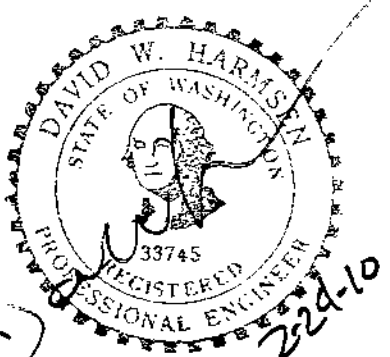
STORM DRAINAGE ANALYSIS FOR

SOLID ROCK CREATIONS

67TH AVENUE NE
ARLINGTON, WASHINGTON

February 26, 2010



HARMSEN &
H&AI
ASSOCIATES INC

17614 West Main St PO Box 516 Monroe, WA 98272-0516 t (360) 794-7811 t (206) 343-5903 f (360) 805-9732 www.h-ai.com

PROJECT DESCRIPTION

This drainage analysis is for the proposed Solid Rock Creations building in the City of Arlington. The new building will be constructed on the west side of 67th Avenue NE approximately 0.3 miles north of SR 531. See Figure 1: Vicinity Map.

METHODOLOGY

The drainage design for the site was prepared using the requirements of the Washington State Department of Ecology *Storm Water Management Manual for Western Washington*, August 2005, (DOE Manual) as adopted by the City of Arlington. The Western Washington Hydrology Model, WWHM3, by DOE was used to calculate runoff and size the storm drainage system.

HYDROLOGIC DATA

According to SCS the underlying soil is Norma loam. This soil is very deep and is poorly drained. It can be found in depressional areas on outwash plains and till plains. Typically is very dark gray loam about 10 inches thick. The subsoil is dark grayish brown sandy loam about 18 inches thick. The substratum to a depth of 60 inches or more is dark gray sandy loam. Permeability of the soil is moderately rapid. Runoff is very slow and the hazard of water erosion is slight. According to the DOE Manual, this soil is in hydrologic group C/D.

However, a geotechnical investigation was performed by Nelson Geotechnical Associates, Inc titled *Stormwater Infiltration Letter, New Commercial Development, Arlington, Washington, prepared for Mr. Dennis Jones*, dated January 29, 2010. Below the topsoil, they encountered weathered outwash and native outwash materials. These soils support infiltration of stormwater and a design infiltration rate of 4 in/hr was established. Depth to groundwater was approximately 8 feet. This report is included in Appendix A.

The rainfall events for the WWHM are internal to the program, and in Snohomish County are based on the measured rainfalls in hour increments for up to the past 48 years.

