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CONTEXT SENSITIVE SOLUTION: A CASE STUDY OF NORTHWEST HIGHWAY WHITE ROCK LAKE, DALLAS IN TEXAS

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ABSTRACT

Loop 12 is the first ring around the city of Dallas. The project is a three-quarter mile section of Loop 12 on Northwest Highway. The project section of Northwest Highway is a set of six bridges that cross a 100-year floodplain. The environmental challenges, the diversity of stakeholders and their needs, and heightened sensitivities from special interest groups posed significant challenges for this project. Texas Department of Transportation (TxDOT) initially identified the traditional stakeholder groups to be representatives of area residences, schools, businesses, highway users, and transportation providers. However, the unique setting for this project also created a number of non-traditional stakeholder groups. A major construction that would last a few years would substantially disrupt their normal activities. These groups were particularly sensitive to changes in the environment as TxDOT leaned after contracting HNTB Corporation to research the community and its history. From the project, we learned that forming multidisciplinary and hierarchical teams is one of key factors for successful project. Early and regular engagement of the public helps the environmental assessment and project progress. Visual simulation is one of effective tools to communicate with the public. Inter-agency coordination is critical. Traffic management strategies must adapt with context sensitive solutions of transportation projects.

Keywords: Context Sensitive Solution, public involvement, Multidisciplinary

INTRODUCTION

The NHS is a federal designation that includes the Interstate System, select Principle Arterials, the Strategic Highway Network (STRAHNET), and Intermodal Connectors (Slater 1996). This network has about 4% of the nation's road miles but carry more than 40% of the highway traffic. By congressional mandate in 1995, the U.S. Department of Transportation collaborated with States and local jurisdictions to identify segments of the nation's most critical roads to focus its resources while serving the majority of Americans; these segments became the NHS. About 90% of the U.S. population lives within 5 miles of an NHS road. Loop 12 receives special scrutiny because it serves the largest metropolitan area in the south, which is also the fastest growing in the nation.

Loop 12 is the first ring around the city of Dallas. It was the outer Dallas beltway during the 1960's but was supplanted later by Interstate 635. Northwest Highway, also designated as Loop 12, is part of the National Highway System (NHS) and is the only state highway in Dallas that forms a complete loop. It serves the important function of linking other principle arterials and Interstate routes that are radial arteries to and from the city center. Loop 12 traverses numerous commercial business districts, industrial sites, suburban neighborhoods, parklands, and other recreational areas around Dallas. The route carries more than 50,000 cars daily. The project is a three-quarter mile section of Loop 12 on Northwest Highway. It bisects the popular city park at White Rock Lake as shown in Figure 1. The project section of Northwest Highway is a set of six bridges that cross a 100-year floodplain.

Northwest Highway is six-lanes and has a relatively narrow raised median. Some of the major intersections have auxiliary turn lanes in both directions. The project extends from point "A", just before the Buckner Boulevard intersection on the eastern end, to point "B", a major intersection at Lawther Drive, on the western portion. It includes one minor intersection, Goforth Road, just before the eastern end. Each intersection has traffic lights and one left turn lane. Both intersecting roads of the project site are two-lanes that provide access between the north and south portions of the park. Park utility vehicles and rangers also use these roads to provide park services and security. Trails adjacent to each of the two-lane roads cross the highway at grade, providing access for pedestrians and bicyclists to each section of the park.

Paths that cross the highway at the western end provide access to public transportation that includes a light-rail and buses of the Dallas Rapid Area Transit (DART) system. Hence, the project facility traverses a high diversity setting that supports multimodal traffic, including a railroad crossing, and supports both motorized and non-motorized modes of transportation. The unique setting is a major highway of the NHS bisecting a highly treasured city park. Many of the area's conservancy groups (Morris 2014) presented special context sensitive challenges for this project.

ISSUES TO RESOLVE

The environmental challenges, the diversity of stakeholders and their needs, and heightened sensitivities from special interest groups posed significant challenges for this project. Amid the wide variety of public sensitivities relating to the park setting, the outstanding technical issues were substantial. They included mitigating future potential flood by replacing six functionally obsolete bridges, designing the roadway for an urban setting that included multi-modal options of both motorized and non-motorized modes of transportation, and incorporating context sensitive architectures appropriate to the community. The next sections describe the context and significance of these issues.

