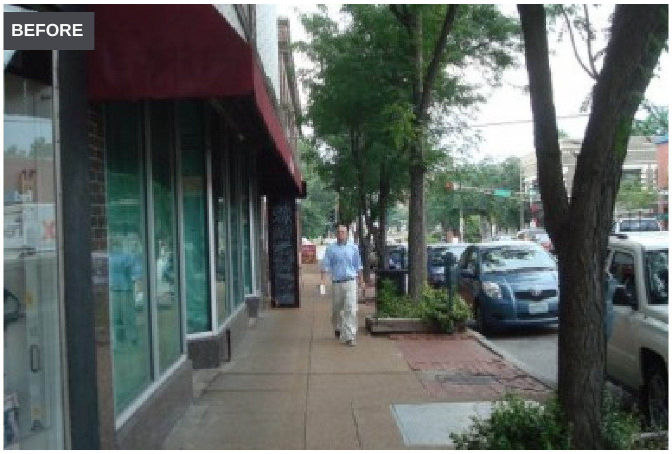
LANDSCAPE ARCHITECTURE FOUNDATION

South Grand Boulevard Great Streets Initiative



Landscape Peformance Benefits

- Expected to reduce traffic accidents by 85% due to dropping traffic speed from 42 mph to 25 mph (projected), resulting in an expected $3 million annual savings to the City. The probability of pedestrian fatality upon vehicular impact dropped from 100% to 25%.
- Projected to reduce vehicle emissions by 50% as a result of reducing delay and improving signal timing.
- Projected to reduce the peak temperature in the street environment by 7.8 degrees through high-albedo materials, increasing planted areas and increasing tree canopy coverage. This would result in savings of 7-14% in electric demands.
- Projected to sequester an additional 51,000 pounds carbon dioxide and to capture an additional 500,000 gallons of stormwater per year by replacing the existing Honey Locust with Homestead Elm and Sycamore. The native species also reduce the fertilizer pollution and Nonpoint Source Pollution from runoff.
- Projected to increase revenue by 19% over a 10-year period, ultimately increasing entrepreneurial investment and employment.
- Dropped the noise level from an average of 68dB to below 60dB as a result of the reduced traffic speed. The current noise levels fall within the range that allows a comfortable conversation. The design thus enhances the sidewalk environment and promotes restaurant business.
- Increased annual tax revenue more than 14% in the first year after redevelopment.
- Enhanced street aesthetics and increased people's satisfaction. 81% of the participants feel that the visual appearance of South Grand will be good or very good after the project is fully constructed; a 268% increase compared to the survey results prior to the construction.

Designer
Design Workshop, Inc.

Land Use
Commercial
Retrofit

Project Type
Retail
Streetscape
Transportation

Location
South Grand Boulevard and
Arsenal Street
St. Louis, Missouri 63118

Size
6-Block Corridor

Budget
3 million

Completion Date
2011

Overview

Culturally-diverse South Grand Boulevard is a historic district of St. Louis noted for its multitude of international restaurants. It is a growing commercial and residential area selected as one of four Great Streets Initiative pilot projects in the St. Louis region in 2009, demonstrating the character of the local neighborhood. The project, which was scrutinized by local government officials, brings people together and strengthens transit, walkability, recreation, and sustainability, while promoting a safe street environment. South Grand Boulevard applies innovative green solutions to reduce stormwater loading at moderate cost and in a manner that provides additional environmental benefits.

Sustainable Features

- Reduced road width and bulb-outs at intersections shorten crosswalk distances from 56' to 37'. This design reduces traffic speed and improves pedestrian and driver safety.
- Tactile crosswalk striping, accessible ramps, visual and audio cues, and detectable warnings and signalization improve ADA accessibility on site. The project now meets federal requirements for accessibility along the corridor at 100% of the intersections. ADA accessibility was of special concern because of the project's close proximity to the Missouri Schools for the

Deaf and Blind. This study area is used by these students to familiarize themselves with urban environments.

