Value Add and Sustainable Parking Strategies: A Financial Evaluation and Real Estate Developer Perspective

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VALUE ADD AND SUSTAINABLE PARKING STRATEGIES:
A FINANCIAL EVALUATION AND REAL ESTATE DEVELOPER PERSPECTIVE

A Thesis
Presented to
The Graduate School of
Clemson University

In Partial Fulfillment
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by
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Accepted by:
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Abstract

Innovative techniques for parking lot design over the past 15 years have resulted in new approaches which address stormwater concerns on commercial real estate sites. A mixed method approach was taken to establish financial value in these new techniques being used. Sheraton Station, a proposed mixed use Transit Oriented Development (TOD) site with multi modal transportation in Hollywood, Florida was used as a research and demonstration project to evaluate ways to make sustainable parking lots more cost effective for real estate developers. After conducting interviews and a survey to evaluate real estate developers’ perceptions on the use of sustainable features in parking lot design, a sustainable design application was used on the current site plan. The sites current design was compared to the altered sustainable design for water runoff effectiveness as well as the financial feasibility of the parking lot, but not the parking garages. The preliminary results of the altered design suggests that implementing a sustainable parking lot costs approximately 24% more upfront in construction material costs and in ongoing maintenance based on a 20 year parking lot useful life. In order to mitigate the increased cost and due to sites reduction in stormwater runoff by 66%, the stormwater detention pond located in the southeast corner of the site was removed and the land was evaluated for an alternative and more cost effective use for the developer of the site. The land used for the stormwater detention pond in this study was to be used for the construction of an additional 6,500 sqft building. The rental income generated by the proposed increase in square footage from the additional building was able to offset the cost of the new sustainable features implemented in the parking lot. By adding the additional building the site remained sustainable from a stormwater runoff perspective while allowing it to become cost effective.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>TITLE PAGE</td>
<td>i</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>ii</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>RESEARCH SIGNIFICANCE AND GOALS</td>
<td>3</td>
</tr>
<tr>
<td>LITERATURE REVIEW</td>
<td>5</td>
</tr>
<tr>
<td>Environmental Impacts of Parking Lots</td>
<td>5</td>
</tr>
<tr>
<td>Parking Lot Materials</td>
<td>11</td>
</tr>
<tr>
<td>METHODOLOGY</td>
<td>14</td>
</tr>
<tr>
<td>Interviews</td>
<td>14</td>
</tr>
<tr>
<td>Survey</td>
<td>15</td>
</tr>
<tr>
<td>Experiment</td>
<td>18</td>
</tr>
<tr>
<td>CASE STUDIES</td>
<td>14</td>
</tr>
<tr>
<td>Heifer International</td>
<td>21</td>
</tr>
<tr>
<td>Wal-Mart Experimental Store</td>
<td>23</td>
</tr>
<tr>
<td>Florida Aquarium</td>
<td>25</td>
</tr>
<tr>
<td>DESIGN GUIDLINES</td>
<td>27</td>
</tr>
<tr>
<td>RESULTS</td>
<td>29</td>
</tr>
<tr>
<td>OTHER OPPORTUNITIES</td>
<td>31</td>
</tr>
<tr>
<td>CONCLUSION</td>
<td>32</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>33</td>
</tr>
</tbody>
</table>
APPENDICES

I: Diagrams .................................................................................................................. 36
II: Maps ........................................................................................................................... 37
III: Developer Proposed Site Plan ................................................................................ 38
IV: Current Site Conditions Photo ................................................................................ 39
V: Proposed Sustainable Parking Master Plan ............................................................. 40
VI: Renderings Section Drawings and Blowup .............................................................. 41
VII: Survey .................................................................................................................... 43
VIII: Cost Assumptions ................................................................................................. 47

LIST OF FIGURES

A: Body of Knowledge Diagram .................................................................................... 36
B: Research Methods Diagram ....................................................................................... 36
C: Context Location Map ............................................................................................... 37
D: Site Location Map ....................................................................................................... 37
E: Developer Proposed Master Plan ................................................................................. 38
F: Existing Site Condition Photo .................................................................................... 39
G: Proposed Sustainable Parking Master Plan ............................................................... 40
H: Proposed Bioswale Perspective Rendering of Storefront ........................................ 41
I: Proposed Bioswale Perspective Rendering of Train Station ..................................... 41
J: Proposed Bioswale Perspective Section Drawing ..................................................... 42
K: Proposed 6500 sqft Outparcel Addition .................................................................... 42
L: Site Detail .................................................................................................................... 47
M: Hydrologic Detail ...................................................................................................... 47
N: Hydrologic Results ................................................................................................... 48
O: Cost Summary ............................................................................................................ 49
P: Cost Breakout ............................................................................................................. 50
Q: Benefit Breakout ....................................................................................................... 51
Introduction

The ever increasing urban sprawl which has occurred over the past 60 years continuously demands reliance on automobiles resulting in an increased demand for parking within the urban and suburban fabric. The elevated need for parking lots and over-carry parking lots has created new and problematic environmental issues. Impervious surfaces, such as parking lots, roadways, and roof tops, cause more storm-water runoff and pollutant loads than any other type of land use (Rushton 2001). According to The United States Census Bureau approximately 16 million hectares (61,000 square miles), are devoted to roads and parking lots in the United States, which is enough to pave over the entire state of Georgia. That amount of impervious paving material would be ranked 24th largest state in the United States.

The materials which make up a parking lot are comprised of a mix of concrete and asphalt with a base course of sand, gravel, crushed stone, or a combination of each. These materials pose a serious environmental problem due to a massive reduction in the impermeability of stormwater. Parking lots using standard methods of design and implementation create an impervious surface that does not allow rainwater to discharge and percolate naturally through the soil, which impedes the natural cycle of rainwater. These hard surfaces, which at one time were native plant cover, increase both the volume and the peak rate of runoff and also provide a place for automotive based contaminants, fertilizers, herbicides and pesticides, sediments, and other types of pollutants from the pavement surface to discharge at an extremely rapid rate. As little as 10% impervious surfaces in the watershed can begin to affect downstream rivers, lakes, and estuaries (Shaver et al. 1995). Additionally, urban runoff increases flooding during wet years and decreases base flow during dry years by reducing infiltration and soil storage while increasing evapotranspiration (Ferguson and Suckling 1990).