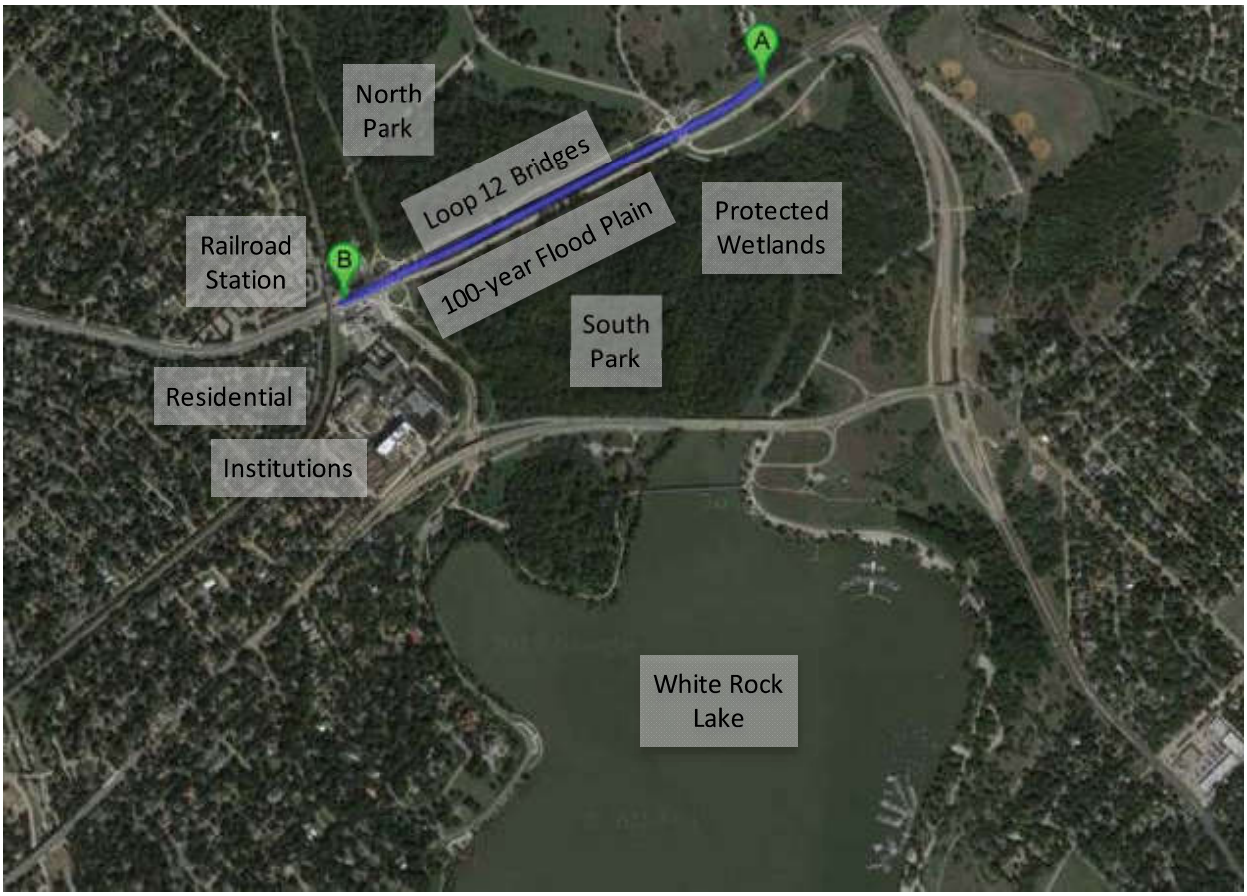

FIGURE 1 Project section and intersecting land use (Google maps satellite, 2012).

Highway Flooding

The project area was a three-quarter mile section of road that consisted of six relatively low bridges that crossed the floodplains and wetland areas at the lake's tributaries (HNTB Corporation 2003). The creek level was almost at the same level as the bridge deck five years before the project commenced. A volumetric survey of the lake in 2002 confirmed Federal Emergency Management Agency (FEMA) findings that the 100-year flood elevation level was as much as 5 feet above the bridge (Hearn, Thomas and Burns 2003). The area flooded as recently as January 9, 2013 when heavy raining caused the lake to rise 86 feet, which was two feet above the flood stage (Wilcox 2013). There were dozens of other floods prior to 2013.