- Recycled and reused 100% of the materials removed during construction, reducing landfill waste. The recycled concrete, bricks and asphalt were used for sub bases and trenching fill. This redevelopment project reused the good, existing subsoils, site furnishings, granite curbing, and bricks onsite.
- Sidewalk width was increased from 6.5 feet to 15 feet. This led to an increase of around 1,000 square feet of outdoor dining space. Seating was increased from 0 to 337 seats, providing gathering and social spaces infused with energy, encouraging people to spend more time in the project area. There was a significant amount of street dining prior to the project. However, it directly interfered with the travel path on the sidewalk. When the sidewalk is wider, the pedestrian realm is organized to create an intuitive travel path separate from the dining spaces. Last, there is also room for the significantly larger tree wells.
- Pervious surfaces were used in sidewalks. This project is one of the first that implemented porous paving materials in St. Louis, which is under court order to improve the City's combined sewer system.
- In Phase 2 of the project, rain gardens will be placed at all intersection bulb-outs and tree pits containing native perennials and forbs which infiltrate and filter stormwater, reduce water usage, and improve stormwater quality by eliminating fertilizer use.
- Soil volume for each tree was increased from 100 to 1,000 cubic feet, enhancing tree growth, health conditions, and longevity.
- The project uses 100% planting materials that are native to Missouri and locally available. Designed with seasonal interest, the added vegetation is expected to increase the populations of birds and butterflies. In addition, these plants conserve water and are durable to withstand the harsh street conditions.

Challenge

The design team was crunched for time, with only four months to gain community approval and produce the construction documents to prevent losing funding for the project. With a multicultural population, it was important to produce a space to accommodate their needs as well as those of business owners, commuters, pedestrians and residents.

Solution

In order to streamline the approval process, online surveys, keypad polling, and special interest meetings were utilized to enable the public to voice their concerns and ensure endorsement of the project. Within these surveys, nine options were presented for consideration. A pilot test was performed of the selected street configuration that guaranteed expected results would take place and give the public verification that their concerns would be met. A hotline was set up so that commuters unable to attend community meetings could voice their concerns by leaving a message. In this way, major decisions were placed in the community's hands.

Cost Comparison

- The project is predicted to achieve a total annual tree benefit of approximately $8,911 compared to the current tree benefit of $3,921 by switching from the existing Honey Locust to Homestead Elm and Sycamore.

Lessons Learned

- With nine street alternatives, it was essential to evaluate the proposed project based on the objectives identified by the users. Since no alternative was 100% perfect, tradeoffs had to be made to satisfy the issues of highest priority identified in a poll of the involved parties, including the pedestrian realm, economic development, and visual appearance.
- Some city officials opposed many elements of the proposed design--narrowing the road, rain gardens, smart parking meters, smart street lighting (tied to a computer that monitors the condition of the lights), and porous pavement. A stronger case must be made to officials who have the power to determine the future of projects.
- The design team was not contracted to oversee the project construction, and thus several aspects of their design were changed without their consultation. It is imperative for the design team to be engaged during construction for successful implementation of original design intent.

Project Team

Land Planner   Landscape: Design Workshop, Inc. Transportation Planning: Nelson Nygaard, TND Engineering Civil Engineering: Horner and Shifrin, Inc. Market Analysis: RCLCO Art Planning: Via Partnership, LLP Public Engagement: Hudson and Associates, LLC Stormwater: University of Georgia School of Environmental Design Street Trees: Jim Urban Cost Estimating: Kwame

Building Group Site Surveying: Kowelman Engineering, Inc. Irrigation and Planting Design: Austin Tao and Associates

