

Economic, Water Quality, and Water Supply Benefits of Sustainable Real Estate Development in Middle Tennessee

Final Report for Morgan Park Place



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World Wildlife Fund



Among all the world's waters, the rivers and streams of the southeastern United States have the greatest diversity of aquatic wildlife. Designated as one of the Global 200 ecoregions, the Cumberland and Tennessee Rivers alone are home to more than 224 native fish species. WWF's Southeastern Rivers and Streams Program works here to galvanize public support, craft solutions, secure conservation easements, restore habitat, reintroduce species directly and by supporting a myriad of local partners, ensure that very biodiversity which makes this region unique in all the world.

Cumberland River Compact



Cumberland River Compact

The Cumberland River Basin is the size of Denmark, supports over 2 million people and is home to over

16,000 miles of rivers and streams. Our mission is to enhance water quality across this great watershed through education and by promoting cooperation among citizens, businesses and agencies alike. We do this by building independent watershed organizations in our sub-watersheds, working with the development community to build water-friendly, educating local officials on best stormwater practices and innovative codes and ordinances to manage water at a local level and by connecting people directly to rivers through clean-ups, stream monitoring, restoring buffer zones, and getting out onto our waterways.

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Due to many factors including increased transparency in the markets, the growing concern for sustainable natural resources, and rising energy costs, environmental sustainability and social responsibility are no longer merely corporate rhetoric. Today, both can provide profitable business strategies and a myriad of brand enhancing opportunities and competitive advantages. J. Gowdy Consulting works with clients to achieve those advantages finding profitable environmental sustainability and social responsibility solutions.

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Executive Summary

The purpose of this report is to analyze the economic and ecological benefits of sustainable real estate development in the Middle Tennessee region. In terms of ecological benefits, this report focuses on water quality and water supply benefits. The scope of this report is limited to the building and development activities that were deemed “primary affecters” of water quality and water supply.

The report analyzes Morgan Park Place across eight development and building activities - Irrigation Systems, Water Runoff Control, Sediment Control, Stormwater Control, Kitchen Equipment, Laundry Equipment, Plumbing, and Efficient Energy Sources.

To compare standard building and development practices and the practices done at Morgan Park Place, estimations were needed in some of the calculations. For each of the estimations made, the range of possible choices and numeric values to use is highlighted. In each case, the most conservative estimation was chosen. This was done in an attempt to remove the risk of overstatement. Thus, the results presented here are considered as the lower limit of actual outcomes - the cost savings, water savings, and the water quality improvements presented are likely even greater than the outcomes presented.

I. Introduction

The purpose of this report is to analyze the economic and ecological benefits of sustainable real estate development in the Middle Tennessee region. In terms of ecological benefits, this report focuses on water quality and water supply benefits.

The case study for this report is the Morgan Park Place development. Morgan Park Place is located in the historic Germantown district of Nashville. The development is marketed as “an urban village” and is a “unique blend of modern world convenience and old fashioned urban living.”¹

The following is a list of development and building activities that are included in the business case.

- Irrigation Systems (Drip system, rain sensor, moisture sensor)
- Water Runoff Control (Landscaping/Vegetation)
- Sediment Control (Silt Fencing)
- Stormwater Control (Rain gardens, gravel pits, and pervious pavement)
- Kitchen Equipment (Dishwashers)
- Laundry Equipment (Washing machines)
- Plumbing (Tankless Water Heater)
- Efficient Energy Sources (higher SEER HVAC)

These activities represent the development and building activities that primarily affect water quality and water supply, as determined by the author and the report’s recipients. It is noted that other development and building activities can also have an effect on either or both water quality and water supply. Further research into these additional activities is acknowledged as a possibility and is recommended.

The business case presented in this report is primarily based upon a comparison between development and building practices considered to be “standard” and actual practices that were conducted at Morgan Park Place. The comparison of standard practices to the practices at Morgan Park Place is based upon primary financials, e.g. purchase price, expected fines. The comparison does not include some financials, e.g. time-based tax credits. It is noted that other financials affect the comparison but not at the magnitude that primary financials do. Further research into these secondary financials is acknowledged as a possibility and is recommended. The comparison also does not include estimated values for the positive externalities (also known as “ecosystem services”) that are associated with the ecological benefits.

For this case study, which focused specifically on the Morgan Park Place development, Lawrence Bros., LLC and New Urban Construction were both the developer and the builder.

II. Data Collection & Methodology

Data Collection - Three meetings were held at the office of the Lawrence Brothers in 2007. The purpose of these meetings was to walk through a questionnaire and obtain specific answers to the questions. For over 90% of the questions presented, the answers were not readily available and follow-up contacts were identified. Over twenty new contacts were identified and contacted. The results of these communications, along with extensive outside research (see References), provided the input to the Results section of the report.

Methodology – For each of the building and development activities analyzed, data was procured from the developer and/or subcontractor. Additionally, outside resources from government and industry provided expert opinions on defining “standard practice”. For each activity, the overall cost to the developer was determined and compared to the expected standard cost. In the case of an incurred price premium, this premium is noted. Then, the cost savings for each activity was calculated based upon the estimated water and energy savings derived from that activity. Based on these savings, a payback period was determined. In some cases, a price premium was not incurred. Thus, the upfront cost was lower for the developer. In each section of the Results, all calculations are presented in full with the goal of transparency.