Mitigating concerns from the potential of flooding would significantly affect the cost and availability of flood insurance, potentially saving the community millions of dollars each year. In addition, the city would potentially save millions of dollars by avoiding expensive litigation in the event of flood damages, injuries, or causalities. The main project goal, therefore, was to raise the highway segment above the floodplains. This action would mitigate future potential floods and promote a safer facility for the traveling public.

Functionally Obsolete Bridges

According to the Texas Department of Transportation (TxDOT), all of the bridges were in a state of major disrepair (TxDOT 2007). The city built three of them in 1931, and the others in 1961.

Subterranean soil borings completed a few years before the project commenced revealed that the bridge foundations were on unstable ground (Meyer 2009). The roadway was prone to lingering settlement by as much as nine inches (TxDOT 2007). The growing traffic volume that included heavy vehicles posed additional significant risks of permanent bridge damage and possible collapse that could result in serious injuries or fatalities. Traffic count profiles showed that the two-way Average Daily Traffic (ADT) for the ring increased from 11,740 in 1997 to 57,290 in 2004 (Campbell 2010). Other traffic studies of the area show that major arterials feed the Northwest Highway with traffic volumes in excess of 100,000 ADT (NCTCOG 2009). Trucks could account for 4% to 10% of the volume depending on the arterial and the time of day (Sims and Royster 2006).

Bridge stabilization required sinking piers down to the bedrock. This implied demolishing the existing bridges, such as the flooded section, to properly examine and address the foundational requirements. Building a new roadway on unreliable soil structure presented the potential for unacceptable safety hazards. Current regulations also required that newly constructed bridges be six to eight feet above the floodplain.

The required overall effort to excavate the area for foundation work, to bring in fill material, to realign the highway while supporting existing traffic, and to rebuild the bridges with context sensitive elements meant that the project would be both expensive and extensive in duration.

Design for Urban Setting

The city excavated the basin for the manmade lake in early 1911 and opened the filled in lake in 1914 as a source of water for the city of Dallas. The surrounding area became a city park in 1929. President Franklin D. Roosevelt helped to fund the lake area development. The neighborhood became a WWII boot camp and later a prisoner of war camp. With population growth, the city constructed another lake further north as a water reservoir and White Rock Lake became a city park. Local jurisdictions converted the old pump and filter houses into community meeting centers. The character of the community changed from a rural setting to a post-WWII residential district (Morris 2014). FIGURE 2 shows how the area's land use changed. Farmlands surrounded it (Long 2013) as late as the 1940's before it transformed into an urban setting of pristine residential neighborhoods and parklands for city dwellers (Google Earth 2014).

Project managers researched this history and considered it in their planning. TxDOT wished to improve the safety and operational efficiency of the highway section, but needed accomplish that without disrupting the ecology of the area and its community. Regular closings of roads, sidewalks, and trails would adversely affect residences, DART light rail commuters, and the operations of small businesses in the project vicinity. Given that the bridge is a bottleneck on Loop 12, the construction would not only disrupt traffic flows for a long period, but it would also disrupt preferred routes for pedestrians, runners, equestrians, and cyclists that visit the area to use the park.

Context Sensitive Design

The Northwest Highway project section bisects a heavily used city park with highly prized recreational and natural surroundings. The new bridges would significantly change the existing relationship between the parkway and the landscape. The local community had become accustomed to a level, open, green parkway since its post-World War II establishment.

Elevating the six-lane highway would cause it to become a more prominent structure visually. It could also be noisier when it rises above the natural sound barrier of the existing foliage. As part of the context sensitive solution (CSS) movement, transportation engineers have begun to incorporate "soundscape" planning into their sustainability approach to transportation noise management (Polcak and Miller 2013).

FIGURE 2 Change in land use (Morris 2014, Google Earth 2014).

Planners were concerned that the community would view it as a loud concrete structure carrying a plume of pollution-emitting steel boxes, cutting through their once serene park atmosphere. It could potentially become a public eyesore forever. TxDOT understood earlier in the project that its success would depend on considerations for the natural ecosystem and community values. The project managers were keenly aware that a holistic approach would be necessary. They needed to account for both the broad and minute details of the project and the impact that it would have on the community. Such details would include the aesthetic appeal of the bridge architecture, the surrounding landscape, and the existing park features. Attention to details would include everything, down to the selection of the lighting type and fixtures for the bridge and the adjoining park trails, the monument signs, and even the type of materials used for the sidewalk drains and filters. The selected material must also comply with the existing community and park ordinances, and their individual master plans. These considerations created an expanded vision for the project. Unfortunately, that expansion also swelled the initial budget more than three-fold, leading to a funding challenge.