Role of the Landscape Architect

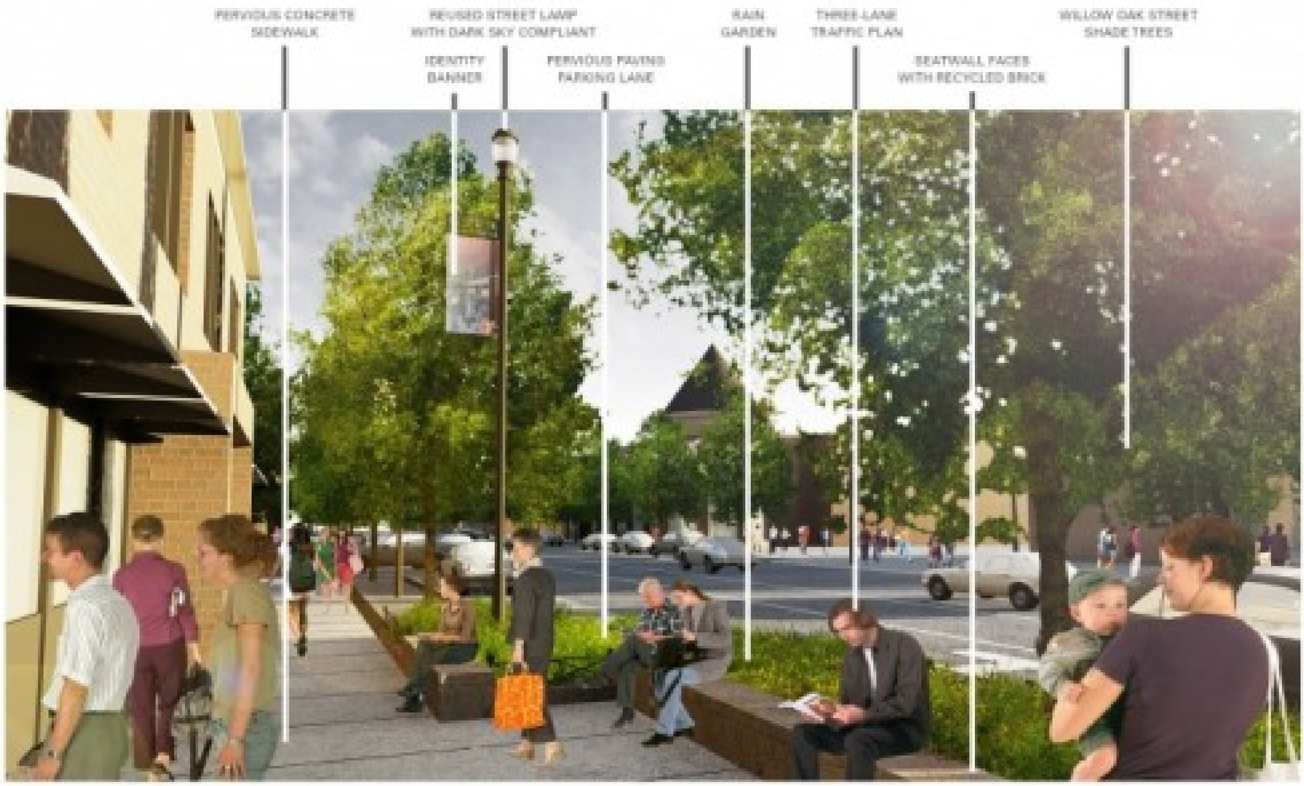
The landscape architect designed and produced construction documents, collaborating with an extensive team of Market Analysts, Transportation Planners, Civil Engineers, and Art Planners . The landscape architect focused on understanding the context of the project and key issues, developing a systematic approach for comprehensive community involvement.Case Study Prepared By: Liaison: Allyson Mendenhall, Associate, Design Workshop, Inc. Kurt Culbertson, Chairman, Design Workshop, Inc. Sara Endsley, A.I.C.P. Design Workshop, Inc. Research Fellow: Bo Yang, PhD, Assistant professor, Utah State University Research Assistant: Yue Zhang, MLA candidate, Utah State University Research Assistant: Pamela Blackmore, BLA candidate (with Honors), Utah State University

References & Resources

2010 Central States ASLA Honor Award
2011 ASLA professional Award
South Grand Boulevard Great Streets Initiative
Riverfront Times
Complete Streets Are Great Streets with Room for All
Urban Review St. Louis, South Grand: From the Gilded Age to "Great Street"
The Architects Newspaper, Sustainable Streetscape
Sustainable Cities Collective: St. Louis leads with model project for smart, green streets
Landscape Architecuture Magazine: The Measured Response
South Grand: From Good to Great

Landscape Architecture Foundation

Additional Images


PERVIOUS CONCRETE SIDEWALK
REUSED STREET LAMP WITH DARK SKY COMPLIANT
IDENTITY BANNER
PERVIOUS PAVING PARKING LANE
RAIN GARDEN
THREE-LANE TRAFFIC PLAN
SEATWALL FACES WITH RECYCLED BRICK
WILLOW OAK STREET SHADE TREES

South Grand Boulevard Great Streets Initiative
Methodology for Landscape Performance Benefits

1) Expected to reduce traffic accidents by 85% due to dropping traffic speed from 42 mph to 25 mph (projected), resulting in an expected $3 million annual savings to the City. The probability of pedestrian fatality upon vehicular impact dropped from 100% to 25%.

South Grand Boulevard exists as one of St. Louis' primary north-south arterials. The high vehicular speed averages 42 mph which fosters an unsafe environment for pedestrians who wish to cross the street and for cyclists who wish to travel alongside vehicles. In 2009, more than 110 traffic accidents were recorded within the study site. Reducing vehicular speed through lane reduction, traffic-calming techniques, and increasing walkability of sidewalks are the major foci of this project.

Speed is an aggravating factor in the severity of all crashes. On average, each 1 mph reduction in speed may reduce accident frequency by 5% (Taylor, 2000). The relationship between speed and the outcome of a crash is directly related to the kinetic energy that is released during a collision ($E=1/2mv^2$). The more kinetic energy absorbed in a collision, the greater the potential for injury to vehicle occupants and pedestrians hit by the vehicle.