With new materials and new technology parking lots have the ability to transition from an uncontained environmental problem to a self-contained working ecosystem. New and creative
solutions to stormwater management are being used frequently in parking lot design in collaboration with new sustainable building practices that are becoming the norm in most new commercial real estate development ventures. The idea of using sustainability outside of the building footprint begins with on-site stormwater management. The goal is to reduce the negative effects that standard parking lots cause with the use of bioswales and pervious paving materials while making it cost effective for the developers paying for it.

Survey questions were designed to evaluate the perceptions real estate developers have towards sustainable parking lot design methods. The results of the survey were measured against the actual raw cost data that was estimated at the Sheraton Station site. The evaluated data was based on current cost for construction practices on the site versus the cost to implement sustainable techniques into the parking lot. The survey outcomes and cost analysis allowed for changes to be made to ensure the cost effectiveness of the implementation of sustainable practices on the parking lot.
Research Significance and Goals

Sustainability and sustainable development has been defined in a variety of ways, however, the most accepted definition is derived from the Bruntland Commission Report of 1987. According to the Bruntland Commission Report, sustainable development is “the ability to meet the needs of the present without compromising the ability of future generations to meet their needs”. The primary objective of the sustainable parking lot study is to find a way to bridge the gap between sustainable development/sustainability and parking lot design and implementation. Parking lots throughout the world have followed a design that is inconsistent with the path of sustainable practices have become prevalent in today’s lifestyle and green initiatives.

A disconnect has occurred between a growing green building movement and the parking lots that surround those buildings. The definition of sustainable development requires that developments are seen as a system that connects both space and time together or in this case the building, surrounding parking lot, the surrounding ecosystem, and the life expectancy of all the elements. Beyond the buildings footprint, parking lots need to be addressed as part of the green development, making it a working sustainable environment, rather than a just an afterthought to a sustainable building.

In order to accomplish this level of sustainability the thesis research examined the reasons why sustainable elements are not more prevalent in today’s designs. The research addresses developers perceptions regarding the implementation of sustainable features outside of the building footprint, specifically parking lots, by evaluating types of incentives used to support or influence sustainable practices when implementing a new parking lot. This study will evaluate a variety ways to make sustainable parking lots more cost effective and beneficial to developers. The research will also show what types of materials/methods are the most efficient from an economic and environmental perspective based on the site conditions.
The thesis will attempt to examine the aesthetic appeal of using sustainable features like bioswales and rain gardens on site rather than the typical stormwater detention ponds to address stormwater runoff. The study will show how the use of a detention pond potentially eliminates large amounts of valuable land in order to contain stormwater on development site. The reduction of land due to the use of a stormwater detention pond retrofitted into an alternative use may potentially offset the high costs of implementing and managing the sustainable features on the parking lot.
Literature Review

Environmental Impacts of Parking Lots

The materials that comprise a parking lot are comprised of a mix of concrete and asphalt with a base course of sand, gravel, crushed stone, or a combination of aforementioned. These materials create a serious problem environmentally due to the massive reduction in impermeability of stormwater. Parking lots using standard methods of design and implementation create an impervious surface that does not allow rainwater to discharge and percolate naturally through the soil, impeding the natural cycle of rainwater. These hard surfaces, which at one time were native plant cover, increase both the volume and the peak rate of runoff and also provide a place for automotive based contaminants, fertilizers, herbicides and pesticides, sediments, and other types of pollutants from the pavement surface to discharge at an extremely rapid rate. As little as 10% impervious surfaces in the watershed can begin to affect downstream rivers, lakes, and estuaries (Shaver et al. 1995). Additionally, urban runoff increases flooding during wet years and decreases base flow during dry years by reducing infiltration and soil storage while increasing evapotranspiration (Ferguson and Suckling 1990).

The standard approach to stormwater management in parking lots attempts to channel water as quickly as possible into detention ponds or underground storage tanks through pipes and drains. As the water moves across the parking lot surface, the water picks up particulate matter including heavy metals, sediments and a variety of pollutants from the surface including pesticides, herbicides, and petroleum products. As a result large volumes of polluted runoff entering surface water and groundwater resources, negatively affects water quality. The runoff from the parking lot then becomes a major contributor to non-point source pollution of our waterways, aquifers, and local ecosystems. Conventional parking lots quickly move stormwater into receiving water bodies. As it flows across pavement, the water picks up pollutants from the
surface. Consequently, large volumes of polluted runoff entering surface water and groundwater resources, negatively affecting water quality. Polluted precipitation runoff has been identified as the leading threat to water quality in the United States (EPA 1992). Impervious surfaces are related to NPS pollution, which contributes to surface water degradation. NPS pollutants are generally spread over a relatively large area at low concentrations whereas a point source is located at a single location, such as a drainage outfall (Sleavin, Civco 2000). It is estimated that 30% to 50% of the earth’s surface is affected by non-point source pollution (Corwin et al., 1998). Contaminants in parking lot runoff can originate from a variety of sources, including the paving materials used to build them. Recently, the USGS has pinpointed parking lot sealants as a large source of non-point source pollution, specifically polycyclic aromatic hydrocarbons (PAHs), a known carcinogen that can be toxic to fish and wildlife. (Van Metre 2008) Automobiles are also a major source of pollutants in parking lot runoff, including antifreeze, oil, hydrocarbons, metals from wearing break linings, rubber particles from tires, nitrous oxide from car exhausts, debris from brake systems, and grease (EPA 2008).

