



City of
OLYMPIA

Structural Soil Demonstration Project

By:

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This project made possible in part by a grant from
The United States Department of Agriculture, US Forest Service, and
The Washington State Department of Natural Resources, Urban and Community Forestry Program

City of Olympia Structural Soil Demonstration Project

For years “urban foresters” have been searching for the answer to one of life’s eternal questions. What is the perfect street tree species that can thrive in the compacted soils of a “downtown” environment and not disrupt sidewalks?

In the past, like most municipalities, Olympia would simply cut a 4’ x 4’ square in the sidewalk, plant a tree and wait until one of two things typically occur. The tree would go into decline and eventually die from lack of adequate soil volume or the tree roots would destroy the sidewalk. Not until the last few years have there been any real options for dealing with this problem.

In the early 1990’s, researchers started to identify the problem at its most basic level. Trees need a significant quantity of soil for adequate growth. Research has shown an average tree with a canopy of 30-40 feet in width will need at least 1500 cubic feet of soil (equivalent to a pit 3 feet deep, 10 wide and 50 feet long). Additionally, when soil is compacted to meet engineering standards for supporting a sidewalk, the macro pore space is driven out and the soil can no longer support the growth of roots.

To find a solution that would create enough soil volume for adequate tree growth and also support a sidewalk, researchers developed the concept of a special planting mix commonly referred to as “Structural Soil”. Structural Soil is typically comprised of about 80% closely graded crushed rock, 20% soil, and minor amounts of various materials that bind with the soil to keep it from settling out of the mix over time. When mixed and installed under sidewalks this “structural soil” can be compacted so it will support a sidewalk and provide adequate macropore space to support the growth of tree roots.

Most notable of the researchers working on this concept is Dr. Nina Bassuk, of Cornell University. Dr. Bassuk and her associates at Cornell University have developed their own special version of “Structural Soil”. In fact, Cornell has patented and trademarked their structural soil under the name 'CU-Soil' to insure quality control. For more information about Cornell’s structural soil, you can visit their web page at: <http://www.cals.cornell.edu/dept/flori/uhi/pubs.html> where detailed information about “CU-Soil” can be found and downloaded.

In Olympia we installed “structural soil” as one element of a downtown street tree-planting project. Approximately 100 linear feet of sidewalk were removed along one block face. The existing soil was removed to a depth of 36 inches and then replaced with structural soil. A new sidewalk was then built over the structural soil and three new trees were planted back into the structural soil through 4’ X 4’ holes in the sidewalk. As a control for our project, we planted four additional trees of the same size and species directly across the street, into a typical compacted native soil under a standard sidewalk. Over time, we will compare the growth rates of trees both in structural soil and in the more typical compacted soil. By comparing the trees in both settings, we will be able to gauge the effectiveness of structural soil.

For our project we used a slightly different “recipe” for structural soil than the 'CU-Soil' developed by Cornell University. We used a structural soil recipe, developed and utilized by the City of New Westminster, British Columbia, that uses a product called “soil stabilizer” instead of the hydrogel specified in the “CU-Soil”. Our engineers thought the hydrogel (with its water loving properties)

might be problematic here in the Pacific Northwest, with our heavy winter rains. New Westminster has been using their soil mix for over 5 years and has had very positive results comparable to the CU-Soil.

After an initial trial period, if our structural soil proves to be successful, we plan to incorporate it into our engineering and development standards and utilize it in both public and private development projects.

More detailed information, the engineering specifications, and cost estimates for installation are available from the City of Olympia's Urban Forester at (360) 753-8046, or the Department of Natural Resources, Urban and Community Forestry Program.

The project site, located on the South East corner of State Street, and Jefferson Avenue, is on public property and can be visited at any time. Guided tours may be arranged by contacting the City of Olympia's Urban Forester.