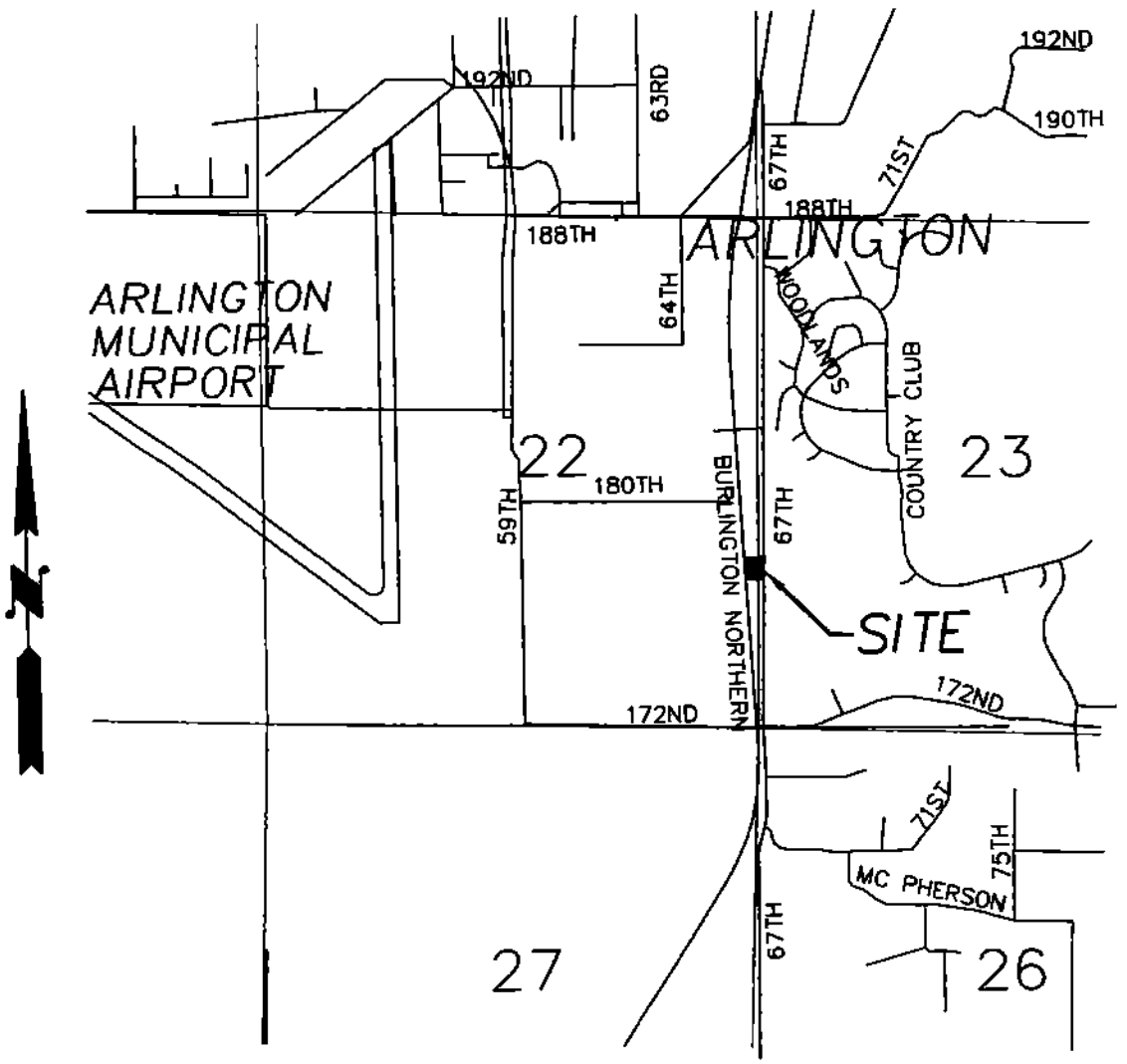


FIGURE 1: VICINITY MAP

DRAINAGE ANALYSIS

EXISTING CONDITIONS

In the near distant past, the site had a single family residence with a drainfield. The house has been demolished and the drainfield decommissioned, so the site is currently vacant. The frontage along 67th Avenue NE is fully built out with curb, gutter and sidewalk. To the west lie the railroad tracks. To the north is City owned property that is currently a gravel driveway with access to the site. To the south lies a storm drainage pond. Storm, sewer and water utilities are located in the street. The site falls quickly from the roadway and then is flat at elevations ranging from 140 at the southwest corner to 141 at the northeast corner. There are no wetlands or other critical areas on or near the site. See Figure 2: Existing Conditions.

As infiltration will be used, no existing site runoff calculations have been performed.

DEVELOPED CONDITIONS

The planned site development is to construct a 4,020 sf building that will serve Solid Rock Creations as a showroom and production site. See Figure 3: Developed Site. The building sits near the middle of the north property line with parking to the south, building access and parking to the east and a paved storage yard to the west. The main access is from 67th Avenue NE at the southeast corner. The storage yard has access to the gravel drive on the City property.

See Appendix B for WWHM site runoff calculations.

