on stakeholder interaction and participation. Immersive environments, virtual reality, animation, and highly realistic rendering programs are leading the cutting edge in 3-D visualization software in the 21st century.

Planning, Public Participation and 3-D Visualization

The theory of participatory planning, borne out of Habermas' Communicative Action Theory, emphasizes the involvement of the entire community in the planning process. The involvement of local stakeholders is believed to enhance the planning process through the incorporation of a wide range of community knowledge, local expertise, and diverse backgrounds resulting in a more representative plan, increased satisfaction, and a sense of shared ownership (Fainsten 2000; Al-Kodmany 2001). Historically, planners have used a variety of visual and non-visual information to convey their ideas to the public including: written text, statistics, plans, sections, sketches, perspective drawings, and maps (Lange 2001).

Unfortunately this information is often laden with expert language and content, this can lead to a disjunction between experts (planners) and the lay-public resulting in miscommunication, frustration, and abstraction (Lange 2005). Additionally, the traditional public meeting has come under scrutiny "for being an ineffective means of conveying information, especially for complex policy issues" (Conroy and Gordon 2004, 19). Pettit et al. (2006) contend that lay-persons generally struggle to turn 2-D maps and plans into 3-D mental images. And Sanoff (1990) argues that planners do not have appropriate visualization tools to generate significant public input. It is evident that the communication of relevant information to all stakeholders in an understandable and meaningful way continues to be a problem within planning (Wissen et al. 2008).

Visualizations that imitate human experience (i.e., 3-D visualizations) have been shown to relieve many of the communication problems that exist between experts and lay persons during the planning process (Kwartler 2005; Lange 2005). Langendorf (2005) argues for the use of computer-aided visualizations in planning based on four assumptions:

1. Multiple viewpoints and information are needed to understand nearly any subject;
2. We are moving from an "information-poor" to "information-rich" society;
3. When visualized complex information generally becomes easier to comprehend;
4. Visualizations aid in the communication required among stakeholders in collaborative planning.

Al-Kodmany (2001), Brail and Klosterman (2001) and Langedorf (2001) agree that visualizations have the ability to transform large amounts of complex and abstract data into comprehensible knowledge and eventually action. Overall research has shown that the expectations of 3-D visualizations to improve communication among stakeholders, enhance the planning process, and result in improved plans are high (Paar 2006).

Despite the relatively recent introduction of 3-D visualization into planning, a healthy body of research already exists that has addressed topics ranging from the ability of 3-D visualizations to enhance public participation to the appropriate levels of realism. The remainder of this section will review research studies that have integrated 3-D visualizations into the planning process.

Lange (2001) created a highly realistic visualization of the landscape surrounding Lake Lucerne in Central Switzerland that approached the level of realism associated with photographs of the same area. A study by Conroy and Gordon (2004) reported a higher level of satisfaction by the public when interactive computer-based materials were included as part of a public meeting as opposed to traditional information materials. Bishop's (2005) review of projects utilizing real-time 3-D visualization as a tool for public participation found that these applications were useful in certain forums, noting that the use of real-time 3-D visualization was largely driven by the need for public participation to occur early in the planning process. Appleton and Lovett (2005) identified several important issues related to the use of visualization in participatory planning including the implications of high levels of realism, directing a user's focus, the use of auxiliary information, presentation format, and the potential for bias.

Lange and Hehl-Lange (2005) introduced a 3-D virtual landscape model as a new approach to a participatory planning workshop concerning the development of wind turbines in Käferberg, Switzerland, and found that it provided an enhanced means of communication among stakeholders. A study of green space planning utilizing 3-D visualizations of proposed alternatives was also found to improve communication (Lange 2008). Pettit et al. (2006) reviewed several collaborative research efforts applying 3-D visualizations to enhance the planning and communication process found that visualizations serve as a common communication tool among stakeholders, allow planners to better engage the public, and have become an important tool in the planner's toolbox.

Among others, Paar's (2006) survey investigating the role of landscape visualization software in Germany, determined that expectations of 3-D visualization to enhance communication between experts and lay-persons was very high. Lange and Hehl-Lange (2006) contend that the integration of 3-D visualization into landscape and environmental planning must be present in the initial steps of the planning process to be effective and truly participatory. Howard and Gaborit's (2007) development of a virtual 3-D cityscape was determined to be suitable for use by the general public in terms of usability and enhanced the public consultation process for urban planning. Wissen et al's (2008) integration of 3-D visualizations in the Entlebuch UNESCO Biosphere Reserve workshops revealed that landscape visualizations are very effective in providing a common language for stakeholders.

William Veteto (2006) used CommunityViz®, a planning and 3-D modeling extension to Environmental System Research Institute's (ESRI) ArcGIS® software, to depict several land use scenarios within the U.S. Highway 93 corridor in western Montana. The study addressed several key issues related to 3-D visualization including: the effectiveness of CommunityViz® to create an interactive 3-D model, the total cost of producing these models, alternative display methods for a 3-D model, and the importance of realism. The study population included planning and GIS professionals (Veteto 2006). Similar to Lange (2005), Veteto discovered that the degree of realism in a 3-D model was increased by the inclusion of a mountain background. However, several respondents failed to give a high score for the degree of realism due to the absence of human elements (e.g., street furniture, people, and cars), lack of realism at the ground level, and generic out-of-the-box buildings in the CommunityViz® 3-D library (Veteto 2006). Veteto (2006) also asked study participants to rank the three methods of presentation; it was found that the video flythrough and forum setting were preferred over user control. Interestingly, planning professionals in a study by Appleton & Lovett (2005) expressed concern with the lack of control over a visualization. This appears to present an important area for further study.

The field of forestry has historically embraced the use of 3-D landscape visualizations in order to manage and assess the visual impacts of forestry techniques on a broad scale. Improvements in landscape visualization software are challenging the typical use of visualizations in forestry (Cavens 2005). Orland (2005) attempted to create multivariate visualizations of forest restoration over time. This technique was applied to the area around the Gunflint Trail in the Boundary Waters Canoe Area that experienced a devastating severe weather event in July of 1999 resulting in the blow down of hundreds of thousands of acres of forest. Based on the subsequent survey of responses to a set of visualizations, the use of 3-D visualization software to show anticipated forest re-growth was found to be extremely promising (Orland 2005). Bishop et al. (2005) found similar responses to their 3-D time series growth models of the Warra Long Term Ecological Research Site in Tasmania.

The recent popularity and availability of 3-D visualization software has begun to be applied to fields that have not historically used these types of software (Bishop 2005). A number of recent studies in agricultural landscape planning have utilized 3-D visualization software to evaluate agricultural landscape change (Bishop 2005; Lovett 2005; Paar and Rekittke 2005). Andrew Lovett (2005) hailed the use of 3-D visualizations to display landscape changes of the agricultural landscape around Buscot and Colehill Estates in Oxfordshire England as a success, noting that the visualizations notably enhanced the participatory decision-making process. Other areas of application have also found promising results with the use of 3-D visualization to aid in planning including the energy, industrial, and infrastructure industries (Benson 2005; Ellsworth et al. 2005; Miller et al. 2005; Perkins and Barnhart 2005).

Sheppard and Cizek (2009) addressed the risks, benefits, and ethics associated with Google Earth® and other 3-D virtual globes and called for additional research evaluating the validity and performance of such systems. Other researchers have also expressed concerns over the use of 3-D visualizations in the participatory planning process including the validation of visualizations (Sheppard 2005; Lange 2001; Perkins and Barnhart 2005), evaluation of how and at what stage in the process they should be used (Al-Kodmany 2001; Brail and Klosterman 2001; Langendorf 2001; Lange 2006), and the appropriate levels of realism (Ervin 2001; Lange 2001; Appleton and Bishop 2005; Pettit et al. 2006).

Perception and Psychology of Visualization

Perception is defined by the Oxford English Dictionary (2009) as, "the process of becoming aware or conscious of a thing or things in general; the state of being aware; consciousness." It is the process through which an individual interprets what he or she is seeing and can be influenced by several factors including their background, expectations, knowledge, and memory (Mitchell 1989; Hearnshaw 1994). According to a study conducted by the United States Forest Service, it is believed that more than 80 percent of human perception is based on sight (Lange 2005). Due to the inherently visual nature of 3-D visualizations, the importance of understanding perception in this study is paramount.

The act of perception is a complex process, one that has received significant attention in the field of psychology as well as the fields of philosophy, anthropology, economics, and geography (Wood 1969). Perception studies in geography have offered diverse subject matter ranging from Robert Kitchin's (1994) study of individual understanding of cognitive maps to Potter's (1979) investigation of residents' perceptions of urban retailing facilities. Due to the large number of perceptual studies in geography, a brief look of several studies will be offered to provide insight into this area of research. Amedeo and Kramer's (1991) examination of designer-user map disparity discovered that symbol choice and presentation affected the ways in which a user perceived the intended information. Howley et al. (2009) evaluated the relationships between high-density living and neighborhood satisfaction within Dublin's central city. The study discovered that the perception of high density development as posing too great a cost on an individuals' quality of life was more a result of environmental conditions, traffic, and lack of services than density itself. Emily Talen (2000) used GIS in a participatory planning effort in Dallas, Texas, to capture stakeholders' perceptions and preferences regarding local issues. This new approach, termed "Bottom-Up GIS" (BUGIS), was found to capture local knowledge that could be incorporated into the planning process. A similar study was also conducted in Berthoud, Colorado, to address conflicts between different proposed land use plans. A variety of tools were used to gauge citizens perceptions relating to population growth, transportation, and land use including maps, development games, images, and keypad polling (Snyder 2006). Both of these studies used GIS as a visualization tool allowing stakeholders to achieve a better understanding of the issues at hand, aided in the transfer of citizen knowledge to spatial data, and strengthened the potential for more in-depth communication with regard to neighborhood issues (Talen 2000; Snyder 2006).

Despite a lack of research investigating stakeholder perceptions through the use of 3-D visualization, a review of those that have been conducted will provide an important foundation upon which the results of this study may be compared. Lange, Hehl-Lange, and Brewer (2008) utilized 3-D visualization software to develop five alternative land use scenarios for the Käferberg green belt region on the outskirts of Zürich, Switzerland. These visualizations were used in a paper-based and internet survey to assess stakeholder perceptions of green space qualities. The use of 3-D visualization was found to be a highly effective means of assessing perceptions of green space, improving public participation, and provided planners and decisions makers with important stakeholder input.

Lange and Hehl-Lange (2005) also used an interactive GIS-based 3-D modeling environment for a participatory planning workshop addressing the siting of wind turbines in the Käferberg open space near Zürich, Switzerland. The results of the study suggested that the 3-D tool provided an important means of communication between stakeholders and experts. This allowed local planners and executives from the energy company interested in developing wind turbines "to understand the values, needs, and aspirations of local people and to develop a clear and shared vision for space" (Lange & Hehl-Lange 2005, 834).

In the last decade a new model of perception has emerged arguing that humans understand only a small amount of information in their immediate environment. It is believed that only enough information is processed to achieve the task at hand (Ware

2008). In general, two basic processes drive the act of perception, bottom-up and top-down. In bottom-up processing, information is continuously selected and filtered eventually resulting in meaningful objects. Millions of features from the visual field are processed by the retina, patterns are built based on attentional demands, and objects are built and stored in visual active memory for the task at hand. Perception is the moment at which the visual and non-visual concepts bind together. Top-down processing is used to accomplish cognitive goals such as an action or understanding of an idea and can be thought of as reinforcing relevant information (Ware 2008). This new understanding of perception can have implications in the design of visualizations by allowing designers "to understand the cognitive processes and visual queries a graphic is intended to support" (Ware 2008, 14).

Dimensions and Visualization

This section will provide a definition of the different dimensions that can be represented by spatial data and offer examples of each as they apply to visualization. Spatial data can actually be represented in five dimensions or contexts ranging from zero dimensions (0-D) to three dimensions (3-D). In order to fully understand these dimensions, a definition of the word itself is necessary. The Oxford English Dictionary (2009) defines dimension as, "a mode of linear measurement, magnitude, or extension, in a particular direction; usually as co-existing with similar measurements or extensions in other directions." With this definition of dimension in mind we can now discuss the varying magnitudes of dimension.

A point in space is a zero dimensional (0-D) object that does not have a magnitude or extension in any particular direction. In geography a point can be defined by Cartesian coordinates as having an x and y location, in this context a point is most often associated with some geographic phenomena on a map such as the location of a city (Coffey 1981). The only property of a line is length and therefore it has only one dimension (1-D). Lines are also one of the common elements in a geographic visualization or map representing features such as roads, rivers, and political boundaries.

Two dimensional (2-D) is often misunderstood because it has two distinct definitions, the first refers to the type of spatial object and the second involves its role in the representation of data. A 2-D object has a linear magnitude or extension in two directions resulting in a plane or polygon surface. In geography this type of 2-D object is most often associated with representing an area on a map; common examples include bodies of water, a zoning district, or building footprint (Coffey 1981). The more common use of 2-D in visualization refers to data that are defined by measurements of a location on an x and y coordinate plane where the z (height or elevation) value is projected onto a 2-D plane allowing for objects having zero, one, and two dimensions to be displayed (Maguire et al. 1991; Abdul-Rahman and Pilouk 2008).

Two and a half dimensional (2.5-D) data is "an isometric model where the z attribute associated with an x, y location is projected onto an x, y, z coordinate reference system and all three axes displayed" creating a surface with no thickness (Maguire et al. 1991, 302). In layman's terms, 2.5-D data can be described as the use of 2-D data to produce a visual phenomenon that appears to be 3-D. Common examples of 2.5-D data include digital elevation models (DEM), triangulated irregular networks (TINs), and shading techniques to represent height as seen in Figure 2 below. The digitally altered photographs used in the NWPSB Viewshed Protection and Visualization project are another example of 2.5-D visualizations where 3-D vector models were superimposed onto a digital photograph (2-D representation).

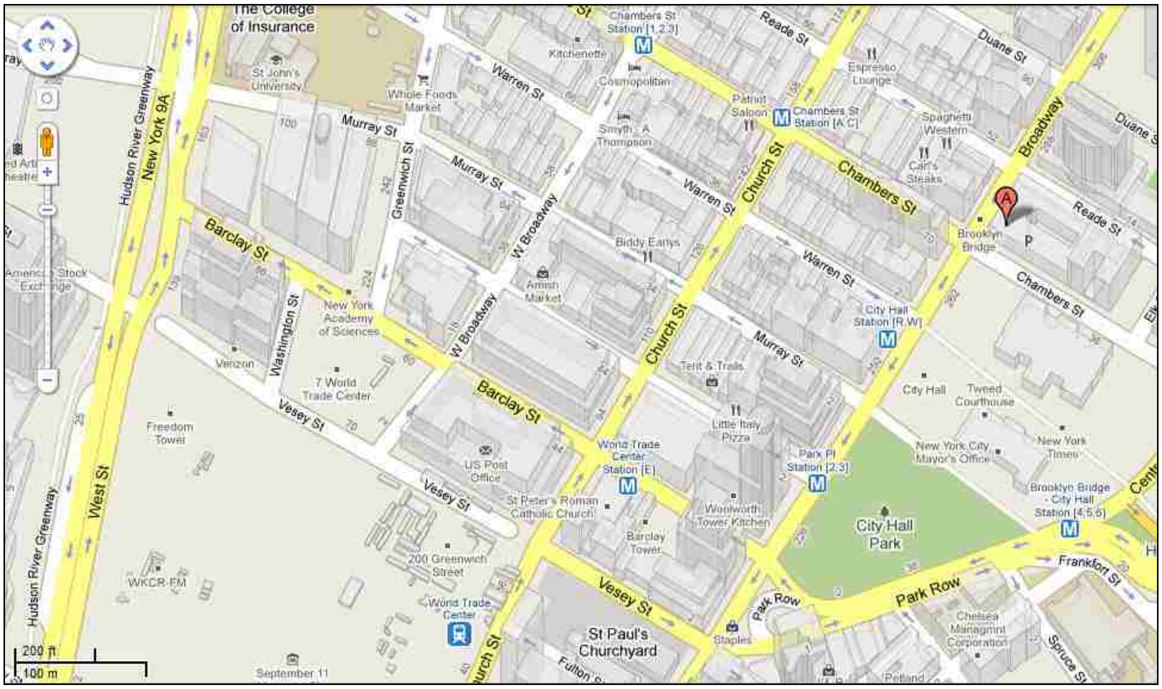


Figure 1. Google Map with 2.5-D Buildings (source: ©2009 Google – Map data ©2009 Sanborn)

Finally, true 3-D data and visualizations are defined as full solid models where magnitudes or extensions occur in the x, y, and z directions, the last representing height. An important distinction between 2.5-D and 3-D visualizations is the multiple occurrences of the z factor. Fully 3-D visualizations are "solid models where many x, y, z observations are structured into a solid structure and visualized in perspective view, complete with multiple occurrences of z" and can be viewed in real-time or rendered into 2-D images (Maguire et al. 1991, 302). The 3-D Google Earth® models created for the NWPSB Viewshed Protection and Visualizations project are perfect examples of true 3-D visualizations. Recent developments in GIS software have also allowed for the representation of 4-D data where time acts as the fourth dimension.

STUDY AREA

The study area for this research focused on the urban, semi-urban, and rural areas along the State of Idaho's Northwest Passage Scenic Byway and All American Road, in particular the areas in and around the cities of Kooskia, Kamiah, and Orofino. The Northwest Passage Scenic Byway (NWPSB) is a 202 mile stretch of highway in North Central Idaho that follows Lewis and Clark's historic route through the ancestral homeland of the Nez Perce Tribe during their search for a link between the Missouri and Columbia Rivers (Idaho Transportation Department 2008). The Byway's eastern section begins at Lolo Pass (elevation 5,233 feet) (Figure 2) on the Montana/ Idaho border and descends nearly 4,000' over 100 miles of winding road alongside theWild and Scenic Lochsa River to Kooskia, Idaho.

Figure 2. Lolo Pass Visitors Center and Eastern Terminus of the Northwest Passage Scenic Byway (source: Author)

The Byway splits into two sections in Kooskia, one following the South Fork of the Clearwater River along Idaho Highway 13 where it eventually becomes the Byway's southern terminus at Grangeville, Idaho. The second (and main) section of the Byway continues West along US Highway 12 paralleling the Clearwater River for 73 miles passing through the cities of Kamiah and Orofino until eventually reaching its Western terminus at the confluence of the Clearwater and Snake Rivers in Lewiston, Idaho (Figure 3).

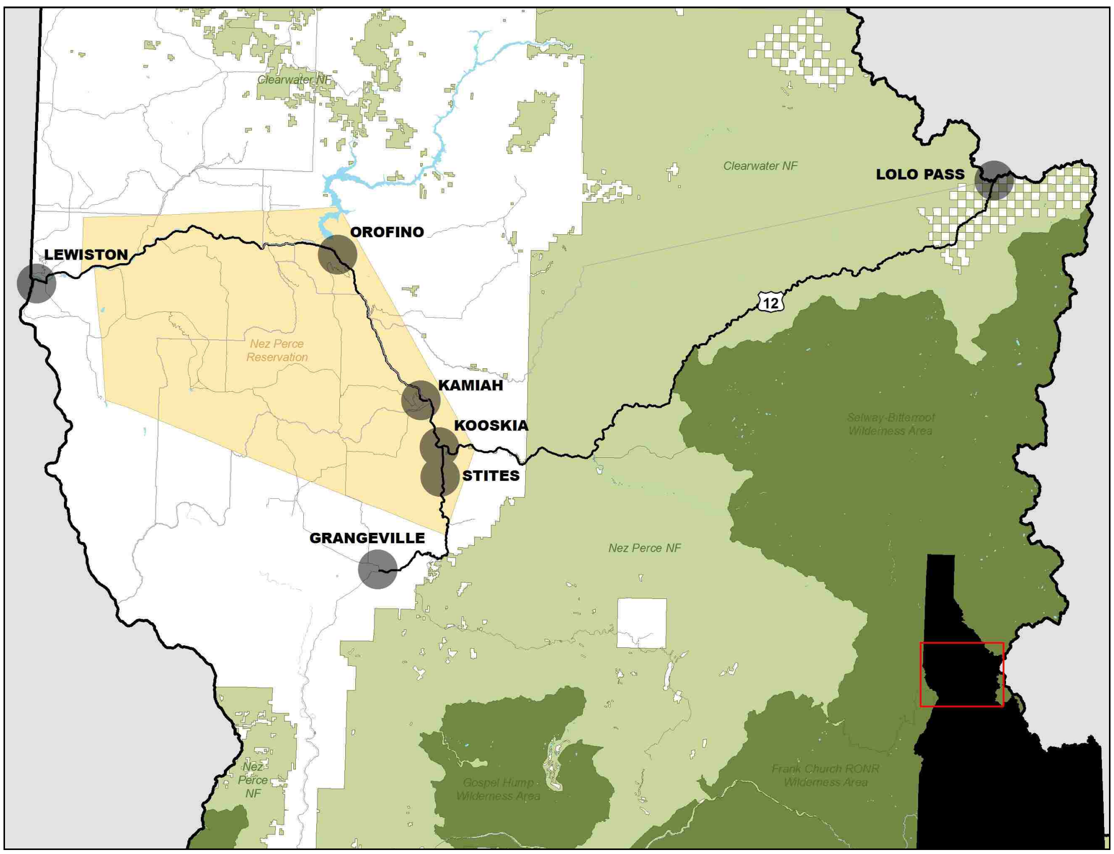


Figure 3. Northwest Passage Scenic Byway Overview Map (source: Author)

The NWPSB passes through some of the most spectacular scenery in the Rocky Mountain region. The physical geography of the region ranges from the rugged subalpine forests atop Lolo Pass to the deep canyon walls along the Clearwater River to the vast fields of wheat, barley, and alfalfa of the Camas Prairie at the Byway's southern terminus in Grangeville, Idaho. The majority of the Byway winds its way through a patchwork of federal, state, tribal, local, and private lands including the Clearwater National Forest, Nez Perce National Forest, and the Nez Perce Indian Reservation (Figure 4).