III. Results

The results of the Morgan Park Place study are presented in this section by activity. For each activity, a summary of the economic, water supply (i.e. water quantity), and water quality data is shown along with an explanation of how the results were calculated. In section 5, a table presents the economic, water supply, and water quality data in summary.

Activity #1 – Irrigation Systems

Water Quality Benefits: N/a Water Savings: 511,146 gals per year Premium Paid: \$29.85 per condo Cost Savings: \$31.95 per year per condo after a 0.9 year payback period
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Introduction: The irrigation system selected for the Morgan Park Place development is included in this report, because it is a drip system instead of a standard broadcast system. The drip system saves water via a rain sensor and a moisture sensor in the soil that shuts the system down when there is rainfall or adequate soil moisture to keep the plant material healthy without over watering. A standard broadcast system does not provide this water saving functionality. Drip irrigation was chosen to enhance the premium landscaping of the site and supports the site goal of no water runoff.

Price Premium: The drip irrigation system installed at Morgan Park Place had an overall cost of \$11,800. This cost of the system can be broken down by component as follows:

- Drip System (model#: NETAFIM-TL9)
- Spray Head Bodies (model#: Toro 570)
- Spray Heads (model#: MP Rotator)
- Control Panel (model#: Toro TMC-424)
- Rain Sensor (model#: Rainbird)
- Moisture Sensor (model#: Rainbird)

These six components make up \$5,994 of the \$11,800 total cost. Of the \$5,994, materials account for \$2,250 and labor accounts for \$3,744. The remainder of the total cost, \$5,806, was for low volt lighting.²

The cost for low volt lighting is not included in the cost comparison, because it does not affect the water savings.

A standard irrigation system is described as one with spray head bodies with fixed nozzles and rotors. The estimated cost of this system is \$4,800.³ Therefore, the overall cost increase incurred by the Morgan Park Place development was \$1,194 (\$5,994 - \$4,800). Per condo unit, this equates to \$29.85 (\$1,194 / 40 units).

Efficiency Overview: Three parts of the irrigation system provide water saving efficiencies. The MP Rotator has a potential water savings of up to 30%.⁴ The Drip System uses 30-70% less water than an overhead system.⁵ Taking the conservative end of this range equates to a 30% estimate. The rain and moisture sensors can reduce the irrigation water use by about 15%.⁶ Overall, these three independent efficiencies lead to a total efficiency of 58.35%.

Water Supply Savings from System Efficiency: For the purpose of establishing an average estimation, the U.S. EPA states that the average American family of four uses 400 gallons of water per day for all indoor and outdoor activities, and about 30 percent of that is devoted to outdoor usage.⁷ This equates to 120 gallons per day and 43,800 gallons per year per family. However, the current occupancy rate at Morgan Park Place is much closer to two occupants per unit.⁸ Therefore, this equates to 60 gallons per day (120 gals/day * 50%) and 21,900 gallons per year per condo unit.

Multiplied by the 40 condo units at Morgan Park Place, this yearly outdoor water usage is estimated at 876,000gallons. However, the average American family does not have an efficient outdoor irrigation system as seen at Morgan Park Place. Applying the total efficiency calculated in the section above (58.35%) to the yearly outdoor water usage estimate for Morgan Park Place (876,000 gallons), yields a total usage estimation of 364,854 gallons and a total savings estimation of 511,146 gallons.

Payback Period & Cost Savings: According to Metro Water of Nashville, the average price per 100 cubic feet (CCF) of residential water usage is \$1.85.⁹ There are 748 gallons per CCF. Therefore, the average price per gallon of water is \$0.0025 (\$1.85 / 748 gals).

The estimated annual cost savings for Morgan Park Place is \$1,277.87 (511,146 gals * \$0.0025) per year. With 40 condo units, the average cost savings per owner is \$31.95 (\$1,277.87 / 40 units).

Knowing that the price premium incurred by the developer is passed on to the customer, the payback period on the additional upfront investment is 0.9 years (\$1,194 / \$1,277.87). In year one and onward, customers would begin earning a return on their investment from the more efficient irrigation system by continuing to save \$31.95 per year on their water bill.

Activity #2 – Water Runoff Control

Water Quality Benefits: Zero synthetic fertilizer runoff from site Water Savings: 438,000 gals per year Price Premium: \$164 per condo Cost Savings: \$27.38 per year per condo after a 6 year payback period
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Introduction: The landscaping and vegetation practices conducted for the Morgan Park Place site qualify as premium choices for water runoff control. Four specific practices were implemented including the removal of construction debris and rocks in the planting beds, the use of high quality compost, the application of compost tea to aid in rebuilding the soil, and the planting of native species. However, only the practice of planting native species could be viably linked to specific water savings. Therefore, this is the only one of the four practices specifically highlighted in the Water Supply Benefits section.