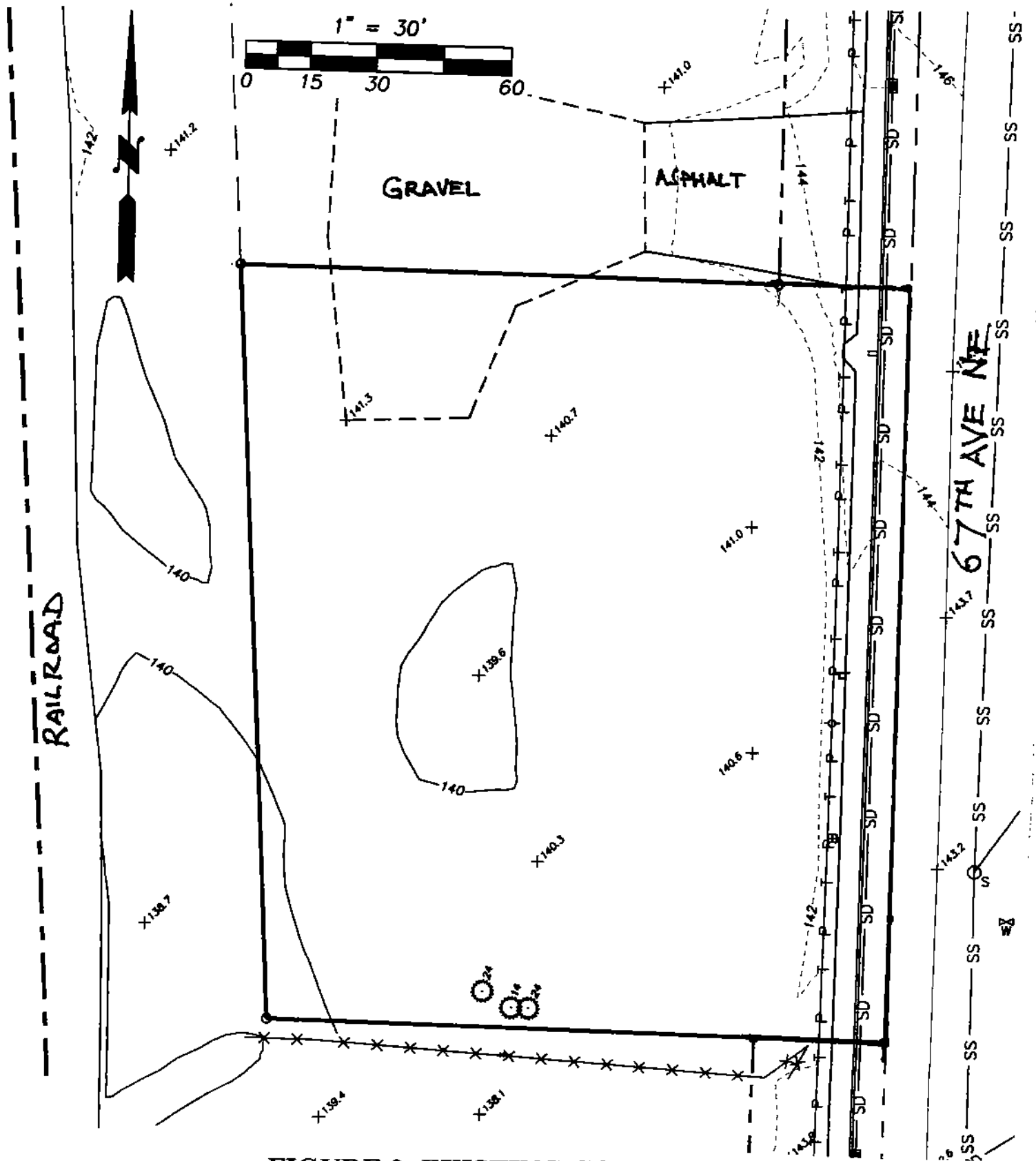


FIGURE 2: EXISTING CONDITIONS

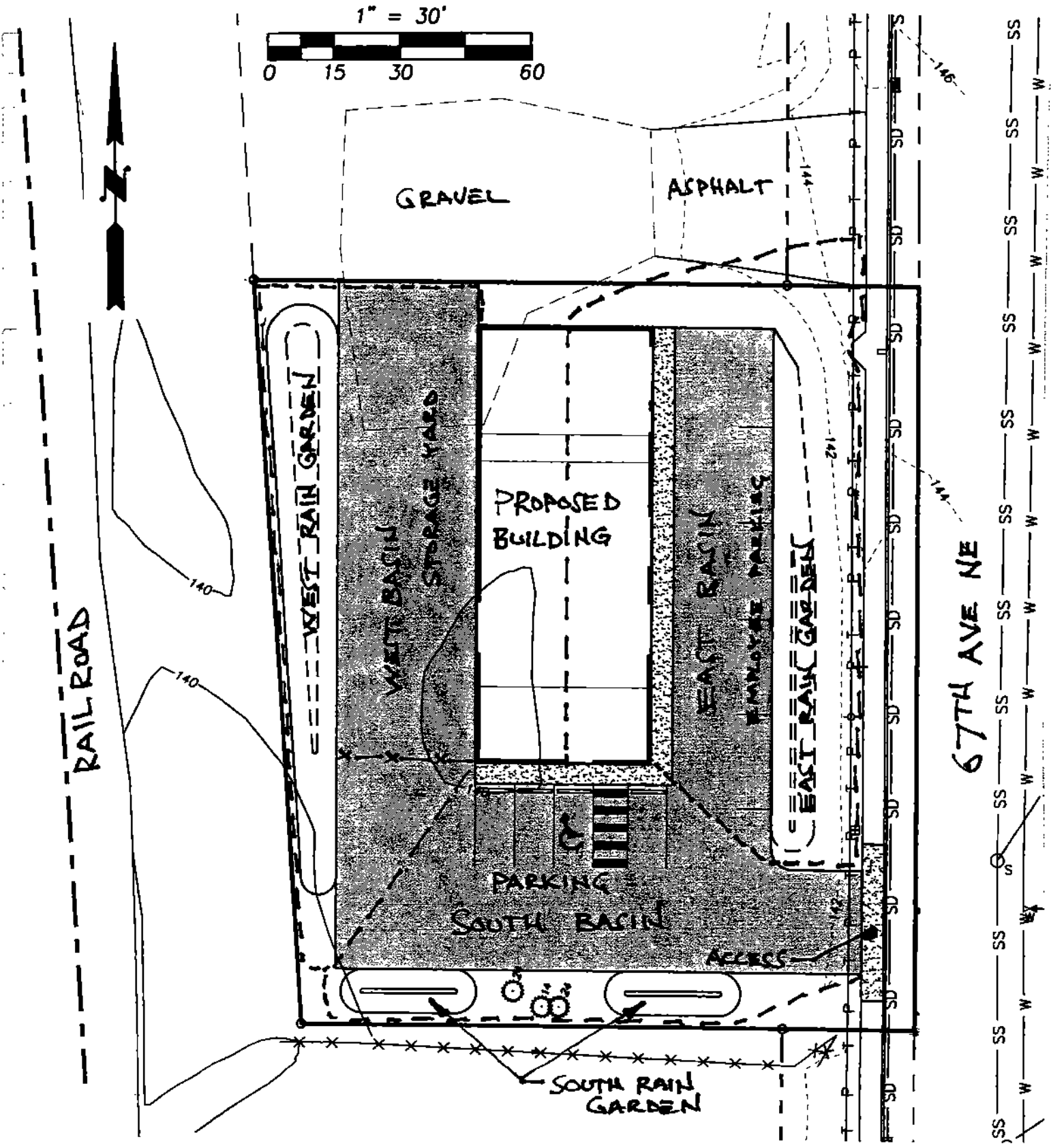


FIGURE 3: DEVELOPED SITE

STORM DRAIN ANALYSIS

The storm drain plan for this development will be prepared using the 2005 DOE Manual. Based on *Figure 2.2 – Flow Chart for Determining Requirements for New Development*, the Drainage Plan will need to meet Minimum Requirements #1-10 because the project has over 5000 sf of impervious area. These requirements and the proposed storm drain system are listed below:

Minimum Requirement #1: Preparation of Stormwater Site Plans

A Storm Drainage Plan will be part of the construction drawings to be submitted to the City of Arlington for review and approval.

Minimum Requirement #2: Construction Storm water Pollution Prevention

The erosion and sediment control minimum elements are as follows:

Element #1: Mark Clearing Limits

Clearing limits for the work are shown on the construction plans and will be established in the field prior to grading operations.