**City of Olympia
Structural Soil Demonstration Project
2001-2004**

		2001	2001	2001	2002	2002	2003	2003	2004	2004
Tree Number	Tree Species	CAP	C	TBG	C	TBG	C	TBG	C	TBG
Cc1	Norwegian Sunset Maple Acer platanoides x truncatum	2.0								
Cc2	Norwegian Sunset Maple Acer platanoides x truncatum	2.25								
Cc3	Norwegian Sunset Maple Acer platanoides x truncatum	2.25								
Cc4	Norwegian Sunset Maple Acer platanoides x truncatum	2.0								
Ss1	Norwegian Sunset Maple Acer platanoides x truncatum	2.0								
Ss2	Norwegian Sunset Maple Acer platanoides x truncatum	1.75								
Ss3	Norwegian Sunset Maple Acer platanoides x truncatum	2.0								

Cc1-cc4 = Trees planted as control in typical compacted subgrade.

Ss1-Ss3 = Trees planted in Structural Soil.

CAP = Caliper at Planting. Caliper in inches taken at the time of planting, six inches above root ball.

C = caliper in inches, six inches above root ball (measurement taken at the end of the growing season)

TBG = Average terminal branch growth in inches for the current year (measurement taken at the end of the growing season)

Structural Soil Write up

Craig Tosomeen

May 29, 2001

This report consists of the following sections

- Project Description
- Specifications
- Physical Tests
- Costs
- Lessons Learnt
- Parking Lot Pavement Design
- Figure and Attachments

Project Description

Structural soil consists of a mixture of crushed rock, topsoil, soil binder and water.

More information here about project and what we are doing

The materials used in the demonstration project are:

Rock = Crushed stone (3/4 inch to 1 1/4 inch) locally known as rail road rock

Topsoil = Organic loam, locally available.

Soil Binder = Stabilizer, a patented non-toxic organic binder

Water = Potable water

Specifications

Structural soil specifications for the project are given below. (Note this section is an extract from the project specifications)

1 Structural Soil

Structural soil shall consist of a mixture of gravel, soil and admixtures as described below. The following sources are approved to supply the materials. Other sources may be approved, based upon satisfactory test results however, it is the contractor's responsibility to provide the required information or testing needed to approve the source.

2 Materials

Structural Soil shall consist of the following materials:

1. Crushed rock ("3/4" to 1 1/4")
2. Loam/organic Topsoil
3. Soil Binder such as 'Stabilizer'
4. Water

Approved suppliers of the materials are:

1. "Railroad Rock" Jones Quarry 2840-C Black Lake Boulevard SW Tumwater WA 98512 Ph (360) 352-1022.
2. "Organic Topsoil" Jones Quarry 2840-C Black Lake Boulevard SW Tumwater WA 98512 Ph (360) 352-1022.
3. Soil Stabilizer Gibson's Nursery and Landscape Supply South 1401 Pines Road Spokane WA 99206 Ph (509) 928-0973.
4. Any portable water source.

2. (1) Proportions of materials

The major components of the structural soil mixture are crushed rock and topsoil. Since when mixed together some of the topsoil fills in the voids of the crushed rock material the sum of the rock and topsoil volumes does not equal the volume of the structural soil material. There is approximately a 10% volume reduction due to mixing the materials together.

Material	Amount for 1 CY of Structural Soil	Amount for 4.6 CY of Structural Soil
Crushed Rock	23.2 cubic feet	4 cubic yards
Topsoil	5.9 cubic feet	1 cubic yard
Soil Binder	13.7 oz	4 pounds
Water	1.6 gallon	46 gallons

The target moisture content is 20% by weight of the topsoil weight. The above water contents assume the top is 'dry'. The amount of water that will need to be added will be dependent on the moisture content of the raw materials. Actual amounts of water used will be determined during mixing.

2. (2) Mixing procedure.

- 1) Mix structural soil in batches of an appropriate size for the equipment being used. The end result is to be a material that is uniformly blended together. Do not batch in quantities that will not allow the equipment to completely mix the material. Determine batch size and quantities of each material needed for the batch.
- 2) Start with half of the crushed rock material.
- 3) Add all of the topsoil material.
- 4) Add the soil binder.
- 5) Add half of the estimated water.
- 6) Add the other half of the crushed rock material.
- 7) Mix the material together.
- 8) Slowly add water to the mixture and continue to mix. The final amount of water will vary with moisture content of the crushed rock and topsoil. Add water in incremental amounts and mix the material between the additions of water.

