Landscape Architecture Foundation

Cascade Garden

Landscape Peformance Benefits

- Sequesters nearly 31,200 lbs of carbon annually in the 44 mature globe willow trees and 18 Colorado blue spruce trees that were transplanted during construction.
- Creates ideal trout habitat conditions with dissolved oxygen levels at or greater than 7 ppm and water temperature at or less than 60°F, following the pond redesign. Trout could not be sustained previously.
- Reduces the project's landfill burden by over 3,700 cu ft by donating material from the existing home to Habitat for Humanity. The recycling of the pine logs alone reduced the total amount of CO2 equivalent produced by approximately 22 tons.
- Reduces irrigation and fertilizer needs by nearly 60% by replacing 5,020 sf of turf with native plants. This saves over 75,000 gallons of water and eliminates the need for 30 lbs of fertilizer annually.
- Blocks approximately 97.8% of unwanted views with earth berming, plantings, and retention of mature trees to reduce visibility of traffic on the nearby road from key points on the property.

Designer
Design Workshop, Inc.

Land Use
Residential

Project Type
Single-family residence

Location
Undisclosed
Aspen, Colorado

Size
2.49 acres

Budget
Undisclosed

Completion Date
2009

Overview

Cascade Garden is a tranquil, high-altitude residential property, designed to preserve the area's natural setting and ecosystem while meeting the propery owner's requests for outdoor amenities. The project involved dismantling an existing house and siting a new home integrated into the landscape with minimal site disturbance. The site features an existing pond, which was planted with riparian vegetation and modified to support trout habitat and supply water for landscape irrigation. Because of the harsh, high-altitude climate and presence of wildlife, plant species were carefully selected to ensure high growth levels and low maintenance. Most of the traditional lawn was replaced with native plants, which conserve water and reduce fertilizer consumption. The home also employs renewable energy through a ground-source heat pump that is used to operate outdoor site features. The design creates a serene environment that complements its surroundings and provides the relaxing outdoor spaces the homeowners sought.

Sustainable Features

- The landscape surrounding the home features a healthy aquatic ecosystem complete with a pond and cascading creek, preserved native flora, and outdoor spaces designed to complement their natural surroundings.
- The existing pond was reshaped while maintaining its surface area of 0.84 acres, deepened to more than 12 ft, and planted with riparian vegetation to improve water quality and provide habitat for trout and other aquatic life.
- The three-tiered patio is constructed of native stone and provides about 600 sf of outdoor space overlooking the pond.
- Based on the recommendations of the landscape architect, the new home was located on the footprint of the previous house to minimize site disturbance. The steep slopes directly north of the home site were not impacted during construction and approximately 18,000 sf of native vegetation on the slopes was retained and enhanced with additional plantings.
- Over 2,500 sf of the access drive was located on previously disturbed ground, minimizing

construction impact.

- Grading and water features capture and infiltrate or utilize all stormwater that falls on the site, eliminating the need for a connection to the municipal storm sewer system. Non-potable water collected on-site is used for all landscape irrigation.
- A ground-source heat pump reduces energy demand from off-site, replacing carbon-based electricity with a renewable source.

Challenge

Hurdles faced during the design of Cascade Garden stemmed largely from the juxtaposition of client requests and environmental limitations. Preservation of the central pond along with the creation of viable habitat for wetland vegetation were top ecological priorities that had to be reconciled with fishing and boating requests. The existing house on the site required responsible disposal to make way for a chief client preference: a newly constructed residence that nonetheless maintains the appearance of history and permanence of the property. Stormwater and snowmelt needed to be contained on-site and used in place of traditional irrigation techniques. Above all, designing for visual aesthetics within a limited native plant palette and developing the natural beauty of the location were top priorities.

Solution

The success of the Cascade Garden project revolved around meeting traditional residential client needs using non-traditional approaches. The existing pond was deepened and planted with native wetland species to create trout habitat and meet recreational needs while maintaining pre-design water surface area. Although the existing home was dismantled, new construction was sited over the footprint of the previous building to avoid additional site disturbance, and materials and appliances were donated to local charities. The landscape plan retained mature trees across the property to lend a sense of permanence and character, while also preserving the steep slopes adjacent to the home site. Wildlife such as ducks, deer and bear, still frequently visit the site. Finally, swales collect all stormwater and snowmelt, which is repurposed for landscape irrigation.