Price Premium: The overall cost of the landscaping and vegetation done for the Morgan Park Place site was \$82,000. This is estimated at an 8% cost increase over standard practices. This cost increase is due to the four premium choices made.¹⁰

Standard practices include planting directly into the heavily compacted soils of a construction site. The removal of the construction debris and rocks in the planting beds is a premium choice and resulted in a 3% cost increase.¹¹

Standard practices do not include the use of high quality compost. Such compost was used on the Morgan Park Place site. The compost used has a high microorganism count, which begins the transformation process of the heavily compacted soils to aerated soils. The use of the compost resulted in a 4% cost increase.¹²

Standard practices do not include the use of compost teas. Such teas were used on the Morgan Park Place site. The teas used aid in attracting microorganisms on plants' leaf surfaces as well as rebuilding the soil. The use of the compost teas resulted in a 1% cost increase.¹³

Standard practices do not often include the planting of native species. Native species were planted on the Morgan Park Place site. Native species are better adapted to local climate and require 20-50% less water.¹⁴

An overall 8% cost increase indicates that standard practices for landscaping and vegetation would have cost \$75,440. Therefore, the overall cost increase incurred by the Morgan Park Place development is \$6,560 (\$82,000 - \$75,440). Per condo unit, this equates to \$164 (\$6,560 / 40 units).

Water Quality Benefits: The main difference between the Morgan Park Place site and the typical development site is that there was no usage of synthetic fertilizers that can contaminate the water supply. By implementing the four premium landscaping choices, there was no need to use synthetic fertilizers for establishment of the plants. Therefore, since no synthetic fertilizers were used onsite; zero runoff water contained these contaminants.

Water Supply Benefits: Planting native species helps retain water better than non-native species and can reduce outdoor water use by 20-50%.¹⁵ Thus, we can estimate water usage savings. The average American family of four uses 400 gallons of water per day, and about 30 percent of that is devoted to outdoor usage.¹⁶ This equates to 120 gallons per day and 43,800 gallons per year per family. However, the current occupancy rate at Morgan Park Place is much closer to two occupants per unit.¹⁷ Therefore, this equates to 60 gallons per day (120 gals/day * 50%) and 21,900 gallons per year per condo unit.

All four of the water control practices promote and support the long-term sustainability of the soil. Thus, instead of taking the conservative end of this range, 20%, the higher end of the estimation range, 50%, is used. Using this rate, the estimated savings per family is 10,950 gallons per year (21,900 * 0.50). Multiplied by the 40 condo units at Morgan Park Place, the overall water savings is 438,000 gallons per year.

Payback Period & Cost Savings: According to Metro Water of Nashville, the average price per 100 cubic feet (CCF) of residential water usage is \$1.85.¹⁸ There are 748 gallons per CCF. Therefore, the average price per gallon of water is \$0.0025 (\$1.85 / 748 gals).

The estimated annual cost savings for Morgan Park Place is \$1,095 (438,000 gals * \$0.0025) per year. With 40 condo units, the average cost savings per owner is \$27.38 (\$1,095 / 40 units).

Knowing that the price premium incurred by the developer is passed on to the customer, the payback period on the additional upfront investment is 6 years (\$6,560 / \$1,095). In year seven and onward, the customers would begin earning a return on their investment from the planting of native species by continuing to save \$27.38 per year on their water bill.

Activity #3 – Sediment Control

Water Quality Benefits: N/a
Water Savings: N/a
Price Discount: \$60.63 per condo
Cost Savings: N/a

Introduction: The most common practice for sediment control on development sites is known as silt fencing. A silt fence is normally trenched in or buried around the development site. The material of the fence allows for water to pass through the fabric, while suspended soil particles in the water are contained by the fence.

Water Quality Benefits: As the silt fence allows for only water to pass through its permeable fabric, it prevents a majority of the potential sediment runoff on the site. This restricts the loss of costly job site material, keeps unnecessary mud from covering our roadways, and protects our rivers and lakes from harmful silt build-up.¹⁹ Silt build-up can damage or ruin habitats for both plant and animal aquatic species, which in turn are food sources for other aquatic and non-aquatic species.

Little data-driven information currently exists regionally and even nationally on the specific benefits of proper silt fencing on water quality.²⁰ Further research into the water quality benefits of silt fencing is acknowledged as a possibility and is recommended.

Cost Savings: The costs associated with “proper” silt fencing include the purchase of the fence product, the installation of the fence on site, the cost of monitoring the fence after rain storms, and the cost of repairing damaged fencing. For the Morgan Park Place site, the following costs were incurred for these four activities.^{21, 22}

- Cost to purchase and install the fence = \$2,200
- Cost of monitoring the fence during construction = \$100.00 per month
- Cost of repairing the fence during construction = \$2,000

Silt fencing was used at Morgan Park Place for approximately six months. Therefore, the overall expected costs for proper silt fencing is $(\$2,200 + \$600 + \$2,000) = \$4,800$

One alternative to silt fencing is to do little to nothing to prevent sediment runoff, which obviously costs as low as \$0. However, the more common practice is silt fencing that is characterized by improper installation, monitoring, and/or repair. The assumption for this study is that silt fencing is performed on the standard or average development site but is not monitored and repaired. Therefore, the developer would incur only the purchase and installation costs but not the monitoring and repairing costs. Therefore, the developer could expect to pay \$2,200.