The large expanse of impervious surfaces from standard parking lot design and implementation creates an impact on local water supply. Because rainwater does not follow the standard hydrologic water cycle, stormwater is unable to percolate the soil. Natural conditions allow for rainwater to filter into the ground which recharges the local aquifer. Low water tables as a result of impervious surfaces, reduce streamflow during dry periods consequently depleting water supplies. As development of land and water resources intensifies, it is increasingly apparent that the reduction of either ground water or surface water can intensify negative issues associated with stream flow (Alley, Reilly, Franke 1999).

Stormwater on impervious surfaces also contributes to higher water run off volumes. According to the United State Geological Survey (USGS), an impervious, man-made surface will
generate 2 to 6 times more runoff than a natural surface. Water runoff and velocity is increased for many reasons in addition to the direct impact of the impervious paving material. Pipes, curbing, gutters, and drains are frequently used to aid in removal of water from parking lot surfaces. This additional infrastructure causes water to move at an even higher velocity downstream, which increases the risk of stream flooding. Often stormwater systems are not equipped to handle the high level of runoff caused by the impervious surfaces. The rapid runoff of the stormwater contributes to overflow and, in the case of combined sewer and stormwater systems, discharges raw sewage into local water bodies. Every year hundreds of billions of gallons of untreated sewage flow into our rivers, lakes, and coastal waters. According to the EPA up to 3.5 million people fall ill from swimming in waters contaminated by sanitary sewer overflows alone ever year which test positive for numerous pathogens including viruses parasites and bacteria. In addition to the vast array of health risks that are associated with the discharge of raw sewage from combined sewer overflows, these discharges can preclude, impair, stress or threaten (cause) bathing beach closures, due to floating debris or slicks, shellfish bed closures, and algae blooms. According to the New York Department of Environmental Conservation (NYDEC 2011) algae blooms depress levels of oxygen in the water creating an increased level of stress on fragile ecosystems. These algae blooms and lower levels of oxygen can do serious damage to a water body’s habitat by changing the natural cycles.

In addition to stormwater problems created by the impervious surfaces of parking lots contribute to what is known as the urban island heat effect. The urban island heat effect occurs in areas with high population densities which contribute to the extensive use of materials that have high heat absorbing properties, like pavement and asphalt. Due to the large expanses of pavement from roadways and parking lots urban areas create their own micro climates, leading to hotter ambient air temperatures and relative surface temperatures. Recent research indicates
that urban areas are two to eight degrees F hotter in summer due to this increased absorbed heat. (EPA, 1992)

The most common paving material used in parking lots today is asphalt, which is an extremely dark heat absorbing material. When asphalt cools at night it releases all of the absorbed heat during the day into the air which creates microclimates surrounding the parking lot. NASA’s Global Hydrology Center has lead a NASA-sponsored study on the effects of Urban Island Heat Effect in Atlanta and its creation of convection based weather patterns. The study concluded that the slow release of heat at night from absorbed materials created pre-dawn or early morning rain showers that would continue until noon, rather than the typical afternoon showers that most other southern cities would see (Bornstein et al. 2009). This type of situation creates a cyclical process that places additional stress on stormwater management and surrounding ecology. A study conducted by Haider Taha suggests that the use of porous paving materials decreased the air temperature of up to 2°C. The study also suggests that increases in albedo and localized decreases in air temperature can reach 4°C under some circumstances (Taha 1997).

Of equal importance, secondary impacts as a result of the direct problems associated with runoff can cause stress on the adjacent habitat and fauna. The rapid rate and volume of runoff from parking lots often damage plant, fish and invertebrate habitat in surrounding areas. The speed and volume of water during heavy storms can erode stream banks. This erosion alters the natural shapes of rivers and streams within the watershed which results in changes to the ecology of the local habitat due to sediment transport. Sediment entering the waterway from an eroded stream bank can annihilate a habitat and place large amounts of stress aquatic on organisms from the lack of light required for growth by an aquaculture. The reduction in
plant growth and quality creates a massive trickledown effect which interferes biodiversity.

decreasing food supplies, altering spawning habitat, and reducing shelter.

Particulate matter, toxic substances, and heavy metals all do damage to wildlife populations in close proximity to parking lots. The bioaccumulation of toxic substances like PCB’s found in the tissue of fish and other organisms is the direct result of stormwater contaminants showing up in our aquifers and surface water supplies. The contamination is a direct result of accelerated water runoff from parking lots and the failure of stormwater combined sewer discharges. Heavy metals also found among sediments are transported during stream erosion, posing serious risk to bottom feeding organisms. These toxins have the ability to work their way up the food chain and are ultimately consumed by humans. This non-point source pollution has a direct impact on the food and water humans consume in order to sustain life.

Parking lot materials

Stormwater rules need to be revisited to incorporate techniques that start treating storm water as soon as it hits the ground. This not only improves water quality but allows infiltration into the water table and ultimately into underground aquifers (Rushton 2001). With the appropriate selection of materials for paving as well as the use of onsite bioremediation areas this task can be accomplished. Best management practices in conjunction with the use of sustainable materials can directly affect the impacts on local ecosystems, groundwater aquifers, and municipal stormwater management systems while still allowing for conventional use of the site.

When sustainable efforts are used in parking lot design, site conditions have the ability to mirror that of the site in pre development conditions with regard to ecological and hydrologic
functionality. These techniques have the ability to reduce stormwater and site development design, construction, and maintenance costs by up to 25-30% when compared to conventional approaches (Zimbler 2005). Best management practices for stormwater management in parking lots include the use of sustainable materials, carbon sequestering fauna, and environmental engineering techniques. The combination of best management practices and the use of sustainable initiatives are what make it possible for a site to mirror the natural hydrologic and ecological processes. Stormwater capture, filtering, infiltrating, and storing stormwater are all components of a fully functioning sustainable parking lot. According to the EPA’s Green Resource Guide these bio systems can include (EPA 2008):

Swales – Open channels or depressions with dense vegetation used to transport, decelerate, and treat runoff. Swales are also designed to help direct water into bio retention areas.

Filter strips/vegetated buffer strips – Flat pieces of land with low slopes, designed to promote natural sheet flow as opposed to channeled runoff.