Cost Comparison

- By installing a ground source heat pump to provide renewable energy, the design avoided approximately $97,000 dollars in current Pitkin County Renewal Energy Mitigation Program fees. Purchase and installation of the unit totaled $83,000. Annual maintenance of the pump costs $1,500 annually when averaged over the five years since installation, which is competitive with maintenance costs of traditional commercial units.

Lessons Learned

- The original planting plan for the perennial garden evolved over time as client preferences changed and limitations imposed by climate and altitude at the site became better understood. Since the installation, the landscape architect has repeatedly added new plants that are more adaptable to the unforgiving setting. The homeowners are actively engaged in this process, working with the landscape architect to identify plants that can withstand the harsh planting zone while still providing the desired visual impact. The garden serves as a reminder that great landscapes develop over a long time and with a lot of effort, both on the part of the designer, but also through devoted maintenance and client input. Educational and therapeutic opportunities were discovered through the integration of the client input into the garden design.

Project Team

Master Plan & Landscape Plan: Design Workshop, Inc.
Aquatic/Pond Consultants: Aqua Sierra, Inc.
Architect: Shope Reno Wharton Architecture
General Contractor: Hansen Construction
Landscape Contractor: Landscape Workshop

Role of the Landscape Architect

The landscape architect sited the home on the property and designed all elements exterior to the home itself including hardscape patios, gardens, pond, retaining walls, access drives, and plantings.

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Additional Images

Cascade Garden
Methodology for Landscape Performance Benefits

- ***Sequesters nearly 31,200 lbs of carbon annually in the 44 mature globe willow trees and 18 Colorado blue spruce trees that were transplanted during construction.***

Willow trees and transplanted Colorado blue spruce trees on-site were counted and measured (DBH at 4.5 ft from ground). These measurements were entered into the tree value calculator (http://www.treebenefits.com/calculator/).

The aggregate carbon reduction of the willow trees is 28,604 lb annually. The spruce trees reduce carbon by 2,586 lb annually.

28,604 + 2,586 = 31,190 lb annually

Limitations

1) Even years later, the transplanted trees did not appear to be as healthy as other trees of the same species on the property. It may be that they have lost some ability to reduce atmospheric carbon due to the stress of being transplanted.
2) Many of the willow trees were had multiple trunks. This study treated each trunk as it own individual tree as there is no option in the tree value calculator to accommodate this feature.

- ***Creates ideal trout habitat conditions with dissolved oxygen levels at or greater than 7 ppm and water temperature at or less than 60°F, following the pond redesign. Trout could not be sustained previously.***

The landscape architect worked with an aquatic consultant to improve the existing pond so that year-round trout habitat could be provided. The pond was deepened to fourteen feet and lined; oxygenators, vegetation cover, dead tree trunks, and other structures intended as rainbow and brown trout habitat were added.

Many factors are important for successful trout habitat. Data were obtained by speaking with an aquatic specialist and performing on-site analysis. According to Kendra Holmes of the aquatic consultant on the project, Aqua Sierra, after the project was installed dissolved oxygen levels were measured and recorded as greater than 7 ppm. On a visit to the site on June 17, 2013, water temperature, alkalinity, pH, and hardness were measured in four different locations using an aquarium thermometer and test strips. Measurements were taken from the furthest downstream position first, working upstream, to ensure the disturbed pond bottom did not impact water quality tests. The results are presented in Table 1.

OBJECTID	on-site pH	Depth	Temperature	Time	Alkalinity	TSS (mg SS/)L	Hardness
2882| 1	7.5	3 inches	59	1:35	130	32	124.20
2883| 2	7.5	3 inches	60	1:50	150	18	118.01
2884| 3	7.5	18 inches	NA	1:50	NA	22	125.28
2885| 4	7.8	3 inches	60	1:53	175	18	136.05
2886| 5	7.5	3 inches	58.5	2:00	120	14	118.62
2887| 6	NA	18 inches	NA	2:00	NA	33	117.61

These results can be compared to ideal trout habitat requirements shown in Table 2 below. A comparison reveals that all on-site samples were within suitable ranges.

Table 2. Suitable water quality parameters for trout. Adapted from (Boren, Baker, Cowley, & Hurd, 2003)

Parameter	Level
pH	6.5-8.5
Alkalinity	10-400 ppm
Hardness	>20 ppm
Dissolved Oxygen	5-12 ppm

Water temperature is one of the most critical factors for trout survival. Research indicates that rainbow trout survive in temperatures ranging from 33-78 degrees Fahrenheit, with optimum growth occurring between 50-55 degrees. Brown trout survive in 33-72 degrees Fahrenheit with optimum growth between 48-55 degrees Fahrenheit (Boren, Baker, Cowley, & Hurd, 2003).