However, by cutting these activities and costs, the developer is subject to a variety of fines. The array of potential fines is vast but can be summarized in three main categories: administrative penalties, stop work orders, and law suits.²³

Administrative penalties are the first level of enforcement. These penalties are assessed for inadequate erosion prevention and sediment control (EPSC) installation and/or maintenance. The expected range for administrative penalties in Nashville is \$100-\$500. These penalties can be assessed on multiple occasions if deemed necessary.²⁴ For the purpose of this report, a conservative estimate of a one-time \$100 penalty is assumed.

Stop work orders are the second level of enforcement. Stop work orders are issued if a development site is deemed an imminent threat to the local water quality. The stop work order serves to stop all site grading/land disturbance activity until appropriate EPSC is in place at the site. This may or may not include an administrative penalty, but there are peripheral costs including idle equipment and contractor

staff. Estimating the cost of a stop work order is difficult to ascertain. In practice, the cost should equal the sum of a developer's job related overhead costs, i.e. those costs that are incurred regardless if work is done or not. Job related overhead costs can include, but are not limited to the following: interest, supervision/administrative salaries, telephone, job trailers, rental equipment, temporary electrical, clerical, and office rent.²⁵ One local developer's estimate for total, daily job related overhead costs is \$2,375.²⁶ The average stop work order is three to four days²⁷, so the estimated cost for stop work orders is \$7,125 (for three days). Note: for the purpose of this report, it is assumed that violations are caught and penalized 100% of the time.

Court summons costs are a third and most drastic level of enforcement. If the developer is unresponsive to the previous penalties, the Metro Government can take the developer to Metro Environmental Court. However, this is uncommon and occurs in less than 1% of cases.²⁸ Therefore, this cost is not included in the calculations for this report.

In summary, the total expected costs for improper silt fencing are equal to the sum of Administrative Penalties plus Stop Work Order Costs plus Court Summons Costs. From the cost estimates determined for this report, the overall total expected costs for improper silt fencing is \$7,225 (\$100 + \$7,125 + \$0).

The expected costs for proper silt fencing are less than the expected costs for improper silt fencing by \$2,425 (\$7,225 - \$4,800). Assuming that the cost savings are distributed evenly across 40 units, then the average upfront cost savings in the purchase price is \$60.63 (\$2,425 / 40 units).

Activity #4 – Stormwater Control

Water Quality Benefits: 80-90% reduction in silt particulate runoff Water Savings: N/a Price Discount: \$67.18 per condo Cost Savings: N/a

Introduction: The rain gardens, gravel pits, and pervious pavement at the Morgan Park Place site all qualify as premium stormwater control measures, because with this system the water is truly filtered into the ground. Additionally, plant biomass helps with evapo-transpiration and removal of particulates in the stormwater. Overall, there are three rain gardens on-site that cover 2,000 square feet. There is an approximate 25" stone sub-base gravel pit below the gardens and a 720 square feet of pervious pavement.²⁹

Water Quality Benefits: The rain gardens, gravel pits, and porous concrete at Morgan Park Place are designed to work as water quality control more than water volume control. (Note: Metro did not require stormwater detention on this site only water quality treatment). Notably, the system is designed to remove 80% of heavy silt particulates from the rainwater passing through the system.³⁰

Cost Savings: The total cost of the stormwater control system is made up of the cost of the rain gardens, pervious pavement, and the gravel pits.

The rain gardens required planting bed preparation and plant material. The planting bed preparation is estimated at \$2 per square foot. With a total of 2,000 square feet, this cost equates to \$4,000. The estimated plant material cost is at \$1,500 per garden or \$4,500 overall.³¹

The pervious pavement cost was \$7,800 overall.³²

The gravel pits provide a stone sub-base for the rain gardens and the pervious pavement. In total, the estimated amount of gravel needed for the entire sub-base is 200 tons at a cost of \$3,000.³³

Therefore, the overall cost for the rain gardens, pervious pavement, and gravel pits was \$19,300 (\$4,000 + \$4,500 + \$7,800 + \$3,000).

The standard practice for stormwater control on many development sites is to install a detention pond.³⁴ The average cost for installing a detention pond is extremely sensitive to site conditions including the following variables: embankment construction, outlet protection, cost of excavation, liner materials, and land costs. Maintenance and inspection costs for mowing and periodic dredging are variable post-development factors. Though these costs are sensitive and variable per site, studies have suggested that preliminary costs can be estimated by the following equation:³⁵

$$C = 168.39 \times 0.69V$$

Where:

C = construction cost estimate and

V = volume of storage of the pond (cubic meters) up to the crest of the emergency spillway.

With an expected site volume of an estimated 50,000 gallons, this translates to 189.25 cubic meters (50,000 gals * 3.785L/gal * 1 cu-meter/1000L).³⁶ Using the equation above, the estimated cost is found to be \$21,987 (168.39 * 0.69 * 189.25)

Therefore, the overall cost savings found by the Morgan Park Place site is estimated to be \$2,687 (\$21,987 – \$19,300). Assuming that the cost savings are distributed evenly across 40 units, then the average upfront cost savings in the purchase price is \$67.18 (\$2,687/40 units).