Riparian buffers – Vegetated strips along waterways that trap and filter contaminants, encourage infiltration, and slow stormwater flow. Riparian buffers also help to preserve streambank stability.

Detention basins – Vegetated basins with controlled outlets, designed to detain runoff (lowering flows and reducing velocity) for a short amount of time (e.g. 24 hours), partially removing pollutants before water is discharged.
Bioretention/Bioswale areas - Treatment areas consisting of a grass buffer strip, ponding area, organic layer, planting soil, and vegetation. Examples include retention ponds and constructed wetlands designed for longer-term retention of stormwater.

Native plantings can also play a key role in the sustainability of a parking lot as well as a bioswale or remediation area. Native plants and vegetation are accustomed to the habitat, soil, and climate of the area and the use of those materials aids in reducing the need and the environmental and financial costs of irrigation. Bioswale plants that are used for remediation of the site often have carbon sequestering characteristics that help stormwater runoff bioremediation prior to entering the groundwater aquifer. These plants play a huge role in the removal of heavy metals and other debris that would otherwise be polluting the surrounding ecosystem.

Outside of the new cutting edge practices in bio engineering, the advancements in parking lot surfaces materials can help to reduce a significant amount of negative impacts associated with the massive expanses of impervious materials used. New permeable materials can be an excellent substitute to help lessen the runoff burden that is typically seen in standard lot design. A variety of different paving materials from porous concrete to pervious pavement can reduce the range of environmental impacts associated with the use of pavement. According to the interview with Kevin Roberson a professional civil engineer with KimeyHorn stated that porous asphalt had the ability to absorb 300 inches of rainwater an hour and pervious concrete has the ability to absorb 100 inches of water an hour in comparison to their standard counterparts which offered very little absorption and heavy amounts of sheeting action. Studies have shown that pervious paving plays a role in onsite pollution reduction and the pervious paving in conjunction with a swale reduced pollutant loads by at least 75% for metals and total suspended solids when compared to asphalt paving without a swale (Rushton 2001).
This not only shows the water absorption properties of pervious paving but the opportunity to reduce onsite pollution and suspended solids when implemented in a parking lot.

There are also several alternatives to standard paving that include permeable and semi-permeable alternative pavers, open jointed pavers filled with turf or aggregate, gravel, concrete, wood mulch, brick, turf blocks, cobble stone or natural stone. All of materials outside of the two different forms of paving material have runoff coefficients of at least .6 making them viable alternatives for areas requiring a more aesthetic look and feel.

Site characteristics like soil typology, climate, slope, and traffic volume can often dictate what types of materials are used in a particular parking lot design. Material selection is also extremely important when choosing different types of sustainable solutions in order to address different site requirements. Climate and traffic volume often are the biggest control factors when selecting a paving material. It is imperative that the climate is evaluated prior to the selection of paving materials from a maintenance perspective. For instance porous concrete is often a better selection of paving material in warmer climates when compared to pervious asphalt. Pervious asphalt, due to its low compression and large amount of petroleum used, will become more malleable in areas with high temperatures. This will result in rutting from traffic and an overall short life expectancy.

Pervious pavers are often a great alternative to standard asphalt and concrete. Pervious paver blocks have properties that in some ways are able to exceed standard paving materials as they are able to slow the sheeting action and control the flow of runoff, allowing the stormwater to filter into the soil (Cal trans California DOT 2003). This reduction in water sheet flow will have a positive impact on a sites ability to sustain the ecosystems hydrologic cycle by allowing the water to slowly percolate in the soil. However pervious pavers may not be an option for the entire surface of primary parking areas because they often are not strong enough to withstand constant weight and use. This is when traffic volume will play a role in material
selection. A successful parking lot model usually contains a hybrid of several materials where the aisles and driveways can be constructed using conventional pavement and pervious pavers, gravel, or natural materials can be used in parking stalls, crosswalks, and overflow lots while being combined with bioswales and rain gardens onsite.
Methodology

Three different methods of research were used in producing the new 17 acre Sheraton Station sustainable parking lot redesign. The research was designed to determine what the perceptions of sustainable parking are as well as ways to address those perceptions both on a financial and environmental level. The methods included interviews, survey, and experimental research in this study. The Interview method was the preliminary method used in the study. Interviews with professionals in the field provided the necessary background needed to create the questions for the survey. The survey was a questionnaire sent to professionals in the real estate industry asking them to evaluate their perceptions of sustainable parking lots. Following the survey an experiment was designed to evaluate whether or not the perceptions that the real estate professionals had were viable. In order to do this the proposed site was redesigned using sustainable techniques to evaluate the stormwater runoff and financial impacts of the new sustainable techniques. The results of the redesign were compared to the developers proposed site plan to establish a benchmark which evaluated sustainable parking lot methods to standard parking lot methods for environmental and financial cost benefit.

Interview

Two interviews were conducted in order to gain more practical knowledge about the site, the constraints, and sustainable and conventional parking lot design and implementation. The first interview, included Robert Skinner, the project development lead and president for the existing project and the second, Kevin Roberson, the RVP of engineering west coast for Kimlyhorn and the lead civil engineer on the Aurora Co Wal-Mart project seen in the case study chapter of the thesis. Both interviews were imperative to the success of the survey and experimental portions of the thesis.
Kevin Roberson, a professional civil engineer with 25 years of experience, was the lead engineer on several different sustainable parking lot designs including the Wal-Mart experimental store in Aurora Colorado. This interview was used to gain a greater understanding of materials and working conditions of a sustainable parking lot. Kevin was able to provide in detail the constraints of implementing sustainable paving materials. He also supplied information on how to select the most appropriate paving material for the project as well as insight to the design and layout of the bioswales within the lot. Kevin was instrumental in making sure that a sustainable lot built in South Florida had the most appropriate paving material selected, and advised that the Sheraton Station site use only pervious concrete and pervious paver stones due to the sandy soil type, low water table, and high temperature. He advised that the useful life would be greatly diminished if porous asphalt was used. This interview lasted approximately 45 minutes.

