Magnuson Park Wetlands and Active Recreation – Seattle, WA
Methodology for Landscape Performance Benefits
Prepared By:
Research Fellow: Nancy Rottle, Associate Professor, University of Washington
Research Assistant: Delia Lacson, MLA Candidate, University of Washington
Research Assistant: Jessica Michalak, MLA Candidate, University of Washington
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Environmental

Reduces suspended solids by 94%, fecal coliform bacteria by 99%, and increases dissolved oxygen by 32% as stormwater runoff travels through wetlands, according to monitoring data.

The improvement in water quality is a crucial element to the design. The created wetlands improve water quality before the water is discharged directly into Lake Washington. Due to the onsite soil compaction that remains, the park as a whole still has very low infiltration rates. This project is an example of a design focusing on water quality treatment over water quantity reduction.

Water from neighboring sites is directed through the ponds and wetland systems. Previously this water was all discharged, via sub-surface pipe, into Lake Washington without intensive treatment. The combined source measurements take into account rainwater that falls on the site and the water from the neighboring areas.

The benefits of phytoremediative stormwater treatment is quantified based on the calculation of percent change using this equation:

Percent Change= (|y1-y2|/ y1)*100% or (|change|/original value) x 100%

Where y1=combined source measurement and y2=outfall measurement[1].The measurements are an average of measurements gathered from 11/4/09-6/21/10.

Suspended Solids
Combined Source: 318.6 $^{mg}/_{L}$
Outfall: 17.7 $^{mg}/_{L}$
Change: |318.6 $^{mg}/_{L}$ - 17.7 $^{mg}/_{L}$| = 300.9 change
Percent: (300.9/ 318.6) x 100= 94.44% decrease

Fecal Coliforms
Combined Source: 3,081 $^{CFU}/_{L00\ mL}$
Outfall: 41 $^{CFU}/_{L00\ mL}$
Change: |3,081$^{CFU}/_{L00\ mL}$ - 41 $^{CFU}/_{L00\ mL}$|= 3040 change
Percent: (3040/ 3,081) x 100 = 98.67% decrease

Dissolved Oxygen
Combined Source: 7.16 $^{mg}/_{L}$
Outfall: 9.47 $^{mg}/_{L}$
Change: |7.16 $^{mg}/_{L}$ - 9.47 $^{mg}/_{L}$|= 2.81 change
Percent: (2.81/ 6.66) x 100 = 32.26% increase

Increased species richness in the park, as represented by a 255% increase in the Pacific Chorus Frog larvae population and an increase from 18 to 21 species of dragonfly or damselflies from 2010 to 2011.

The rice paddies have proven to be a successful habitat for the Pacific Chorus Frog. The rice paddies were designed specifically to encourage the population growth of the PCF while reducing the potential for growth in invasive species (bullfrogs).

The increase in the population of Pacific Chorus Frogs was calculated by determining the change in population, as indicated in the monitoring reports from 2010 and 2011. The formula and work are as follows:

Percentage Change= (|y1-y2|/ y1)*100% or (|change|/original value) x 100%

Where y1=2010 count of PCF Larvae and y2=2011 count of PCF Larvae[2]

Change in Pacific Chorus Frog Population
2010 Count of PCF Larvae: 82
2011 Count of PCF Larvae: 291
Change: |82 - 291| = 209 change
Percent: (209/ 82) x 100= 254.87% increase

Additionally, the presence of dragonflies and damselflies in the park as a whole has been observed and recorded by an expert. His data is also included in the monitoring reports. The addition of three more species to those observed from prior years brings the total of species observed in the park to 21.[3] The increases in both populations show the growth of biodiversity in the park as well as more growth outlined in the monitoring reports.

Avoided 985 tons of carbon dioxide emissions by reusing or recycling over 12,750 tons of asphalt and concrete from the site as compared to traditional landfill disposal.

Over 150,000 SF of asphalt was recycled offsite, and over 200,000 SF of concrete was kept out of landfills through on onsite reuse. That recycling prevented 200 truck trips from Seattle streets. Non-traditional material disposal and sourcing prevented the emissions of 985 metric tons (MT) of carbon dioxide (CO2) through on-site re-use and recycling versus traditional methods, valued at $11,820.

These figures were calculated by assuming a 6" depth of concrete and asphalt paving[4]. Multiplying that depth by the square footages provided by the Berger Partnership for each of re-used or recycled material. From the cubic foot measurements the density[5] of each substance was found and used to calculate the weight, which was then converted into tons.