Activity #5 – Kitchen Equipment

Water Quality Benefits: N/a
Water Savings: 128,200 gals per year
Price Premium: \$182 per condo
Cost Savings: \$16.97 per year per condo after a 10.7 year payback period

Introduction: The kitchen equipment, i.e. dishwashers, selected for the Morgan Park Place development is included in this report because the dishwashers selected are highly energy efficient. Since the energy creation process requires water as input, energy efficiency translates to water supply savings. In addition, there are water savings resulting from water efficiency for the dishwasher selected.

Price Premium: The dishwashers installed at Morgan Park Place are a GE Profile model (model#: PDW9280). There is one dishwasher per condo unit. The cost per GE dishwasher was \$902. In comparison, the per unit cost of a standard dishwasher is \$720.³⁷ Therefore, the overall cost increase incurred by the Morgan Park Place development was \$7,280 (40 units * \$182 price difference).

Efficiency Overview: The higher energy efficiency of the dishwashers does not primarily affect either water usage or water quality on site, i.e. the energy efficiency will not lower the condo owner's water bill or prevent water runoff on the site. However, usage of the energy efficient dishwashers does result in a 34.8% increase in energy savings in comparison to the standard washing machine (346 KWH/year v. 531 KWH/year).³⁸ This energy savings translates to economic savings for the condo owner and water savings for river systems.

The GE dishwasher also uses approximately 33% less water per load than the standard dishwasher. This water savings translates to economic savings for the condo owner and water savings for river systems.

Water Savings from Energy Efficiency: The 34.8% energy savings affects off-site water supply. In areas where coal is used to produce energy, 25 gallons of water is required to produce 1 KWH of energy.³⁹ The average electric washing machines use 531 KWH per year. On average, the GE Profile dishwasher uses only 346 KWH per year. The result is an annual energy savings of 185 KWH per year (531 KWH – 346 KWH). In Nashville, 60% of electricity generated by TVA is sourced from coal-fired power plants.⁴⁰ Therefore, only 111 KWH of the 185 KWH saved qualify as KWH sourced from coal. This 111 KWH saved, multiplied by the factor of 25 gallons of water to produce 1 KWH, yields savings of 2,775 gallons of water per year per washer. With 40 dishwashers onsite at Morgan Park Place, the savings for the site is 111,000 gallons of water per year.

Water Savings from Product Efficiency: Traditional dishwashers use an average of 1,290 gallons of water per year.⁴¹ The GE Profile dishwasher uses only an average of 860 gallons of water per year.⁴² Therefore, a savings of 430 gallons of water are saved per dishwasher. With 40 GE Profile dishwashers onsite at Morgan Park Place, the savings for the site is 17,200 gals/year.

In total, the estimated onsite water savings from the dishwashers equates to 128,200 gallons (111,000 gallons + 17,200 gallons) per year.

Payback Period & Cost Savings: The GE Profile model used at the Morgan Park Place site uses an estimated 185 KWH less than the standard dishwasher (531 KWH/year – 346 KWH/year). Using the national average for cost per KWH of \$0.086/KWH, the estimated amount of energy cost savings for the condo owner is \$15.91 per year (185 KWH * \$0.086).⁴³

The GE Profile model used at Morgan Park Place also uses 430 gallons less than the standard dishwasher (1,290 gals/year – 860 gals/year). According to Metro Water of Nashville, the average price per 100 cubic feet (CCF) of residential water usage is \$1.85.⁴⁴ There are 748 gallons per CCF. Therefore, the average price per gallon of water is \$0.0025 (\$1.85 / 748 gals). Overall, this equates to a water cost savings of \$1.06 per year (430 gals * \$0.0025/gal).

The overall cost savings from energy and water savings equates to \$16.97 (\$15.91 + \$1.06) per year.

Knowing that the price premium incurred by the developer is passed on to the customer, the payback period on the additional upfront investment is 10.7 years (\$182 / \$16.97). Therefore, after 10.7 years into the investment period, customers would begin earning a return on their investment and would continue to gain \$16.97 in cost savings per year. However, the estimated life span of the Profile dishwasher is 11 years.⁴⁵ This affects the summary calculations in Section IV.

Activity #6 – Laundry Equipment

Water Quality Benefits: N/a
Water Savings: 703,400 gals per year
Price Premium: \$599 per condo
Cost Savings: \$74.92 per year per condo after a 12 year payback period

Introduction: The laundry equipment, i.e. washing machines, selected for the Morgan Park Place development is included in this report because the washing machines selected are highly energy efficient and water efficient. Since the energy creation process requires water as input, energy efficiency translates to water supply savings.

Price Premium: The washing machines installed at Morgan Park Place are a GE frontload model (model#: WCVH62-60F). There is one washing machine per condo unit. The cost per GE washing machine was \$899. In comparison, the per unit cost of a standard washing machine is \$300.⁴⁶ Therefore,

the overall cost increase incurred by the Morgan Park Place development was \$23,960 (40 units * \$599 price difference).