Figure 4. Northwest Passage Scenic Byway East of Kooskia, Idaho (source: Author)

Vast forests, wide open spaces, and crystal clear rivers along the Byway provide a wide range of outdoor activities including whitewater rafting, hiking, hunting, fishing, skiing, and wildlife watching. The Byway also passes through the ancestral lands of the NiMíiPuu (Nez Perce) as well as the approximate route of Lewis and Clark's journey to find a Northwest Passage. This intersection of native and western American culture can be experienced firsthand by visitors to the Byway. Highlights include the Heart of the

Monster (Figure 5), the Wolf Education and Research Center, the Nez Perce National Historic Park, the Lewis and Clark Discovery Center, their Canoe Camp, and the Clearwater Battlefield.

Figure 5. Heart of the Monster near Kamiah, Idaho (source: Author)

The Byway is an important economic catalyst for the small towns that dot its length as it draws thousands of visitors every year. The two lane highway also serves as an important transportation and shipping corridor for residents and tourists in this otherwise remote region. The majority of lands adjacent to the Byway are undeveloped due to the rural and extremely rugged nature of the area (Figure 6). Tourism, agriculture, timber harvesting, manufacturing, services, and recreation represent the major industries along the Byway (Idaho Department of Labor 2009).

Figure 6. Middle Fork of the Clearwater River during January 2008 (source: Author)

NWPSB VIEWSHED PROTECTION AND VISUALIZATION PROJECT

This research is being conducted in conjunction with the Northwest Passage Scenic Byway (NWPSB) Commission and Advisory Team's Viewshed Protection and Visualization Project. The NWPSB includes representatives from the National Park Service, the United States Forest Service (USFS), the North Central Idaho Travel Association (NCITA), the Idaho Transportation Department (ITD), the Nez Perce Tribe, and local governments and organizations. A list of all represented agencies and groups involved with this project are shown in Table 1 below.

Table 1. Agencies and Groups Represented in the Northwest Passage Scenic Byway Viewshed Protection and Visualization Project

Federal Agencies	State Agencies	Local Agencies/Organizations
Bureau of Land Management Clearwater National Forest Nez Perce National Forest Nez Perce Tribe National Park Service NWPSB	Idaho Department of Fish & Game Idaho Transportation Department North Central Idaho Travel Assn.	City of Grangeville City of Kamiah City of Kooskia City of Lewiston City of Orofino Clearwater County Clearwater Economic Development Agency Grangeville Chamber of Commerce Idaho County Kamiah Chamber of Commerce Kooskia Chamber of Commerce Lewiston Chamber of Commerce Nez Perce County Orofino Chamber of Commerce Stites City Council Upper Clearwater Community Fndn

The roots of the NWPSB extend back to 1989 when the State of Idaho designated a section of US Hwy 12 near Orofino, Idaho as the Clearwater Canyons Scenic Byway (Northwest Passage Scenic Byway Advisory Team 2006). In 1997 the Clearwater Canyons Scenic Byway was changed to Idaho's Northwest Passage Scenic Byway as part of a recommendation from the 1997 Corridor Management Plan (CMP). The Byway was extended in 2000 to include the section of US Highway 12 from Kooskia to Lolo Pass (Figure 1) (Northwest Passage Scenic Byway Advisory Team 2006).

The NWPSB received national designation by the United States Department of Transportation as a National Scenic Byway in 2002 and was awarded All-American Road (one of only of 27 in the United States) designation by the Federal Highway Administration on September 22nd, 2005 (Northwest Passage Scenic Byway Advisory Team 2006). According to the Northwest Passage Scenic Byway Corridor Management Plan Update (2006, 10), "the mission of the NWPSB is to welcome, serve, and educate the motoring public; advocate for transportation safety; and promote economic development while sustaining a way of life that is valued by its residents." The NWPSB Advisory Team oversees Byway improvements consistent with the Corridor Management Plan "to advocate and promote community awareness and support for scenic conservation, particularly involving local land use planning and context-sensitive design practices" (Idaho Transportation Department 2008).

In 2007 the NWPSB received federal funding to continue the implementation of the NWPSB Corridor Management Plan through the development of "visualization tools for residents along the Byway to understand potential degradation of viewshed and potential recreational opportunities" (Department of Transportation, United States 2008). In February 2008, WGM Group (an engineering firm in Missoula, Montana) was awarded a contract with the NWPSB to develop 13 visualizations for six communities (Grangeville, Kooskia, Kamiah, Lewiston, Orofino, and Stites) along the NWPSB. The visualizations were utilized during a series of planning workshops at each of the respective communities and included a combination of fully interactive 3-D models, digitally altered photographs, and plan-view maps.

Two consultants from WGM Group, NWPSB advisory team members, and stakeholders participated in site visits at each of the communities on March 19th and 20th 2008 (Figure 7). During each site visit a round-table discussion and community walk-through were conducted in order to identify a priority project and critical view (a term used by NWPSB officials to describe the positive or negative impacts to a viewshed).

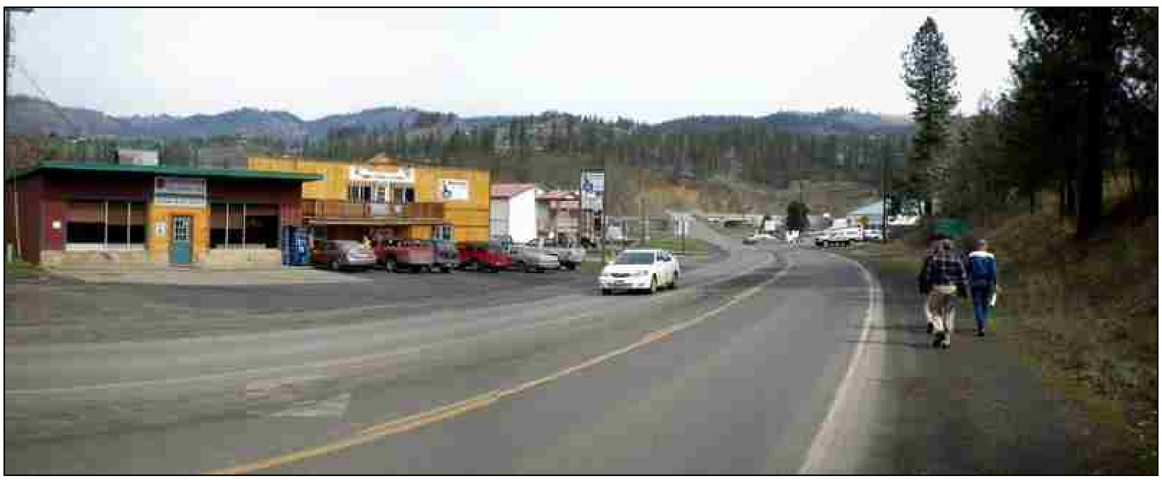


Figure 7. Community Walk-Thru in Kamiah, Idaho on March 19th, 2008 (source: Author)

Visualizations were created for each community based on the identified projects to be used during the community workshops that were held from April 21– 25, 2008. The workshops were used to present the visualizations and proposed plans to the communities, identify and discuss priority locations for preservation, talk about strategies to preserve those sites and views, and allow stakeholders to discuss concerns, ideas, and plans with NWPSB committee members, ITD representatives, and the consultants. The NWPSB Viewshed Protection and Visualization project included six communities along the Byway, however only three were addressed in this study due to a lack of willing participants from Lewiston, Grangeville, and Stites. The remainder of this section will describe the community projects and methods used to develop the visualizations for Kamiah, Kooskia, and Orofino.

Kooskia

Kooskia (population 675), Idaho, is located at the confluence of the South and Middle Forks of the Clearwater River (U.S. Census Bureau 2000). During the Kooskia site visit, stakeholders and NWPSB advisory team members identified a one-and-a-half mile pedestrian/ bicycle pathway between the city limits and the Kooskia High School as their number one priority project for visualization (see Figure 4). Concerns over the development of a parcel of land along the confluence of the South and Middle Forks of the Clearwater River adjacent to Idaho Highway 13 were voiced by several stakeholders and was selected as the second project/critical view for visualization (Figure 8). It is also important to note that each of the communities participating in the project have limited access to high-speed internet (i.e., DSL, Cable internet). High-speed internet through satellite is available but not commonly used due to the excessive cost. This aspect is an important consideration that will be addressed later in this project.

Figure 8. Kooskia, Idaho, Proposed Projects (source: Author)

Kamiah

Kamiah, Idaho, population 1,160, is located along the Clearwater River in (Figure 3) (U.S. Census Bureau 2000). The highest priority project identified by Kamiah stakeholders was the intersection of Main Street and US Highway 12. This 4-way intersection is considered the entrance to downtown Kamiah. Stakeholders feel that the intersection lacks the appearance and feeling of a town entrance and has caused many travelers to bypass the quaint Kamiah Main Street. Stakeholders and NWPSB advisory team members envisioned a “spruced up” intersection with better pedestrian access and planter boxes to entice travelers to explore downtown Kamiah. Kamiah stakeholders also identified the area of the “old log yard” along the south bank of the Clearwater River on the west side of US Highway 12 as an area of visual concern. A 3-D visualization was developed for this area to show potential development scenarios and strategies to minimize the visual impact of this brownfield site (Figure 9).

Figure 9. Kamiah, Idaho, Proposed Projects (source: Author)

Orofino

The City of Orofino, Idaho is located along the north bank of the Clearwater River and Orofino Creek. The population was listed at 3,247 in 2000 (U.S. Census Bureau 2000). Orofino stakeholders and NWPSB advisory team members overwhelmingly agreed upon the number one priority project for the community as the improvement of the west entrance to Orofino on US Highway 12. This area is approximately 2.5 miles from downtown Orofino and maintains a distinctly different feel from the downtown area. Stakeholders were interested in developing this area in order to "visually" link it to downtown; the addition of streetlights, sidewalks, and landscaping were discussed as possible ways to create a sense of arrival to Orofino (Figure 10).

Figure 10. Orofino, Idaho Proposed Projects (source: Author)

VISUALIZATION METHODS

This section describes the general concepts, techniques, and software used in the creation of the visualizations for the NWPSB Viewshed Protection and Visualization project. These include a 2-D map, digitally altered photograph, and fully interactive 3-D model (see Appendices E – R) for each of the community's proposed projects as described in the previous section. Figure 11 below provides a flow chart of the visualization process used to create the products for the NWPSB project.

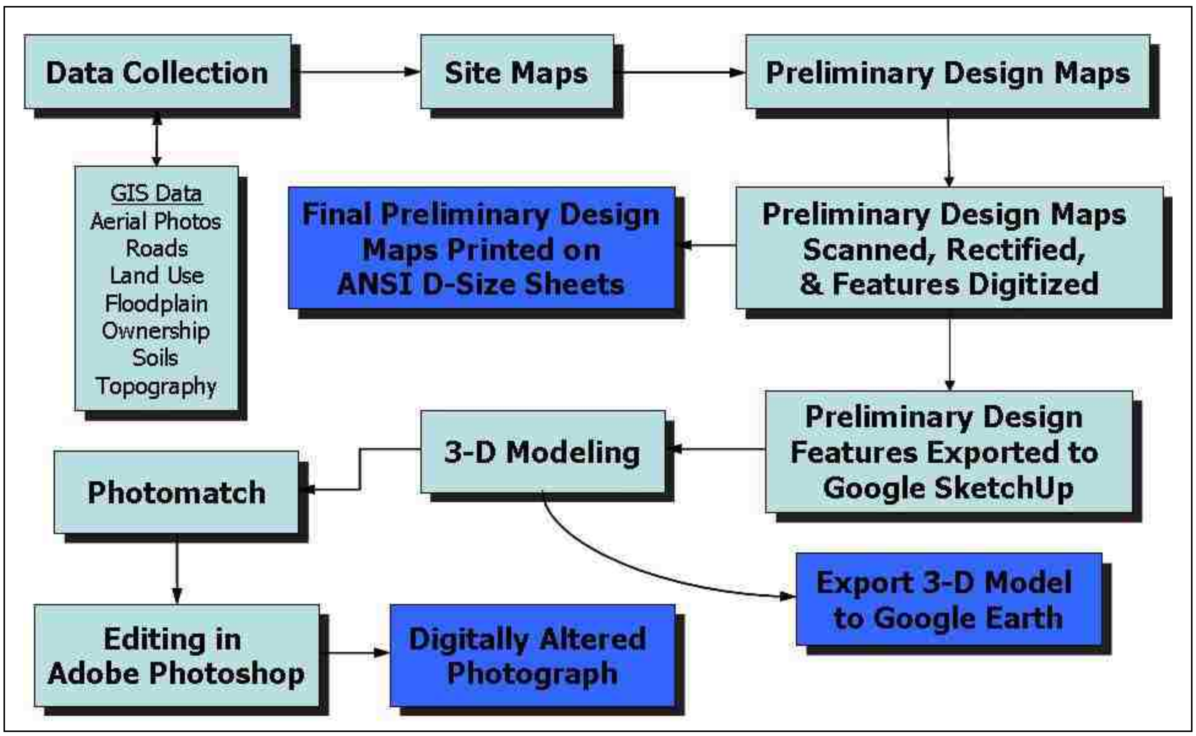


Figure 11 - Visualization Method Flow Chart

Data Collection

The first step in the development of the visualizations used in the NWPSB Viewshed Protection and Visualization project was to obtain existing site data for each community. Aerial photographs of each community and their adjacent areas were downloaded from the Idaho Interactive Numeric and Spatial Information Data Engine (INSIDE), an online data repository for Idaho GIS data, as compressed quadrangle mosaics (CQM). Land use, soils, floodplain, land ownership, topography, and transportation network shapefiles (a vector data storage format for storing the location, shape, and attributes of geographic features) were downloaded from the Idaho Department of Water Resource's online GIS data repository or obtained from the Idaho County, Clearwater County, and Lewis County GIS departments.

Development of Preliminary Design Maps

A preliminary design (or conceptual design) is generally considered to be the first phase of design in professional planning or engineering. It is a general idea or abstract for an area (vacant piece of land, intersection, existing building) that takes into consideration a variety of factors including the physical constraints of an area, the vision or intention of the group or person(s) for which it is being considered, integration with the adjacent environment (built or natural), and alternative scenarios. A preliminary design is typically portrayed as a drawing or map and can range from hand sketches to refined digital maps.

Preliminary designs were created for each proposed plan in the NWPSB Viewshed Protection and Visualization project. This was a complex process that required multiple variables (e.g., transportation, aesthetics, erosion, economics, etc.) to be considered. As a result, a collaborative effort was required between a land use planner, transportation engineer, and GIS specialist to create a series of realistic and appropriate visualizations for the NWPSB project. The steps taken in the development of the preliminary design maps are reviewed next.

The first step involved the creation of a series of basic site maps (e.g., aerial photo, land use, land ownership, soils, transportation network, and floodplain) utilizing the spatial data described in the previous section. These maps were printed in full color on ANSI D-size sheets and served as reference maps for the planner and transportation engineer. Next, a map of each project area was created that included land ownership boundaries (parcel boundaries) and the requisite aerial photograph. Tracing paper was placed over each map and preliminary designs for each proposed plan were sketched onto the paper (Figure 11). The tracing paper overlay was then removed from the aerial photo/land ownership map and taped to a blank piece of white paper. A digital version (JPEG) of each preliminary design was created using a large format scanner. Once all of the preliminary design sketches were scanned and converted to digital format they were brought into ArcMap to be digitized (the process of converting analog map data to digital format in the shape of points, lines, and polygons).

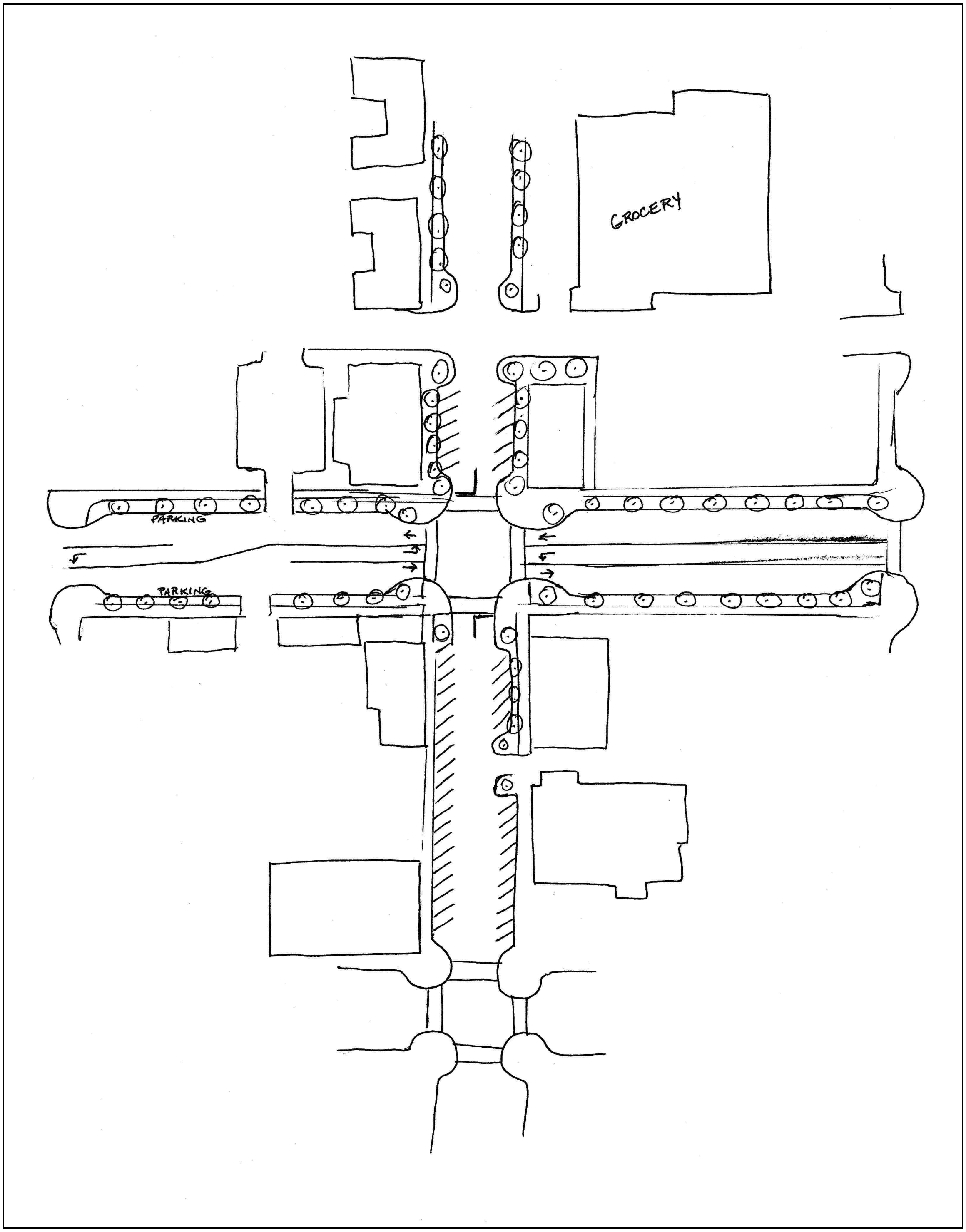


Figure 12. Example of a Conceptual Design Sketch from Kamiah, Idaho (source: Author)

Before the preliminary design features (i.e., roads, sidewalks, curbs, medians, trails, parking areas) could be digitized, the scanned designs needed to be rectified (the process of applying a mathematical transformation to an image that results in a planimetric image) because they did not contain any spatial reference information. Assigning a spatial reference system to the scanned maps allowed the digitized preliminary design features to be overlaid on the aerial photographs in the final preliminary design maps. As preliminary design features were digitized, an attribute name was assigned to each feature referring to its design type (e.g., sidewalk, curb, median, etc.). This process was completed in order to parse out and symbolize design features to be used in the final preliminary design maps. Once each of the preceding steps was completed for each of the preliminary designs, a print layout was designed in ArcMap. A final preliminary design map was created for each project combining the digitized data and aerial photograph of each project site. The final maps were export to portable document format (PDF) and printed in full color on ANSI D-size sheets for use at the NWPSB Viewshed Protection and Visualizaton project community workshops.

3-D Model Development

Corresponding 3-D models were created for each proposed project using Google SketchUp®. The digitized preliminary design data for each project was used in the creation of the 3-D models. The shapefiles containing the design features were exported from ArcGIS® into Google SketchUp® using the ArcGIS® plugin for Google SketchUp®.