Concrete
200,000 sf x .5 f= 100,000 cf x 150 $^{lbs}/_{cf}$ = 15,000,000lbs/2,000 $^{lbs}/_{ton}$=7,500 tons

Asphalt
150,000 sf x .5 f= 75,000 cf x140 $^{lbs}/_{cf}$ = 10,500,00 lbs/ 2,000 $^{lbs}/_{ton}$ = 5,250 tons

Those calculated values were used in the Waste Reduction Model **(**WARM) calculator to compare the amount of CO2 produced from landfilling verses recycling the materials[6]. The calculator can be found at: http://www.epa.gov/climatechange/waste/calculators/Warm_home.html The total amount of CO2 prevented by recycling the asphalt and concrete was 985 MT of CO2.

After determining the metric tonnage of CO_2 the market value of this conserved amount was estimated using the Green Infrastructure Guide's range of high and low values.[7] The range is

large since CO_2 values are not a solidly defined commodity, and therefore this estimate is not reported in the case study.

Low Value CO_2: $12/MT[8]
High Value CO_2: $85/MT[9]

Market Value Range
985 MT x $12/MT=$12,000
985 MT x $85/MT= $84,000

Social

Has provided hands-on volunteer and educational opportunities to 2,500 students and approximately 1,000 park and wetlands land stewards and maintenance volunteers. Activities include tree plantings, nature experiments, data collection, invasive species removal, and establishing native plantings.

The park creates increased opportunities for human interface, interactive learning, and stewardship. Through educational collaboration with the Magnuson Outdoor Learning Lab, over 556 6th-8th grade students from urban neighborhoods experienced and interfaced with nature, though experiments, data collection, invasive species removal, while exploring biodiversity in Magnuson Park from 2006-2008. [10] Over 2,000 student volunteer hours were contributed in the course of three years and over 100 native trees and shrubs were planted.[11]

Through collaboration with local businesses over 986 individuals, from 30 groups, have donated time to the stewardship and maintenance of the park as of July 2011. Wetland maintenance volunteers have met, weekly or monthly, on Saturday in the park 59 times as of July 2011***. [12]***

Cost Comparison Methods

By reusing 2,700 cubic yards of concrete from the site as subbase for the synthetic turf fields, the project saved $95,000 in materials and delivery costs. This also served to avoid 3,600 vehicle miles and 11.8 tons of carbon emissions that would be produced in transporting this volume of gravel to the site.

This value is simply comparing the expected cost of a like material and delivery charges being used in place of the recycled concrete in the sub base of the synthetic turf fields, it is not calculating any of the associated labor for either scenario. The quote was received from Salmon Bay Sand and Gravel, a local supplier. The quoted of value of materials and delivery was $94,674[13]. The vehicle miles and carbon emissions were calculated by multiplying the distance between the supplier and job site by the number of trips required to transport all of the material. It would have taken 270 trucks travelling 6.7 miles each way to transport the volume of material recycled onsite. Using those numbers it was possible to calculate the amount of carbon emissions of the trucks, laden and unladen. Formulas for estimating emissions from trucks and product transport were used to estimate carbon reductions. Ton-miles were used to estimate carbon emissions driving from the supplier to the site with 14.1 tons of 1” minus gravel. The tonnage per truck was calculated by multiplying the capacity of the truck in cy by the weight of the material in tons/cy.

Emissions for laden trucks
Ton-miles: 6.7 miles x 270 trips x 14.1[14] tons per trip = 25,506.9 ton-miles
Carbon dioxide per ton-mile: 0.297 kg CO_2/ton-mile[15]
Kg to lbs: 2.2 lb/kg x 0.297 kg CO_2/ton-mile = 0.653 lbs. CO_2/ton-mile
Total lbs. CO_2: 0.653 lbs. per ton-mile x 25,506.9 ton-miles = 16,656 lbs. CO_2
Tons CO_2: 16,656 lbs. CO_2/2000 lbs. = 8.328 tons CO_2

Emissions for unladen trucks
Vehicle-miles: 6.7 miles x 270 vehicles = 1,809 vehicle-miles
Emission Factor for On-Road Vehicle Product Transport (vehicle-mile) Medium- and Heavy-duty Truck: 1.726kg CO2/vehicle-mile[16]
Kg to lbs: 1.726 kg CO_2/v-m x 2.2 lb/kg = 3.797 lbs. CO_2/vehicle-mile
Total lbs. CO_2: 3.797 lbs. CO_2/vehicle-mile x 1,809 vehicle-miles = 6,868.773 lbs. CO_2
Tons CO_2: 6,868.773 lbs. CO_2/2000 lbs. = 3.434 tons CO_2

Total Tons CO_2: 10.5 tons CO_2+ 3.434 tons CO_2= 11.762 tons CO_2
Total Vehicle Miles:1,809 miles x 2 (round trip)= 3,618 miles