The water temperature data from Table 1 was interpolated in GIS using the Kriging method to show lateral temperature trends throughout the pond. Figure 1 shows these trends in the pond and the sampling locations.

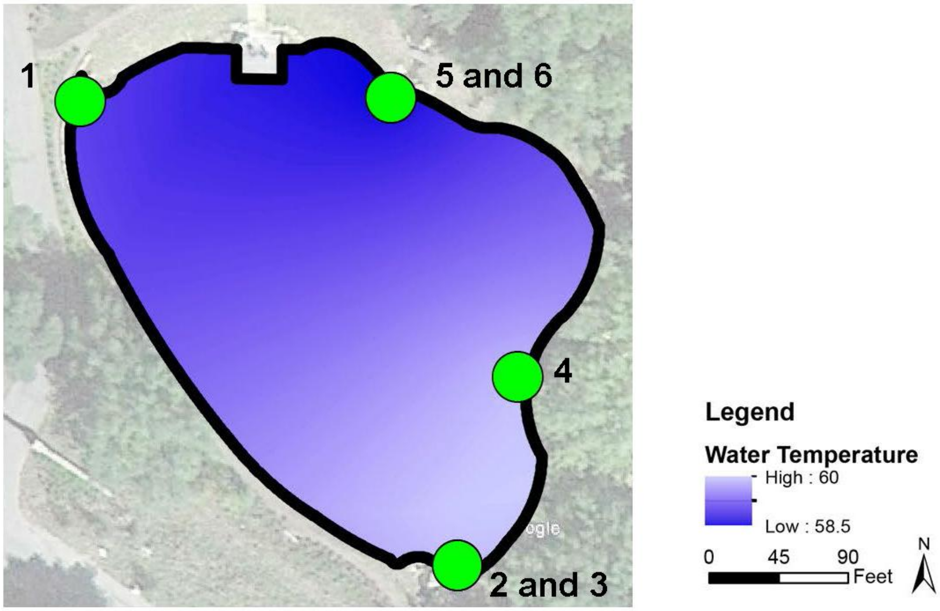


Figure 1. Water quality sampling locations #1-6 and water temperature interpolation

While temperatures were not in the “optimum” range, it is important to note that the samples were taken near the edge of the pond, in shallow water representing the worst case scenario. Information from Aqua Sierra indicated that the pond was last stocked in May of 2012, and trout were visible to the researchers.

Limitations:

1) The data gathered represents a single sample on a sunny June day. More samples on other dates would need to be tested to give a better idea of year round suitability.
2) The aquarium test strips used did not have very precise scales and some judgment was left to researchers.
3) Rainbow trout tend to hybridize with native cutthroat trout species and brown trout tend to replace native cutthroat trout species, and thus stocking non-native trout species can have unanticipated consequences on native trout. However, the Colorado Division of Wildlife has considered these potential threats and created regulations regarding stocking private ponds. It is legal to stock salmonids into private ponds, provided it is not within critical habitat areas. (U.S FWS, 2009)

• ***Reduces the project’s landfill burden by over 3,700 cu ft by donating material from the existing home to Habitat for Humanity. The recycling of the pine logs alone reduced the total amount of CO2 equivalent produced by approximately 22 tons.***

Data on what was removed from the existing home was received from the contractor, including quantities, descriptions, and sizes. Some items did not have a size, so an estimate was made based on accompanying photographs. The total volume of material donated was assessed by multiplying the length, width, and height of each item, then totaling those results

The average weight for pine timber used in construction was obtained from the American Wood Council (available from http://www.awc.org/pdf/WSDD/wsdd.pdf, page 9). The weight for Western White Pine is 27.2 lb/cu ft. The volume of pine logs donated was 847.25 cu ft and the total weight was 23045.15 lb, or 11.52 tons.

Using the EPA’s Waste Reduction Model (WARM) calculator (http://epa.gov/epawaste/conserve/tools/warm/Warm_Form.html), the effect of recycling the 11.52

tons of wood compared to sending it to the local landfill (local landfill is 13.1 miles from the site) was assessed using the tool. It was found that approximately 20 metric tons of carbon dioxide equivalent were saved.
20 metric tons = 22 short tons

Limitations

1) The data on what was removed from the home is not all-inclusive. Anecdotal reports suggest that other material was also removed, including a trampoline and copper roofing. While these items may not have been donated, it does lead one to suspect that the inventory was not complete.
2) The volume of items such as lamps and ceiling fans was estimated from photographs as the items themselves were not measured at the time and not available to researchers when the study was being conducted.
3) The carbon dioxide equivalencies of the logs were calculated using a tool that considers them as lumber, which though a close approximation, is not exactly the same.