Before 3-D modeling could begin, the spatial location and associated aerial photograph had to be imported from Google Earth®. The location of each project site was located in Google Earth® and the "Get Current View" button was selected in Google SketchUp®. The "Get Current View" function imported the terrain information and aerial photograph from Google Earth® into Google SketchUp®. This step was completed for each project. Next, the preliminary site data were selected and moved to the proper spatial location (in line with the aerial photograph). This was to ensure the proper display of the completed 3-D models in Google Earth®.

With the preliminary site design information now in Google SketchUp® and correctly aligned spatially, the process of 3-D modeling could begin. This includes the application of different materials to model features (i.e., grass material for open areas, concrete for sidewalks, etc.), the extrusion and addition of architectural features (e.g., windows, doors, eaves) to buildings, and the placement of trees, vegetation, people, and site furniture (e.g., street lights, garbage cans) into the models. The 3-D modeling stage was an on-going collaborative process between the professional planner, transportation engineer, and GIS specialist to ensure that each of the features in the model was appropriate for the conceptual design.

Once the 3-D modeling stage was completed for each project, the models were exported to Google Earth® format for final viewing. Each Google SketchUp® model was opened and the "Export to Google Earth®" function was used to create a KMZ file (a file format used to store geographic features and models that are readable by Google Earth®). By simply double clicking on the KMZ file, the 3-D model will automatically be opened by Google Earth® and the program will "fly" to the extent of the model. At this point the 3-D model is available for exploration in Google Earth®.

Creating the Digitally Altered Photographs

The digitally altered photographs were the final visualizations to be created for each proposed plan. Digital photographs that were taken during the site visits in March, 2008, were used in conjunction with the 3-D models of each project. These digitally altered photographs were created with the photomatch utility in Google SketchUp® and Adobe Photoshop. Essentially, the 3-D vector data (3-D model) was placed (superimposed) onto the digital photograph.

First, the 3-D models were opened in Google SketchUp® and the corresponding digital photograph of each site was also imported into SketchUp. The Google SketchUp® photomatch utility was used to match the perspective of the models with the perspective in each of the photographs. This process would allow each of the 3-D models to be superimposed onto the digital photograph with the correct perspective, scale, and height in relation to the photographs.

When the photomatch utility is activated a set of green and red perspective lines and a yellow square representing the origin appear in the Google SketchUp® workspace. These reference points are used to align the perspective of the photographs with the 3-D models. In each Google SketchUp® project, two sets of parallel edges were found and the green and red perspective lines were aligned to these edges (Figure 12).

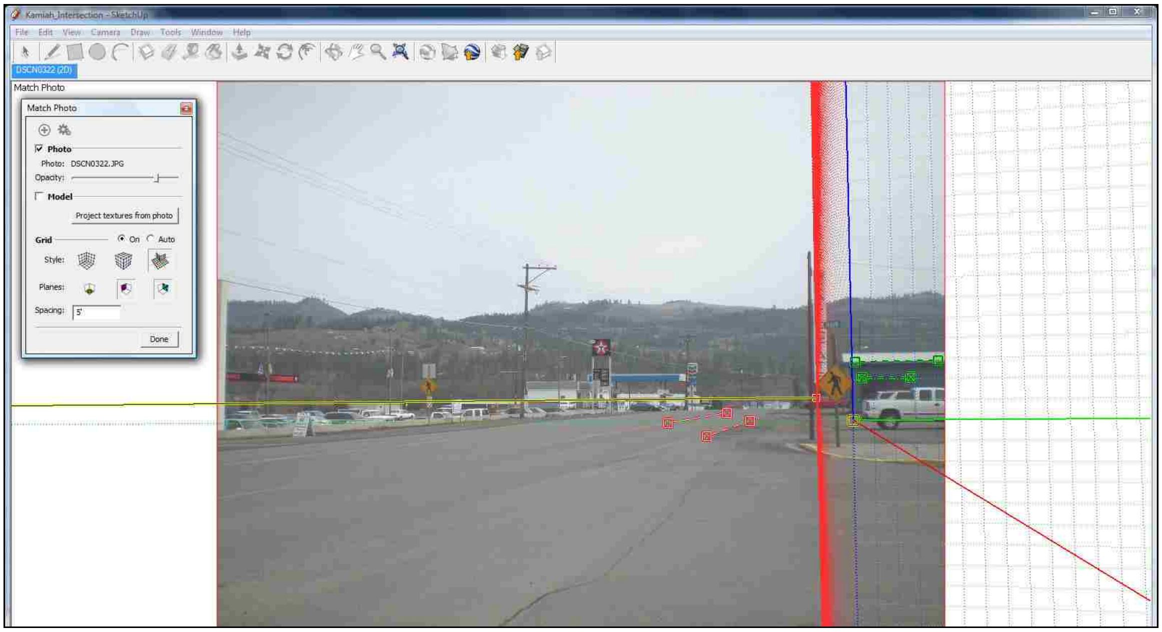


Figure 13. Photomatch Utility in Google SketchUp® (source: Author)

Most often the parallel edges of a building found in the photographs were used; however in some instances this was not an option and other parallel features from the photographs were used including sidewalks, curbs, and roadways.

The origin of the red and green parallel perspective lines also needed to be set by moving the yellow origin square to the intersecting point of these lines. This step was necessary in order to set the correct scale (or grid height) of the vertical axis in the photographs. Once these steps were completed the 3-D models were automatically “placed” into the correct perspective and height within their respective photographs (Figure 13).

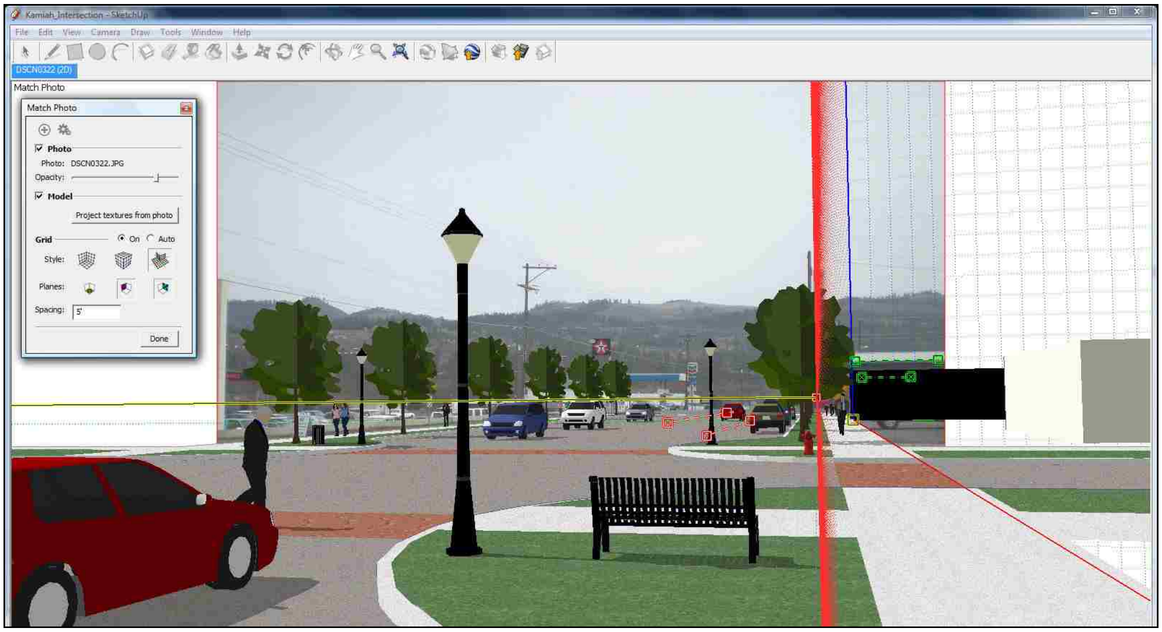


Figure 14. Photomatch Utility with 3-D Model in Google SketchUp® (source: Author)

The superimposed 3-D models were exported from Google SketchUp® at the identical resolution of their corresponding digital photograph in TIF format. These images were then brought into Adobe Photoshop and were combined with the original photograph. Several of the photographs needed to be edited in order to properly layer the superimposed 3-D model in the photographs. This process included the use of several Photoshop layers, the clone tool, and magic wand tool. Once editing and merging was completed for each project, the final superimposed photographs were saved as high resolution JPEGs.

The final step involved the creation of "before" and "after" compositions, these images displayed the original photograph of each site area alongside the digitally altered photographs. Final compositions were arranged in Adobe Illustrator and printed in full color on ANSI D-size sheets then mounted on poster board for use during the community workshops. Legal size sheets were also printed in full color to serve as handouts during the workshops.

SOFTWARE USED

A review of the software used to produce the visualizations for the NWPSB Viewshed Protection and Visualization project is provided in this section.

Google SketchUp®

Google SketchUp® is a 3-D modeling program that was originally developed by @LastSoftware. Founded in 1999 by a group of AEC professionals from Denver, Colorado, who had a vision of developing 3-D design software that was easy to use and accessible to the general public (Google SketchUp® 2007). In March of 2006 Google purchased SketchUp from @LastSoftware and released a free version of SketchUp for public use. In that time SketchUp has continued to provide a wide range of extensions and plug-ins that interface with other modeling, drawing, and GIS software (see Figure 15).

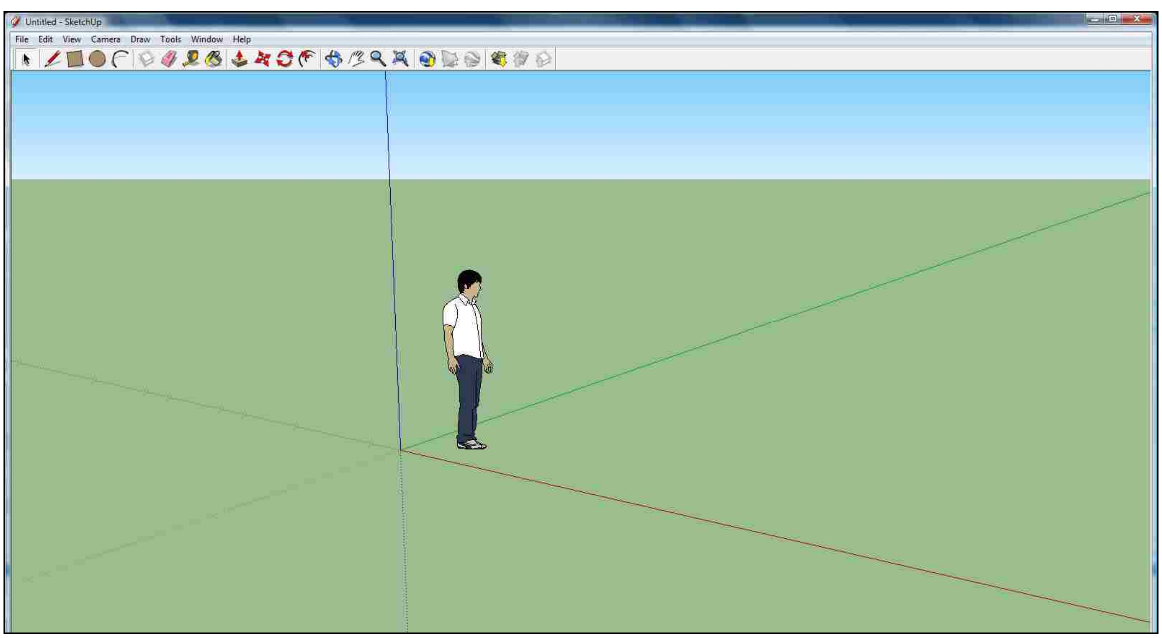


Figure 15. Google SketchUp® Interface (source: Google SketchUp®)

SketchUp is an extremely user-friendly modeling program with a clean and simple interface with a relatively small learning curve that allows users to produce complex and detailed 3-D models. Additionally, SketchUp models can be utilized in ArcMap GIS (with the 3-D Analyst extension) and Google Earth®. The Pro (paid) version of SketchUp costs $495 and provides additional functionality including the ability to export models to other software applications (i.e., AutoCAD, 3-D Nature Studio, ArcGIS®) for further rendering and analysis. SketchUp Pro also includes a layout add-on to create 2-D presentations of 3-D models, the ability to calculate areas, and a lighting engine that allows user to perform shadow studies. Google SketchUp® also offers the ability to connect to Google's 3-D Warehouse, an online depository of thousands of pre-built 3-D models shown in Figure 15 below.

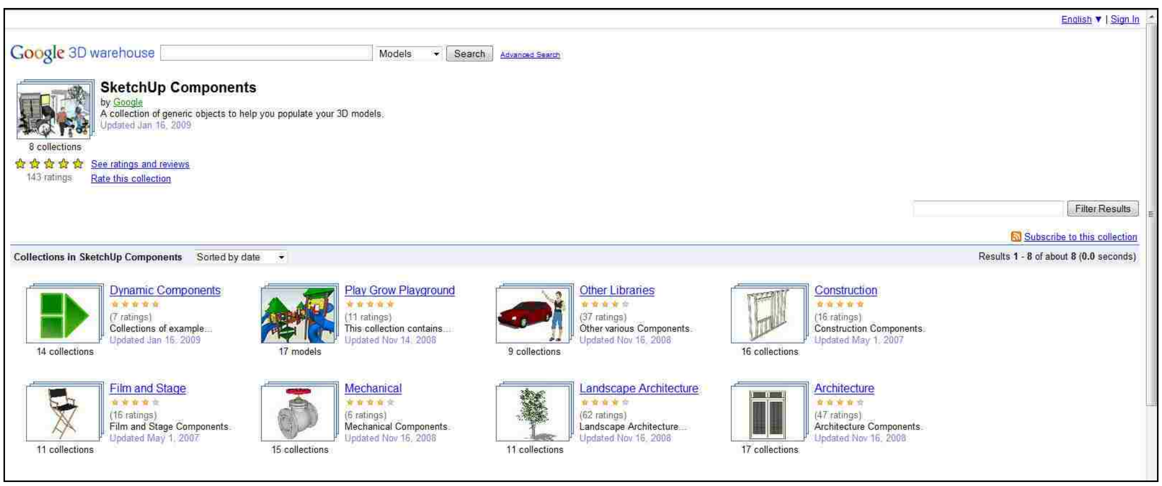


Figure 16. Google 3-D Warehouse (source: Google)

Overall the simplicity of Google SketchUp®, coupled with the robust features and compatibility with a variety of software programs make this a powerful planning tool and important addition to any planning support system (Google 2007).

Google Earth®

Google Earth® is a free interactive 3-D software model of the earth (also known as a virtual globe) that was originally created by Keyhole, Inc., in 2001. In 2004 Google acquired Keyhole, Inc., and changed the name to Google Earth® from the original name EarthViewer (Köbben and Graham 2009). Google Earth®, and other virtual globes for that matter, separate themselves from other online mapping services by allowing a user to pan, tilt, fly, and zoom in multiple directions, angles, and distances from the ground (see Figure 16).

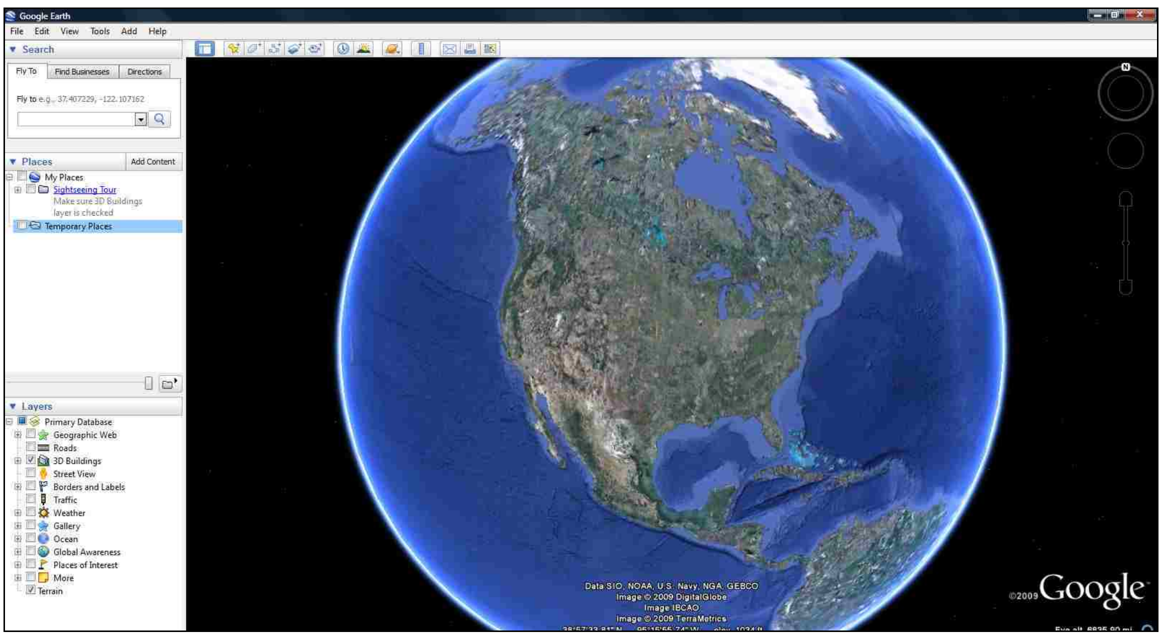


Figure 17. Google Earth® Virtual Globe Software (source: Google Earth®)

Google Earth® combines a tremendous amount of information including digital terrain models with accuracies from 10 meters to 90 meters, aerial photographs and satellite imagery, 3-D buildings, road networks, political borders, place names, and a vast number of "placemarks" locating everything from World Heritage Sites to famous sports arenas and beyond. The world famous search capabilities of Google are also incorporated into

Google Earth® allowing a user to search for just about anything with a spatial component.

During 2003 Google Earth® (EarthViewer at the time) hit the mainstream when it was used by several news agencies during coverage of the Iraqi invasion. Since that time millions around the world have travelled the world over from the comfort of their home office. Google Earth® has also proven to be a powerful research tool allowing researchers the ability to better communicate their findings with the general public (Köbben and Graham 2009; Sheppard and Cizek 2008). Furthermore, Google Earth® allows for easy customization and the ability to overlay spatial data on an existing aerial backdrop, a process that was previously available only with complex GIS or CAD software. The impact and application of Google Earth® on spatial comprehension, science, geography, and the GIS industry has only begun to be fully realized.

ArcGIS®

ArcGIS® is a suite of software products produced by Environmental Systems Research Institute (ESRI) for the storage, editing, analysis, and display of geospatial information. This project utilized ArcGIS® version 9.2 for the storage and display of spatial information utilized in the development of preliminary site design maps for the NWPSB Viewshed Protection and Visualization project.

Adobe Photoshop

Adobe Photoshop® (Photoshop) is a raster based editing program for the manipulation of photographs and graphics, it is created and published by Adobe Systems.

Photoshop was used in this project to edit digital photographs and merge 3-D vector data with digital photographs.

RESEARCH METHODOLOGY

The Northwest Passage Scenic Byway Viewshed Protection and Visualization project was used as a case study allowing for the opportunity to study the use of visualization methods in the planning process based on the perspective of the stakeholder. Ten interviews were conducted with three stakeholder groups from January, 2009 to August 2009.

In order to understand stakeholder perceptions, a qualitative approach was taken in this study as this has been shown to be an appropriate method for understanding the "meanings, concepts, definitions, characteristics, metaphors, symbols, and descriptions of things" that should help to form a stakeholder's perception (Berg 1998, 3). Perception is the moment at which visual and non-visual information bind together. It is the process through which an individual interprets what they are seeing, and can be influenced by several factors including background, expectation, knowledge, and memory (Mitchell 1989; Hearnshaw 1994). Believing this to be true, it would be impossible to assert that one single objective social reality exists. This study maintains this position and seeks to understand the different ways in which individuals understand and perceive the use of 3-D visualization in planning through the use of participant observation and semi-standardized interviews (Berg 1998). Both methods allow the researcher to view the world from the subject's perspective, and have been found to be effective means for understanding perceptions (Berg 1998). Therefore the use of a quantitative research instrument such as a survey, or even a qualitatively oriented questionnaire, could not capture the intimate details associated with an individual's perception and certainly would fail in attempting to establish a single objective reality regarding the use of visualizations in planning.

Participant Observation

Participant observation took place during the NWPSB Viewshed Protection and Visualization project's community workshops for Kooskia, Kamiah, and Orofino, Idaho on April 21 and 22, 2009. The community workshops entailed the unveiling and subsequent discussion of the prepared visualizations for each community. Participant observation took place throughout these meetings and served the purpose of "providing complementary evidence" to be used in conjunction with the semi-standardized in-depth interviews (Kearns 2005, 193). The type of observation used in this study was characterized as quasi-controlled, meaning that a particular location (community meeting) had been pre-determined at which to observe, but no clear or explicit decision was made on how to do this or regarding what was to be observed. The rationale behind this decision was to observe stakeholders in a more natural setting than is typically found in "more controlled and formalized methods such as interviewing" (Kearns 2005, 193). Participant observation in the context of this study allowed the researcher to gather supplementary descriptive information that was used in conjunction with the more formal interviews (Kearns 2005). It also allowed the researcher to fine-tune the interview guide based upon observations and themes that arose during the workshops.