Funding

Data from the FHWA shows that there was a sudden increase in the rate of rising construction costs starting in 2004. Similar to the consumer price index, the federal government had created a construction price index. The sudden price escalation after 2003 coincided with the advanced project planning phases, which included the environmental assessment and engineering specifications. The environmental assessment is a federally mandated process that analyzes the impacts that government action would have the affected community. States are required to complete this assessment for any project that involves federal funding, and this component of a project is often expensive. At the time of the project proposal to the federal government in the

late 1990s, TxDOT estimated that the cost of the complete project would be about $9M as shown in Table 1.

This amount included the cost of reconstructing the six-lane highway and some realignment to elevate it a few feet above the maximum expected flood levels. It did not include all of the context sensitive design (CSD) proposals that emerged once the planning and public involvement processes initiated.

After incorporating some of the CSD aspects into the plan that emerged from recommendations of the historical and community background research, the budget swelled to more than $16M (TxDOT 2007). This was around the time when the planning process begun. Just before the start of the "Great Recession" of 2007, inflated construction and material costs caused the project estimate to reach nearly $30M at the time of construction letting. However, there was substantial stakeholder buy-in at the time. As part of the NHS, this project was eligible for 80% federal match, and the congressional request was already in deliberation as part of the Transportation Equity Act for the 21st Century (TEA-21).

TABLE 1 History of Project Cost Estimates

Year	Estimate	Comment
1998	$9,000,000	Estimate when originally proposed
2003	$16,500,000	Included 80% FHWA match
2007	$29,869,171	Cost expected at the time of letting
2008	$31,480,361	Awarded amount

In addition, the City of Dallas and the County pledged about $2M towards the project. With these commitments at all layers of state, federal, and local governments, TxDOT prepared the request for proposal. The passing of the TEA-21 in 1998 allocated funding for the project. These overall financial commitments were the turning point of the project. TxDOT subsequently initiated the planning and public involvement processes and awarded the construction project in 2008 to Rebcon, Inc. for about $31.5M

IDENTIFYING THE STAKEHOLDERS

TxDOT initially identified the traditional stakeholder groups to be representatives of area residences, schools, businesses, highway users, and transportation providers. However, the unique setting for this project also created a number of non-traditional stakeholder groups. The project section of the highway bisects a significant attraction point for special interest groups. They include environmentalists, conservancies, cultural organizations, and recreational hobbyists that host a variety of sports and hobbies at the park.

A major construction that would last a few years would substantially disrupt their normal activities. These groups were particularly sensitive to changes in the environment as TxDOT leaned after contracting HNTB Corporation to research the community and its history. The next sections provide the backgrounds and special concerns for each of these stakeholder groups.

Special Interest Groups

According to one of the leading volunteer groups "For the Love of the Lake," their mission is to preserve and enhance the lake park as an urban oasis. They support other special interest groups that sponsor and manage activities that are beneficial to the park and to the people that visit to

enjoy its surroundings. These groups were particularly concerned with disruptions that would constrain access to the park, its lake, and the surrounding environment. Members of the group were also concerned about changes in the character of the area once an elevated bridge came into view and the loud drone of traffic breaks the silence in the natural surroundings.

Community Associations

Representatives of the area residences, such as the White Rock Neighborhood Association and the White Rock Valley Association established bylaws to maintain the character of their neighborhoods and to protect them from encroachments such as road expansions. Their bylaws are to block the expansion of the Dallas thoroughfare system, ensure minimal destruction of trees, enforce the area's park management plan, block the DART from operating diesel commuter trains, and to prevent the expansion of parking facilities in the area (Frisbie 2005). The Lakewood neighborhood adjacent to the project site ranked as one of the top 10 Dallas communities for wealthy buyers where the median income was $250,000 or more (Boardman 2013). The community also has a number of condominiums and luxury apartments with strict ordinances.

CONTEXT SENSITIVE APPROACHES

On behalf of TxDOT, HNTB Corporation, a contractor, formed three teams for: environmental matters, public involvement, and design for urban context. The head staff from each team worked closely with members of the initial stakeholder group that included TxDOT engineering, the technical advisory group, the Texas Department of Fish & Wildlife, the City of Dallas Public Works, neighborhood associations, and special interest groups.