• ***Reduces irrigation and fertilizer needs by nearly 60% by replacing 5,020 sf of turf with native plants . This saves over 75,000 gallons of water and eliminates the need for 30 lbs of fertilizer annually.***

Existing turf was determined by surveys, photographs and AutoCAD files of the property prepared for demolition of the existing house.

Existing turf on the property covered approximately 8,650 sf.

Current turf on the property was determined through planting plans for the current property.

Current turf on the property covers 3,630 sf.

8,650 – 3,630 = 5,020 or a reduction of approximately 5,020 sf of turf.

Irrigation water naturally flowing through the site is detained in the on-site pond. Some of this irrigation water is recirculated through a stream course and cascade above the pond using a pump that is turned on only when homeowners are present. Irrigation water is pumped out of the pond and applied to turf areas through a standard irrigation system.The current maintenance contract for the turf areas on the property calls for one inch of irrigation per week during the 24 weeks of the maintenance (snow-free) season and two pounds of fertilizer per 1,000 square feet three times per year for turf grass.

2 lb / 1,000 sf X 3 times per year = 6 lb / 1,000 sf per year
6 X 8.65 = 51.9 lb of fertilizer were needed in previous condition
6 X 3.630 = 21.78 lb of fertilizer are needed in current condition
51.9 – 21.78 = 30.12 lb of fertilizer saved annually
30.12 / 51.9 = 0.58 or 58% reduction in fertilizer use
1 in per week X 24 weeks = 24 in
24 in = 2 ft
2 X 8,650 = 17,300 cu ft of water needed to irrigate previous condition
2 X 3,630 = 7,260 cu ft of water needed to irrigate current condition
17,300 – 7,260 = 10,040 cu ft of water saved annually
1 cu ft = 7.48 gallons
7.48 X 10,040 = approximately 75,099 gallons of water saved annually

Limitation

1) The surveys used to discover the amount of turf previously existing on site mark the lawn areas as “approximate” and thus are not exact figures.

• ***Blocks approximately 97.8% of unwanted views with earth berming, plantings, and retention of mature trees to reduce visibility of traffic on the nearby road from key points on***

the property.

The procedure below followed the methodology developed by Clay and Marsh (1997) and Chen *et al.* (2009).

Panoramic photographs were taken from a key point on the property: the seating area on the middle tier of the patio (Figure 2). This location was chosen for its obvious use by the homeowner as a primary area from which to enjoy the scenic view of the mountains over the pond.

Figure 2. Panoramic photograph showing the view from the patio

The photographs were taken as a red Toyota Prius drove down the road directly abutting the south edge of the property. A photograph of the Pruis was also taken (Figure 3).

Figure 3. Photograph of Toyota Prius

Figure 4. Color Overlay matching the Prius' outline

The photograph was imported into Adobe Photoshop where a color overlay was applied to give the car a solid color. The image was flipped vertically to match the direction of travel of the Prius in the panoramic photo (Figure 4). The image was resized in Photoshop to match the scale of the car as it appears in the photograph. The image of the car was then copied and pasted repeatedly to create a swath from one end of the property to the other that is representative of the total area the vehicle would occupy when traveling on the road (Figure 5). This is the visual area that would be occupied by a vehicle if no buffer were present between the viewer and the road.

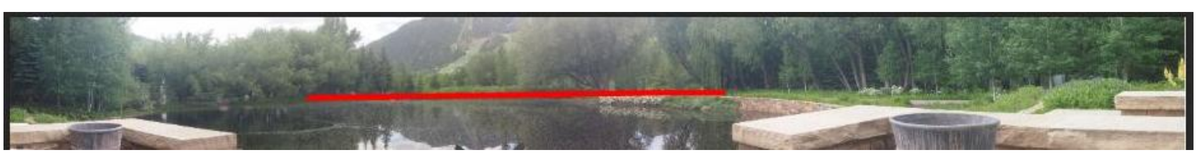


Figure 5. The line of travel swath layered atop the panoramic photograph

The histogram feature in Photoshop was used to measure the number of pixels present in the swath layer (Figure 6). This is the number of pixels that would be visible if no buffer were present.