In this project, traffic speeds are expected to reduce from an average of 42mph (68 km/h) to 25mph (40 km/h). Therefore,

- the reduction in accidents would be: (42 mph – 25 mph) × 5%/1mph = 85%
- 40% decrease in speed can result in a 65% reduction in the kinetic energy of a vehicle. Calculations are shown below:
  - 25 mph ÷ 42 mph = 0.6 (60%)
  - $E_2/E_1 = \frac{1/2\, mv_2^2}{1/2\, mv_1^2} = \frac{v_2^2}{v_1^2} = \frac{25^2}{42^2} = 0.35\ (35\%)$

Walz et al. (1983) analyzed the relationship between the impact speed and the potential pedestrian injury severity. The probability for survival for a given Injury Severity Score (ISS) was estimated from 952 cases (Interdisciplinary Working Group for Accident Mechanics, 1986). The data were combined to relate the probability of death to impact speed (Figure. 1)

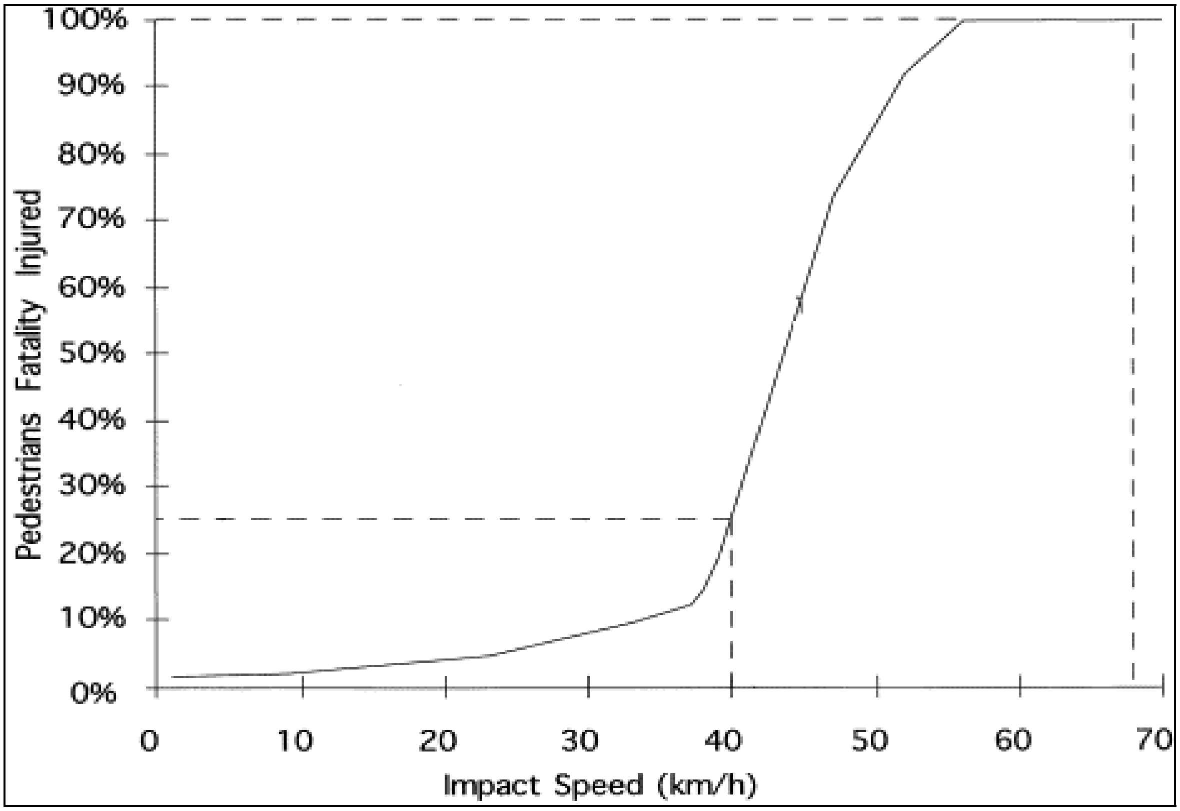


Figure 1. Probability of pedestrian fatality as a result of impact speed. Derived from Walz et al. 1983. (Source: "Vehicle travel speeds and the incidence of fatal pedestrian crashes", by Anderson *et al*., 1997, Accident Analysis & Prevention, Vol. 29 (5), p.669)

According to the National Highway Traffic Safety Administration (2000) and adjusted to 2010 dollars, the minimum cost of a crash is about $44,000. This includes costs typically absorbed by local governments (police department, emergency services, property damage). The median total cost is about $319,000. This estimate includes quantified economic impact into perspective with the emotional impact that affects the lives of crash victims and their families. On average, 90 accidents occur annually along this section of South Grand Boulevard from 2004 to 2009. Therefore, the average accident cost ranges from $3,960,000 to $28,710,000 per year.