Element #2: Establish Construction Access

A stabilized construction entrance will be provided from the gravel/paved driveway to the north.

Element #3: Control Flow Rates

The underlying soils are sand and gravel, so it is anticipated that runoff from the site will be minimal on any exposed surface as rainfall will directly infiltrate into the soil.

Element #4: Install Sediment Controls

An erosion control plan was prepared for the site. It includes measures to provide for sediment trapping such as filter fencing and managed work limits. The sediment controls are to be installed prior to the commencement of grading operations.

Element #5: Stabilize Soils

The erosion control plan prepared details measures for both temporary and permanent stabilization of exposed surfaces.

Element #6: Protect Slopes

Cut and fill slopes within the project will generally be limited to a maximum of 2 horizontal to 1 vertical with most slopes being 3:1.

Element #7: Protect Drain Inlets

Two catchbasins on 67th Avenue NE will be protected through the use of catchbasin inserts as detailed on the plans.

Element #8: Stabilize Channels and Outlets
No open conveyance channels or outlets exist or are proposed for this site.

Element #9: Control of Pollutants
Those BMPs contained in Volume II of the DOE Manual will be used to control pollution from sources other than sedimentation. Volume II of the DOE Manual shall also be reviewed during construction if any other BMPs become relevant.

- All pollutants, including waste materials and demolition debris, that occur on-site shall be handled and disposed of in a manner that does not cause contamination of stormwater.
- Cover, containment, and protection from vandalism shall be provided for all chemicals, liquid products, petroleum products, and non-inert wastes present on the site (see Chapter 173-304 WAC for the definition of inert waste). On-site fueling tanks shall include secondary containment.
- Maintenance and repair of heavy equipment and vehicles involving oil changes, hydraulic system drain down, solvent and de-greasing cleaning operations, fuel tank drain down and removal, and other activities which may result in discharge or spillage of pollutants to the ground or into stormwater runoff must be conducted using spill prevention measures, such as drip pans. Contaminated surfaces shall be cleaned immediately following any discharge or spill incident. Emergency repairs may be performed on-site using temporary plastic placed beneath and, if raining, over the vehicle.
- Application of agricultural chemicals, including fertilizers and pesticides, shall be conducted in a manner and at application rates that will not result in loss of chemical to stormwater runoff. Manufacturers' recommendations for application rates and procedures shall be followed.
- BMPs shall be used to prevent or treat contamination of stormwater runoff by pH modifying sources. These sources include, but are not limited to, bulk cement, cement kiln dust, fly ash, new concrete washing and curing waters, waste streams generated from concrete grinding and sawing, exposed aggregate processes, and concrete pumping and mixer washout waters. Stormwater discharges shall not cause or contribute to a violation of the water quality standard for pH in the receiving water.

Element #10: Control De-Watering
The winter high groundwater elevation is approximately 8 feet below the surface. No dewatering is expected. If any dewatering is required, flow will be directed to an interim infiltration facility.

Element #11: Maintain BMPs

Notes for the maintenance of erosion control facilities are included on the erosion control plans.

Element #12: Manage the Project

The project will be subject to seasonal work limitations, site inspection, and monitoring as required by the City of Arlington.

Minimum Requirement #3: Source Control of Pollution

- Maintenance of Storm Drainage and Treatment Systems: The Operations and Maintenance Manual dictate the timing and implementation of storm system maintenance.
- Landscaping and Lawn/Vegetation Management: Maintenance of landscaping shall follow specific protocols that dispose of collected trimmings and waste off-site, make use of proper fertilization techniques and follow other best management practices for control of landscaped areas.
- The site shall maintain specific locations for dumpsters and maintain dumpsters to contain wastes without leaks.
- The paved parking areas will be periodically swept to remove sediment and debris.

Minimum Requirement #4: Preservation of Natural Drainage System

Given that the soils are granular in nature, under the original conditions stormwater would have infiltrated. Thus, the proposed storm drainage plan maintains the natural condition by using an infiltration trench.