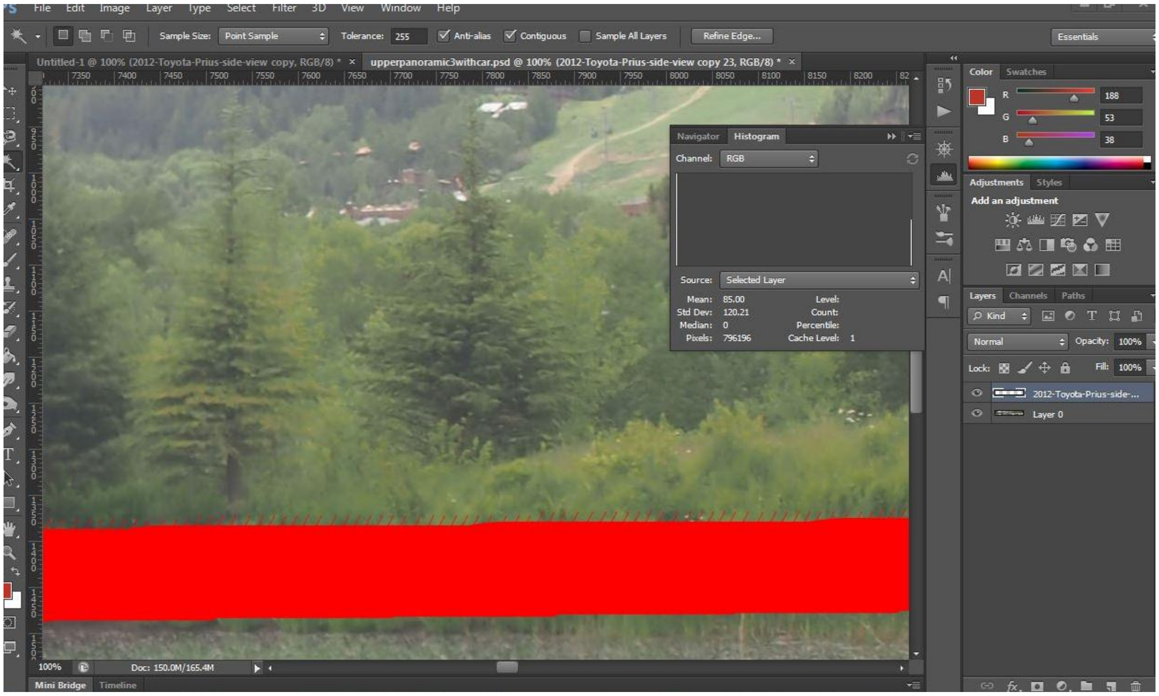


Figure 6. Pixel count for the selected layer (the traffic swath)

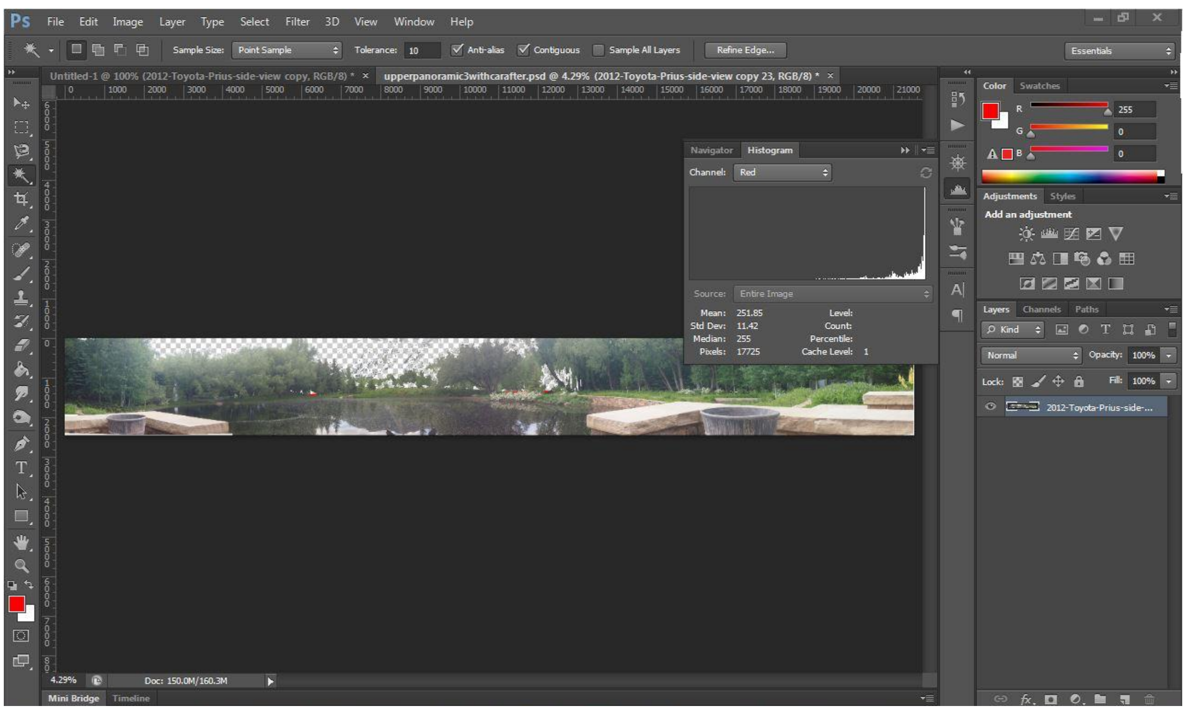
There are a total of 796,196 pixels in the swath. Note that the Cache Level on the Histogram has been set to 1 to ensure that the entire layer is being evaluated, not a random selection (to save time Photoshop will often survey a random selection of pixels to create the histogram, thus limiting the count to ¼ or ½ the actual number present).