Field notes were taken during the workshops with pen and paper. Attention was given to the physical setting, relationships between workshop participants, body language, and identification of central characters following the recommendations of Berg

(1998). The reactions, references, and comments to the different visualizations were also of primary concern during observation. Immediately following each workshop, time was taken to reflect on the field notes. Ideas, themes, and/or personal reactions were documented during this reflection period. Field notes were then entered into a computer for content analysis. Coding was performed using QSR International's Nvivo software and common themes were identified.

Participant observation and analysis of the community workshops provided an important view into the use of 3-D visualizations in the planning process that could not be obtained through interviews alone. Themes arising from the content analysis of field notes also allowed the researcher to develop new, and refine existing, questions for the interview guide.

Semi-Standardized In-Depth Interviews

During the in-depth interviews participants were asked a series of questions relating to the use of the visualizations in the planning process. Each of the visualizations was presented and participants were also given the opportunity to "drive" Google Earth® and explore the 3-D models on their own. An interview guide (see Appendix A: Interview Guide) was constructed to obtain feedback on topics including the level of conceptualization for a project based on the visualization (2-D or 3-D) used, appropriate levels of realism, positive and negative aspects of each visualization, scale and viewpoint used in the visualizations, user control and navigation, and the overall utility of the visualizations. The interview guide was divided into two main parts; the first part was used to gain important background information about the stakeholders including their involvement with in the NWPSB Viewshed Protection and Visualization project. The second part of the interview guide focused on the perceptions, reactions, and responses of stakeholders to the use of the visualizations in the project. This information helped in answering the research questions posed in this study and provided useful insights into the use of visualizations in planning.

Interviewees consisted of stakeholders from Kooskia, Kamiah, and Orofino, and represented three primary stakeholder groups: local government entities, private business owners, and local residents. Three interviews were conducted with each of the three stakeholder groups and the tenth interview with the professional planner involved with the project. Purposeful sampling of interview subjects was undertaken in order to address gaps in previous research (Appleton and Lovett 2005; Lange 2005; Veteto 2006). Those studies focused primarily on the reactions and perceptions of planning related professionals and failed to understand the reactions and perceptions of stakeholders to the use of visualizations in the planning process. Furthermore, purposeful sampling allowed the researcher to move away from a focus on generalizability and attempted to select cases or groups for systematic study that were information rich (Bailey 2007). Flick (2002: 64) expands on this idea of information rich data explaining that "sampling decisions aim at that material which promises the greatest insights, viewed in the light of the material already used and the knowledge formed from it." Due to the nature of this study, and the researcher's ontological belief in multiple social realities, this was determined to be an appropriate method of sampling.

All interviewees attended their respective community's workshop in April 2009 and therefore were involved with and exposed to the visualizations used in the NWPSB

Viewshed Protection and Visualization project. This was a necessary requirement as it allowed for stakeholders to respond to and comment on the use of visualizations in the planning process. Subjects were selected from workshop attendance sheets provided to the researcher by the director of the NWPSB. Contact was made with prospective candidates through email and/or telephone. A brief explanation of the researcher's involvement with the NWPSB project and academic research project was provided. Those agreeing to meet were offered to choose the time and location of the interview in order to allow for flexibility with work schedules and personal commitments.

Due to the interactive and visual nature of the project, it was determined that interviews needed to be conducted in person. This also allowed the researcher to once again experience the Byway and its communities. The researcher travelled to Kooskia, Kamiah, and Orofino periodically from January 2009 to August 2009 to conduct the interviews. Care was taken to select relatively quiet and comfortable locations; interviews took place at several places including community centers, places of employment, cafés, and a restaurant.

Each interview was digitally recorded, upon written consent, and transcribed with a personal computer using Microsoft Word and NHC's Express Mini Scribe software. Interviews typically lasted from 45 minutes to 90 minutes depending on responses and the duration of the initial "chit chat." Extreme care was taken during the coding and analysis of the transcribed interviews to omit the name, job title, gender, or other revealing characteristics so as to protect the anonymity of the interview subjects. A generic name and number (i.e., Interview Subject 1) was given to interviewees when referred to in this text or related documents.

Content analysis of the transcribed interviews was conducted using QSR International's NVivo software package. An inductive approach was taken during this analysis, a method in which the researcher immerses oneself "in the documents in order to identify the dimensions or themes that seem meaningful to the producers of each message" (Berg 1998, 230). This approach supported the research by presenting "the perception of others in the most forthright manner" and allowed the categories created to be linked or grounded to the data from which they came (Berg 1998). Open coding was used during this process and a unique set of codes were created based on the data. These codes took into consideration the literal words offered during the interviews and the manner in which they were offered (Berg 1998). Simple ideas, words, and meanings coded, once the data had been coded several times groups of common codes were formed. These groups allowed the researcher to develop different themes based on the responses to the different interview questions.

RESULTS

This section includes the results from this study. First, field notes and themes arising from the participant observations are covered. The second section explores the responses from the in-depth interviews and identifies themes that emerged during content analysis.

Section One: Participant Observation

This section will provide an overview of the NWPSB community workshops held in Kamiah, Kooskia, and Orofino on April 21-23, 2008, including the general format of the meetings, topics addressed, observations made by the researcher, and resulting themes. The information gained from participant observation at these meetings provides an important view into the use of 2-D and 3-D visualizations in the planning process.

The community workshops represented the final phase of the NWPSB Viewshed Protection and Visualization project. The workshops were intended to provide stakeholders of the respective communities an opportunity to meet with NWPSB representatives, view the results of the proposed projects in the form of visualizations, discuss the proposed projects, and talk about opportunities for viewshed protection, community funding, and future plans. Each lasted approximately three hours and followed similar agendas, a brief outline of which is shown below (for the full agenda see Appendix C: NWPSB Workshop Agenda):

- Introductions
- Overview of the NWPSB
- How Your Business and Community Can Benefit from Byway Marketing Efforts
- Scenic and Historic Conservation Options Along the Byway
- The Opportunity to Image (presentation of visualizations)

- Small Group Breakouts
- Next Steps to Move Forward with Byway Projects and Scenic Conservation

Each of the workshops took place during the evening (6-9 pm PST) and were held at the following locations: the Ponderosa Restaurant in Orofino, the Kamiah Welcome Center, and the ground floor meeting room at the Kooskia City Hall. These locations provided ample room for all of the presenters and stakeholders. Attendance at the workshops was high according to Byway officials and included 23 stakeholders at the Kamiah meeting, 19 stakeholders in Kooskia, and 15 stakeholders at the workshop in Orofino (these numbers do not include the seven presenters or the researcher). Workshop attendees included:

- Tourism related business owners (lodging, dining, outfitters, ect.),
- Property owners along the Byway,
- Chamber of commerce and economic development representatives,
- Real estate professionals,
- City and County elected officials,
- Planning and zoning commission members,
- Private and federal agency representatives
- Concerned citizens

Two primary themes emerged during analysis of field notes:

1. Visualizations as an Important Communication Tool

2. Distrust of Federal and State Agencies

Theme One: Visualizations as an Important Communication Tool

All of the workshops provided lively discussion surrounding the issues of scenic conservation, viewshed protection, and community enhancement among others. Reactions to the proposed projects and visualizations varied widely, ranging from little or no verbal or emotional response to highly vocal and emotional responses of approval and disapproval. In particular, the majority of the stakeholders at the Kamiah meeting showed a general sense of excitement and approval for the proposed Main Street and US Hwy 12 improvements when the visualizations were revealed. During the workshop several of the stakeholders commented that they had difficulty understanding the proposed project prior to seeing the visualizations. In particular, the "older" stakeholders commented on the fact that the visualizations (especially the digitally altered photographs) helped to aid in their understanding the proposed projects. Many of the stakeholders would point to or make reference to the visualizations when voicing their opinion regarding a particular detail or overall concept of the proposed plans. This improved communication between stakeholders, Byway officials, and the planners.

Similar responses were observed at the Kooskia workshop with respect to the proposed trail project along the dike from downtown Kooskia to the high school as well as the potential riverfront development. Similar to Kamiah, stakeholders often referred to the images and 3-D models as discussions took place and stakeholders expressed their concerns and support for the proposed projects. Discussions focused primarily on the concepts shown in the visualizations as opposed to the content. The majority of stakeholders were concerned with the overall concept of the projects rather than the design components. Those who participated in the pre-workshop community walk-through felt that the concepts presented in the visualizations exceeded their expectations and "looked" far more appealing than what they had originally envisioned.

Responses to the visualizations in Orofino of the proposed improvements to US Hwy 12 were mixed, approximately half of the stakeholders voiced appreciation and support for the project while the remaining workshop attendees were not quite as convinced that the proposed project could be accomplished. In particular, one local government official commented that the "art" was not in the creation of the concept or visual imagery, but rather the ability to have the project pass through each level of government red-tape. He cited previous difficulties with State officials and "unrealistic" requirements for small town projects during the design and review processes that historically have made many projects un-doable due to exorbitantly high costs. The visualizations appeared to have played an important role in the planning process by allowing stakeholders to "see" the proposed projects but more importantly they acted as a catalyst for the discussion of issues related to these type of projects (i.e., politics, funding, local support). Finally, they appeared to have provided a common means of communication between stakeholders, Byway officials, ITD, and the consultants, echoing similar results from previous studies (Al-Kodmany 2001; Appleton and Lovett 2005; Lange 2005).

Theme Two: Distrust of Federal and State Agencies

The second theme addresses the general distrust of federal and state agencies voiced by many of the stakeholders during the NWPSB community workshops. During each of the workshops a small number of the stakeholders who had been involved in past community projects (i.e., government officials), particularly those involving road or highway improvements, commented on the difficulties they have faced in the past when trying to work with ITD and other state agencies on community projects. Stakeholders described issues with funding, government red-tape and the "ridiculous technical requirements of ITD" when approaching community projects as serious impediments to success. This distrust of federal and state agencies appeared to carry over into the NWPSB Viewshed Protection and Visualization project. Stakeholders agreed that the design of the proposed project was interesting, but it seemed highly unlikely to move forward due to the aforementioned issues. One of the stakeholder's commented that, "the art is not in the image or the plan, it is getting it done, making it happen." In this context, the visualizations were of secondary thought. It did not matter what was shown, what really mattered was whether or not what was shown could be accomplished. This theme highlights an important issue in which visualizations are merely one component in an otherwise complex web that is planning.

Section Two: In-Depth Interviews

The first set of questions asked of study participants addressed their background characteristics including their occupation, amount of time spent living in each respective community, their involvement with the NWPSB (and particularly the Viewshed Protection and Visualization project), and their general level of community involvement. These questions were intended to provide a depiction of interview participants and therefore content analysis was not as rigorous as the remaining questions from the interviews.

Question One: Respondents' Occupations and Tenure in the Community

What is your occupation and how long have you lived in [Orofino, Kamiah, or Kooskia]? As was expected, a wide range of answers were provided by interview subjects that displayed the diverse background and life experience of each participant.

These questions also acted as an ice breaker. They provided an opportunity for both the interview subject and researcher to become comfortable with one another, topics such as the weather, politics, economy, the local area and community were discussed. Occupations of the study participants ranged from a United States Forest Service (USFS) employee to several local business owners, a graphic designer, local government entities, a stay-at-home mom, a professional planner, and two community organizers. Interestingly all of the study participants had lived in their respective community for no less than eight years. The average length of residency for all nine of the ten (one subject had been involved with the project but was not a local stakeholder) interview subjects exceeded 18 years. Several of the participants grew up in their respective community and had moved away for a time but then returned. Three of the stakeholders were lifetime residents in their respective community. Needless to say, all of the stakeholders held an intimate knowledge of their community that aided in their ability to provide a rich set of data.

Question Two: Involvement in the Project

What was your involvement with the NWPSB Viewshed Protection and Visualization project? Since it was known that each interview subject had attended their community's workshop in April 2008, this question was used as a springboard to delve deeper into each stakeholder's connection with the project and other instances of community involvement. Eight of the ten interview subjects had participated in their community's pre-workshop walk-through and were actively involved in the identification of their community's priority projects. Several of the stakeholder's had also been involved with previous NWPSB projects. Two of the stakeholders acted as the point of contact for their community throughout the duration of the Viewshed Protection and Visualization project and also performed the duty of greeter during their community's workshop.

The majority of stakeholders described themselves as active community members who took an interest in the NWPSB project due to their desire to play a role in the development and enhancement of their community. Four of the stakeholders were Gem Committee members, a program created by the Idaho Department of Commerce that provided training and technical assistance in community development for rural communities. All of the stakeholders had strong participation in community groups or volunteer positions that included serving on planning committees, acting as chamber presidents, volunteering at the local community centers, acting as liaison to government committees, and actively participating at community meetings. Overall it became clear that each of the stakeholders had been actively involved with their communities, and had prior experience with and exposure to the planning process. This allowed them to provide personal and detailed insights into the use of the 2-D and 3-D visualizations in the NWPSB Viewshed Protection and Visualization project.

The second section of in the interview guide represented the "heart" of the research as it explored the perceptions stakeholders held in regard to the use of 2-D and 3-D visualizations in the planning process. Scheduled and unscheduled probes were used to expand on specific topics or ideas that arose during the interview, those that the researcher could not have anticipated due to each subject's personal view of the world.

Question Three: Comparison of 2-D and 3-D Visualizations

After looking at the two visualizations (digitally altered photograph and 3-D model) which do you believe best helps you understand/conceptualize the proposed development/improvement? Question four from the interview guide asking stakeholders to compare the 2-D and 3-D visualizations produced similar or duplicate themes and therefore these two questions were combined. Interview subjects were given ample time to review the entire set of visualizations specific to their community. These included both the digitally altered photographs and 3-D models. The digitally altered photographs were displayed in full color on legal size paper; 3-D models were displayed in Google Earth® (interview subjects were given the opportunity to "fly" around the model). Overwhelmingly the subjects agreed that the 2-D digitally altered photograph was the best method of visualization for conceptualizing the proposed projects. Four primary themes emerged during content analysis of the responses that helped explain this choice:

1. *Ability to Conceptualize*
2. *Project Size and Scale*
3. *Demographics*
4. *Lack of Visual Reference in Google Earth®*

Theme number one addresses the importance that the visualizations played in helping stakeholders conceptualize or understand their proposed projects. The second theme looks at the role project size and scale play in determining the appropriate and most useful method of visualization. Theme number three describes the affect that demographics, in particular the rural character of the communities and the age of the majority of stakeholders, played in affecting a stakeholder's perception of the different visualizations. The final theme describes a lack of visual reference cues in Google Earth® that affected a stakeholder's ability to conceptualize the proposed projects.

Theme One: Ability to Conceptualize

This first theme addressed how visualizations can help the general public conceptualize a planning project (and less at the specific type of visualization 2-D versus 3-D). Previous studies (Al-Kodmany 2001; Pettit et al. 2006) have found that lay-persons tend to have difficulty turning words and plans into 3-D mental images. Seven out of the ten stakeholders from this study also described a failure to conceptualize the proposed project(s) based on verbal descriptions alone thus confirming the results from previous research. In fact, a number of the proposed projects had been discussed for several years but failed to garner enough support to move them from words to reality. One stakeholder described the initial reactions of several community members to the visualizations and their new found ability to conceptualize an old project:

> Very positive, yes. People were impressed. They talked about this project for years. People were afraid of it, ok, as to what the thing is…so when this came out [the visualization] with a few modifications they thought it was something that could be done in a small community. We have told them that in the past but until they couldn't actually visualize it, it wasn't connecting. And one of the issues we've had with the highway project here is our merchants that have businesses along that are saying we're going to lose our parking, we're not going to be accessible. You know, yada yada yada. And this shows that it is something that's feasible. (Interview Subject 1).

The following responses also describe the ability of stakeholders to conceptualize their community's proposed projects through the use of visualizations:

> And it was actually fun to be at that meeting and to watch people's expressions as the pictures came up and it was like, wow, Kamiah

> could look like that. So it was a bit inspiring, it had the desired effect (Interview Subject 2).
>
> I think when you talked about it I really had my doubts. But when I saw the pictures it all made sense. We had a lot of controversy when we did Main Street because you can't believe how ugly these buildings were. So there were all different kinds of ideas about how to fix up the town. We had a gal who said to draw the concepts out with the western Victorian style buildings and all of a sudden people could see it (Interview Subject 3).
>
> A lot of people visualize something like this anyway…I think more importantly they were just visualizing the sidewalk. There's actually a walkway on the other side that people walk on, it's not very wide, and so I think that's what they see. I didn't visualize it like this. Talking about it would be very difficult (Interview Subject 8).

Theme Two: Project Size and Scale

All ten of the stakeholders interviewed selected the 2-D digitally altered photograph as the visualization that allowed them to best conceptualize the proposed projects for their community. This came as a surprise to the researcher that usurped the belief that a fully interactive 3-D model would be preferred among stakeholders. However, the site specific nature and small scale of the community projects supplanted this notion and provided one of the main areas of focus during the interviews. One stakeholder explained how project size and scale have an impact on the appropriateness of the 2-D digitally altered photographs:

> So I have an ability to look at 2-D in 3-D in my head. And so either is useful for me but knowing that not everybody has that skill or ability to do that, 3-D's can be super helpful. However, for a project like this where it was very conceptual, very broad scale these are just ideas…people may have gotten distracted by the 3-D (Interview Subject 2).

Further explanation was provided:

> I think the 2-D imagery was really really, really really impactful and it was easy to grasp. You can see very clearly looking at the kind of before and after of a single scenario. Whereas the fly thru's would have conveyed better had they been, had it been more of a community driven visioning. And a lot of it was, I think had to do with…it was project specific with something that they, the communities themselves, had talked about…All of those were really specific projects that they talked about and being able to see how that might look was really helpful for them. Each of these visualizations (3-D) shows much more than one, you know, than an intersection or building façade or a bike lane. It shows a bigger area and how it might develop…in that sense the 2-D visualization is appropriate for a very site specific, sort of one instance. It is very site specific, detail oriented. I think the fly thru visualization with 3-D shows a bigger area that is more conceptual, in more of a landscape scale what could happen. (Interview Subject 6).

The theme of project size and scale was also identified by Lange (2001) as a contributing factor to the perceived level of realism in virtual landscape images. The degree of realism for a background (large geographic area) image was found to be higher than that of a middleground scene, while the middleground scene received higher scores than the foreground scene. The inclusion of texture mapped buildings was also found to significantly improve the level of realism in an image when compared to the use of simple 3-D volumes.

Despite the strong affinity toward the use of the 2-D digitally altered photographs as the primary display method, four of the stakeholders indicated that a combination of the 2-D and 3-D visualizations would complement each other by providing multiple viewpoints and context of the project within its surroundings. However, each stopped short in saying that the 3-D visualization could be used as the standalone method for these projects. One of the stakeholders describes the benefits of using both methods, "that one (3-D) does help explain how…after you've seen this one (digitally altered photograph) it explains it more" (Interview Subject 3). This perspective was shared by other stakeholders:

> I'm thinking you almost need to have both because this, I mean, right here you can see the detail (digitally altered photograph) but I didn't even notice that it goes down to two lanes until you show that one (3-D). I'm looking at this one (digitally altered photograph) and it shows it but you don't really see it. It still looks really wide… this is more of a micro and that's more macro…looking at the bigger picture (Interview Subject 8).
>
> Well the, one of the benefits of the 3-D is to do the fly around and get different perspectives, so that is one primary benefit that you can't get out of 2-D. You can get a little bit more scope and scale (Interview Subject 2).

Several stakeholders suggested that the 3-D visualizations would be more appropriate for large scale projects such as countywide zoning or community visioning, "whereas the fly thru's would have conveyed better had they been, had it been more of a community driven visioning." These findings echo similar results from Lange and Hehl-Lange's (2005) integration of 3-D visualization into a participatory planning workshop addressing the siting of wind turbines near Zürich, Switzerland. The workshop demonstrated that 3-D visualization could provide an important avenue for communication among stakeholders and planners.

Theme Three: Demographics

The third theme explores the role that demographics (primarily age and location) play in the conceptualization of the visualizations. While only three of the stakeholders addressed demographics as a reason for selecting the 2-D digitally altered photograph over the 3-D model, their responses were such that further discussion is warranted here.

The “older” age of the majority of stakeholders and the rural location of the communities resulting in a lack of available technology were both identified as reasons why the 3-D model was not considered an appropriate visualization medium for the proposed community projects. Several of the stakeholders explained why the 3-D model did not work due to the demographics of the community:

> Ok, first of all because it is hardcopy rather than on the computer. We have people in this community that do not have computers. For example, I live 13 miles out of town…no cell service, before I bought satellite, it was not cheap, and I had dial-up at a whopping 13 kbits/second. So something like this could not go out to our [community]. So when people come in its like, what’s going on with that idea, so it’s not forgotten. When we have these town meetings it can be brought out…we’re talking about growth management and economic development and here’s a visualization. So we can we can keep it up in front of their face…this one you have to load it and they go, oh yeah there it is again. Here they walk in and it’s like, oh yeah. And this appeals to the old-timers. It appeals to our young people, you know. I mean the young people would have a blast with this (Google Earth®) if that’s all that we were talking to but we’re talking to a wide spectrum of individuals economically as well as socially…you know abilities, all that stuff. So the good ‘ol paper…that we can bring out time and time again, it’s consistent. (Interview Subject 1).