- 9) Stop adding water and mixing when there is a minute amount of free topsoil remaining. The topsoil will coat the crushed rock and not fall out of the material. All of the crushed rock should be uniformly coated with topsoil. There should be no clumps of topsoil or uncovered crushed rock in the mixture.
- 10) If too much water is added to the mixture water will drain out of the material and the topsoil will wash off of the crushed rock. If this occurs this batch of material is to be discarded and shall not be incorporated into the completed work.

3. Placement

Protect soils and mixes from absorbing excess water and from erosion at all times. Do not store materials unprotected from rainfall events. Do not allow excess water to enter site prior to compaction. If water is introduced into the material after grading, allow material to drain or aerate to optimum compaction moisture content.

All areas to receive Structural Soil mixture shall be inspected by the Engineer before starting placement of mixture. All defects such as incorrect grading, compaction and inadequate drainage, etc., shall be corrected prior to beginning placement of Structural Soil.

Confirm that the sub-grade is at the proper elevation and compacted as required. Sub-grade elevations shall slope parallel to the finished grade. Clear the excavation of all construction debris, trash, rubble and foreign material. Fill any over excavation with approved fill and compact to the required sub-grade compaction.

Install Structural Soil in 6-inch lifts and compact each lift to 85 percent of maximum density. Delay compaction 24 hours if moisture content exceeds maximum allowable and protect Structural Soil with plastic or plywood as directed by the Engineer.

The water service lines that cross the structural soil material fill area may be corroded and fragile. The contractor shall take particular care when working around the water service lines. If a service line is damaged, develops a leak or is bent, the service line shall be replaced as per City of Olympia standards at the contractor's expense. The structural soil that will be the bedding for the water service lines shall compacted to conform to the grade of the water service line. The contractor shall not compact the immediate vicinity above a water service line until a fill depth of 12-inches above the water service line is reached.

Bring Structural Soils to finished grades as shown on the drawings. Immediately protect the Structural Soil material from contamination by water by covering with plastic or plywood as directed by the Engineer.

The Engineer may periodically check the material being delivered and installed at the site for mixture proportions and consistency with the material requirements of these specifications. In the event that the installed material varies significantly from the specified material, the Contractor shall remove the material and replace with the specified Structural Soil material at no extra cost to the Contracting Agency.

4 Measurement

Structural Soil per cubic yard shall be measured by the neat lines as shown on the plans.

5 Payment

Payment of the bid item "Structural Soil" per cubic yard shall include all costs to supply, mix, haul, place and compact the structural soil material. All costs associated with subgrade preparation shall be included in this bid item.

Physical Tests

Some physical test were performed on the native material and structural soil mixture. The results of the tests are summarized below:

Rock

Crushed Rock, Gradation of 100% passing 1.25 inch, 26% Passing 0.75 inch, 4% passing 0.25 inch and 0.5% passing No 40 sieve by weight.

Soil

ASTM D2487 Soils Classification SW-SC Well-graded Sand with Silty Clay. With a composition of 9% Gravel, 81% Sand, 8% Silt and 2% Clay. Organic Content of 8.3% dry weight.

Stabilizer

Stabilizer as supplied by Stabile Inc. 2218 E magnolia Street Phoenix Arizona 85034 USA (602) 225-5900 & 1(800) 336-2468 Phone (602) 225-5902 Fax

Structural Soil

Compaction and bearing tests were performed on the structural soil mixture. The proctor density of the material was 138.7 pounds per cubic foot. The California Bearing Ratio (CBR) value at 100% density was 74. Figure 1 presents the relationship between percent compaction, CBR value and percent voids. Figure 1 shows the how the amount of voids declines with compaction highlighting the need to not compact the material.

Since a high voids content was desired, 85% compaction was the target for the project. This resulted in a CBR value of 30. Subgrades in Olympia are compacted to 95% under roads and 90% under non-traffic areas. Generally if this compaction reaches a CBR value of 20 it would be adequate for supporting our standard 4-inch concrete sidewalk or standard roadway sections. A CBR value of 30 provided sufficient bearing capacity for the sidewalk and provided about one third voids content in the structural soil.