The following sections summarize context sensitive approaches that addressed the most critical aspects of the project. Each section highlights effective decision-making based on: 1) holistic considerations of the park history and setting 2) deliberating concepts for park development alternatives 3) evaluating practical constraints for roadway alignment alternatives, and 4) identifying and associating community values relative to architectural style choices.

Holistic Thinking

The design for urban context team began their research at the City of Dallas archives and the Texas Historical Society to learn about the project context. In particular, they were researching the history of the area and the characteristics of the neighborhoods around the project site. Through this research, the team became keenly aware that the park setting was the critical centerpiece of the project site and that the area residents were extremely passionate about conserving its serenity and character. They became more sensitive to the hydrology of the White Rock Creek and its tributaries. After learning that the lake was once much larger, the research team drafted a proposal to bring the lake back to its original footprint, and to improve the flow of the creek.

Given the history and character of the area, the teams examined the effects of adding aesthetic features to the bridge and to the park surroundings. They considered designs for fountains, quiet pools, and stone sculptures. They also discussed improvements to the hike and bike trails. Their plans even included enhancements to the pedestrian bridges that ran alongside the highway. Additionally, the team explored opportunities to improve the park lighting and to include art around the project area.

This level of holistic thinking was necessary because of the variety of stakeholders involved and their sensitivities to the prized park setting and lake area. The team was preparing to present all of their thoughts to the public as early as possible. They wanted to maximize public support and stakeholder buy-in. Their comprehensive plans initially generated controversy and it was difficult for TxDOT to bring the groups together. Therefore, to achieve consensus, the vision needed balancing with realistic goals and expectations. This balancing of expectations and planning actually went on for about five years.

Park Development Alternatives

Plans to construct a raised six-lane highway across the park included plans to enhance the surrounding amenities. The project team considered two alternatives for improving the lake. The first was to dredge the area under the bridge to expand the lake's footprint and the other was to improve the flow of the existing creeks (TxDOT 2007). Raising the bridges would improve the headroom for kayakers that use the creek. Kayaking to the northern side of the park is possible when the creek is relatively low, otherwise, the kayakers would need to turn around or carry their kayaks across the highway and re-enter the creek at the north side.

The design team also considered improving the lighting for both the park and the highway. However, simply adding lights would be inadequate because the White Rock Lake Park Master Plan dictated strict lighting ordinances that included both aesthetics and function (Northrup, Gillum and Sutter 2008).

The goal of the design team was to enhance the park's natural features and character while maximizing park security and safety. The master plan required careful planning of the light fixture placement so that they would play a minor role in the park environment. The strict park ordinances included the following requirements:

- Fixtures with shielded down lights
- Fixtures placed no higher than the tree tops
- Minimal number of fixtures
- Concealed lighting sources, including placement in trees
- Power supplies and ballasts to be hidden underground
- Use of only metal halide or mercury vapor bulbs, not high pressure sodium

Other design alternatives for the environment included improvements to the transit station north of the project limits and installing aesthetic entry markers at both sides of the White Rock Lake park entry abutting the project area.

Roadway Alignment Alternatives

The geometric alignment of the new bridges relative to the existing roadway was a major consideration for the design process. The alternatives considered and discussed were:

- No Build
- Consolidated Bridge – one uniform structure across the length of the segment with no plantings
- Boulevard – a mix of fill and bridge sections with tree plantings in the shoulders and the median

- Split Parkway – an elliptically shaped bridge-less construction where the north and south arcs of the road would curve around the floodplains, with the lake filled to mask the site of the old bridges after their removal
- Gateway – replace the six existing bridges with elevated versions that included an aesthetic "gateway" feature for each bridge section

The "no build" option served as a baseline to compare cost, duration, and impact with the other design alternatives. The cost to implement each option varied substantially, by millions of dollars. It was clear to the design process that a compromise was necessary.

Bridge Design Architectures

The design team considered and proposed three alternatives for the bridge architectural style: art deco, contemporary, and rustic. The art deco style consisted of bold geometric shapes and ornamentation. The Chrysler Building in New York City is an example of the art deco style. This style became an option because it complemented or matched the style of some of the park buildings, including portions of the existing structure. In particular, the old bathhouse building in the park is art deco. The town renovated the bathhouse, where visitors once showered after using the lake, to host the popular museum. Its architectural style remained intact.