> I think that for the cases of these communities where they’re a small community and fairly unsophisticated. Not really, having not really delved into planning much if at all. I think the 2-D imagery was really really, really really impactful and it was easy to grasp (Interview Subject 6)

> Ummm…they would need it mailed to them. My grandparents, we tried to get the internet for them, they’re just not interested in it. If you’re looking 60 plus then the amount of people that would actually use it is getting really slim (Interview Subject 10).

> And it just all depends on the group. And when you’re dealing with that type of demographic, you’re going to have the full range. When it gets down to final project planning I think 3-D is great…it’s really helpful but typically you’re dealing with a more technical audience (Interview Subject 2).

The role of demographics emerged as an important factor contributing to the conceptualization and utility of the visualizations for the NWPSB Viewshed Protection and Visualization projects. Al-Kodmany (2001) described similar results regarding the use of computer-based technology (in particular GIS) for the community planning effort in the Pilsen Neighborhood of Chicago. He cautioned that these types of tools can "disenfranchise and empower citizens, depending on the context" and warned that "GIS could become a disempowering tool that...can alienate computer illiterate residents such as the elderly or historical leaders of a community" (Al-Kodmany 2001, 122). Despite the importance that demographics played in this study, this theme has seen little mention in similar studies and represents a prime area for further investigation.

Theme Four: Difficulty in Identifying the Surroundings

The final theme that emerged from the question asking stakeholders to choose the visualization that best helps them conceptualize the proposed projects addressed the difficulty stakeholders had when trying to identify their surroundings in the 3-D models. A lack of visual reference cues and landmarks in Google Earth® was identified as one of the primary difficulties of the 3-D model. The inability to quickly and easily place themselves in the context or area being displayed rendered the 3-D model mildly ineffective for many of the stakeholders. One stakeholder made the following observation about the lack of a visual reference in Google Earth®, "Yeah, it looks like a nice intersection but it's hard to say, oh that's Kamiah. But this one (digitally altered photograph) is really identifiable right away" (Interview Subject 3). A similar comment was made, “They don’t identify with that (3-D)…that’s just some place, buildings. This is more, this IS Kamiah. This is what we have right now” (Interview Subject 1). Another echoed similar thoughts:

> What I would do was, just from my perspective, if you wouldn’t have pointed that out I probably wouldn’t have…I’ve been here a long time, I’ve been around the area and I wouldn’t have noticed it right away. If you had reference points, something really simple like a building, that way you just go, oh…or even the street name but if you’re a local like me I wouldn’t even know the street name I’d know that’s Hayes (Interview Subject 8).

The photographic background in the 2-D digitally altered photographs played a significant role by allowing stakeholders to quickly comprehend the location of the project(s). This also allowed stakeholders to move beyond the question of “where are we” and “what is there” to more significant discussion. The importance of the photographic background for many of the stakeholders may be explained by the idea that humans attempt to organize an image into a real world scene as priority over any other interpretation (Hearnshaw 1994). Several stakeholders supported this idea based on their comments addressing the photographic background of the visualizations:

> That helps to give you a location…a sense of where it is. Because it’s hard to think about what you’re going to put where if you don’t know what you’re putting it into. So I think that’s a good thing to have the backgrounds in there (Interview Subject 4).
>
> I think the photograph really helps because it really puts the project into perspective. This one (3-D), it’s hard to tell where you are…I mean I know this is Orofino but you just don’t get the same feeling of how it specifically fits into the area (Interview Subject 8).

Question Five: Overall Level of Realism of the 3-D Models

What do you believe the overall level of realism is in the model and where would you rank it on a scale from one to ten? All ten interview subjects responded to this question in addition to three scheduled probes:

- *How important is the level of realism?*
- *Would an increase or decrease in the level of realism help you conceptualize the project better?*
- *How appropriate is the level of realism for this project?*

Stakeholder responses primarily focused on the subject of realism as it related to the 2-D digitally altered photographs. This focus can be explained by the overwhelming response to the 2-D digitally altered photographs as the chosen method that best aids in the conceptualization of the proposed project(s). Two themes emerged from responses that addressed the topic of realism:

1. *The Ability to Distinguish Between Existing and Proposed Features*
2. *Stakeholders Easily Become Mired in Details*

Theme One: The Ability to Distinguish Between Existing and Proposed Features

A significant number of stakeholders said that they believed the overall realism of the visualizations lay somewhere between a very low level of realism and photorealism (the process of creating computer images indistinguishable from photographs of a real-life scene). One stakeholder tried to explain this evaluation, "Well it's interesting because…it's an interesting question because I'm, you know I like that there's an element of, not cartoon but…like it doesn't look like it was photoshopped" (Interview Subject 6). Overall the level of realism among all of the 2-D digitally altered photographs was given an average rank of seven out of ten. This mid-level realism was a driving force that allowed stakeholders to easily identify the proposed elements of a project. Some comments from stakeholders drive this idea home:

> You can visualize it without having to see a real tree. You know it's obviously not a real tree but I get that, wow that looks totally different but it's the same picture. I don't know that it makes that much of a difference how the people look, real people walking down the sidewalk with actual faces. It probably does for some but I can see the benefit as it is. Like if you just simply try to show real people, real textures or whatever. It might not come across as much of a…like you might not be able to say, oh there is this difference. We have this as it exists and we have this potential. People might lose it because it looks so real. If it has a little bit more, a little bit more of an animation I guess to it, it leaves the imagination to fill in the blanks (Interview Subject 6).

> Since it's a concept it doesn't bother me a lot…I mean if daffy duck were over here that would bother me although we might have him in town you never know. I've seen ducks in funny places this winter, but I don't think necessarily that it's cartoonish as much as maybe you know the level that would bother me except that it's overlaid on something that's reality. And that's probably that what makes it…the contrast is what makes it work (Interview Subject 4).

> I mean it is kind of cartoonish but it gets the idea across. It doesn't have to be totally realistic. Well in that way I think it helps in differentiating what's real and what's going to be proposed. If you had everything looking the same you'd be like ok, what's the difference? You'd really spend a lot of time…but this way it's cartoonish so you can see what the difference is. This part's totally different than looking at this…you can just tell by how much different it is (Interview Subject 8).

> Well, I mean I don't think you want it to look just like a photograph. The whole purpose of having a drawing rather than a photograph is you eliminate things that are distracting. I would put it fairly realistic though, I certainly would never have objected to unrealism…especially since there is still the photograph in the background (Interview Subject 3).

The level of realism used in the 2-D digitally altered photographs was considered appropriate given the context of the project. A higher level approaching photorealism may have limited the stakeholders' abilities to distinguish between the existing and proposed elements of the projects. Lange (2001: 180) also argued that virtual landscape simulations "with a lower degree of realism can still contain the most important information needed for a specific purpose." Realism was identified as a key factor in Appleton and Lovett's (2005) investigation of issues regarding the use of GIS-based visualization in planning. Responses from planning professional indicated that high levels of realism may give a false sense of a final product, cause confusion for stakeholders if different levels of realism are used in the same visualizations, and can inadvertently lower the accuracy or acceptance of a project if improper levels of realism are used in a visualization.

Theme Two: Stakeholders Easily Become Mired in Details

When asked to comment about the level of realism in the visualizations, many of the stakeholders easily became mired in the minutiae of the proposed project(s). Several commented on the level of realism but were quickly distracted by a small detail or aspect of the visualization. Two sub-themes emerged from interviewee responses that helped explain why a stakeholder might easily became mired in the specific details of the visualizations:

1. *Preexisting Vision of a Plan*
2. *Emotional Response to a Plan*

The first sub-theme explores the idea of a stakeholder who maintains a preexisting vision of a plan in their mind's eye. If that concept differs from what is actually shown in the images, the stakeholder's own idea of what should or should not be present may be challenged. This may result in an inadvertent focus by the stakeholder on those details that did not appear in their mental picture. It is possible that the images will be rendered useless for the stakeholder due to their inability to view it without bias. One would just as well place large flashing lights at points in the images as this would provide the same effect. Nearly any type of visual image can invoke this response and it may be a particularly difficult aspect to predict or overcome. A perfect example of this phenomenon was observed while discussing the appropriate level of realism for the images with one of the stakeholders:

> I think one of the main things, well there's two I guess, I don't think the bench is very practical because there's traffic and people aren't going to sit down there and watch the traffic much. And then the second thing, I really like the idea of the curbs going out into traffic and providing more safety. I don't know whether this would be grass or some kind of green turf or artificial turf or something. If its grass then you would have to have irrigation, mowing. That was one of the things I thought about. What would you use…if it was all cement it wouldn't be near as nice as what it is here but something other than grass might be better (Interview Subject 3).

The stakeholder held a strong mental image of the proposed project prior to viewing the images causing them to become mired in the minutiae of several elements because it did not conform to their original perception.

The second sub-theme related to the level of realism addresses the role that a stakeholder's personal interest in a project can play in the manifestation of an emotional response to elements of a visualization. This was apparent in the following stakeholder response:

> Realism, this is very feasible. Ok, it's a ten. In Kamiah because of the comments that I've heard and the reception and stuff, it's probably about a seven or an eight. And a couple of reasons why, the biggest thing is the trees. I personally love the trees, ok; Joe Blow coming through the town loves the trees. We have a couple of very powerful merchants that are totally against the trees because they don't want the mess and they don't want their signs to be blocked. Had this have been a low profile greenery (Interview Subject 1).

One of the stakeholders with professional experience reviewing plans understood the intent of a conceptual plan and commented on the fact that visualizations, even those with a lower level of realism, can easily distract a user's focus. "I think there may be a tendency to jump into details even on the 2-D, it's a black bench, we want green. And not being able to get past some of those things, I can but some people can't" (Interview Subject 2). Another stakeholder also recognized the intent of the visualizations and avoided focusing on any one particular detail:

> I know that this sign is there and these people you put there so I can see where they are going to walk. And this bush is funky looking, I like the trees, but this bush is a little funky looking. You know it's a matter of deciding whether you're going to spend all your time looking for the right bush or get the concept across. And I think this conveys the concept and if you're worried about funky bushes you might be just a little too far into the visuals rather than what you're trying to convey (Interview Subject 4).

Question Seven: Scale and Improvements

How does the scale or area shown in the visualizations affect your understanding of the proposal? Was it appropriate for the given project? What changes or improvements in the model would help you better conceptualize the project? What other additional information would aid in the understanding of this proposal? One common theme regarding the desire by stakeholders to see additional 2-D digitally altered photographic views of a project emerged from the content analyses of questions seven, nine, and eleven, and therefore the results coming from these questions have been combined.

All ten stakeholders agreed that the views chosen, and areas displayed, in the 2-D digitally altered photographs were appropriate and did not distract them from understanding a given proposal. The majority of stakeholders also pointed out that the site specific nature of the projects caused the scale of the 3-D model(s) to be inappropriate. However, several stakeholders indicated that additional views would be a welcome addition. Participants from Lange's (2001) study and planning related professionals from Appleton and Lovett's (2005) study also indicated that multiple views of a project would help reduce the potential for bias that may occur due to a single viewpoint And despite the ability of the 3-D models to provide an unlimited number of perspectives of a proposed project, once again the site specific nature of each trumped these benefits. Responses related to the topic of scale are presented:

> Well I could certainly see what was being meant by this even though you have to look pretty hard to see this and then you don't see the other corner at all. But I don't know whether 'cuz if you go from a top down look I don't think it really, it makes it clearer of exactly how it's going to be done but you don't get the effect of…if you were actually going to be driving or walking through it. Which is what I think is important here because that's what people are concerned about. How would…if you had these things pooching out into the highway, how would it affect the way you negotiate. And I think that is what this does (photomontage). Shows what the traffic would look like. So I like this view (Interview Subject 3)
>
> I think the scale is fine. The area covered is fine. The actual, ok which corner are we standing on and which street are we looking down…the only, and this would only come with personal knowledge of the neighborhood is that right now you can't stand on this street corner. At least not very safely. Even though somebody obviously did to take this photo. But it's a view that the majority of the community knows. It's a recognizable feature in the community. I think it was just fine (Interview Subject 2).
>
> I think each one was very appropriate in its size and the view that was shown. Only because they were so specific, if you zoom out on one you would lose the point of what is being proposed. No I thought they were very appropriate (Interview Subject 6).

When asked what improvements or additional information would aid in their understanding of the proposed project(s) for their community, the majority of stakeholders once again focused on the desire for additional views:

> I think that would be something that would help too. If you could take a picture from this side of the highway and this side of the highway…if you had one looking that way and one looking that way you could conceptually see it better. More like a 3-D look. Just several different views so you could do some comparisons…like, ok, it looks great here but maybe in some spots it doesn't look as good or maybe some people might be confused but if they saw it on another side (Interview Subject 8).
>
> First of all, for this to be available to people like me electronically so I can use it. If you have any costs that would be involved with this, that would be good. You know, we've given you this for this block. It doesn't have to be exact, just kind of a range. We of course would have liked to have more views…it would have been really nice had we not only had this one but maybe a down Main Street. And then, the view from the other end so you have a coming and going would've been very helpful (Interview Subject 1).
>
> I think I'd like to see it so that you could tell more what was on this side, by the river. So that you had a concept of how wide that is because if you go down to that area right now so places they have a space as wide as this table, maybe three feet, four feet and other places there's nothing. There's just nothing.

Additional improvements to the visualizations were suggested, however, no other common themes emerged. Responses varied and tended to address very small details of the visualizations such as the placement of a tree or bench and the possible addition of speed limit signs to visualizations showing road or highway improvements. Planners and planning related professionals interviewed by Appleton and Lovett (2005) also indicated that stakeholders may be distracted by highly detailed visualizations, however, this represents yet another important area for further research.

Question Eight: Multiple Viewpoints, User Control, and Access to Visualizations

All ten stakeholders were asked the following questions: *how important is the ability to fully navigate or change view points of the proposed project(s)? How important is the ability to share and/or access the model over the internet?*

At this point during the interviews stakeholders were given the opportunity to fly around Google Earth® and view the 3-D model(s) for the proposed project(s) in their community. Stakeholders who declined to fly around were shown a pre-constructed fly-through in lieu of user control. After viewing the model(s) in Google Earth®, the subjects were asked a series of questions about their experience(s). Two themes emerged from the responses regarding the importance of user control and accessibility of a Google Earth® model:

1. *The Technical Ability of the Stakeholder*
2. *Access to High Speed Internet*

Theme One: The Technical Ability of the Stakeholder

The first theme explores how the technical ability of a stakeholder affected their decision to view the 3-D models in Google Earth®. Three of the five stakeholders who opted to drive Google Earth® themselves indicated that they had prior experience using the software and were allowed to explore the model(s) on their own. The two users who had not previously used the Google Earth® were given a quick overview of the software and the navigational controls. After several minutes both of the new users became comfortable with the controls and were able to explore the 3-D model(s) of their community's proposed project(s). The technical aptitude of the two new users was demonstrated by their ability to quickly learn and use the navigational controls in Google Earth®. All five of the stakeholders agreed that the ability to choose their own viewpoint of a project in Google Earth® was an important option to provide to stakeholders.

The five stakeholders who opted to view a pre-constructed fly-thru of Google Earth® also agreed that multiple viewpoints of a project were important but preferred to see them in hardcopy format. One of the stakeholders, when asked whether or not they would view the 3-D model in Google Earth® if the file were available, commented that, "I'm not too good on the graphics side. Do you have more pictures? If I had a lot more to look at it might be. If someone gave it to me I don't think I'd gain anything by going through it myself" (Interview Subject 2). The self proclaimed technical ineptitude and perceived difficulty in operating Google Earth® caused them to forego the idea all together. Others who declined user control of the Google Earth® model also indicated a lack of technical skill:

> This one's probably for people who are more analytical, more technical. They know how to use this kind of stuff…I mean, I can get on the internet and do email and that's about it. I don't think I'd use this, just too much for me (Interview Subject 4).

One of the stakeholders, in commenting on the use of Google Earth®, hit the proverbial nail on the head; "I mean someone who's going to be using Google Earth® is going to have enough savvy to experiment and explore its capabilities. So providing the KMZ file or something like that…yeah I think it's a great way to visualize" (Interview Subject 6). Another experienced Google Earth® user concurred, "When it gets down to final project planning I think 3-D is great…it's really helpful but typically you're dealing with a more technical audience."

Theme Two: Access to High Speed Internet

The second theme addresses the role that access to high speed internet can play in restricting the availability of a Google Earth® model to rural communities. Several stakeholders believed that providing a Google Earth® file to stakeholders was an important option. However, the rural location of the community was a restrictive factor due to the lack of available high speed internet, a necessary component for running the Google Earth® software. The following responses touch on this difficulty:

> I would probably play with it, I don't know if everybody would. An internet connection in this community is an issue but if it were a standalone…if it was a disc that would be perfect and eliminate those issues that we have (Interview Subject 2).
>
> We have people in this community that do not have computers. For example, I live 13 miles out of town…no cell service, before I bought satellite, it was not cheap, I had dial-up at a whopping 13 kb/sec. So something like this could not go out to our [community] (Interview Subject 1).

Both Al-Kodmany (2001) and Lange and Hehl-Lange (2006) have noted that 3-D visualizations require high speed internet and powerful computers, a consideration that must be taken into account by those involved in their creation and use in the planning process. This issue becomes a very important consideration for planners, government officials, and others promoting the use of resource intensive (both computers and internet) visualizations in rural communities.

Question Ten: Overall Importance of Visualizations in Planning Process

In terms of the overall planning process/discussion, how useful were the visualizations? Could the same discussion occur without the visualizations? The final question was asked to get an overall indication of the importance and role that visualizations played in the planning process. All ten stakeholders believed that the discussions surrounding their communities proposed projects could not have occurred in the same capacity had the visualizations, in particular the 2-D digitally altered photographs, not been an integral component. Some of those comments follow:

> People had heard about it for years that we'd been talking about this and you know it's just another person talking. Now we've got something. Talk is cheap. And when we're looking at, from my perspective, when I'm looking at funding…if I go in and I say you know we've been talking about this for years and we really want it done, they're going to say yeah, yeah, yeah. If I go in with something like this (holds up altered photomontage)…we've got a concept, it's like, OH. Particularly if this is the front (points at photomontage) of the proposal. Like I said, this is going to be a very effective tool and has proven to be…because this is keeping it in front of God and everybody (Interview Subject 1).

> I think to me just because we had been looking for something for a long time that would do the job. I think this does it (Interview Subject 3).

> No, I was super happy. I was just tickled. And like I said, to watch the audience react to this was…just as a community member was fun to see. And there was a lot of chatter after the meeting, you know and the days following, did you see and can you imagine? Just some conversations in the frozen food aisle (Interview Subject 2).

> But sort of with the pre-workshop sessions that were held and the information that we got, or that you got, I think they were just really spot-on for the context (Interview Subject 6).

Lange and Hehl-Lange's (2005) study incorporating the use of a virtual landscape model in a participatory planning workshop for the siting of wind turbines found the real-time 3-D visualizations to be a key element of the workshop that allowed for better communication between stakeholders and planning officials. Lange and Bishop (2005) also argue that 3-D landscape visualization plays a key role in the planning process by offering an improved means for decision making. Others (Al-Kodmany 2001; Appleton and Lovett 2005; Lange 2005; Pettit et al. 2006) have also argued that the use of 3-D visualization in planning significantly improves communication between stakeholders and planners, increases public participation, and provides an important tool for decision making during the planning process.

DISCUSSION AND CONCLUSIONS

The research presented here sought to address the responses and perceptions stakeholders had regarding the use of 3-D visualizations in the NWPSB Viewshed Protection and Visualization project as well as the role that these type of visualizations play in the planning process. Additional research questions evaluated the use of Google Earth® as a display medium, the impact of realism, and the importance of accessibility to visualizations. Participant observations during the NWPSB community workshops and in-depth interviews with stakeholders provided an important view into the use of 3-D visualizations in the planning process. Content analysis from both research methods provided a rich set of data from which the research questions could be answered.

Overall, the use of 3-D visualizations in the NWPSB Viewshed Protection and Visualization project was found to be highly successful, enhancing the planning process and improving communication among stakeholders and planning officials. Much to the surprise of the researcher, the use of Google Earth® and fully interactive 3-D models proved to less successful as the digitally altered photographs were found to provide a more effective means of communication and conceptualization.

This final section includes a discussion of the role that visualizations played in the NWPSB Viewshed Protection and Visualization Project and factors affecting the perceptions of their use. The techniques and software used in the development of the visualizations are reviewed and recommendations for those involved with the development and use of 3-D visualizations in planning have been offered. Finally, research limitations and future research needs are discussed. It is with optimism that these findings will aid future research and/or provide important information to planning professionals, governmental agencies, and technical experts hoping to utilize 3-D visualizations in the planning process.

The Role and Perception of Visualizations in the NWPSB Viewshed Protection and Visualization Project

The results of this research continue to reinforce the belief that 3-D visualizations, whether in the form of a digitally altered photograph or fully interactive 3-D model, are an integral component in the planning process supporting results for previous research (Appleton & Lovett 2005; Lange 2005; Veteto 2006; Howard & Gaborit 2007; Wissen et al. 2008). They provide a common language for all stakeholders, experts, and government officials involved in the process and have the ability to turn large amounts of abstract data into comprehensible knowledge. They were also found to be a means to integrate all of the different perceptions stakeholders held of the proposed projects. The ability for stakeholders to compare the existing elements of a site against the proposed features, side-by-side, proved to be one of the most empowering aspects of the project.