Efficiencies Overview: The higher energy efficiency of the washing machines does not primarily affect either water usage or water quality on site, i.e. the energy efficiency will not lower the condo owner's water bill or prevent water runoff on the site. However, usage of the energy efficient washing machines does result in a 53.1% increase in energy savings in comparison to the standard washing machine (239 KWH/year v. 510 KWH/year).⁴⁷ This energy savings translates to economic and water savings for the condo owner.

The GE washing machine also uses approximately 60% less water per load than the standard topload washer.^{48, 49} This water savings translates to economic savings for the condo owner and water savings for river systems.

Water Savings from Energy Efficiency: The 53.1% energy savings affects off-site water supply. In areas where coal is used to produce energy, 25 gallons of water is required to produce 1 KWH of energy.⁵⁰ The average electric washing machines use 510 KWH per year, while the GE frontload washing machine uses only 239 KWH per year.⁵¹ The result is an annual energy savings of 271 KWH per year (510 KWH – 239 KWH). In Nashville, 60% of electricity generated by TVA is sourced from coal-fired power plants.⁵² Therefore, only 162.6 KWH of the 271 KWH saved qualify as KWH sourced from coal. This 162.6 KWH saved, multiplied by the factor of 25 gallons of water to produce 1 KWH, yields savings of 4,065 gallons of water per year per washer. With 40 washers onsite at Morgan Park Place, the savings for the site is 162,600 gallons of water per year.

Water Savings from Product Efficiency: Traditional washing machines use 41 gallons of water per load.⁵³ The GE frontload washer uses only 15 gallons per load.⁵⁴ Therefore, 26 gallons of water are saved per load. Based on GE's usage estimate of 10 loads per week, this equates to 520 loads per year. The total amount of water saved per year per GE frontload washer is 13,520 gallons (520 loads * 26 gallons saved). With 40 washers onsite at Morgan Park Place, the savings for the site is 540,800 gals/year.

In total, the estimated onsite water savings equates to 703,400 gallons (162,600 gallons + 540,800 gallons).

Payback Period & Cost Savings: According to the GE corporate website, the GE frontload "washer's total energy and water savings can pay for the initial cost of the washer over its life," which is estimated at 12 years.⁵⁵ This is based on an average cost of water, energy, and sewer over 12 years and on an average usage of 10 loads per week. This equates to an average yearly savings of \$74.92 (\$899 / 12 years) on energy and water bills.). Therefore, after 12 years into the investment period, customers would begin earning a return on their investment and would continue to gain \$74.92 in cost savings per year. However, the estimated life span of the GE frontload washer is 12 years. This affects the summary calculations in Section IV.

Activity #7 – Plumbing (Tankless On Demand Water Heater)

Water Quality Benefits: N/a Water Savings: 622,620 gallons of water per year Price Premium: \$495 per condo Cost Savings: \$76.80 per year per condo after a 6.4 year payback period

Introduction: The Tankless On Demand water heater selected for the Morgan Park Place development is included in this report because it is highly energy efficient. Since the energy creation process requires water as an input, energy efficiency translates to water supply savings.

Price Premium: The On Demand water heaters installed at Morgan Park Place are a Rinnai product (model: #2532FFU91N). There is one water heater per condo unit. The cost per Rinnai water heater was \$875.⁵⁶ In comparison, the per unit cost of a standard 52 gallon water heater is \$380.⁵⁷ Therefore, the overall cost increase incurred by the Morgan Park Place development was \$19,800 (40 units * \$495 price difference).

Efficiencies Overview: The higher energy efficiency of the On Demand water heaters does not primarily affect either water usage or water quality on site, i.e. the energy efficiency will not lower the condo owners' water bill or prevent water runoff on the site. However, usage of the On Demand water heater does result in a 30% increase in energy savings in comparison to the conventional water heater.⁵⁸ This energy savings translates to economic savings for the condo owner and water savings for river systems.

Water Savings from Energy Efficiency: The 30% energy savings also affects off-site water supply. In areas where coal is used to produce energy, 25 gallons of water is required to produce 1 KWH of energy.⁵⁹ The average electric water heater uses 3,459 KWH per year.⁶⁰ In Nashville, 60% of electricity generated by TVA is sourced from coal-fired power plants.⁶¹ Therefore, only 2,075.4 KWH (3,459 KWH * 60%) of the 3,459 KWH energy used is sourced from coal per year.

With the 30% savings from the Rinnai water heater, the result is an annual energy savings of 622.6 KWH (2,075.4 KWH * 30%). Multiplied by the factor of 25 gallons of water to produce 1 KWH, the result yields savings of 15,565.5 gallons of water per year per water heater. With 40 water heaters onsite at Morgan Park Place, the savings for the site is 622,620 gallons of water per year.

Payback Period & Cost Savings: The average American family annually spends \$256 on their electric water heater bill.⁶² Since the Rinnai water heater is 30% more energy efficient than a standard water heater, the result is that the expected annual savings from using the Rinnai product is \$76.80 (\$256 * 30%). Therefore, knowing that the price premium incurred by the developer is passed on to the customer, the payback period on the additional upfront investment is 6.4 years (\$495 / \$76.80). In year seven and onward, the customers would begin earning a return on their investment from the Rinnai water heater by continuing to save \$76.80 per year on their energy bill.