Based on the above analysis, accidents will be reduced by 85% compared to the existing condition. Taking 90 crashes per year and multiplying by 85% yields 76 fewer crashes. This would generate a savings of between $3 million to $24 million per year.

- $44,000 × (90 × 85%) = $3,300,000
- $319,000 × (90 × 85%) = $24,400,000

2) **Projected to reduce vehicle emissions by 50% as a result of reducing delay and improving signal timing.**

Several studies indicate that effective signal timing and coordination plan can reduce on-road emissions. The Institute of Transportation Engineers (2009) showed that improved traffic signal timing can reduce fuel consumption by 10% and reduce harmful emissions up to 22%.

In the South Grand project, the transportation engineers utilized the program SimTraffic to calculate the current and future emission rates (based on the proposed 3-lane design model). The study results show that under similar speed levels, vehicles travelling on the 4-lane configuration produce greater harmful emissions and use more fuel than the 3-lane configuration. This is because the poor signalization timing at traffic signals in the 4-lane configuration causes traffic congestions and longer delays.

The estimated emission rates were determined in the SimTraffic program and presented in Table 1.

Table 1. Estimated emission rates in the current and proposed street models. (Source: South Grand Master Plan Book, Design Workshop, p.20)

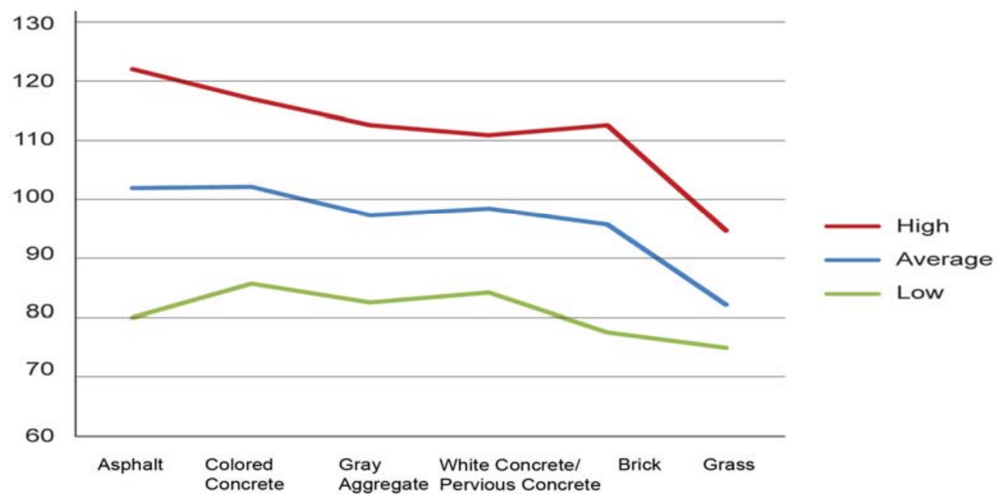
	Current 4-lane emission	Proposed 3-lane emission	Reduction rate
HC (g)	112	35	69%
CO (g)	3050	1369	55%
NOx (g)	364	169	53.5%

Abbreviations: HC, hydrocarbon; CO, carbon monoxide; NO, nitrogen oxides.

3) **Projected to reduce the peak temperature in the street environment by 7.8 degrees through high-albedo materials, increasing planted areas and increasing tree canopy coverage. This would result in a saving of 7-14% in electric demands.**

Surface materials largely affect surface temperatures and thus the surrounding air temperatures. Measurements taken on South Grand in early September are shown in Figure 2, demonstrating that asphalt has the highest peak temperature (122 degree), while grass has the lowest temperature (75 degree).

Pavement Material	Lowest Temp. in °F	Highest Temp. in °F	Avg. Temp. in °F
Grass	74.9	90	82.45
Brick	77.5	112.6	95.05
Grey Concrete	82.7	112.6	97.65
White Concrete	84.2	110.4	97.3
Painted/Colored Concrete	85.7	116	100.85
Asphalt	88.2	122	105.1



Note: Measurements were taken using a hand held infrared thermometer at 12" above the surface. All measurements were taken in the sun on the same day with the same ambient temperature.