The contemporary style is a more modern look. The Sydney Opera House in Australia is an example of the contemporary style. The team selected this style as a candidate because it reflected some of the architectures of the region and of nearby communities. The sloped gateways of that style included grassy fills. The bridge lighting was prominent. The design also required small grassy-inset medians for both the highway and the cross street. This design incorporated a significant amount of landscaping, shrubbery, and trees that are native to the area.

Governments and national parks typically use the rustic style. Traditional American log houses are good examples of the rustic style. Many of the historic brickwork and structures in the park are reminiscent of this architecture. The walking bridge across one of the creeks is of the rustic style. TxDOT maintained its plan to renovate that bridge as well. The project management presented all of these alternatives at the public involvement forums. They held one of these forums at the historic pump house on the park.

In summary, the context sensitive approaches of this project involved holistic thinking that touched all elements of concern to the community. The overall plan accounted for the history and character of the area. The bridge construction alone did not become the exclusive focus for this project. Rather, the team considered elements that included park design alternatives to enhance the visitor's experience, roadway alignment alternatives that were sensitive to the park setting, and architectural styles that integrated with familiar settings of the area. In short, the context sensitive solutions fully integrated with the design solution.

LESSONS LEARNED

The sparse literature available did not sufficiently identify lessons learned in this project. However, the author was fortunate to locate two of the key project officials and was able to conduct some interviews and email exchanges to learn more. The TxDOT officials were Cynthia White, the public affairs manager (White 2014), and Jeffrey Bush, the lead engineer overseeing the project implementation (Bush 2014). From these interviews and other resources such as internet forums about the project, the main lessons learned are as follows:

- Study the character and history of the community
- Form multidisciplinary and hierarchical teams
- Engage the public early and regularly
- Public involvement helps the environmental assessment
- Visual simulations are effective
- Inter-agency coordination is critical
- Budget for unanticipated findings
- Traffic management strategies must adapt

Study the Character and History of the Community

Once considered a threat to the serene park setting, the new bridge became an integral component of the highly prized park in Dallas. The team largely attributed this success to the early research conducted to understand the history of the area, the park, and the lake itself. Understanding the character of the community helped immensely with the neighborhood association engagements. The trails provided unimpeded access between the north and south ends of the park as well as continuity by reconnecting with the intersecting local roads where the traffic was less. The trails also improved access to existing paths and bridges that crossed the creeks. The community stakeholders were pleased with how the bridge design reflected the character of the historic park structures. This result could not have been as effective without the thorough analysis and research conducted early in the project, allowing the team to understand the character and history of the community.

Form Multidisciplinary and Hierarchical Teams

TxDOT realized from experience that it is not sufficient to have multidisciplinary teams alone. The teams must also have a hierarchical reporting structure to promote accountability. There were three layers in this project. The top layer was the *management staff* that consisted of representatives from local, city, state, and federal governments, as well as TxDOT project leaders. The middle layer was the *project staff* consisting of technical people from both TxDOT and design consultation organizations. The bottom layer was the *advisory panel* that consisted mainly of representatives from the public. Once constituted, the combined design team and advisory panel consisted of multiple disciplines, including ecologists, designers, highway engineers, parks board members, parks department staff, public works staff, city representatives, lake advocates, trail experts, and neighborhood associations.

The team hung poster front of the room to visualize all of the design alternatives for discussion. The visual simulations facilitated multidisciplinary team interaction by simplifying most aspects of the project so that everyone could contribute more effectively. The posters were of the various architectural options for the bridge, the gateways, and the route alignment alternatives under consideration.

The panel members met monthly to discuss concerns at the project, environmental, and neighborhood levels. The representatives of the various city departments of Dallas presented their views and the advisory panel reacted. Representatives from the Dallas Parks & Recreation and the Public Works presented practical realities of the alternatives considered, and illuminated the high costs for some of them.

Engage the Public Early and Regularly

In addition to early engagement, frequent and regular meetings elicited more useful and meaningful feedback from the public. Identifying their concerns early in the project provided ample time to produce design alternatives that would address their collective and varied concerns. The public's view towards the management team changed over time as they met more frequently and became more familiar with each other. They learned more about how the project objectives would benefit them as well as the society. TxDOT realized that when the public is engaged sufficiently early, they tend to remain engaged and actually become advocates, even if they might have initially opposed it. After investing so much of their time and effort into making the project successful, they begin to possess ownership of it. Subsequently, they become powerful emissaries, soliciting help from their friends, and often emerging with novel solutions.