Activity #8 – Efficient Energy Sources (higher SEER HVAC)

Water Quality Benefits: N/a Water Savings: 551,000 gallons of water per year Price Premium: \$600 per condo Cost Savings: \$171 per year per condo after a 3.5 year payback period

Introduction: The HVAC equipment selected for the Morgan Park Place development is included in this report because of its above-average SEER (Seasonal Energy Efficiency Ratio) rating. The higher SEER rating translates to increased energy efficiency. Since the energy creation process requires water as an input, energy efficiency translates to water supply savings.

The HVAC units installed at Morgan Park Place are rated at 16 SEER and include two-stage cooling and a three-stage heating with variable speed air handlers. The normal or standard HVAC system for condos is a 13 SEER single stage system with a single speed blower.⁶³

Efficiency Overview: The higher SEER rating does not primarily affect either water usage or water quality on site, i.e. a higher SEER rating will not lower the condo owners water bill or prevent water runoff on the site. However, the higher SEER rating does result in 20-30% in energy savings in comparison to the conventional HVAC.⁶⁴ This energy savings translates to economic savings for the condo owner and water savings for river systems.

Price Premium: The average cost per 16 SEER HVAC units was \$600 more than the average cost would have been for 13 SEER HVAC units at Morgan Park Place.⁶⁵ Therefore, the overall cost increase incurred by the Morgan Park Place development was \$24,000 (40 units * \$600 price difference).

Water Savings from Energy Efficiency: The 20% energy savings also affects off-site water supply. In areas where coal is used to produce energy, 25 gallons of water is required to produce 1 KWH of energy.⁶⁷

The average American home uses 850 KWH per month, which equates to 10,200 KWH per year.⁶⁸ Again assuming that 45% of energy usage is for heating and cooling, the result is 4,590 KWH per year (10,200 KWH * 45%). In Nashville, 60% of electricity generated by TVA is sourced from coal-fired power plants.⁶⁹ Therefore, the average heating and cooling energy usage from coal-fired sources is 2,754 KWH per year (4,590 KWH * 60%).

Taking the conservative end of the 20%-30% savings range, the result is a total savings of 551 KWH (2,754 KWH * 20%). Multiplied by the factor of 25 gallons of water to produce 1 KWH, the result yields savings of 13,775 gallons of water per year per HVAC unit. With 40 HVAC units onsite at Morgan Park Place, the savings for the site is 551,000 gallons of water per year.

Payback Period & Cost Savings: The average American family spends \$1,900 per year on energy bills, of which 45% is spent on heating and cooling.⁶⁶ This yields an average of \$855 (\$1,900 * 45%) spent on heating and cooling per year. Taking the conservative end of the 20-30% savings range, the result is that the expected annual savings from using the higher SEER HVAC system is \$171 (\$855 * 20%). Therefore, knowing that the price premium incurred by the developer is passed on to the customer, the payback period on the additional upfront investment is 3.5 years (\$600 / \$171). In year four and onward, the customers would begin earning a return on their investment in the higher SEER HVAC unit by continuing to save \$171 per year on their energy bill.

The next section, Summary Results, contains a summation of cost comparisons, payback terms, and water quality and supply benefits for all seven activities.

IV. Summary - Activities #1-8

In total, the premium paid by the developer is estimated at \$77,682 (see Summary Report). Assuming that this cost increase is passed along to the condo owners evenly across the forty condo units, the estimated premium paid per condo owner is \$1942.05.

Six of the eight activities investigated provide annual cost savings to the condo owner after an initial payback period. These *annual* cost savings are as follows:

- Activity #1: \$31.95
- Activity #2: \$27.38
- Activity #3: N/a (does provide upfront cost savings, which lowers overall premium paid)
- Activity #4: N/a (does provide upfront cost savings, which lowers overall premium paid)
- Activity #5: \$16.97 (Product Expected Life: 11 years)
- Activity #6: \$74.92 (Product Expected Life: 12 years)
- Activity #7: \$76.80
- Activity #8: \$171.00

This equates to a total annual cost savings of \$399.02 that begin in year 1. Therefore, the overall payback period for the overall, upfront premium paid is 4.87 years (\$1942.05 / \$399.02). In the fifth year, the

condo owner would continue to receive \$399.02 in cost savings and begin achieving a positive return on the upfront investment.

Since both the dishwasher and washing machine have expected lives of eleven and twelve years, respectively, this complicates the return on investment calculations from year eleven and onward. The following paragraphs describe how the calculations are affected.

The expected life of the dishwasher is eleven years. After eleven years the net return on investment would be \$2,446 ($\$399.02 * (11 - 4.87)$ years). From this point in time onward, the annual cost savings for the dishwasher ($\$16.97 / \text{year}$) no longer is included in the calculations.

The expected life of the washing machine is twelve years. After twelve years the net return on investment would be \$2,828 (first eleven years + twelfth year) = $\$2,446 + (\$399.02 - \$16.97)$. From this point in time onward, the annual cost savings for the washing machine ($\$74.92 / \text{year}$) is no longer included in the calculations.