Costs

There were 9 responsible bidders for the structural soil demonstration project. The area of structural soil was 100 feet long, by 10 feet wide by 3 feet deep, with a volume of 114 cubic yards. The demonstration project work included removing and replacing a sidewalk above the structural soil. The construction costs of the bids ranged from \$21,600 to \$31,300 with an average bid of \$25,900. The price to supply, deliver and install the structural soil material per cubic yard ranged from \$19 to \$85 with an average bid of \$42, the median price was \$39.50. The city paid \$24 per cubic yard for the structural soil material to the low bidder.

This compare to a price quote we received for the supply of CU structural soil at \$65 per cubic yard plus delivery. The source was over an hour's drive away and delivery charges were \$85 per hr with a truck and trailer hauling 22 cubic yard. The expected cost delivered was \$72 per cubic yard.

The engineering and inspection cost of the project was \$12,700 dollars. This is a higher percent of the construction costs than usually expected with a project. The additional cost came from developing the structural soil material.

Lessons Learnt

From our experience with mixing and placing the structural material there were several points that became evident through the project. These lessons learnt are summarized below:

- Structural soil did not need compaction to reach 85% of max proctor. It was evident that placing and spreading the material was sufficiently compacted to reach 85% compaction.
- Materials must be readily available locally if the price of the structural soil material is to be as cost competitive as possible. Trucking the material long distances does not make economic sense.
- Mixing takes time. There is no free soil when mixture is ready. The soil should completely and uniformly coat the rock. A more appropriate name for the mixture would be dirty rock rather than structural soil.
- Over compaction could be a problem with this material. Since the proctor test showed that the voids content goes down significantly with increasing density it was important not to compact this material pas the 85% value.

Parking Lot Pavement Design

Parking lots in the city of Olympia are typically designed to our local access roadway standard. This standard requires a design 18 Kip equivalent axial load of 50,000 trips. The minimum section is 3 inches of asphalt cement, 2 inches of crushed surface top coarse (CSTC) over 10 inches of gravel base.

Structural soil can be replaced for the gravel base. Over a very soft un-compacted subgrade, 25 inches of structural soil is needed. Over a fine grade subgrade 10 inches of structural soil is needed.

The Pavement section would then be:

<i>Soft Subgrade</i>	<i>Fine Grained Subgrade</i>
3 inch Asphalt Cement	3 inch Asphalt Cement
2 inch Crushed Surfacing Top Coarse	2 inch Crushed Surfacing Top Coarse
Geotextile separation layer	Geotextile separation layer
25 inch Structural Soil	10 inch Structural Soil
Soft un-compacted subgrade	Grainular -compacted subgrade

On soft clay material an additional layer of geotextile would be needed beneath between the structural soil and the subgrade

Pavement design data is given in the attachments

Figures

Figure 1. Structural Soil Physical Properties

Attachments

Soil Gradation

Soil Stabilizer Advertisement

Structural Soil Proctor

Bid Tabs

Plan Sheets

Parking Lot Pavement Design with Structural Soil

City of Olympia Structural Soil Demonstration Project Spring 2001



Project site before construction, South side of State Ave. Looking West.



Project site before construction, South side of State Ave. Looking East.



Control Site, North Side of State Ave., looking East.



Sidewalk demolished, and existing soil being excavated.



Site excavated, showing exposed underground utilities.



Site protected with plastic sheeting, to reduce excess water from entering excavated area.



Site excavated, note: sloping sides of trench, per engineering specifications



First lift of "structural soil" being compacted, later determined to be unnecessary.



Dump truck, dumping load of structural soil into excavated area. Engineer determined dumping and spreading sufficient to reach 85% design compaction.



Project site, looking East, showing, structural soil in place and forming for new curb on corner of State and Jefferson.



Installation of "geo-textile" fabric to separate "structural soil" from top coarse to be installed before sidewalk is poured.



Close-up of "Geo-textile" fabric



Give this man a shovel to lean on, he looks tired.



Project site, ready to pour concrete.



New sidewalk, poured and ready to cure.



Structural Soil in place and ready for new trees.