Figure 2. Temperatures of various materials used on site (adapted from South Grand Master Plan Book, Design Workshop, p.21).

The project increases vegetative cover and uses high-albedo (reflective) surface materials to reduce the impacts of the urban heat island (UHI) effect. White concrete porous paving is used on site to minimize heat storage and absorption. The average air temperature in the street is projected to be reduced by 7.8 degrees Fahrenheit as a result of replacing asphalt with high-albedo pervious concrete. Moreover, increasing planted areas and tree canopy coverage also contribute to the UHI effect reduction.

$$105.1\ ^{\circ}F - 97.3\ ^{\circ}F = 7.8\ ^{\circ}F$$

Typically, electric demand of U.S. cities increases about 1-2% per Fahrenheit degree (3-4% per Celsius degree) increase in temperature (McPherson and Rowntree, 1993). Therefore, the project is estimated to save 7.8% to 15.6% electric consumption in cooling.

4) **Projected to sequester an additional 51,000 pounds carbon dioxide and to capture an additional 500,000 gallons of stormwater per year by replacing the existing Honey Locust with Homestead Elm and Sycamore. The native species also reduce the fertilizer pollution and Nonpoint Source Pollution from runoff.**

Carbon dioxide (CO_2) Sequestration

Urban trees can reduce atmospheric carbon dioxide (CO_2) in two ways: directly through sequestration of CO_2 and indirectly through lowering the demand for heating and air conditioning, thereby reducing emissions associated with electric power and natural gas. Accounting for CO_2 emissions from tree decomposition and tree-related maintenance activity, the reduced atmospheric CO_2 by street trees in St. Louis are shown as follows (data from online National Tree Benefit Calculator):

- Honey Locust at mature size: 312 pounds per tree
- Homestead Elm at mature size: 714 pounds per tree.
- Sycamore at mature size: 620 pounds per tree

This project is expected to reduce an additional 42,500 pounds of CO_2 by replacing the existing 71 Honey Locust trees with 49 Sycamore and 48 Homestead Elm trees. This result is calculated by subtracting the existing CO_2 emissions from the proposed values.

- Annual CO_2 reduction from existing trees: 312 pounds × 71 = 22,152 pounds
- Annual CO_2 reduction from this project: 714 pounds × 48 + 620 pounds × 49 = 64,652 pounds
- 64,652 – 22,152 = 42,500 pounds

Stormwater

Each Homestead Elm at mature size would capture approximately 12,515 gallons of stormwater per year. Each Sycamore would capture 7,829 gallons of stormwater per year. And each mature Honey Locust would capture 6,815 gallons of stormwater per year.

Therefore, the existing street trees would capture approximately 483,865 gallons of runoff.

- 6,815 gallons × 71 = 483,865 gallons

The proposed project would capture 984,341 gallons of water.

- 12,515 gallons × 48 + 7,829 gallons × 49 = 984,341 gallons

The increased amount of stormwater captured in the new project would be:

- 984,341 gallons – 483,865 gallons = 500,476 gallons

5) **Projected to increase revenue by 19% over a 10-year period, ultimately increasing entrepreneurial investment and employment.**

This analysis is conducted by Design Workshop (Table 2).

Table 2. Estimated annual revenue increase over a 10-year period in South Grand (Source: Design Workshop, Inc.)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Annual Revenue (Million dollars)	204.0	207.8	211.6	215.4	219.2	223.0	226.8	230.6	234.4	238.2
Annual Revenue Increase (%)	1.9%	3.8%	5.7%	7.6%	9.5%	11.4%	13.3%	15.2%	17.1%	19.0%

6) **Dropped the noise level from an average of 68dB to below 60dB as a result of the reduced traffic speed. The current noise levels fall within the range that allows a comfortable conversation. The design thus enhances the sidewalk environment and promotes restaurant business.**

The study site is at the hub of St. Louis International Community. Seven restaurants are located along South Grand in this six-block section. Through widening the sidewalks, more room was made for outdoor dining. It is important to create a comfortable and quiet environment that allows people to communicate easily. The goal of this project is to recreate an attractive pedestrian and outdoor dining environment which in turn will lead to increased revenue for the business owners. Therefore reducing the noise level to an acceptable range will not only enhance human comfort, but also stimulate economic outcomes.

Before this design, the noise level in South Grand is about 68 dB and will be further increased to over 77 dB because of trucks and buses. This project is designed to reduce traffic speed from 42 mph to 25 mph. This results in a reduction of noise level from 68 dB to below 60 dB in normal traffic conditions (Figure 3). From a study conducted by Purdue University (Table 3), 60 dB provides a quiet and comfortable environment for conversation.