The second of the two interviews conducted on Friday January 27 2012 with Robert Skinner. This interview was administered in order to gain a greater understanding of the sites current and proposed conditions. The interview was also used to gather an understanding of how developers perceive the value in sustainable parking both on an environmental level as well as a financial level. The information derived from the interview aided in some of the design features as well as having an immense impact on the way the survey was devised, the questions that were asked, and the order of the questions that were asked. The interview with Mr. Skinner lasted approximately twenty five minutes.

Survey

An electronic 20 question survey was conducted from Feb 2 – March 1 2012 via Survey Monkey to gage the value of sustainable parking lot features from a real estate developer’s perspective. The objective of the research was to find out why sustainable features aren’t being
used more often in parking lot design. The answers would then be used as a comparison to the experimental phase of the research to see if perceptions matched the true data derived from the experiment.

The 20 question survey was sent out to 208 individuals in the real development field and of the 208 recipients, 41 people responded to the survey. The demographic of those polled were all in the real estate development arena from developers, to development managers, to planners, to bankers. The list of persons polled were generated through multiple sources from real estate developers that had been work colleagues with instructors at the university to individuals who had prior relationships with real estate brokers that had been affiliated with past work.

This survey was prepared in order to quantify the value that individuals working in the real estate development arena placed on sustainable features within their projects as well as sustainable features within the parking lot of their projects. The questions that were asked included yes or no, multiple choice, and scale for the survey. This allowed for responses to the survey questions to be grouped as well as the ability to evaluate trends associated with the responses to the survey.

The results of the 20 question survey were analyzed and the outcomes were able clarify more definitive reasons why real estate developers do not use sustainable features in the design and implementation of the parking lots on their projects with the number one reason being cost effectiveness. Surprisingly, 85% of the respondents that believed that adding sustainable features to their projects added value. The third and final question that had extremely lopsided results was the question that addressed what the developer’s biggest concern would be for implementing sustainable features into the parking lot. 66% of those
polled believed that overall cost created the biggest concern for the implementation of the sustainable features within the parking lot.

Survey Graphs

What would it take to implement sustainable parking lot features in your projects?

- Subsidies: 14%
- Equally cost effective when compared to standard methods: 52%
- Larger building footprints from reduction in impervious surfaces: 30%
- Reduced parking restrictions by city planning: 4%

What would be your biggest concern with the implementation and use of sustainable materials and practices in your parking lots?

- City Planning Approval: 66%
- City Engineering Approval: 5%
- Maintenance: 7%
- Total Cost: 22%
Experiment

The final stage of the research methods was to conduct an experiment that would evaluate stormwater runoff and its financial impact of the site based on a 3 year rainfall (approximately 2.5 In/Hr). The site’s proposed parking plan was evaluated based on the 2.5 in/hr runoff with impervious surface coefficient and water runoff was calculated based on volume and detention requirements needed for a curb and gutter parking lot with standard concrete paving. A cost estimate was then developed based on referenced comparable construction cost standards and requirements needed to make the site viable. After a financial estimate was established, the proposed plan was then retrofitted with sustainable techniques including pervious concrete, bioswales, pervious pavers, and reduced parking space size. The site was then reevaluated based on the new runoff coefficient and the same 2.5 in/hr. The new sustainable site then was evaluated from a financial perspective and new water runoff and detention requirements.
The results of the experiment showed a massive reduction in runoff with the use of sustainable materials on the lot. The reduction was 66% less than a standard lot design which in turn reduced the detention size requirement for the site. The detention pond size requirement was reduced by 81% when compared to the standard method. The net increases for the site came in the form of monetary value. The results of the experiment showed that the estimated sustainable design cost per parking space was $9,643 (lifetime including maintenance) and the estimated standard design cost per parking space was $7,681 (lifetime including maintenance), a 24% net increase in cost when compared to standard methods. All runoff and cost calculations can be seen in the cost appendix portion of the paper.
Case Studies

Case Study No. 1 – Heifer International

Site Photographs

Key Features

- Location: Little Rock AR
- Built: 2003
- Type: Office
- 4.2 Acre Lot
- Sustainable features
  - Pervious pavement
- Gravel Pave w/ Wheel Stops
- Native turf seeding
- Bioswales
- 23 Trees used per acre
- Significance
  - EPA Pilot project

Summary

The Heifer International American headquarters located in Little Rock, Arkansas was part of a series of pilot projects that was sponsored by the Environmental Protection Agency’s (EPA) office of Solid Waste and Emergency Response (OSWER) to aid in understanding how environmental improvements affect public health. The pilot projects for (OSWER) were aimed at providing innovative ways to address environmental issues like land revitalization, air and water pollution, and recycling in today’s changing environmental conditions.
In 2003 OSWAR awarded a grant to design and build a new sustainable and environmentally friendly parking lot to match the new “green” building which was located on a former brownfield site at Heifer International. This site was the first of its kind in the south and was developed to serve as a model for other projects that might consider using sustainable features in future projects. Because Heifer International was paired with the EPA, the lot was able to undergo extensive future site analysis to explore the functionality of the site over time.

The specific features that were used in the Heifer International parking lot included a 100% recycled material gravel pave lot that reduced the impervious footprint of the parking lot by 30% with parking spaces composed of porous concrete. As part of the state of the art storm water management system, the site also contained several rain garden areas. The rain garden areas created a closed loop system that allowed the site to contain the water rather than channeling the runoff to the Arkansas River that is located in close proximity to the site. The rain garden and wetlands on the site have the ability to store 750,000 gallons of water which is the average capture of rainfall in a two week period. The water captured in the rain gardens also served as the main source for irrigation on site.