Trees installed in structural soil. South Side of State Avenue, looking East



Trees installed in structural soil, South Side of State Avenue, looking West



Control-Trees planted in typical compacted native soil. North Side of State Avenue, looking East. (Directly across State Avenue from project site.)



Close-up of tree planted in structural soil, with a plastic tree grate installed.

1. Structural Soil

Structural soil shall consist of a mixture of gravel, soil and admixtures as described below.

2. Materials

Structural Soil shall consist of the following materials:

1. Crushed rock, Gradation of 100% passing 1.25 inch, Max. 30% Passing 0.75 inch
2. Loam/Organic Topsoil
3. Soil Binder such as "Stabilizer"
4. Water

Approved suppliers of the materials are:

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2. Organic Topsoil@ Jones Quarry 2840-C Black Lake Boulevard SW Tumwater WA 98512 Ph (360) 352-1022.
3. Soil Stabilizer Gibson's Nursery and Landscape Supply South 1401 Pines Road Spokane, WA 99206 Ph (509) 928-0973.
4. Any portable water source.

Other suppliers maybe approved as supplying equal materials if requested. To request approval the developer must submit material specification information in sufficient detail for the city to determine if the material is considered equal. The city shall be the sole judge to determine if a material is equal.

2. (1) Proportions of materials

The major components of the structural soil mixture are crushed rock and topsoil. Since when mixed together some of the topsoil fills in the voids of the crushed rock material the sum of the rock and topsoil volumes does not equal the volume of the structural soil material. There is approximately a 10% volume reduction due to mixing the materials together.

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Water

1.6 gallon

46 gallons

The target moisture content is 20% by weight of the topsoil weight. The above water contents assume the top is dry. The amount of water that will need to be added will be dependent on the moisture content of the raw materials. Actual amounts of water used will be determined during mixing.

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- 9) Stop adding water and mixing when there is a minute amount of free topsoil remaining. The topsoil will coat the crushed rock and not fall out of the material. All of the crushed rock should be uniformly coated with topsoil. There should be no clumps of topsoil or uncovered crushed rock in the mixture.
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3. Placement

Protect soils and mixes from absorbing excess water and from erosion at all times. Do not store materials unprotected from rainfall events. Do not allow excess water to enter site prior to compaction. If water is introduced into the material after grading, allow material to drain or aerate to optimum compaction moisture content.

All areas to receive Structural Soil mixture shall be inspected by the City before starting placement of mixture. All defects such as incorrect grading, compaction and inadequate drainage, etc., shall be corrected prior to beginning placement of Structural Soil.

Confirm that the sub-grade is at the proper elevation and compacted as required. Sub-grade elevations shall slope parallel to the finished grade. Clear the excavation of all construction debris, trash, rubble and foreign material. Fill any over excavation with approved fill and compact to the required sub-grade compaction.

Install Structural Soil in 6-inch lifts and spread uniformly over the area. Delay placement 24 hours if moisture content exceeds maximum allowable, protect Structural Soil with plastic or plywood during delay.

Bring Structural Soils to finished grades as shown in standard detail (XXX). Immediately protect the Structural Soil material from contamination by water by covering with plastic or plywood.

Bid Tabulation Sheet
Street Corridor Improvements-Structural Soil Demonstration
Project No. CF14