Minimum Requirement #5: On-site Storm Water Management

The proposed drainage system consists of collection and conveyance of the runoff from the building and pavement by catch basins and underground pipe. Storm water from surfaces subject to regular vehicular traffic will be treated using a bio-retention cell (rain garden); see Minimum Requirement #6 below. An infiltration trench is the proposed flow control measure; see Minimum Requirement #7 below.

Minimum Requirement #6: Runoff Treatment

With total pollution generating impervious surface greater than 5,000 sf, the project will need to provide for runoff treatment. The proposed method for treating stormwater runoff from those surfaces that fall within this requirement is a bio-retention cell, also known as a 'rain garden'. This low impact development system is detailed in the *Low Impact Development Technical Guidance Manual for Puget Sound* and is also a part of the 2005 DOE Manual under *Appendix III-C Washington State Department of Ecology Low Impact Development Design and Flow Modeling Guidance.* The system consists of a shallow pond that is partially filled with a highly permeable soil mixed with compost amendment and a surface mulch layer. This amended soil provides for treatment of runoff prior to final infiltration into the lower layers of native sands and gravels. By infiltrating greater than 91% of the runoff, the bio-retention cell meets basic treatment requirements.

Three bio-retention cells will be used to provide treatment for the site. They are located between the parking and 67th Avenue NE (East Rain Garden), between the parking and the south boundary (South Rain Garden), and between the storage yard and the west boundary (West Rain Garden). The east and west rain gardens also account for the applicable tributary area of the impervious roofs. The proposed stormwater collection system will be surface flow directly from the parking areas. They are sized as follows:

General Sizing Data:	
Side Slopes:	3:1
Depth of Amended Soil:	18"
Depth of Open Water:	12"
Infiltration Rate of Amended Soil:	2"/hr
Infiltration Rate of Native Sands:	4"/hr
Porosity of Amended Soil	0.4
Percentage of Infiltration Proposed:	100%

East Rain Garden	
Impervious Area:	5,120 sf
Pervious Area:	2,930 sf
Bottom Area of Open Water:	63 sf
Percent of Infiltration:	100%

West Rain Garden	
Impervious Area:	6,360 sf
Pervious Area:	1,790 sf
Bottom Area of Open Water:	240 sf
Percent of Infiltration:	100%

South Rain Garden

Impervious Area:	4,390 sf
Pervious Area:	1,360 sf
Bottom Area of Open Water:	40 sf *
Percent of Infiltration:	100%

* This rain garden is split in two to avoid existing trees.

See Appendix B for output from WWHM3.

Minimum Requirement #7: Flow Control

The site requires flow controls measures to mitigate for the increase in stormwater. All proposed impervious and tributary areas have been routed through one of three rain gardens. The rain gardens are designed to provide for 100% infiltration of stormwater according to the WWHM3 software. Therefor, the rain gardens meet the requirement for Flow Control as well as Runoff Treatment.

Minimum Requirement #8: Wetlands Protection

There are no known wetlands on or adjacent to the site.

Minimum Requirement #9: Basin Planning

The City of Arlington has no known basin plan for this site.

Minimum Requirement #10: Operation and Maintenance

An Operations and Maintenance Manual is included in Appendix C.

APPENDIX A:
GEOTECHNICAL LETTERS

NELSON GEOTECHNICAL ASSOCIATES, INC.
GEOTECHNICAL ENGINEERS & GEOLOGISTS

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(425) 337-1669 Snohomish County

Engineering-Geology Branch
437 East Penny Road
Wenatchee, WA 98801
(509) 665-7696 FAX (509) 665-7692

MEMORANDUM

DATE: February 23, 2010

TO: Dennis Jones – Mountain Top Construction of Washington

CC: David Harmsen – Harmsen & Associates, Inc.

FROM: Khaled M. Shawish, PE

RE: New Commercial Project
Rain Garden Recommendations
Arlington, Washington
NGA File No. 822910

We were requested by David Harmsen to provide our opinion if a higher infiltration rate than the rate that was provided in our geotechnical letter could be used for designing rain gardens on this site. For our use, we were provided with a copy of a technical memorandum titled "Bioretention Soil Mix Review and Recommendations For Western Washington," prepared by the name of Curtis Hinman of Washington State University, dated January 2009. This memo provided recommendations and infiltration rates for bioretention soil mix designs for use in rain gardens.