Public Involvement Helps the Environmental Assessment

The public involvement process was a substantial source of information for the formal environmental assessment required. The analysis needed to include answers about how the various alternatives would satisfy the project purpose and their potential impacts to the environment, with and without the actions planned. The environmental assessment document required a community profile that defined the affected area, including neighborhood boundaries, locations of residences, businesses, area demographics, community history, and land use plans. With a substantial body of the planning and design alternatives completed during the public involvement process, the team had ample material to prepare an environmental impact statement. The result of the assessment was "Findings of No Significant Impact (FONSI)," which the government issued on November 29, 2005 (Davidson 2006).

Visual Simulations are Effective

With graphic renderings and simulations, the public was able to see how it would be possible to design and build new bridges and a highway to be part of the park rather than a sore sight. Visual simulations of the outcome helped to maximize understanding for everyone of how the new roadway structure might blend into the surroundings.

The original intersection included part of the park trail that crossed the highway at grade. A poster of the rustic architecture rendering simulated a split in the trail where one end would go under the bridge and the other would stay at grade. From these images, the public could clearly visualize the benefits of the proposed design.

One poster showed how DART commuters would descend the stairs of the rail platform and enter the sidewalk that would lead them to the main intersection of Northwest Highway and Lawther Drive. Commuters would then need to cross the intersection at grade to enter the park, arrive at their residences, do some shopping, or to go to their offices nearby. A visual simulation of the improved intersection highlighted how it would be safer by moving the path under the elevated bridge. This rendering won a Merit Award from the American Society of Landscape Architects. The artists were also capable of rendering how the lighting fixtures and the illumination would change the character of the surroundings at different times of the day.

Inter-agency Coordination is Critical

The construction crew discovered that buried water pipes crossing the right-of-way required replacement because of corrosion. Some of the pipes diverted water from the upstream (north side of the lake) to the downstream side. The design team coordinated these findings with the

Dallas Water works. The plan called for replacing the corroded 48-inch diameter pipes with new 60-inch diameter pipes that would handle future increased usage (Meyer 2009). Although replacement would increase the budget significantly, it became necessary because eminent breaks would result in disasters that would be much more difficult to fix once the new bridge was in place. Both sides agreed to share the cost of managing the pipeline replacement because it replacement was essential to mitigate future risks. Despite the additional time that this effort would add to the already delayed project schedule, the teams efficiently coordinated plans, activities, and the budget. According to TxDOT online records, the pipe replacements added more than one million to the original project budget. It included a special manhole cover design for $111,100 that needed to be consistent with the park setting and neighborhood ordinance.

Inter-agency coordination with all aspects to the project plans was critical to its overall integration for implementation while minimizing additional project delays. As the project progressed, TxDOT also needed to coordinate with other agencies for various aspects that did not involve construction. Examples are project landscaping and utility relocation that also required modifications to fit with the neighborhood ordinance, such as hiding the electrical conduits.

Budget for Unanticipated Findings

The original drawings and the final design implementation for this project were different (Bush 2014). TxDOT learned that designs do change over time, including through the time of project letting, and even during construction as described in the previous section when the crew discovered corroded pipes under the right-of-way. Stakeholder feedback and consensus building meant that the team needed to make compromises and design changes that the team did not previously anticipate. There were additional findings even during excavation that led to changes in the budget.

Traffic Management Strategies Must Adapt

During construction, trail and road closures were necessary (White 2014). Hence, delays through the project section were unavoidable. Detours possibly diverted potential customers from area businesses. TxDOT did admirable work to maintain some significant level of mobility during the project development phases so that local businesses and park activities would remain vibrant. Any curtailment in these activities could adversely affect the area's appeal to visitors. Therefore, TxDOT integrated traffic management with the overall construction plans and adapted them as the construction progressed. The traffic management plan called for building the westbound portion of the bridge first (Bush 2014). Once it was completed, the existing eastbound traffic would switch onto it, but the existing westbound traffic would remain at its current location. TxDOT then constructed the eastbound bridge in a single phase. Once completed, traffic diverted onto the eastbound bridge. TxDOT was able to maintain at least two lanes open in either direction throughout the construction phases. However, the lack of shoulders led to congestion during peak hours.

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