After twenty years the net return on investment would be \$5,285 (first twelve years + last eight years) = $\$2,828 + (\$399.02 - \$16.97 - \$74.92) * (8 \text{ years})$.

The relationship between the premiums paid versus cost savings is presented in the figure below.

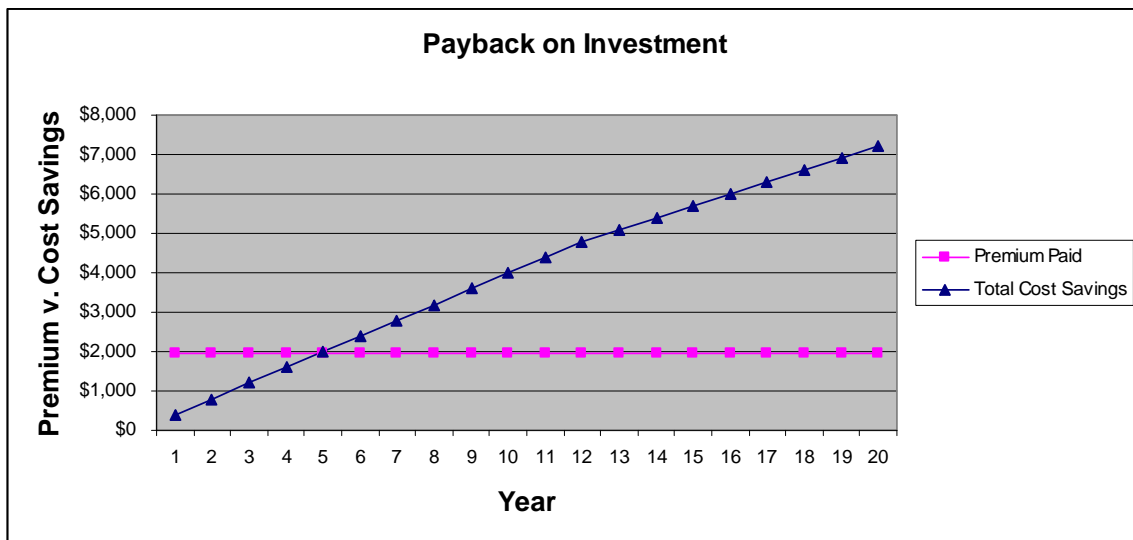


Figure 1

The total estimated water supply savings is 2,954,366 gallons per year (see Summary Report). These savings are due to the practices described in activities 1, 2, 4, 5, 6, and 7.

- Activity #1: 511,146 gals/year
- Activity #2: 438,000 gals/year
- Activity #3: N/a
- Activity #4: N/a
- Activity #5: 128,200 gals/year
- Activity #6: 703,400 gals/year
- Activity #7: 622,620 gals/year
- Activity #8: 551,000 gals/year

The total effect on water quality is two-fold: zero synthetic fertilizer runoff and an 80-90% reduction in silt particulate runoff (see Summary Report). These benefits are due to the practices described in activities 2 and 3.

V. Summary Report

No.	Aspect	Uniqueness	Standard Choice	Onsite Cost	Standard Cost	Premium Paid	Payback Period	Cost Savings after Payback Period	Water Supply Savings (gals/year)	Water Quality Gains (gals/year)
1	Irrigation System	Drip-based	Broadcast System	\$5,994	\$4,800	\$1,194	0.9 years	\$ 31.95 per year per condo	511,146	None
2	Erosion Control	Vegetation and Landscaping	Rocks & debris remain, no compost, no compost teas	\$82,000	\$75,440	\$6,560	6 years	\$27.38 per year per condo	438,000	Zero synthetic Fertilizer runoff
3	Sediment Control	Full Compliance (proper installation)	Potential Non-Compliance (from improper installation)	\$4,800	\$7,225	(\$2,425)	N/a	(\$60.63 decrease in purchase price)	None	N/a
4	Stormwater Control	Rain Gardens, Gravel Pits, Pervious Pavement	Detention Ponds	\$19,300	\$21,987	(\$2,687)	N/a	(\$67.18 cost decrease in purchase price)	None	80-90% reduction in silt particulate runoff
5	Profile Dishwashers	Energy Efficiency	Not Energy Efficient	\$902/unit	\$720/unit	\$7,280	10.7 years	\$16.97 per year per condo	128,200	None
6	Frontload Washing machines	Water and Energy Efficiency	Topload Washing machines	\$899/unit	\$300/unit	\$23,960	12 years	\$74.92 per year per condo	703,400	None
7	Tankless On Demand Water Heater	Energy Efficiency	Electric Water Heater	\$875/unit	\$380/unit	\$ 19,800	6.4 years	\$76.80 per year per condo	622,620	None
8	Higher SEER HVAC	SEER 16 rating	SEER 13 rating	N/a	N/a	\$24,000	3.5 years	\$171 per year per condo	551,000	None
					Totals:	\$77,682	4.87 years	Dependent upon year	2,954,366	

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