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[1] Values can be found on Table E-1, page E-7 in the Year 1 Monitoring report Appendix E on Magnuson Park http://www.seattle.gov/parks/ProParks/projects/magnuson_appendix_E.pdf

[2] PCF counts can be found in Table E-16, page E-26 and in Table E-16, page E-26 of 2010 and 2011, respectively. "Magnuson Monitoring Report—Year 1, Appendix E". 2010. http://www.seattle.gov/parks/ProParks/projects/magnuson_appendix_E.pdf and "Magnuson Monitoring Report—Year 2, Appendix E". 2011. http://www.seattle.gov/parks/ProParks/projects/magnuson_phase_2_year_2_2011.pdf

[3] Dragonfly and damselfly data can be found in Table E-17, page E-29 and in Table E-17, page E-29 of 2010 and 2011, respectively. "Magnuson Monitoring Report—Year 1, Appendix E". 2010. http://www.seattle.gov/parks/ProParks/projects/magnuson_appendix_E.pdf and "Magnuson Monitoring Report—Year 2, Appendix E". 2011. http://www.seattle.gov/parks/ProParks/projects/magnuson_phase_2_year_2_2011.pdf

[4] 6" value based off standards found in Landscape Architectural Graphic Standards, Student Edition on pages 267 and 270 respectively, assuming that because of the heavy vehicle weights at an airbase the roads would have been constructed as thick or thicker than for secondary road surfaces. Hopper, Leonard J., ed. *Landscape Architectural Graphic Standards*. Student ed. Wiley, 2007.

[5] Density values for calculations: 150 lbs/cf concrete, graphic standards for LA pg 489, Asphalt concrete140lbs sf. "Weight Per Cubic Foot And Specific Gravity (Typical) from READE", n.d. http://www.reade.com/resources/reference-charts-particle-property-briefings/89-weight-per-cubic-foot-and-specific-gravity.

[6] The values from the WARM calculator are: 491 *MT of* CO_2 reduction (59 from concrete, 432 from asphalt) and 494 *MT of* CO_2 projected increase from traditional disposal (291 from concrete, 204 from asphalt) totaling a net change of 985 *MT of* CO_2.

[7] The values are found on page 46 of the document. Waterhouse, Kalle Butler, The Value of Green Infrastructure: A Guide to Recognizing Its Economic, Social and Environmental Benefits. The Center for Neighborhood Technology. Digital.

[8] IBID.

[9] IBID.

[10] This information is found in the MOLL 2007 and 2008 annual reports. The total is of student participants from 2007 and 2008. Those are found on page 2 of the 2007 report (200+) and on page 2 of the 2008 report (356). "Magnuson Outdoor Learning Lab - Burke Museum", 2007. http://www.burkemuseum.org/education/moll_annual07 and "Magnuson Outdoor Learning Lab - Burke Museum", 2008. http://www.burkemuseum.org/education/moll_annual08 .

[11] This information is found in the MOLL 2007 annual report on page 4. "Magnuson Outdoor Learning Lab - Burke Museum", 2007. http://www.burkemuseum.org/education/moll_annual07.

[12] This is a total of the volunteer information available in the Otak monitoring reports from 2010 and 2011. Volunteer information can be found in Table E-10, page E-17 and in Table E-10, page E-18 of 2010 and 2011, respectively. "Magnuson Monitoring Report—Year 1, Appendix E". 2010. http://www.seattle.gov/parks/ProParks/projects/magnuson_appendix_E.pdf and "Magnuson Monitoring Report—Year 2, Appendix E". 2011. http://www.seattle.gov/parks/ProParks/projects/magnuson_phase_2_year_2_2011.pdf

[13] Quote from Salmon Bay Sand and Gravel: $72,954.00 for 2702 cy of 1" minus gravel delivered, $9,457.00 environmental fee, $4,050.00fuel surcharge, $8,213.80 9.5% tax, totaling $ 94, 674.80 Buff Judah, material quote for Jessica Michalak, November 29, 2011, Invoice No: 5862901

[14] 10 cy truck x 1.41 ton/cy= 14.1 tons/truck. The value for 1" minus gravel was found at: "Converting Cubic Yards to Tons - OnlineConversion Forums", n.d. http://forum.onlineconversion.com/showthread.php?t=1670.

[15] See Table 5 in EPA Climate Leaders, pages 10. "EPA Climate Leaders: Greenhouse Gas Inventory Protocol Core Module Guidance", May 2008. http://www.epa.gov/climateleaders/documents/resources/commute_travel_product.pdf

[16] See Table 6 in EPA Climate Leaders, page 11. "EPA Climate Leaders: Greenhouse Gas Inventory Protocol Core Module Guidance", May 2008. http://www.epa.gov/climateleaders/documents/resources/commute_travel_product.pdf