Many of the stakeholders in this study acknowledged past difficulties when attempting to form a mental image of a proposed project. The integration of the 3-D visualizations, particularly the digitally altered photographs, into the planning process helped overcome this difficulty by providing a means through which stakeholders could conceptualize a proposed plan. Perhaps more importantly it provided them with a powerful communication tool that opened the lines of communication between ITD officials, land use planners, and NWPSB committee members. Problems of abstraction and miscomprehension that often occur between professionals (experts) and the lay public (stakeholders), as described by Lange (2005), were avoided because the visualizations provided a common language for all of the participants.

This study also found that the use of visualizations in the conceptual design stage of the planning process was as important as it was successful; stakeholders and planning officials were able to easily communicate with one another, potentially reducing conflicts that often occur in the latter stages of the planning process (Lange 2005). These findings support ideas presented by previous researchers (Al-Kodmany 2001; Lange 2006) who believed that the incorporation of visualizations into the early stages of the planning process would enable more informed decisions by stakeholders.

The use of the fully interactive 3-D models via Google Earth® did not provide a superior level of conceptualization for the proposed projects compared to the digitally altered photographs. This usurped beliefs that the research had prior to this study. Stakeholders overwhelmingly selected the digitally altered photographs as the visualization that offered them the highest level of conceptualization of a proposed project. The primary factor affecting this decision was determined to be a result of the site specific nature of the projects. The lack of computers and high speed internet in the project communities, limited exposure of stakeholders to technology, and an overall comfort with the hardcopy images were also identified as contributing factors affecting the level of conceptualization. This is not to say that a fully interactive 3-D model shown in Google Earth® cannot provide a high level of conceptualization, however, results from this study indicate that they have their limitations. Just because a 3-D model *can* be created and presented in a fully interactive environment does not mean that it *should be*. Furthermore, the use of Google Earth® as a primary display medium for 3-D visualizations did not resolve any of the issues addressed in previous research including the lack of multiple viewpoints, bias associated with a single view, and the direction of a viewer's focus related to the display of 3-D models in 2-D format (Appleton and Lovett 2005).

The level of realism used in the visualizations was also found to be an integral factor affecting a stakeholder's perception of a proposed project. The level of realism in the digitally altered photographs was given an average rating of seven out of ten by the study participants. Stakeholders also determined that the level of realism in the visualizations was appropriate given the context of the projects and stage in the planning process. The "mid-level" of perceived realism in the visualizations allowed stakeholders to easily distinguish the existing features from the proposed elements of a plan. This proved to be an important consideration especially during the early stages of the planning process so as not to induce a high level of expectation of the final product. In the end, the visualizations developed for the NWPSB Viewshed Protection and Visualization project were a tremendous success. Communication was improved between stakeholders and Byway officials, ITD, and planners, a vision of the future provided momentum to purse each project, and a sense of ownership was felt among the stakeholders.

The next section of this section provides further discussion regarding the most common topics and recurring themes derived from content analysis of participant observations and in-depth interviews. These themes expand upon and support previous research associated with the use of visualizations in planning. New themes that emerged during the study will also be discussed. The three themes include:

1. *Project Size and Geographic Scale*

2. *Level of Realism*
3. *Demographics*

Theme One: Project Size and Geographic Scale

The site specific nature (project size) of the proposed plans in the NWPSB Viewshed Protection and Visualization project proved to be the most influential aspect of this study that significantly affected stakeholder responses to the visualizations. In fact, all of the stakeholders interviewed in this study overwhelmingly agreed that the digitally altered photographs provided a superior level of comprehension of a proposed project compared to the fully interactive 3-D models. This theme permeated nearly every topic discussed and proved to be one of the most important findings of this study. It is interesting to note that the influence project size played in this study has seen very little mention in previous research.

Although the proposed plans for the NWPSB Viewshed Protection and Visualization project were highly conceptual in nature, the small-scale of the projects naturally led to an increased level of detail in the digitally altered photographs. The level of detail in 3-D modeling is a function of scale and time. As the geographic area covered or scale of a modeling area increases in size, the amount of time needed to achieve even a low level of detail also goes up. This is a result of the increased number of large forms or features (i.e., buildings, trees, roads) that need to be created. The inverse is true for a small geographic or site specific modeling area, as was the case for the proposed plans in the NWPSB project. When the geographic area decreases in scale, the number of large forms that need to be modeled also decreases. As a result more time is available to address the minute details of a scene (i.e., architectural features of a building, sidewalks, people, vegetation, etc.). The following photographs demonstrate this phenomenon:

Figure 18. Photograph Showing the Relationship between Geographic Scale and the Level of Detail (source: Author)

The photograph on the left was taken at street level of an intersection in downtown Missoula, Montana; the photograph on the right includes the same intersection but shows it at a much larger geographic scale. If the same amount of time was dedicated to producing a 3-D model of each scene, the final products would show drastically different levels of detail. Only three buildings would need to be modeled in the site specific scene (photograph on the left) leaving an abundance of time to address the small details (e.g., windows on the buildings, architectural features, street furniture, cars, etc.). In contrast, the large geographic area shown in the photograph on the right contains dozens upon dozens of large forms (buildings). A considerable amount of time would be required just to model their basic geometric shapes. The effect that geographic scale has on the level of detail in a 3-D model becomes clear.

And while there is no magic scale that exists in which a fully interactive 3-D model becomes more appropriate than a digitally altered photograph, or vice versa, the geographic area covered by a project was shown in this study to be an influential factor in the use of 3-D visualizations; one that can significantly affect a stakeholder's perception of a project. Therefore the geographic scale of a project is an important consideration when developing 3-D visualizations for use in the planning process. The results of this study suggest that the use of digitally altered photographs are an appropriate visualization method for site specific projects that generally cover no more geographic area than is visible in a street level or ground level photograph.

Conversely the use of the fully interactive 3-D models were deemed to be an appropriate application for planning projects associated with large geographic areas such as city or county wide zoning, large scale developments, and landscape change. These types of projects tend to be more conceptual in nature where details are less important than the "overall" picture. This type of visualization method was also found to be appropriate for a more interactive and participatory planning process, where stakeholders play an integral role in the development and testing of multiple land use scenarios. These findings support previous research by Lange and Hehl-Lange (2005) that discovered that the use of an interactive GIS based virtual landscape model in a participatory planning effort for the siting of wind turbines in Zürich, Switzerland, allowed stakeholders to successfully test different alternatives on the fly. It is important to note that the suggestions provided in this section are based on findings from a small sample size of stakeholder responses. Additional research in this area is recommended to further support these claims.

Theme Two: Level of Realism

The level of realism used in the digitally altered photographs was given an average rating of seven out of ten by stakeholders despite several comments indicating that the proposed elements in the visualizations were cartoonish in nature. The presence of the photographic background appeared to affect stakeholders perceived level of realism of the visualizations resulting in the relatively high rating. These findings echo similar results from Eckart Lange's (2001) study on the level of perceived realism of virtual landscapes. Lange found that a virtual landscape of a background scene that included a detailed aerial photograph approached the degree of realism associated with a photograph of the same area. The level of realism decreased in the foreground and middle ground images, but was positively affected by the inclusion of 3-D objects, especially buildings.

More importantly the combination of the cartoonish like elements of the proposed features and the photographic background allowed stakeholders to easily distinguish between the existing and proposed elements of a project. This forms the argument that visualizations with a lower degree of realism can effectively provide the most important information for a specific purpose. Many of the 3-D software and rendering programs available today are capable of producing near photorealistic images. However care must be taken not to let this technology drive the planning process. Just because visualizations with high levels of realism *can* be produced does not mean that they *should* be in every case. Brail and Klosterman (2001) warn of this pitfall, noting that the focus on one particular tool or technology can actually distort the nature of planning. Sheppard also warned against this focus on technology asserting that "emerging visualization systems should respond to tangible social and professional needs, not merely to commercial opportunities and popular expectations" (2005, 79). In the end, visualizations are just one of many components that play a role in the planning process.

The stage in the planning process represents another one of the primary factors affecting the appropriate level of realism for visualizations. The early stages of the planning process are often conceptual in nature where several visions or ideas for a project are presented. In order to maintain this conceptual level, a low degree of realism appears to be appropriate so as not to introduce a false sense of a final product. Research by Appleton and Lovett (2005) showed that inappropriate or mixed levels of realism in visualizations can lead to confusion among stakeholders, a false sense of a final product, and an unintended sense of accuracy. Care must be taken when deciding upon the level of realism to use in visualizations. Results from this research suggest that as a project moves from a conceptual stage to a final plan, the level of realism should also move from a lower to higher level.

The inclusion of the photographic background in the digitally altered photographs also allowed stakeholders to quickly identify the location of a project and see how the proposed changes would fit in with the existing environment. The inability to easily identify their surroundings was one of the primary complaints stakeholders had regarding the use of Google Earth®. When the 3-D models were shown in Google Earth®, the majority of stakeholders needed up to a minute to fully orient themselves. This proved to take a significantly longer time compared to the digitally altered photographs, where most stakeholders instantly recognized the project location. Several factors including a lack of experience viewing aerial photographs, a lack of distinguishable landmarks in Google Earth®, and the low quality of the aerial photographs help explain this lag time. The latter was also identified by Lange (2005) as a primary factor that reduced the perceived level of realism in a virtual landscape. Unfortunately the resolution of the aerial photographs in Google Earth® is a factor that is outside the control of the user. However, it is an important factor for planning officials to consider if using Google Earth® as a display medium for a planning project in a rural location. Despite the incredible resolution of aerial photographs in many part of the country, rural areas such as those represented in this study generally lack such detailed imagery. This, of course, will change over time as high resolution aerial photography technology improves and becomes cost effective, but it is an important consideration in the near-term. The inclusion of the photographic background in the visualizations also avoided the need to model existing elements in the study areas, significantly reducing the time (cost) needed to create each model. This is another important consideration when developing visualizations for planning, especially those with a small budget and limited resources.

Visualizations are abstractions of complex realities. The primary goal when utilizing visualizations in planning is to create representations of reality that allow a stakeholder to comprehend a proposed plan or action. Research (Lange 2001; Appleton and Lovett 2005) has shown that the level of realism in visualization can significantly affect a stakeholder's perception of a project. This perception is highly subjective and can be influenced by an individual's age, gender, education, and life experiences. Nonetheless, stakeholders felt that the level of realism in the digitally altered photographs for the NWPSB Viewshed Protection and Visualizations project were appropriate given the site specific nature of the plans, stage in the planning process, audience, and viewpoint of the proposed projects. The results from this study indicate that each of these elements plays an important role when deciding upon the appropriate level of realism for visualizations in planning.

Theme Three: The Role of Demographics

This final theme addresses how demographics, in particular the age of stakeholders and rural location of the communities, influenced the decision by stakeholders to select the digitally altered photographs as the most effective visualization for the NWPSB Viewshed Protection and Visualization project.

Rural areas are typically defined as large, isolated regions of a country that often have low population density. Rural areas, as defined by the Congressional Research Service (2005):

> Comprise open country and settlements with fewer than 2,500 residents. Territory outside of urbanized areas is designated rural and can have population densities as high as 999 per square mile or as low as 1 person per square mile. Rural areas consist of all territory outside of Census Bureaudefined *urbanized areas* and *urban clusters*. Urbanized areas have an urban nucleus of 50,000 or more people. They may or may not contain individual cities with 50,000 or more. In general, they must have a core with a population density generally exceeding 1,000 persons per square mile and may contain adjoining territory with at least 500 persons per square mile.

According to this definition, the cities of Kamiah, Kooskia, and Orofino, Idaho and their surrounding areas are considered rural. In fact, the only Census defined urban area along the NWPSB is Lewiston, Idaho, the western terminus of the Byway. The next closest urban areas are Missoula, Montana, and Spokane, Washington, both of which are more than 150 miles away (see Figure 18). Boise, the capital of Idaho, is over 230 miles from the communities participating in this study. The total population of North Central Idaho, the geographic region in which the NWPSB resides, barely exceeded 100,000 people per the 2000 census (30,904 of which reside in Lewiston). It is clear that this is an extremely isolated and rural section of the country.

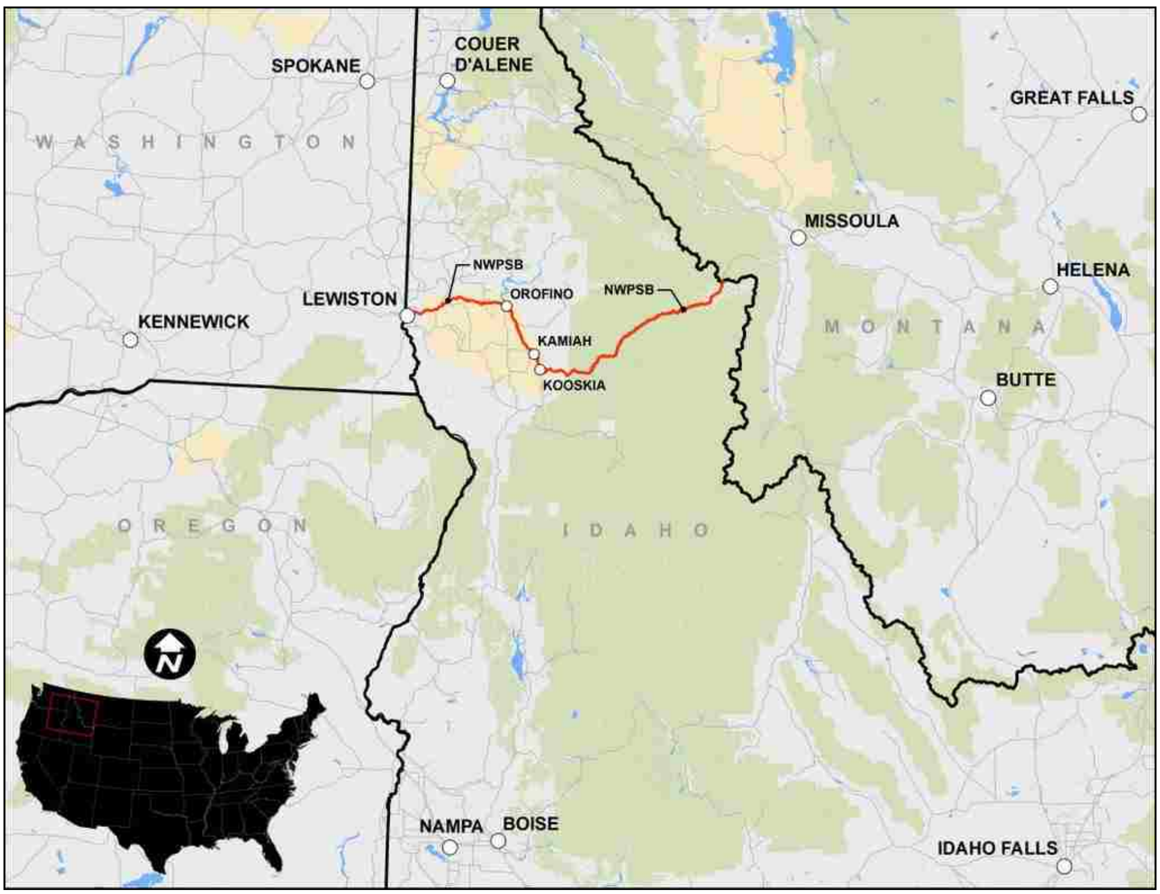


Figure 19. Regional Map Showing the Rural Location of the NWPSB (source: Author)

As a result of the rural location, the availability of high speed internet is sparse and non-existent in many areas. This was identified as a restrictive component of the 3-D model since a high speed internet connection is a necessary component to utilize Google Earth®. Coupled with a lack of experience using computers and a general discomfort with technology among the majority of stakeholders, the use of Google Earth® as a means of providing information to those involved with the planning process was limited. Al-Kodmany's (2001) study incorporating computer-based visualization tools in a neighborhood planning process also found that these types of tools run the risk of "disempowering" the elderly and computer illiterate stakeholders. Care must be taken not to alienate this important demographic group from the planning process as it offers important perspectives and a wealth of information for communities. Several of the stakeholders suggested ways to alleviate the concerns over the lack of high speed internet and the lack of technical ability of stakeholders including: burning the 3-D model files onto a DVD to avoid having to download the files on-line (although Google Earth® would still require a high speed internet connection), recording a video of the fly-thru's in Google Earth®, creating hardcopies of several views from Google Earth®, and providing a training session for stakeholders.

In the end some of the stakeholders felt that the printed digitally altered photographs simply provided the best means of communication. They were appropriate for the site specific nature of the projects, older stakeholders could relate more easily to them, and they had a lasting in-your-face quality. This last aspect was a very important for many of the stakeholders due to the slow development of projects in their communities. With a hard copy available to show at community meetings, motivation and interest for a project could be kept high over the long term. They felt the same could not be said of the 3-D models due to the general lack of computer use during public meetings and the ability for a digital file to be easily forgotten. This is not to say that 3-D Google Earth® models do not have any utility in the planning process, in fact the opposite is true. However, in the context of this study where age, technical ability, and the rural character of the communities played an influential role, the use of Google Earth® was not appropriate.

Review of the Techniques and Software Used in the Creation of Visualizations

The development of the visualizations for the NWPSB Viewshed Protection and Visualization project proved to be a relatively intensive process involving numerous steps. The software used to develop these visualizations included Google SketchUp® Pro, Google Earth® Pro, ArcGIS® 9.2, Adobe Photoshop CS3, and Adobe Illustrator CS3. Each of these software components requires a paid license to operate ranging from $500 to over $2000. This aspect could make the process of creating 3-D visualizations unachievable for many groups, small businesses, or individuals and is arguably a significant impediment. However, the majority of the techniques used to create the 3-D visualizations for this project can be accomplished with free versions of these software programs. Google offers a license free version of SketchUp and Earth available to anyone with an internet connection (it is necessary to download the installation files). There are also a number of open source GIS platforms now available including Quantum GIS (QGIS), Geographic Resource Analysis Support System (GRASS), OpenJump, and Minerva, among others. These applications can provide a practical and cost-effective alternative to ArcGIS® for the display and editing of geospatial data. The GNU Image

Manipulation Program (GIMP) is a viable alternative to Adobe Photoshop. This free open source application offers nearly identical tools and editing options as Photoshop.

The development of the conceptual design maps in ArcGIS® was recognized as a potentially restrictive component in the development of visualizations for non-GIS professionals due to the complex nature of the software. Several complicated GIS techniques were needed to convert the conceptual design sketches to digital format. Experience working with and handling geospatial data was also necessary in order to develop the conceptual design maps. This could prove to be a highly restrictive factor for small communities or non-profit groups interested in developing the types of visualizations used in this study.

In general, the techniques used to develop the 3-D models using Google SketchUp® were less complex than those associated with the GIS software. Google SketchUp® provides a simple interface, relatively small learning curve, extensive 3-D model library, and interoperability with a number of software programs including Google Earth®. Coupled with an abundance of online tutorials, videos, and free instruction, a new user would be able to produce an effective 3-D model or digitally altered photograph with a little bit of time and instruction. The photomatch utility in Google SketchUp® does require some advanced modeling techniques and deeper understanding of the software, but in the hands of even a casual user this utility can help create visualizations that were previously unattainable by all but the most experienced graphic artists. Based on the factors listed above and the researchers experience using Google SketchUp®, this powerful and free software package offers tremendous promise as a visualization tool for planning.

Google Earth® also represents an important visualization tool for planning. This free software program provides a comprehensive repository of aerial photographs and terrain data for the entire world in addition to a massive web of geographic information. This is arguably one of the most significant developments in computer hardware or software in the last 20 years. Similar to SketchUp, Google Earth® offers a very simple set of controls allowing a user to pan, tilt, zoom, and fly to any location on earth with the click of a button or scroll of the mouse. The ease in which Google Earth® and Google SketchUp® integrate with one another, allowing a user to display their creations from SketchUp in Google Earth®, has incredible value. Due to the vast amount of data being transferred, a high speed internet connection is required to use Google Earth®. This was identified as a major obstacle for areas with little or no access to high speed internet.

Recommendations

Based on the results of this study several recommendations are offered regarding the use of 3-D visualizations in planning. 3-D visualization is fast becoming a popular planning tool; however, extreme care must be taken by those involved in the field to not let this trend drive the planning process. Understanding the appropriate type of visualization and technique for the problem at hand is paramount. The fact that we *can*, does not mean that we *should* is an adage that must be kept in mind at all times. When used appropriately, 3-D visualizations can provide an effective means of communication between stakeholders and planning officials. However, when used inappropriately the planning process can be usurped resulting in miscommunication, confusion, and wasted time.

Specifically, those involved with the creation and use of 3-D visualizations in planning must be cognizant of the technical ability of stakeholders, availability of computers and high speed internet, the effects of project size and geographic scale, and the time needed to create these types of visualizations. It would be impossible to recommend one particular strategy or set of rules for others to follow when utilizing 3-D visualization in the planning process. The specific and complex nature of each individual project prohibits this type of action. However, it is recommended that a combination of visualizations be employed during the planning process (i.e., fully interactive 3-D models, digitally altered photographs, and maps) when budgets allow in order to provide a comprehensive set of products for all stakeholders. Furthermore, visualizations have the potential to bring issues to the forefront of discussion that was not previously considered by those involved with their creation. This is a result that can be beneficial to the planning process, but one that may catch planning officials off guard.