The most significant contributions that the Heifer International case study had on this thesis was the mixed method approach to designing the parking structure as well as the ongoing analysis of the functionality of the different methods that were used. This ongoing analysis of functionality of the parking lot showed the viability of different materials over an extended period of time. The site also contained several different cost analysis assumptions that provided a comparable reference when underwriting the cost to build the sustainable lot at Sheridan Station.
Case Study No. 2 – Wal-Mart Experimental Store

Site Photographs

Key Features

- Location: Aurora CO
- Built: 2005
- Type: Retail
- 9.1 Acre Lot
- Sustainable features
  - Pervious Asphalt
  - Native turf seeding
  - Bioswales
  - Water detention
  - All native plants used
- Significance
  - Mixed material method

Summary

The Aurora Wal-Mart experimental store is located just east of Metropolitan Denver. This location used over 19 types of pavement, many including recycled pavement, including some from the demolition of nearby Stapelton International Airport. The Wal-Mart store also looked at several different types of pervious pavement and/or concrete. The different pavement materials were used to assist with draining water from the parking lot. Each pavement system was put in place to monitor the amount of water that would percolate through the pavement system and into the groundwater system. The pervious asphalts and porous concrete had
proved to work well in this location and are being implemented in other locations throughout the United States.

Native grasses and trees were planted to reduce water needed for irrigation. The plants that were selected for the store have proved to be very hardy and the trees have provided much needed shade for the parking lot. The use of the native tree and plant materials on site have dramatically reduced Irrigation costs. According to Wal-Mart corporate the irrigation costs have decreased upward of 85% when compared to neighboring store locations.

The most significant contributions that the Wal-Mart case study had on this thesis was the paving materials selection. Wal-Mart’s efforts for the continual study of all 19 different paving materials used on the site for their cost effectiveness durability and performance translated into raw data that was applied to the site location of this thesis. For example, pervious concrete was selected for the Sheraton Station site over porous asphalt because of management and overall cost effectiveness. Due to the soil and high temperature conditions in Florida, porous asphalt would have required far more maintenance due in part to compression of the paving material and rutting from a combination of heavy traffic and the high temperatures. The Wal-Mart store contained the largest amount of sustainable features that were transitioned into the Sheraton station site.
Case Study No. 3 – The Florida Aquarium

Site Photographs

Key Features

- Location: Tampa FL
- Type: Civic
- Built: 2007
- 11.25 Acre Lot
- Sustainable features
  - Pervious pavement
- Native vegetation cover
- Bioswales
- Strands
- Significance
  - Constructed under the same budget as the original design

The Florida Aquarium located in Tampa, Florida was the location of the final case study. This site was a retrofit of an existing parking lot at the end of its useful life. The Florida Aquarium contained many of the elements commonly seen in the other case studies which included; bioswales, pervious paving material, native plantings, and strands. The significance that The Florida Aquarium was that the parking lot had been retrofitted and constructed under the same budget as the original design, making it both cost effective and environmentally friendly.
Like the Sheraton Station site, the Florida Aquarium required bioswales in the parking lot without reducing the number of parking spaces. The designers for the parking lot retrofit at the Florida Aquarium made each parking space approximately (2 feet) 61 cm. shorter to provide drainage depressions between parking rows which allowed the front end of vehicles to hang over approximately (4 feet) 122 cm. The wide turf depressed bioswale replaced 18 sqft of pervious pavement per parking space helping to mitigate the cost of the more expensive paving material.
Design Guidelines

The Sheraton Station site was governed by the existing site conditions, soil, water table, and topography. From the case study, literature review, interviews, and runoff calculations, the site was designed based on reduction in stormwater runoff and feasibility. Pervious concrete was chosen for the site rather than its more cost effective counterpart porous asphalt because of the characteristics the material had in a humid sub-tropical South Florida environment. The pervious concrete material would not be as prone to compression and material breakdown compared to its counterpart, due to the high volume of traffic and large vehicles using the site. The rutting and compression that occurs from large traffic volumes will reduce the value of the paving surfaces water absorption properties resulting in higher maintenance costs to fix. Pervious paving stone were also used on site to replace standard paving stones. These pavers were used in areas with no vehicular traffic, surrounding the retail, apartment, office, hotel, and restaurant/bank buildings found on the site specifically for pedestrian use.

Native plantings replaced the standard turf that often has high irrigation on the site to reduce the need for an outside water source and act as a filter for bioremediation of the parking lot. Fauna was chosen based not only on the criteria of being native to Florida but for its carbon sequestration capabilities.

Over 70,000 sqft of bioswales were implemented on the site replacing standard bedding areas on the sites current master plan. These bioswales with filter strips were low depressions found on site with dense vegetation. The bioswales were used to transport, decelerate, and treat the remaining runoff that the pervious concrete could not absorb.

All parking spaces were shortened by two feet with the islands being replaced with filter strips. Concrete stops were placed at the front of each space to allow the fronts of the cars to
hang over the filter strips. Filter strips are flat pieces of land with low slopes, designed to promote natural sheet flow as opposed to channeled runoff reducing the burden being placed on the bioswales on the site.

The remaining change made to the site was the removal of the detention pond found in the southeast corner of the site. Detention ponds are not resource efficient in terms of land are considered unattractive additions to real estate developments. The absorption properties of the pervious concrete and the use of bioswales and filter strips, the need for a retention pond was eliminated and replaced with a new outparcel. The proposed sustainable plan calls for a new 6,500 sqft building to be placed on the site in order to ease the burden of cost created by the use of the new sustainable materials as well as the increase in bioswales throughout the site. 25 additional parking spaces were also added to outside of the new building based on the zoning defined by the city of Hollywood Florida for TOD sites which was 3 spaces per 1,000 square feet. The removal of the detention pond not only created more space, but increased aesthetic appeal of the site.
Results

After the completion of the experimental phase of the sustainable parking lot study, data suggest that sustainable parking lots over a 20 year useful life lots can cost up to 24% more than there standard counterpart. This lack of cost effectiveness supports the results of the survey. Sustainable parking spaces based on the cost assumptions derived from the table in the Cost Assumptions Appendix are approximately $9,634 per space including maintenance. Standard parking lot per space cost is estimated to be $7,681 including maintenance. The total additional cost beyond the standard method of parking was $2,025,049(A).