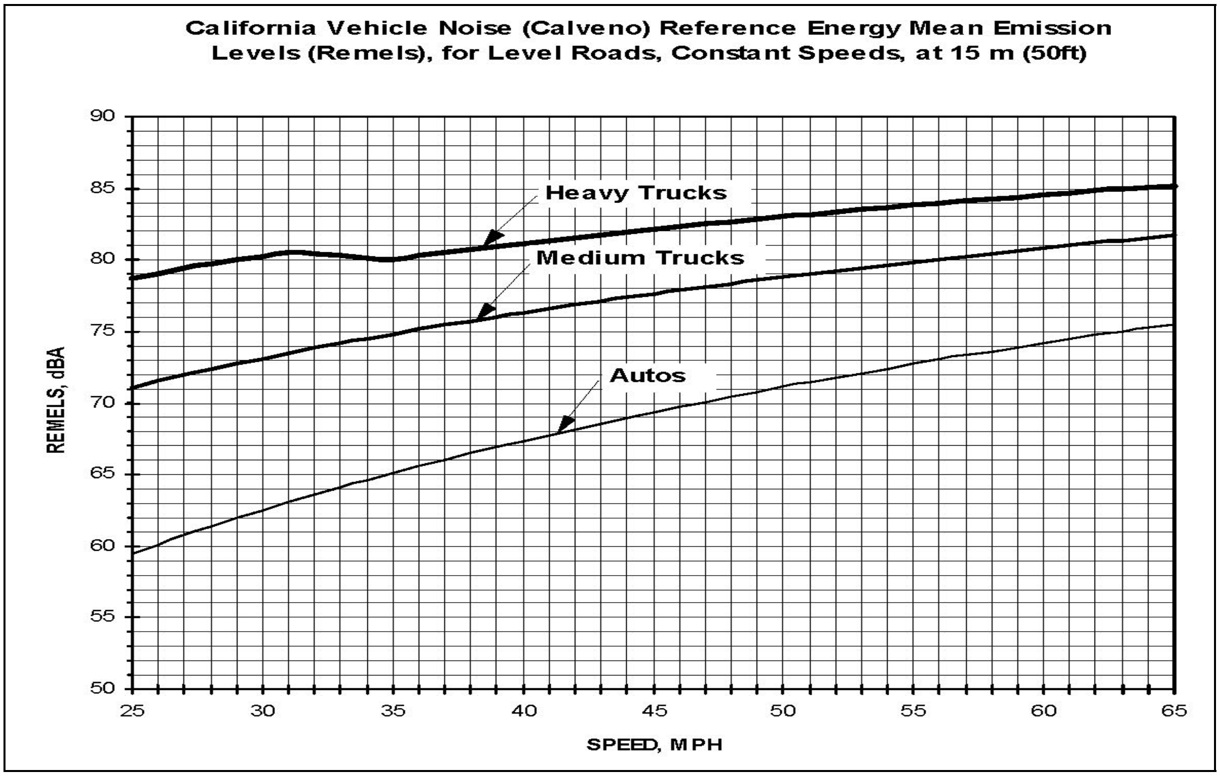


Figure 3: Relationship between vehicle speed and noise emissions. (Source: Ruby Hendrinks, 1995, Use of California Vehicle Noise Reference Energy Mean Emission Level (Calveno REMELS) in STAMINA2.0 FHWA Highway Traffic Noise Prediction Program, Technical Advisory, Noise, TAN 95-03, p.3)

Table 3: Noise sources and their effects. (Source: Purdue University Department of Chemistry, www.chem.purdue.edu/chemsafety/)

Noise Source	Decibel Level	Comment
Garbage disposal, dishwasher, average factory, freight train (at 15 meters). Car wash at 20 ft (89 dB); propeller plane flyover at 1000 ft (88 dB); diesel truck 40 mph at 50 ft (84 dB); diesel train at 45 mph at 100 ft (83 dB). Food blender (88 dB); milling machine (85 dB); garbage disposal (80 dB).	80	2 times as loud as 70 dB. Possible damage in 8 h exposure.
Passenger car at 65 mph at 25 ft (77 dB); freeway at 50 ft from pavement edge 10 a.m. (76 dB). Living room music (76 dB); radio or TV-audio, vacuum cleaner (70 dB).	70	Arbitrary base of comparison. Upper 70s are annoyingly loud to some people.
Conversation in restaurant, office, background music, air conditioning unit at 100 ft	60	Half as loud as 70 dB. Fairly quiet
Quiet suburb, conversation at home. Large electrical	50	One-fourth as loud as 70 dB.

transformers at 100 ft		

7) Increased annual tax revenue more than 14% in the first year after redevelopment.