In our previous letter dated January 29, 2010, we recommended an infiltration rate of 0.5 inches per hour for use in designing the rain gardens. Based on our review of the provided memo, our understanding that regular maintenance would be conducted in rain gardens, and that the bottom of the rain gardens would extend into native, clean sand and gravel, it is our opinion that infiltration rates of 1 to 2 inches per hour should be adequate for designing the rain gardens provided that clean sand and gravel (less than one percent fines by weight) is used in the biomix design.

We trust this memorandum satisfies your needs at this time. Please contact us should you have any questions regarding this memorandum or if we can be of future help.

STORMWATER INFILTRATION LETTER
NEW COMMERCIAL DEVELOPMENT
ARLINGTON, WASHINGTON
PREPARED FOR
MR. DENNIS JONES

NELSON GEOTECHNICAL ASSOCIATES, INC.
GEOTECHNICAL ENGINEERS & GEOLOGISTS

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January 29, 2010

Dennis Jones
Mountain Top Construction of WA
15413 – 9th Place West
Lynnwood, WA 98087

Stormwater Infiltration Letter
New Commercial Building Infiltration
Arlington, Washington
NGA File No. 822910

Dear Mr. Jones:

This letter documents our explorations and provides our opinions and recommendations for the feasibility of stormwater infiltration at your planned commercial development project located at 17700 – 67th Avenue NE in Arlington, Washington, as shown on the Vicinity Map in Figure 1.

INTRODUCTION

Final development plans were not available at the time this letter was prepared; however you informed us that planned improvements would consist of a building in the northern portion of the site, and parking on the eastern and southern portions of the site. You desire to infiltrate stormwater generated on site. An infiltration system would be placed under the parking areas. A general schematic site layout is shown on the Site Plan in Figure 2.

SCOPE

The purpose of this study is to explore and characterize the subsurface conditions within the site and to provide opinions and recommendations for stormwater infiltration. Specifically, our scope of services includes the following:

1. Review existing soils and geologic maps of the area.

2. Explore the site subsurface soil and groundwater conditions with trackhoe-excavated test pits. A mini-trackhoe was provided by you.

3. Collect samples and conduct laboratory tests to determine infiltration rates based on the Stormwater Management Manual for the Puget Sound Basin (1992).

4. Install three groundwater monitoring peizometers in the explorations.

5. Provide recommendations for infiltration system installation.

6. Document the results of our explorations, findings, conclusions, and recommendations in a written geotechnical engineering letter.

SITE CONDITIONS

Surface Conditions

The site is an approximate 0.5-acre, rectangular-shaped lot. The site is bounded to the east by 67th Avenue West, to the south by a large detention pond, to the west by the Burlington Northern Santa Fe Railroad Tracks, and to the north by a vacant commercial property. The site is currently cleared and is covered with areas of grasses/weeds, dirt, and a few piles of organic debris and garbage. We observed an area of crushed rock/crushed concrete in the middle of the site, and we were informed that an old house was removed from the site. The site is generally flat, with a short slope down to the site from the sidewalk adjacent to 67th Avenue West. Off site to the south, the area slopes down to a large detention pond. The slope appeared to be about 27 degrees. We did not observed ponding water on the site during our visit on January 15, 2010.

Subsurface Conditions

Geology: The site is mapped on the Geologic Map of the Arlington West Quadrangle, Snohomish County, Washington, by James P. Minard (1985). The site is mapped as the Marysville Sand Member (Qvrm) of the Recessional Outwash (Qvr). The Marysville sand member is described as well-drained, stratified to massive outwash sand, some gravel, and some silt and clay. Our explorations generally encountered sand with silt underlain by sand and varying amounts of gravel generally consistent with the description of recessional outwash.