BID TABULATION SHEET																									
PROJECT NAME		Structural Soil Demonstration				BID OPEN		2/13/2001																	
PROJECT NO. :		CF14		ENGINEER'S		ESTIMATE		Rejected Bid																	
				BID #1		BID #2		BID #3		BID #4		BID #5		BID #6		BID #7		BID #8		BID #9		BID #10			
				Christensen Inc., General Contractor		Roanlin's Inc.		Fox Island Const. Inc.		3 Kings Enviromental, Inc.		Kodo Construction, Inc.		Stouder General Construction		Pascher Construction, Inc.		DLB Earthwork CO.		Pacific Enterprises		Taurman Pacific Inc.			
				3285 Ferguson St. SW Suite #101		321 W. State		PO Box 161		PO Box 280		PO Box 1018		3381 Brown Road		PO Box 1819		PO Box 12599		PO Box 14094		19222 Huntington St. SW			
				Tumwater, WA. 98512		Aberdeen, WA. 98520		Fox Island, WA. 98333		Battleground, WA. 98604		Auburn, WA. 98071		Ferndale, WA 98248		Shelton, WA. 98584		Olympia, WA. 98508		Tumwater, WA 98511		Rochester, WA. 98579			
ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL		
109-010	Mobilization	LS	1.0	\$1,600.00	\$1,600.00	\$300.00	\$300.00	\$2,500.00	\$2,500.00	\$2,500.00	\$2,500.00	\$603.00	\$603.00	\$2,500.00	\$2,500.00	\$5,400.00	\$5,400.00	\$2,000.00	\$2,000.00	\$7,750.00	\$7,750.00	\$2,950.00	\$2,950.00	\$9,200.00	\$9,200.00
110-030	Traffic Control Labor	HR	40.0	\$30.00	\$1,200.00	\$8.00	\$320.00	\$39.00	\$1,560.00	\$30.00	\$1,200.00	\$38.40	\$1,536.00	\$22.00	\$880.00	\$46.44	\$1,857.60	\$30.00	\$1,200.00	\$34.00	\$1,360.00	\$35.00	\$1,400.00	\$30.00	\$1,200.00
110-040	Traffic Control Supervisor	HR	10.0	\$35.00	\$350.00	\$32.00	\$320.00	\$39.00	\$390.00	\$20.00	\$200.00	\$45.60	\$456.00	\$39.00	\$390.00	\$43.20	\$432.00	\$45.00	\$450.00	\$36.00	\$360.00	\$35.00	\$350.00	\$38.00	\$380.00
202-030	Remove Sidewalk	SY	132.0	\$15.00	\$1,980.00	\$3.50	\$462.00	\$8.00	\$1,056.00	\$16.00	\$2,112.00	\$16.36	\$2,159.52	\$23.00	\$3,036.00	\$16.36	\$2,159.52	\$22.35	\$2,950.20	\$6.00	\$792.00	\$9.50	\$1,254.00	\$8.00	\$1,056.00
202-040	Remove Curb	LF	30.0	\$5.00	\$150.00	\$8.00	\$240.00	\$9.00	\$270.00	\$7.00	\$210.00	\$29.96	\$898.80	\$20.00	\$600.00	\$21.60	\$648.00	\$15.66	\$469.80	\$7.00	\$210.00	\$28.00	\$840.00	\$8.00	\$240.00
203-010	Roadway Excavation Incl. Haul	CY	114.0	\$20.00	\$2,280.00	\$7.00	\$798.00	\$12.00	\$1,368.00	\$37.00	\$4,218.00	\$19.95	\$2,274.30	\$29.00	\$3,306.00	\$18.95	\$2,160.30	\$15.00	\$1,710.00	\$20.00	\$2,280.00	\$52.00	\$5,928.00	\$8.00	\$912.00
203-099	Structural Soil	CY	114.0	\$30.00	\$3,420.00	\$10.00	\$1,140.00	\$24.00	\$2,736.00	\$39.50	\$4,503.00	\$28.82	\$3,285.48	\$46.00	\$5,244.00	\$23.68	\$2,699.52	\$19.00	\$2,160.00	\$59.00	\$6,726.00	\$49.00	\$5,586.00	\$85.00	\$9,690.00