The Community Improvement District tracked the sales tax revenues and indicated that there is a 14% increase in tax revenues in the first year after project construction. This rate is even 2% higher than the original projection by Design Workshop**.**

8) Enhanced street aesthetics and increased people's satisfaction. 81% of the participants feel that the visual appearance of South Grand will be good or very good after the project is fully constructed; a 268% increase compared to the survey results prior to the construction.

The project integrates art into the designed elements of the streetscape. To ensure the aesthetic quality, the project dedicates 1% of the construction budget to promote art. From the public survey results, more than 80% of the people surveyed like the new appearance of the proposed South Grand. This is a 268% increase compared to people's reflection on the existing South Grand.

$$(81\% - 22\%) \div 22\% = 268\%$$

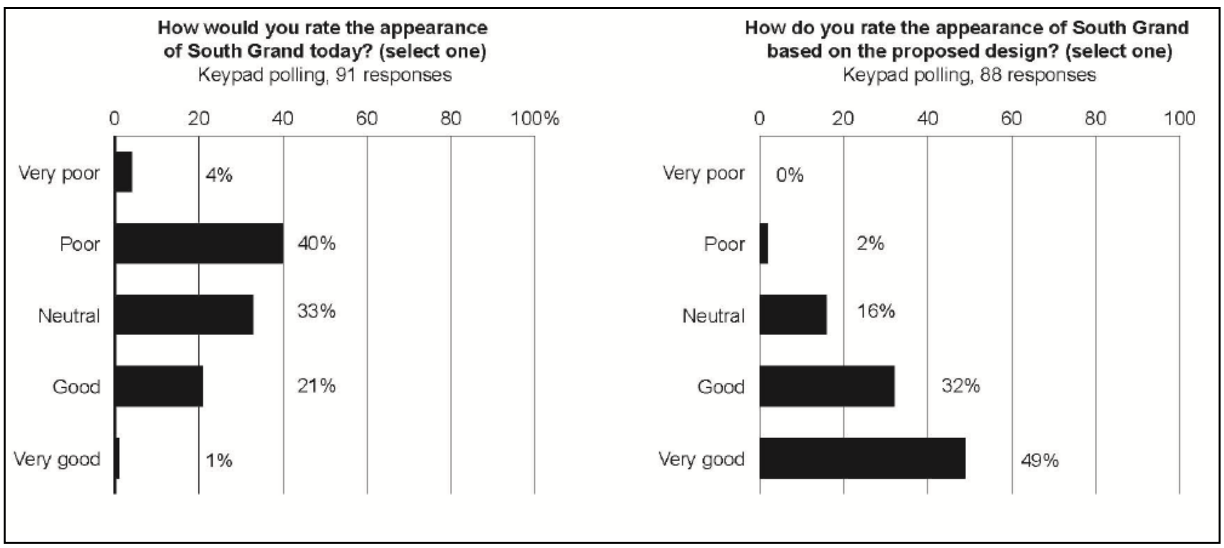


Figure 4. People's perceptions of the South Grand. Results from 2009 keypad polling (Source: Design Workshop, South Grand Master Plan Book. p.33).

Cost Comparison

The project is predicted to achieve a total annual tree benefit of approximately $8,911 compared to the current tree benefit of $3,921 by switching from the existing Honey Locust to Homestead Elm and Sycamore.

According to the City of St. Louis, MO, Street Tree Resource Analysis (completed in March, 2009 by Davey Resource Group), the total annual benefits of the existing Honey Locust trees were about $55 per tree. The proposed Homestead Elm and Sycamore trees at mature sizes will provide an annual benefit of about $105 and $79 per tree, respectively (National Tree Benefit Online Calculation).

Measured from the CAD map, there are 71 Honey Locust trees on site. These Honey Locust trees were replaced by 48 Homestead Elm and 49 Sycamore. The total benefits were calculated as follows.

- Annual benefits from the existing trees: $55.22 × 71 = $3920.62
- Annual benefits from the tree replacements: $105× 48 + $79 × 49 = $8911

References

1) Anderson R.W.G. et al. (1997). Vehicle travel speeds and the incidence of fatal pedestrian crashes, Accident Analysis and Prevention, 29 (5), pp. 667-674.

2) Davey Resource Group. (2009). Importance Values for St. Louis' Most Abundant Street Trees.

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