In order to mitigate and dissolve the cost of the sustainable parking a 6,500 sqft building was erected on the southeast corner of the lot replacing the proposed detention pond, which increased the impervious surface area by less than 3% on the site. The cost to construct the building and amenities at current comparable construction rates for the area is $106 a sqft equating to a total cost of $689,000(B). Current value of the rented building on an annual basis on Triple Net (NNN) lease is approximately $175,500 for comparable class A retail space in the area ($27.00 sqft). Over a 20 year period the lease has an income value of $3,510,000 (C).

The value of the building at sale is estimated to be $1,950,000 (D). The value is derived by dividing the annual Net Operating Income (NOI) of the building ($175,500) by a capitalization rate (cap rate) of 9.0% which equals $1,950,000. Because cap rates 20 years from now are unknown a method of defining a cap rate by using historical averages was used. The cap rate was derived by adding 200 basis points to the historic value of a ten year treasury bond which is 7.0% for a total value of 9.0% cap rate.

Equation

\[
\text{NOI}/(\text{Ten Year Treasury} + 200 \text{ BP}) = \text{Value at Sale}
\]
The return on investment (ROI) for the additional constructed building that replaced the detention pond is a value of $2,745,951 (E), which is why this study feasible from an economic perspective. This was derived by subtracting the additional costs of implementing sustainable features on the site (A) and the building costs (B) from the profit earned with the lease of the building (C) and sale of the building (D).

Equation

\[
[(C) + (D)] - [(A) + (B)] = (E)
\]

\[
[(20yr lease value) + (Value at sale)] - [(parking lot cost) + (building cost)] = (ROI)
\]
Other Opportunities

In order to make this study more appropriate for varying sizes of parking lots and development sites, opportunities still exist for making sustainable parking lots more cost effective. In response to the survey data taken, cost effectiveness was at the top of the list of reasons to implement sustainable features on the site. The Sheraton Station site required a 6,500 sqft in additional rental space on the site to make the sustainable features on the parking lot not only cost effective but an excellent return on investment. This was accomplished in large part to the removal of the detention pond on the south east corner of the 17 acre site.

Because of the limitations that zoning places on impervious surfaces on real estate sites, increasing the pervious material to reduce stormwater runoff on site justifies increases in floor plates or increases in impervious surfaces like rooftops. On a smaller site the cost of sustainable parking could be off set with the opportunity to sell off additional land outparcels to other developers from the allowable increases in impervious surface coverage. Other alternatives include the creation of onsite park amenities or the donation of the land for civic use reducing cost by the reduction in tax liability. Creative and effective ways to mitigate cost of sustainable features in a parking lot exist and are not solely reliant on increases in floor plates for increased rentable square footage.
Conclusion

The results of the survey phase and the experimental phase of the study reveal the perceptions that real estate developers have with regard to sustainable parking were accurate. Sustainable parking does cost significantly more than standard methods and it is of reasonable concern that a parking lot could potentially cost 24% more over the useful life of the parking lot. However, solutions exist to help mitigate those costs and in some cases eliminate them all together with minor adjustments to the design of the site. This study has shown that water runoff can be reduced by up to 66% without compromising the functionality, size, and effectiveness of the parking lot. Challenging the regulations to shrink parking spaces and use land that was required for a stormwater detention area is what made this study a sustainable and effective design alternative both financially and environmentally.
References


Appendix I - Diagrams

Figure A - Body of Knowledge Diagram

Figure B - Research Method Diagram
Appendix II - Maps

Figure C - Context Location Map of Sheraton Station Hollywood, Florida

Figure D - Site Location Map of Sheraton Station Hollywood, Florida
Appendix III - Developer Proposed Site Plan of Sheraton Station Hollywood, Florida

Figure E
Appendix IV - Existing Site Condition Photo of Sheraton Station Hollywood, Florida

Figure F
Appendix V – Proposed Sustainable Parking Master Plan

Figure G
Appendix VI – Renderings, Section Drawings, and Blowups

Figure H - Proposed Bioswale Perspective Rendering of Storefront Parking

Figure I - Proposed Bioswale Perspective Rendering of Train Station
Figure J - Proposed Bioswale Perspective Section Drawing

Figure K - Proposed 6,500 sqft outparcel addition
Appendix VII – Survey Questions

1. Which of the following areas of real estate do you work in?
   - Retail
   - Office
   - Industrial
   - Multi Family
   - Multiple Types

2. What is your role in the development process?
   - Owner
   - Development Manager
   - Asset Manager
   - Construction Manager
   - Financial Analyst
   - Lender
   - City Official

3. Do you use sustainable elements in your projects?
   - Yes
   - No

4. Do you find that sustainable features add value to property?
   - Yes
   - No

5. Do you think that sustainable elements should be required in all new construction projects?
   - Yes
   - No

6. How much of a financial impact does parking have on your projects from an implementation and management perspective?
   - 0%-.5%
   - .5%-1%
   - 1%-2%
   - 2%-3%
7. How much of an impact does controlling stormwater runoff have on your projects?

☐ 3%-4%
☐ 4%-5%
☐ 5% or More

8. Do you think that the planning and zoning restrictions placed on parking have a positive impact on your projects?

☐ Yes
☐ No

9. Do you have any experience sustainable parking design and materials in your projects?

☐ Yes
☐ No

10. What are some of the biggest problems with parking lot design and construction?

☐ City Planning and Zoning (enough spaces)
☐ City Permitting
☐ City Engineering
☐ Contractor Issues
☐ Cost
☐ Tenant Parking Requirements

11. Are you familiar with?

☐ bio swales
☐ rain gardens
12. Do you have any experience sustainable parking design and materials in your projects?

☐ Yes
☐ No

13. If you have had experience using sustainable parking lot initiatives and materials, where the results in a positive or negative?