Research Limitations

Despite the rigorous nature of this study, several limiting research factors exist. First, with respect to the participant observations at the community workshops, it is possible that stakeholders responded or acted differently during the meetings as they were aware that they were being observed for a research study. Nonetheless the workshops provided a prime opportunity to study stakeholder reactions to the visualizations and their overall use in the planning process. The in-depth interviews also had the potential for stakeholders to act or respond differently due to a lack of trust with the researcher or discomfort with the interview process. Efforts by the researcher to limit these issues included an explanation of the researcher's background, academic interests, and research study. Stakeholders were also encouraged to contact the NWPSB director to verify the researcher's credibility. Interview subjects were also informed of their rights to forego answering any questions and their right to terminating the interview at anytime. Finally, interview subjects were offered the opportunity to read the study upon completion.

The adequacy of the sample size for the interviews and participant observation may also be questioned. It is possible that additional interviews may have added to the results and findings of the study. However, based on the time and resources (self-funded) available to the researcher, this sample size was deemed to be appropriate for this study. Furthermore, a saturation point appeared to have been reached as no new information was being derived from the in-depth interviews. A larger sample size would not likely have produced different or additional findings. It is important to note that the findings from this research were specific to a small project in rural Idaho. As such, the extension of the findings to other communities may not apply and must be done with extreme care. Finally, the researcher was an employee of the consulting firm that participated in the NWPSB Viewshed Protection and Visualization project and which also created the visualizations for the project. This aspect may arguably invoke some bias into the findings.

Future Research

The research presented here represents one of the first studies comparing the use of digitally altered photographs and fully interactive 3-D models in terms of the level of conceptualization they provided to stakeholders in the planning process. Continued research in this area is vital in order to understand the most appropriate use of 3-D visualizations in planning. Further investigation will also help determine the appropriate type of visualization for different stages of the planning process and how they can provide a high level of conceptualization and communication between lay people and experts. In particular, this study revealed that the size of a project and demographics of a stakeholder group can significantly affect stakeholders' perceptions of a proposed project depending on the type of visualization used. Further research addressing each of these factors would help understand their impact on the appropriate methods of visualization in planning.

Generally speaking, research addressing stakeholder perceptions concerning the use of 3-D visualizations in the planning process is still lacking. Further inquiry is needed in order to fully understand their use and appropriateness. With the continued rise in the popularity and use of virtual globes, research addressing their role and utility in the planning process is also necessary in order to take full advantage of their ability to reach a wide number of stakeholders. The appropriate levels of realism, ethical considerations, and utility as a participatory planning tool continue to provide areas for further investigation with regard to 3-D visualizations in planning.

APPENDIX A – INTERVIEW GUIDE

What is your occupation? How long have you lived in ________?

Please describe your involvement with the Northwest Passage Scenic Byway.

After looking at the two visualizations (digitally altered photo and 3-D model) which do you believe best helps you understand/conceptualize the proposed development/improvement?

- Is the 3-D model easier to understand or interpret than the 2-D visualizations?
- How well is the information conveyed?
- Did the model alter or enhance your view of the proposal?

How does the 3-D model compare to the two 2-D visualizations?

- What are some of the negative or difficult things to understand in the 3-D model?
- What are some of the positives?

What do you believe the overall level of realism is in the model?

- How important is the level of realism?
- Would an increase or decrease in the level of realism help you conceptualize the project better?
- How appropriate is the level of realism?

How does the scale of the model affect your understanding?

- Would a smaller or larger scale aid in your understanding?

The user will be allowed to navigate the 3-D model with Google Earth®:

- How important is the ability to fully navigate/change view points in the model?
- Is the model easy to use/navigate?
- How important is the ability to share and/or access the model over the internet?

What changes or improvements in the model would help you better conceptualize the project?

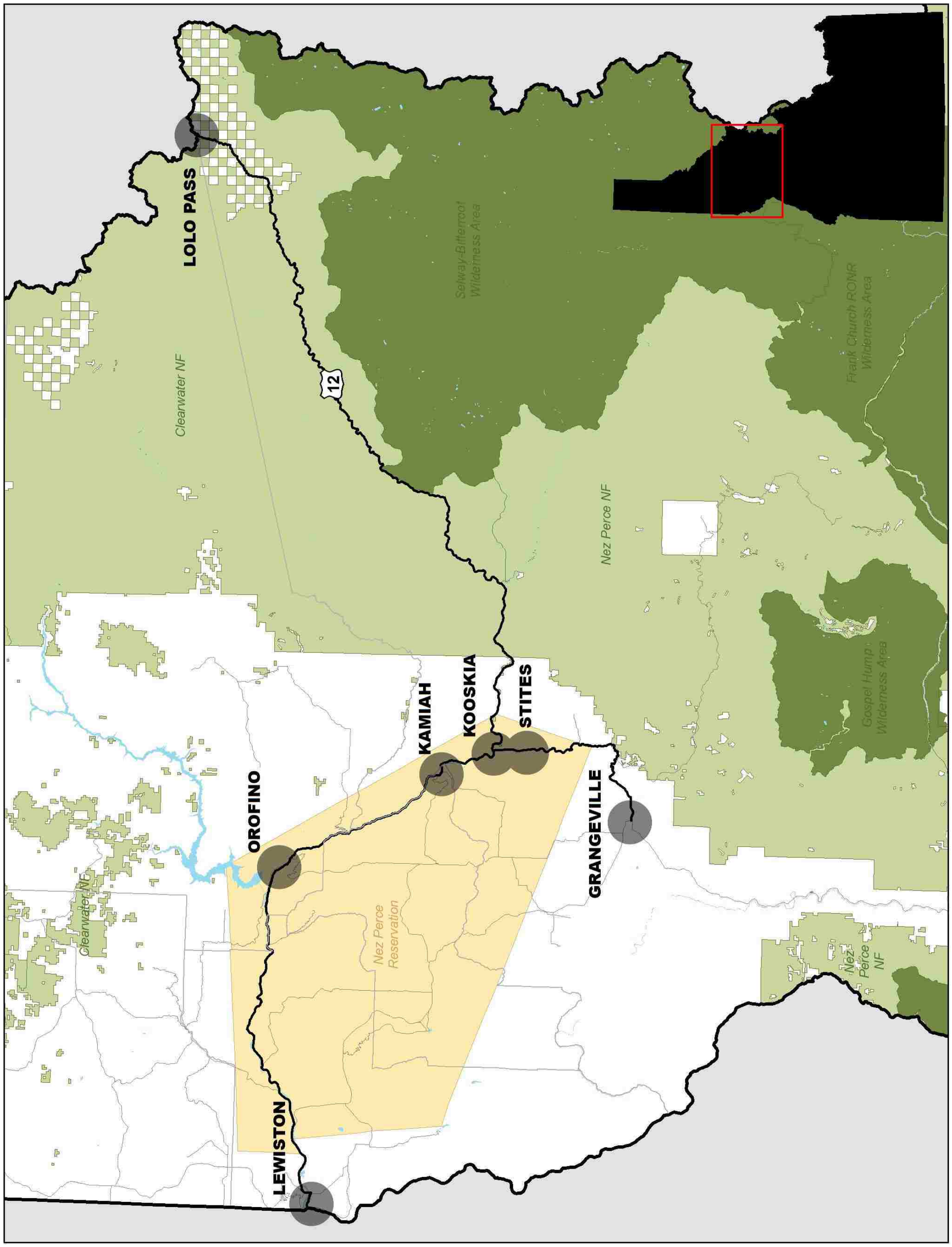
In terms of the overall planning process/discussion, how useful was the model?

- Could the same discussion occur without the visualizations?

What other additional information would aid in the understanding of this proposal?

Are there any additional comments you have with regard to the model?

APPENDIX B – NORTHWEST PASSAGE SCENIC BYWAY OVERVIEW MAP



APPENDIX C – NWPSB COMMUNITY WORKSHOP AGENDA

Northwest Passage Scenic Byway

Community Marketing & Scenic Conservation Workshop

AGENDA

Monday, April 21, 2008

Nez Perce County Commission Chambers, Lewiston

9:00 am	**Introductions** – DEB SMITH ♦ Purpose of workshop
9:05 am	**Overview of the NWPSB** – SCOTT ECKBERG/MARY JAHN, KEN HELM ♦ Byway history, AAR designation, NWPSB-AT, and planning/funding/project successes to date: CMPs, signs, kiosks, interpretive sites, wayfinding plan, audio tour, etc. ♦ NWPSB-AT current activities ♦ ITD U.S. 12 and S.H. 13 Corridor Studies
9:15 am	**How Your Business and Community Can Benefit From Byway Marketing Efforts** – DIANE NORTON, KELLY DAHLQUIST, LORRAINE ROACH ♦ State and regional efforts to promote the byway and communities/businesses along it (State Tourism Office, NCITA, RMI, Wired to Nature, etc.) ♦ *Top 10 Scenic Drives in the Northern Rockies*: a $535,000 program to market the NW Passage and other attractions to domestic and international travelers ♦ Visitor expectations for a Byway experience: services, amenities, visitor info
9:35 am	**Scenic and Historic Conservation Options Along The Byway** – WGM GROUP ♦ Importance of scenic attributes/viewsheds for long-term appeal of the NWPSB and communities ♦ Examples of good and bad development in terms of scenic/historic impacts ♦ Areas already blighted or at risk for scenic/viewshed degradation, and possible options for scenic conservation strategies ♦ 3D visual simulation of various development scenarios and their benefits/impacts ♦ Threats to the scenic and historic character of the byway corridor and historic downtowns, and ways to address them ♦ Ways to encourage growth and development in the scenic byway corridor while protecting its outstanding scenic views and historic/cultural sites ♦ Incentives for property owners and developers (conservation easements, land trusts, etc.) ♦ Public policy options to promote conservation and compatible development
10:15 am	**The Opportunity to Imagine** – WGM GROUP ♦ Visual simulation of high priority community projects: before and after visuals of projects identified by Byway communities, and discussion of local projects with computer enhanced images of how projects might look when completed ♦ Overview of potential funding and next steps for community projects
10:40 am	**Small Group Breakouts** – WGM GROUP ♦ Discussion of blighted/at-risk areas and local projects, ♦ Steps needed to protect/improve/implement, ♦ Priorities and additional assistance needed by community to move ahead
11:15 am	**Next steps to move forward with byway projects and scenic conservation** – WGM GRP ♦ Reports from small groups, general discussion re. next steps, wrap-up ♦ Discussion and recommendations about potential actions and time frames.
11:45 am	**Adjourn**