The swath layer was moved underneath the panorama layer and the wand tool, set on a very low tolerance, was used to erase those parts of the panorama image that lie on the far side of the road (Figure 7). This revealed the swath in just those areas that are not covered by berms, plantings, fences, or gates on the property.

Figure 7. Removing the background revealed the visible parts of the traffic swath.

Finally, the layers were merged and the visible parts of the traffic swath were selected. The histogram function was used again to determine how many visible pixels from the swath remained (Figure 8).

Figure 8. The histogram reveals how many pixels are visible



A total of 17,725 pixels are visible.
17,725 / 796,196 = 0.02226 or approximately 2.2%.
100% – 2.2% = 97.8% of the view of traffic is blocked.

Limitations

1) The use of the Toyota Prius as a metric for the traffic swath is a limitation. Obviously other types of vehicles (trucks, motorcycles, etc.) would yield different results. We chose the Prius because it is a popular, average-sized vehicle and because that was the only car available at the time of the study.
2) The distance from the point of photography to the road, while nearly constant, is not perfectly

so. Therefore, the scale of the car would vary slightly, becoming smaller and less visible towards the edges of the photograph while we relied on a standard size for our swath.

Methodology for Cost Comparison

• **By installing a ground source heat pump to provide renewable energy, the design avoided approximately $97,000 dollars in current Pitkin County Renewal Energy Mitigation Program fees. Purchase and installation of the unit totaled $83,000. Annual maintenance of the pump costs $1,500 annually when averaged over the five years since installation, which is competitive with maintenance costs of traditional commercial units.**

The ground source heat pump provides renewable energy for the snowmelt system and spa. The total square footage of the spa and snowmelt areas was determined by measuring their area on construction documents. The totals are as follows:
Spa = 108.75 sf
Snowmelt = 2095.31 sf

The calculator used to assess current Pitkin County Renewable Energy Mitigation Program (REMP) fees is available from http://www.aspenpitkin.com/Departments/Community-Development-Pitkin-County/Building/Building-Energy-Codes/.

Total fees: $97,183.47

According to the landscape architect, the heat pumps are manufactured by Water Furnace and cost approximately $28,000 to install. The cost of drilling, field pipe, and grout was an additional $55,000. The annual maintenance cost of the units is approximately $1,500 annually averaged across the past five years (since installation) which is competitive with traditional commercial systems.

$28,000 + $55,000 + $1,500 x 5 = $90,500 total cost to date.

Limitations

1) The calculations are based on current Pitkin County REMP calculations. The calculations for the date of installation were not available, and though comparable would likely have been less.
2) The figures used for the cost of installation and maintenance are estimates from the landscape architecture firm, not exact figures.

References

Boren, J., Baker, T. T., Cowley, D. E., & Hurd, B. J. (2003). Growing Trout in New Mexico Ponds. New Mexico State University, Cooperative Extension Service, Guide L-108. Retrieved July 5, 2013, from http://www.nmworkssouthern.nmsu.edu/pubs/_l/L108.pdf

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