☐ Yes
☐ No
☐ N/A

14. 9) What would be your biggest concern with the implementation of using sustainable materials and Stormwater treatment in your parking lots?

☐ City Planning Approval
☐ City Engineering Approval
☐ Competent Contractors
☐ Cost
☐ Maintenance of the Lot Post Construction

15. Why do you think that development community avoids the implementation of sustainable parking?

☐ Cost
☐ Lack of Education on New and Innovative Techniques
☐ Too Time Consuming (finding contractors, convincing city engineers/planners)
☐ Lack of Architects With Knowledge on New Methods

16. What would it take to implement sustainable parking lot features in your projects?

☐ Subsidies
☐ Larger building footprints from reduction in impervious surfaces
☐ Reduced parking restrictions by city planning
☐ Press
Equally cost effective when compared to standard methods

17. Do you think having sustainable elements in projects increase rents and overall value?

☐ Yes
☐ No

18. Do you think that more sustainable parking lots could add to increased rents and overall value?

☐ Yes
☐ No

19. Do you think that aesthetics add value and increased rents to your projects?

☐ Yes
☐ No

20. Do you feel that having a more aesthetically pleasing parking lot could increase value and yield higher rents?

☐ Yes
☐ No
Appendix VIII - Assumptions

Figure L – Site Detail

<table>
<thead>
<tr>
<th>Site Detail</th>
<th>Length and Width of Neighborhood:</th>
<th>Total Length of Frontage Streets:</th>
<th>Trees:</th>
</tr>
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<tr>
<td></td>
<td>972 ft</td>
<td>281 ft</td>
<td>313</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lot Acres:</th>
<th>21.70 acres (945,252 ft²)</th>
<th>Lot Width:</th>
<th>561 ft</th>
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<tbody>
<tr>
<td>Lot Length:</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Lot Lawn Area:</th>
<th>165,149 ft²</th>
<th>Lot Rain Garden Area:</th>
<th>70,017 ft²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lot Native Veg Area:</td>
<td></td>
<td></td>
<td>152,591 ft²</td>
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</tbody>
</table>

Figure M – Hydrologic Detail

<table>
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<th>Hydrologic Detail</th>
<th>Conventional:</th>
<th>Green:</th>
<th>Difference:</th>
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<tbody>
<tr>
<td>Curve Number</td>
<td>88</td>
<td>35</td>
<td>-53</td>
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<tr>
<td>C Value</td>
<td>0.8</td>
<td>0.27</td>
<td>-0.53</td>
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<tr>
<td>Time of Concentration</td>
<td>56 Min.</td>
<td>68 Min.</td>
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<tr>
<td>Average Annual Discharge</td>
<td>2,067,002.85 ft³</td>
<td>699,181.53 ft³</td>
<td>1,367,821 ft³</td>
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</table>

Average Annual Ground Water Recharge Increase:

854,888 ft³
<table>
<thead>
<tr>
<th>Hydrologic Results</th>
<th>Conventional</th>
<th>Green</th>
<th>Reduction</th>
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<tr>
<td><strong>Lot Level Improvements:</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Lot Discharge (cf)</td>
<td>137,803</td>
<td>2,586</td>
<td>98.10%</td>
</tr>
<tr>
<td>Lot Peak Discharge (cfs)</td>
<td>20.65</td>
<td>0.36</td>
<td>98.30%</td>
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<tr>
<td><strong>Total Site Improvements:</strong></td>
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<tr>
<td>Total Peak Discharge (cfs)</td>
<td>38.46</td>
<td>13.01</td>
<td>66.20%</td>
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<tr>
<td><strong>Detention Size Improvements:</strong></td>
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<td></td>
<td></td>
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<tr>
<td>Total Detention Required (ft³)</td>
<td>203,622</td>
<td>39,020</td>
<td>81%</td>
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<tr>
<td><strong>Annual Discharge Improvements:</strong></td>
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<tr>
<td>Average Annual Discharge (acre ft)</td>
<td>47.45</td>
<td>16.05</td>
<td>19.63</td>
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Average Annual Ground Water Recharge Increase:?
## Figure O – Cost Summary

<table>
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<tr>
<th>Cost Summary</th>
<th>Conventional</th>
<th>Green</th>
<th>Increase</th>
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<tr>
<td><strong>Present Value</strong></td>
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<tr>
<td>Over 20 Year</td>
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<td></td>
</tr>
<tr>
<td>Life Cycle:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Per Lot Life Cycle Costs</td>
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<td>$5,901,453</td>
<td>($2,000,153)</td>
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<td>Total Life Cycle Costs</td>
<td>$3,901,300</td>
<td>$5,901,453</td>
<td>($2,000,153)</td>
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<tr>
<td><strong>First Year Site</strong></td>
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<td>Construction and Maintenance</td>
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<tr>
<td>Costs:</td>
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<td></td>
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<tr>
<td>Per Lot Costs</td>
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<td>$4,339,451</td>
<td>($882,920)</td>
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<td>Total Costs</td>
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<tr>
<td><strong>Benefits</strong></td>
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<td></td>
</tr>
<tr>
<td><strong>Present Value</strong></td>
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<td></td>
<td></td>
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<tr>
<td>Over 20 Year</td>
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<td>Life Cycle:</td>
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### Cost Breakout

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<tr>
<td><strong>Developer’s</strong></td>
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<tr>
<td><strong>Construction and</strong></td>
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<tr>
<td><strong>Maintenance Costs:</strong></td>
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<td>Per Lot Costs</td>
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<td>$4,339,451</td>
<td>($882,920)</td>
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<td>Total Costs</td>
<td>$3,456,532</td>
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<td>($882,920)</td>
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<tr>
<td><strong>Present Value</strong></td>
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<tr>
<td><strong>Over 20 Year</strong></td>
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<tr>
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<td><strong>Public Costs:</strong></td>
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<td><strong>Life Cycle</strong></td>
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<tr>
<td><strong>Cost to Developer</strong></td>
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Figure Q – Benefit Breakout

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<td>Life Cycle</td>
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