211-010	Trimming and Cleanup	LS	1.0	\$400.00	\$400.00	\$313.50	\$313.50	\$1,145.00	\$1,145.00	\$1,000.00	\$1,000.00	\$360.00	\$360.00	\$1,000.00	\$1,000.00	\$864.00	\$864.00	\$500.00	\$500.00	\$275.00	\$275.00	\$1,972.00	\$1,972.00	\$500.00	\$500.00
212-020	Const.Geo For Separation	SY	114.0	\$2.00	\$228.00	\$2.50	\$285.00	\$2.00	\$228.00	\$4.50	\$513.00	\$2.83	\$322.62	\$4.00	\$456.00	\$2.195	\$250.23	\$2.37	\$270.18	\$3.50	\$399.00	\$1.70	\$193.80	\$3.00	\$342.00
404-010	CSTC	TN	15.0	\$25.00	\$375.00	\$150.00	\$2,250.00	\$300.00	\$4,500.00	\$15.00	\$225.00	\$50.40	\$756.00	\$20.00	\$300.00	\$64.80	\$972.00	\$15.00	\$225.00	\$36.40	\$546.00	\$36.00	\$540.00	\$26.00	\$390.00
505-030	Cement Conc., Approach 3-Day	SY	290.0	\$50.00	\$14,500.00	\$1,044.00	\$11,044.00	\$50.00	\$14,500.00	\$45.00	\$13,050.00	\$50.24	\$14,569.96	\$36.00	\$10,440.00	\$24.28	\$704.12	\$66.50	\$1,928.50	\$50.00	\$1,450.00	\$41.00	\$1,189.00	\$30.00	\$870.00
603-099	Tree Gate Frame	EA	3.0	\$125.00	\$375.00	\$90.00	\$270.00	\$80.00	\$240.00	\$200.00	\$600.00	\$100.00	\$300.00	\$200.00	\$600.00	\$216.00	\$648.00	\$700.00	\$2,100.00	\$150.00	\$450.00	\$110.00	\$330.00	\$135.00	\$405.00
804-010	Concrete Curb	LF	70.0	\$20.00	\$1,400.00	\$13.00	\$910.00	\$18.00	\$1,260.00	\$15.00	\$1,050.00	\$13.50	\$945.00	\$17.00	\$1,190.00	\$21.60	\$1,512.00	\$19.80	\$1,386.00	\$17.00	\$1,190.00	\$16.00	\$1,120.00	\$15.00	\$1,050.00
814-010	Cement Concrete Sidewalk	SY	114.0	\$35.00	\$3,990.00	\$23.00	\$2,622.00	\$33.00	\$3,762.00	\$30.00	\$3,420.00	\$47.03	\$5,361.42	\$28.00	\$3,192.00	\$24.30	\$2,770.20	\$27.50	\$3,135.00	\$32.00	\$3,648.00	\$38.00	\$4,332.00	\$24.00	\$2,736.00
814-020	Cement Concrete Integral Curb and Walk	SY	10.0	\$45.00	\$450.00	\$55.00	\$550.00	\$52.00	\$520.00	\$45.00	\$450.00	\$166.95	\$1,669.50	\$45.00	\$450.00	\$97.20	\$972.00	\$152.00	\$1,520.00	\$50.00	\$500.00	\$41.00	\$410.00	\$30.00	\$300.00
814-038	Curb Ramp	EA	1.0	\$900.00	\$900.00	\$750.00	\$750.00	\$500.00	\$500.00	\$300.00	\$300.00	\$600.00	\$600.00	\$500.00	\$500.00	\$972.00	\$972.00	\$1,750.00	\$1,750.00	\$350.00	\$350.00	\$750.00	\$750.00	\$390.00	\$390.00
821-010	Permanent Signing	LS	1.0	\$500.00	\$500.00	\$143.50	\$143.50	\$200.00	\$200.00	\$100.00	\$100.00	\$1,200.00	\$1,200.00	\$200.00	\$200.00	\$216.00	\$216.00	\$500.00	\$500.00	\$190.00	\$190.00	\$250.00	\$250.00	\$1,650.00	\$1,650.00
TOTAL				\$21,048.00		\$10,618.00		\$21,645.00		\$23,906.00		\$24,184.60		\$24,888.00		\$25,237.49		\$24,260.68		\$28,476.00		\$29,394.80		\$31,311.00	
TAXES @ 8%																									
GRAND TOTAL				\$ 21,048.00		\$ 10,618.00		\$ 21,645.00		\$ 23,906.00		\$ 24,184.60		\$ 24,888.00		\$ 25,237.49		\$ 24,260.68		\$ 28,476.00		\$ 29,394.80		\$ 31,311.00	
PROJECT DESIGNER				PROJECT ENGINEER																					
PROJECT INSPECTOR				PROJECT MANAGER				(AUTH. TO AWARD)																	