APPENDIX D – COMMON ACRONYMS

2-D – Two Dimensional

3-D – Three Dimensional

CMP – Corridor Management Plan

GIS – Geographic Information Systems

ITD – Idaho Transportation Department

KMZ – Keyhole Markup Language Compressed File

NPS – National Park Service

NWPSB – Northwest Passage Scenic Byway

USFS – United States Forest Service

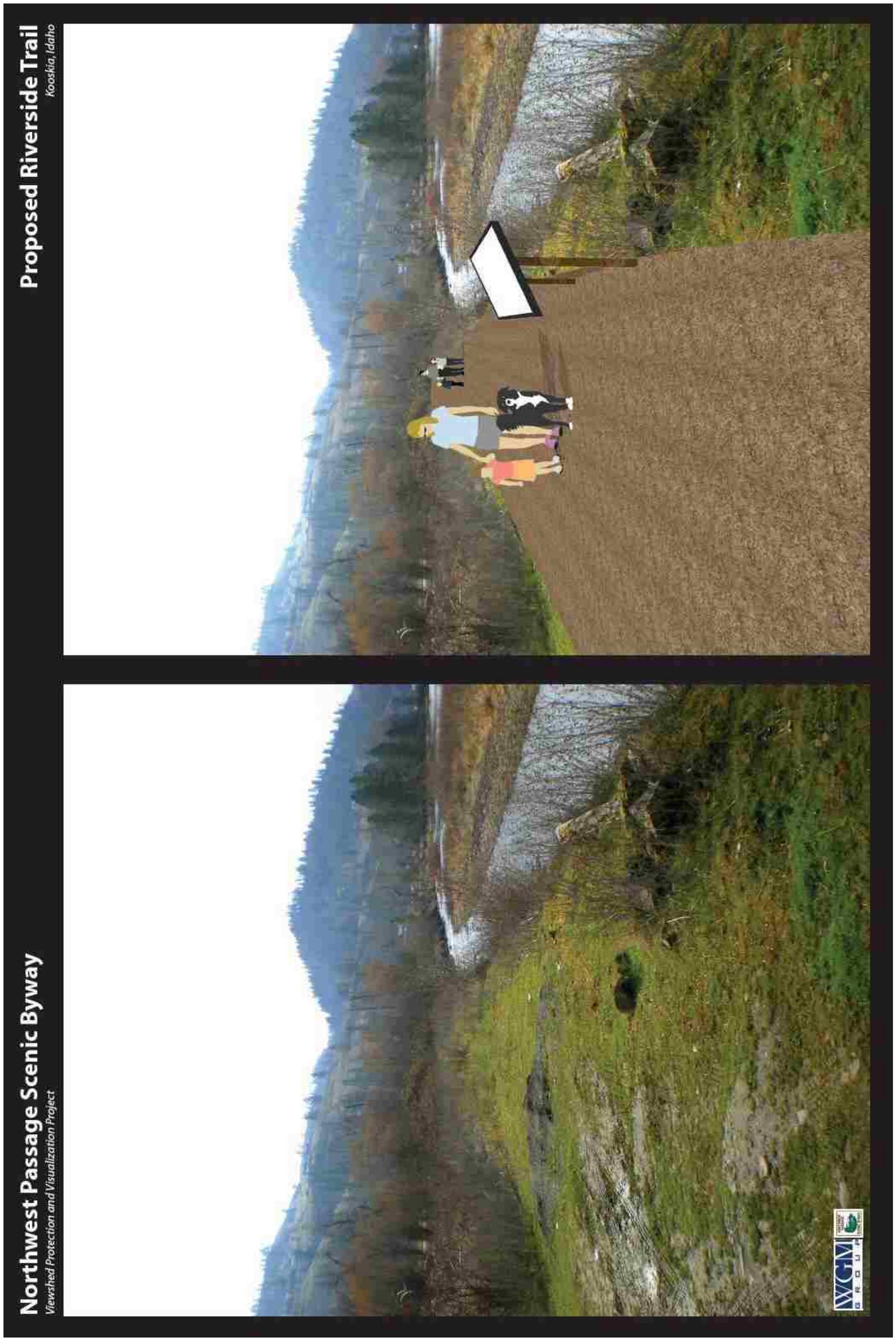
APPENDIX E - KOOSKIA RIVERFRONT DEVELOPMENT CONCEPTUAL DESIGN MAP

APPENDIX F - KOOSKIA RIVERFRONT DEVELOPMENT 3-D MODEL IN GOOGLE SKETCHUP®

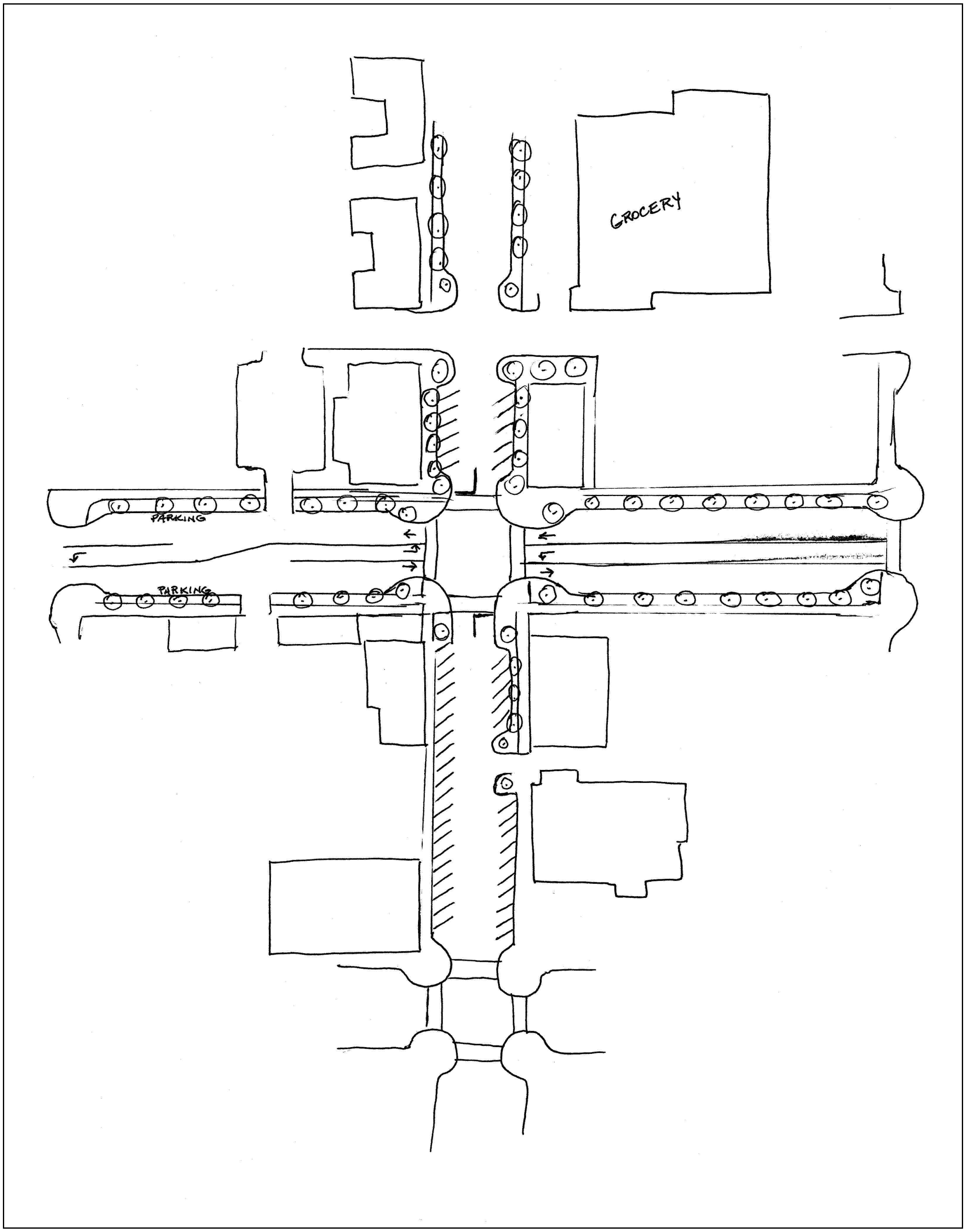
APPENDIX G - KOOSKIA RIVERFRONT DEVELOPMENT 3-D MODEL IN GOOGLE EARTH®

APPENDIX H - KOOSKIA SIDEWALK IMPROVEMENTS DIGITALLY ALTERED PHOTOGRAPH

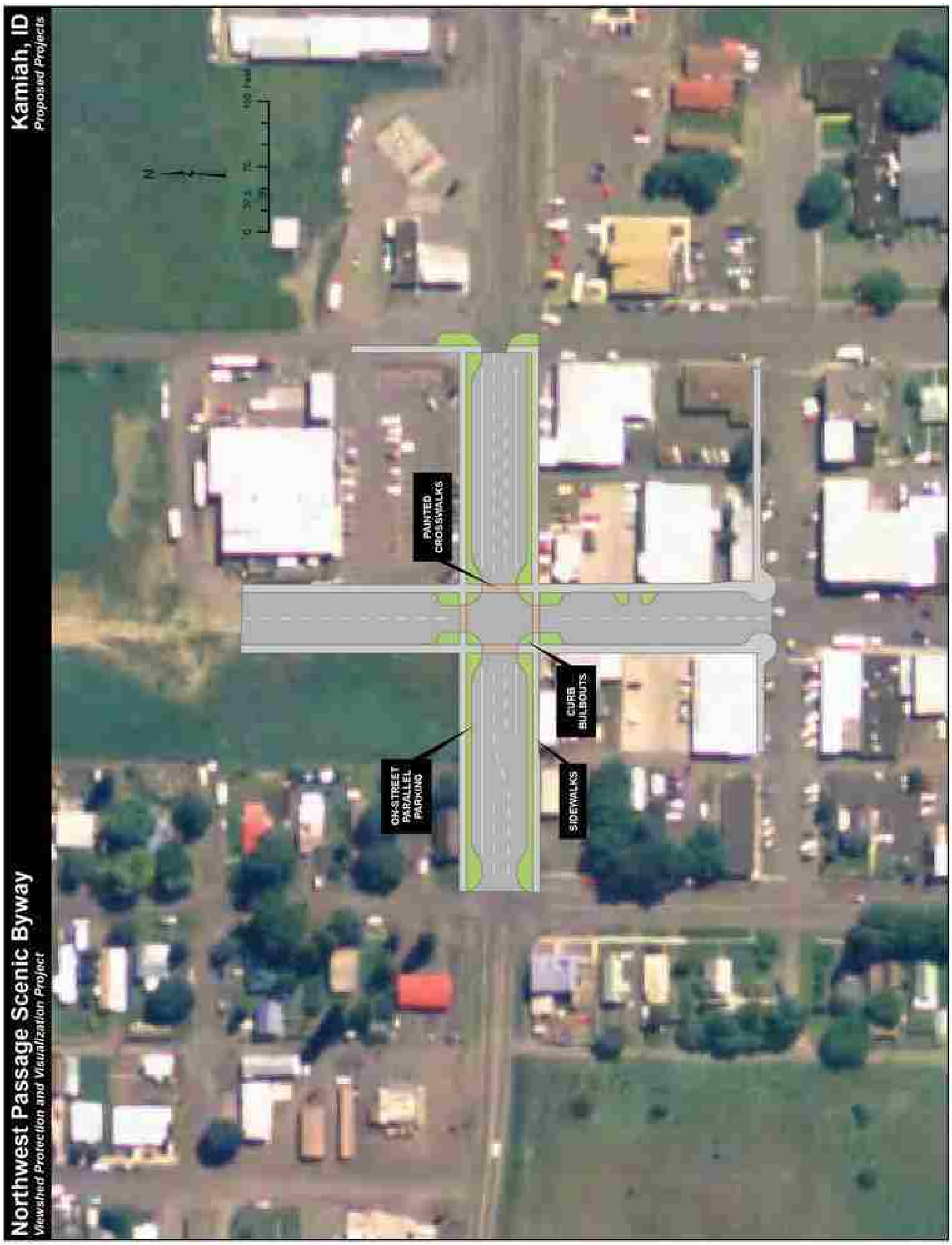
APPENDIX I - KOOSKIA RIVERSIDE TRAIL DIGITALLY ALTERED PHOTOGRAPH



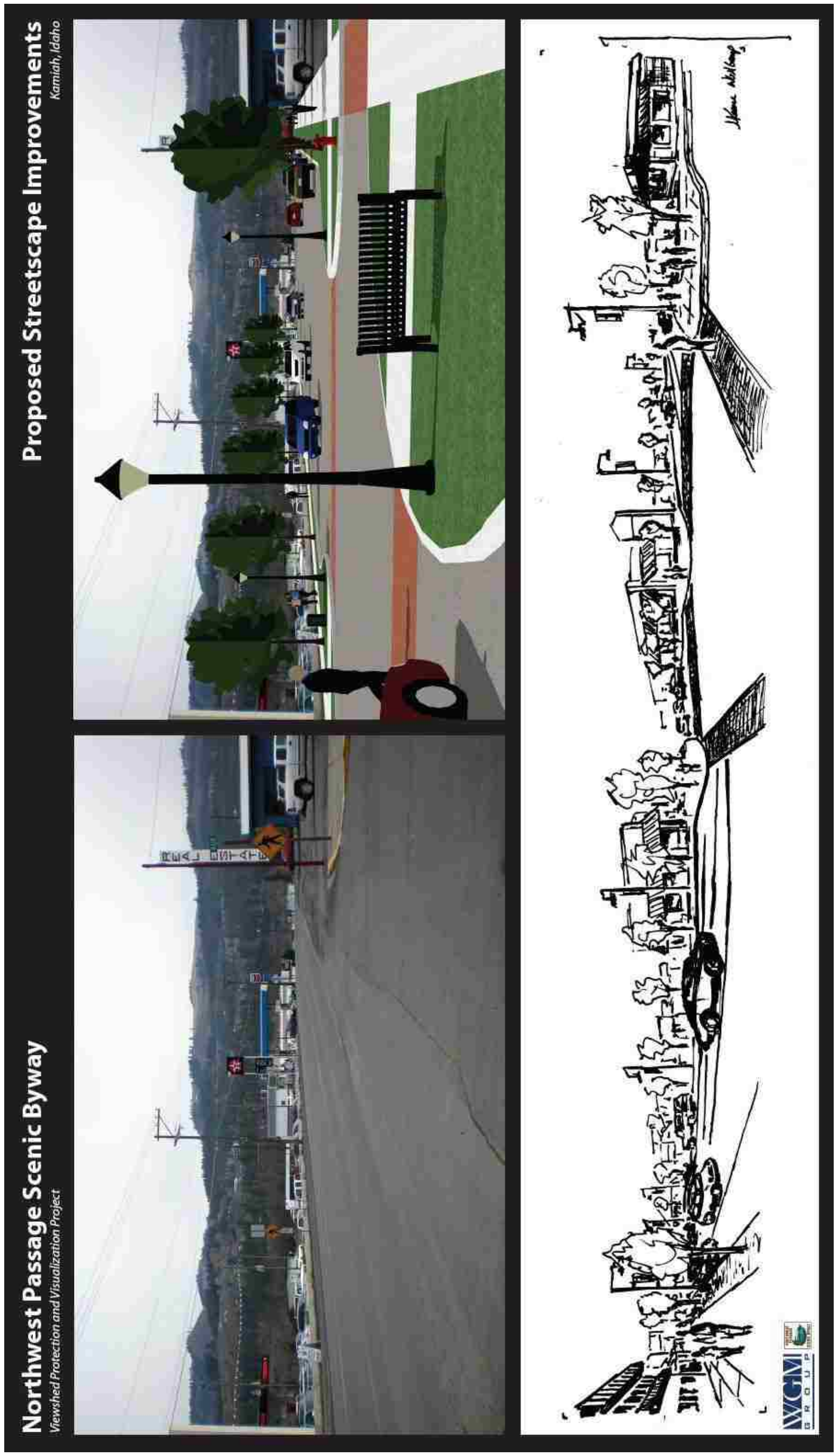
APPENDIX J - KAMIAH INTERSECTION IMPROVEMENTS CONCEPTUAL DESIGN SKETCH



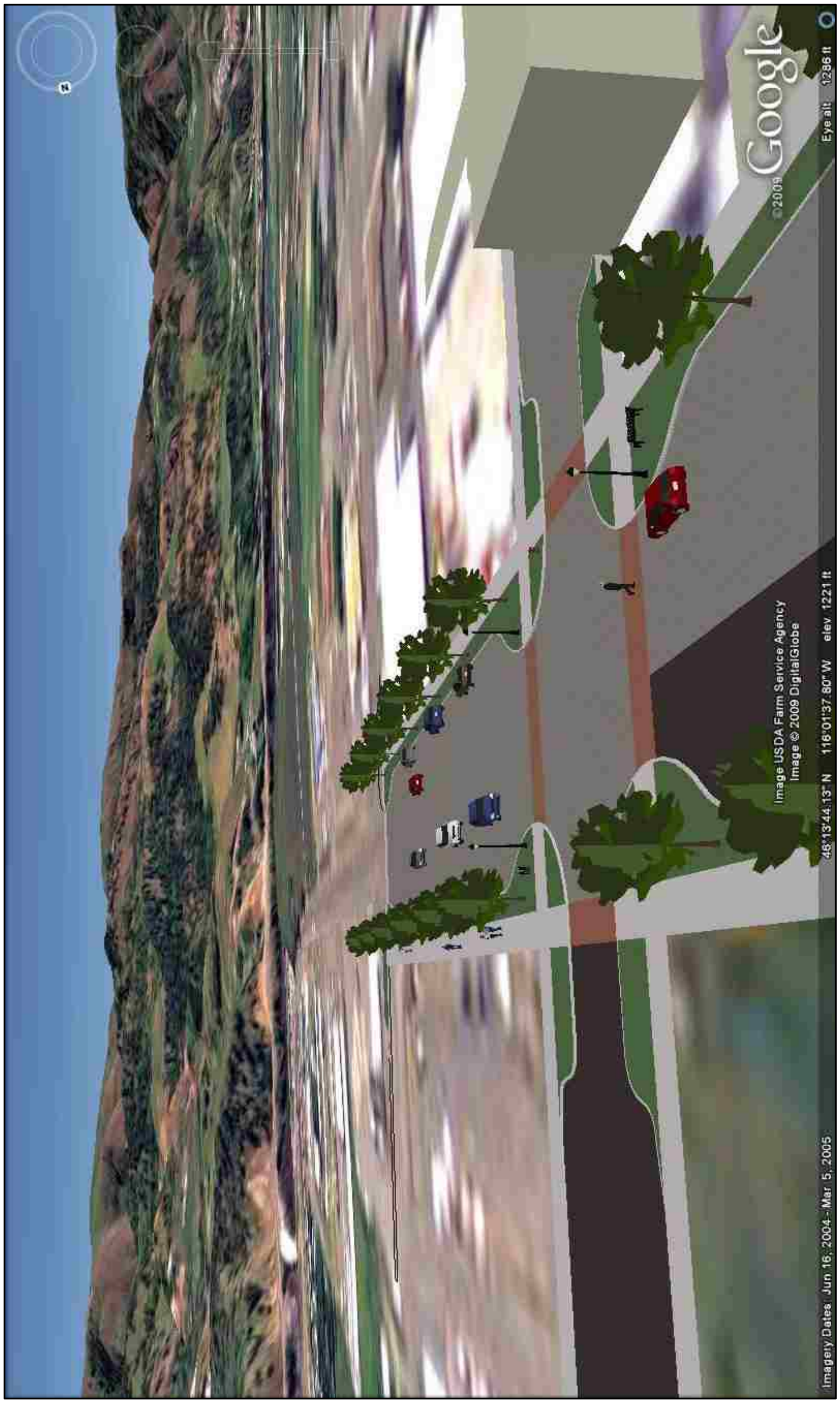
APPENDIX K - KAMIAH INTERSECTION IMPROVEMENTS CONCEPTUAL DESIGN MAP



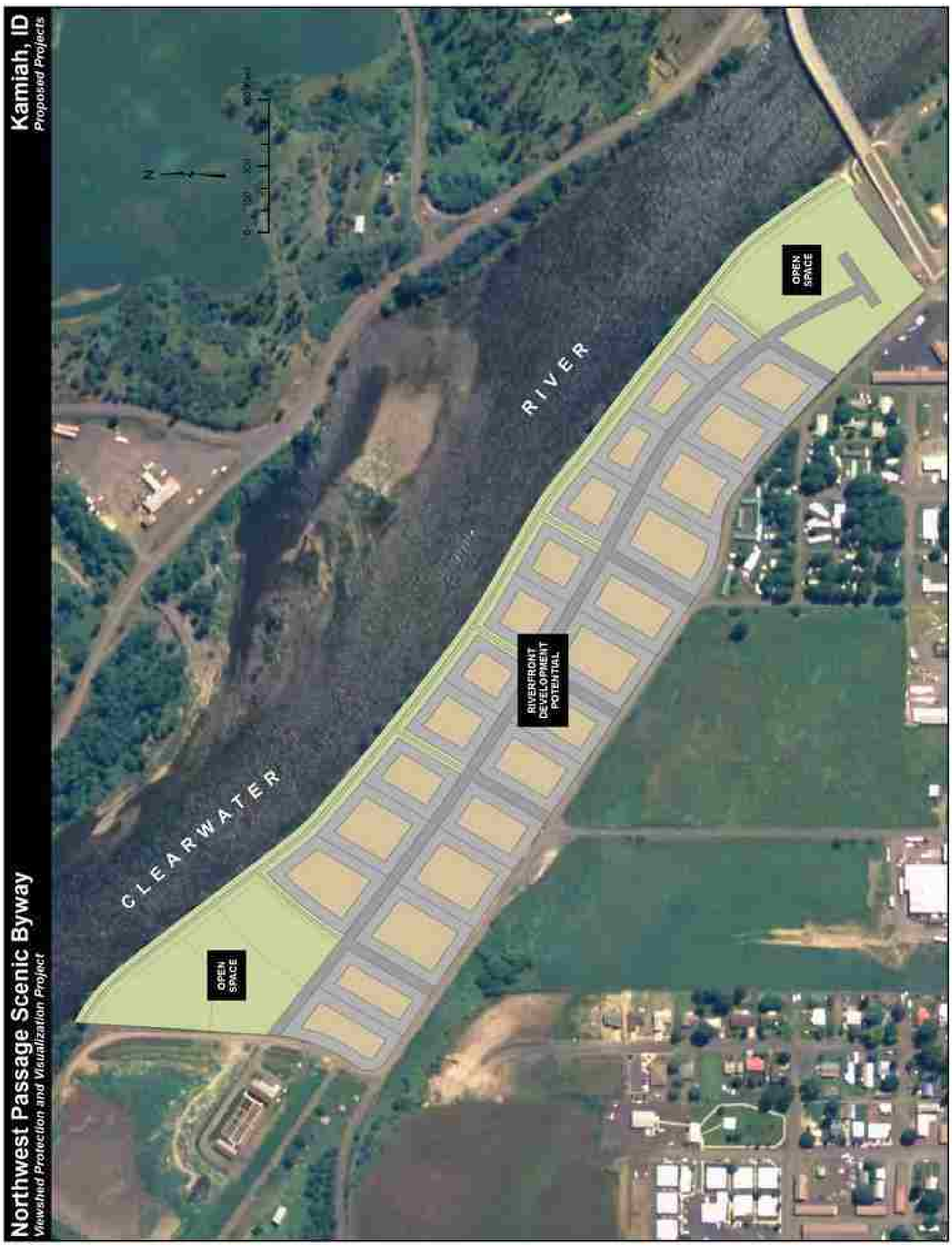
APPENDIX L - KAMIAH INTERSECTION IMPROVEMENTS DIGITALLY ALTERED PHOTOGRAPH



APPENDIX M - KAMIAH INTERSECTION IMPROVEMENTS 3-D MODEL IN GOOGLE EARTH®

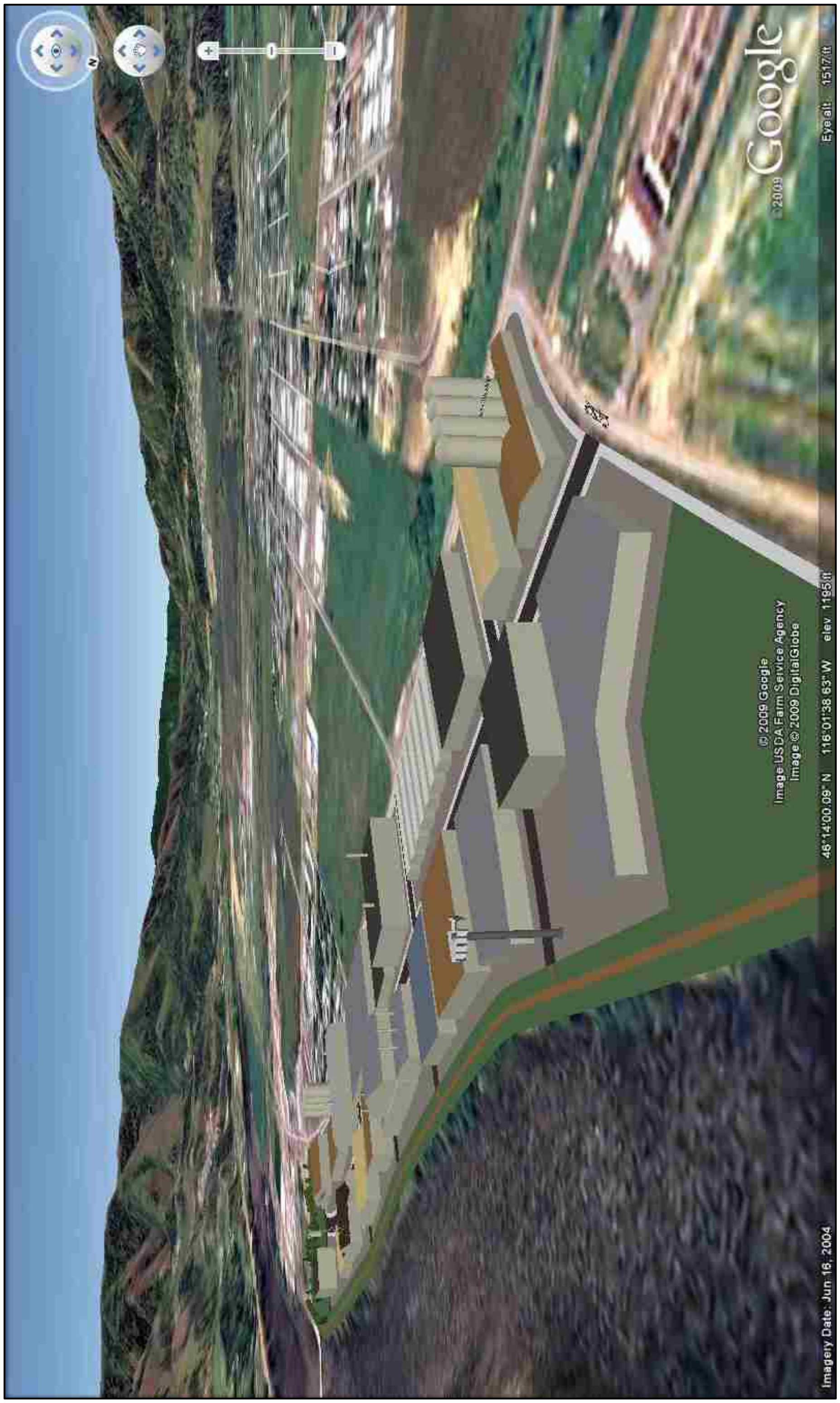


APPENDIX N - KAMIAH RIVERFRONT DEVELOPMENT 3-D MODEL IN GOOGLE SKETCHUP®



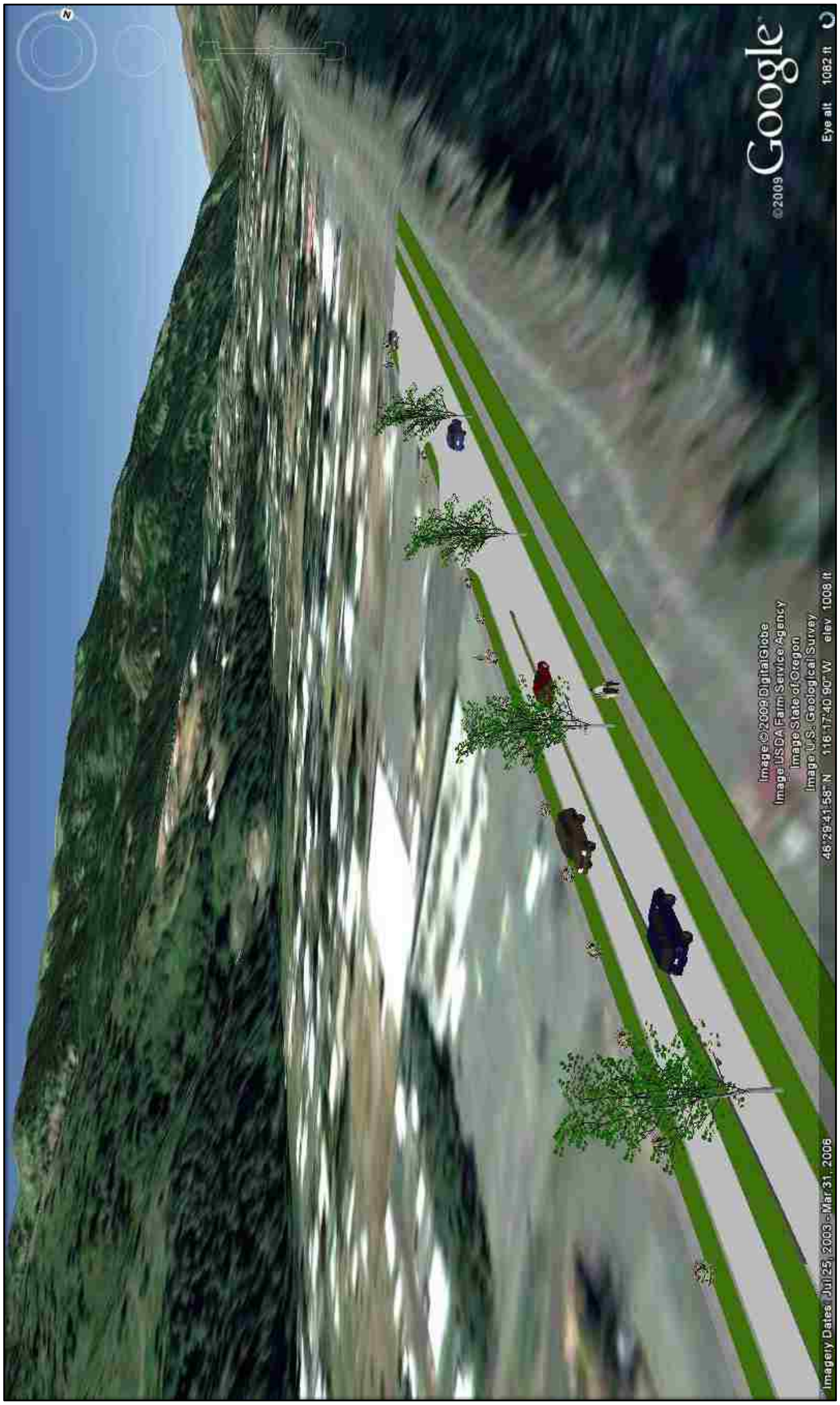
APPENDIX O - KAMIAH RIVERFRONT DEVELOPMENT 3-D MODEL IN GOOGLE SKETCHUP®

APPENDIX P - KAMIAH RIVERFRONT DEVELOPMENT 3-D MODEL IN GOOGLE EARTH®



APPENDIX Q - OROFINO HIGHWAY IMPROVEMENTS DIGITALLY ALTERED PHOTOGRAPH

APPENDIX R - OROFINO HIGHWAY IMPROVEMENTS 3-D MODEL IN GOOGLE EARTH®



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