Explorations: The subsurface conditions within the site were explored on January 15, 2010 by excavating three test pits with a mini-trackhoe. Water monitoring pipes were also installed in all of the explorations. The approximate locations of our explorations are shown on the Schematic Site Plan in Figure 2. A geologist from Nelson Geotechnical Associates, Inc. (NGA) was present during the explorations, collected samples of the soils encountered, and maintained logs of the explorations. The soils were visually classified in general accordance with the Unified Soil Classification System, presented as Figure 3. The logs of the explorations are presented as Figure 4.

At the surface of Test Pits 1 and 2, we encountered approximately 1.0 feet of topsoil. Below the topsoil, we encountered about 1.5 to 2.0 feet of medium dense, orange-brown, fine to medium sand with silt and trace roots. We interpreted this material to be weathered outwash. Below the weathered soil in Test Pit 1, we encountered medium dense, light gray-brown fine to medium sand with silt. Below the weathered soil in Test Pit 2, we encountered medium dense to dense, light brown-gray, fine to medium sand with trace gravel. These materials were interpreted to be native outwash. Test Pit 1 was terminated in the sand with silt at a depth of 7.5 feet, and Test Pit 2 was terminated in the sand at a depth of 8.5 feet below the existing ground surface.

Below approximately 1.0 feet of topsoil in Test Pit 3, we encountered about three feet of loose to medium dense, gray grading to brown, silty fine to medium sand. We interpreted this material to be fill underlain by buried topsoil/modified ground. The buried topsoil was underlain by medium dense to dense, fine to course sand with trace gravel. We interpreted this material to be native outwash. Test Pit 3 was terminated in the sand with gravel at a depth of 8.0 feet below the existing ground surface.

Hydrologic Conditions

Groundwater seepage was encountered in Test Pit 2 at 8.5 feet below the existing ground surface, but water was not encountered in the other test pits at that time. During our following visit, we measured the water levels in the water monitoring pipes that were installed in the test pits. Water was detected only in the pipe in Test Pit 2 at a depth of 8.3 feet below the existing ground surface.

A large detention pond, about 2/3rds the width of the site and extending to the south for several blocks is located to the south of the site. Water was in the pond at the time of our visit. The groundwater on this

site could be related to the water level in the pond. We did not observe evidence of fluctuating water levels in any of the test pits.

LABORATORY ANALYSIS

We performed three grain-size sieve analyses on selected soil samples obtained from the explorations. Laboratory tests were performed on samples taken from Test Pit 1 at 5.5, Test Pit 2 at 4.0 feet, and Test Pit 3 at 6.0 feet below the existing ground surface. The results of the sieve analyses are presented as Figures 5 through 7.

CONCLUSIONS AND RECOMMENDATIONS

It is our opinion that the subsurface soils below approximately three to five feet are suitable for stormwater infiltration based on the explorations. Below surficial topsoil, weathered soil, and undocumented fill, the soils are generally sandy with varying amounts of gravel. However, groundwater was encountered at approximately eight feet below the existing ground surface, which will restrict the depth of the infiltration trenches.

It is our understanding that the City of Arlington currently uses the 1992 DOE manual, but may soon adopt the 2005 Stormwater Management in Western Washington. The provided infiltration rates below are based on the 2005 manual. Based on the laboratory tests and Table 3.8 in the 2005 Stormwater Management in Western Washington manual, the analyses indicates infiltration rates of 2 inches per hour for Test Pit 1 at 5.5 feet; 3.5 inches per hour for Test Pit 2 at 4.0 feet; and 9 inches per hour at 6.0 feet in Test Pit 3. We recommend using a design infiltration rate of 4.0 inches per hour for infiltration trenches extending through the upper weathered material and fill, and terminating in the clean sand and gravel at depth.

Approximately five feet of fill and buried topsoil were encountered in Test Pit 3. We recommend that any infiltration trenches extend through the upper silty topsoil/fill material to expose the clean native sand with gravel soils. The manual also recommends that infiltration systems be a minimum of 50 feet way from slopes steeper than 15 degrees. The storm water handling system should be designed in accordance with the City of Arlington regulations.

The stormwater manual recommends a five-foot separation between the base of an infiltration system and any underlying bedrock, impermeable horizon, or groundwater. We encountered groundwater in Test Pit 2 at approximately eight feet below the existing ground surface. It is therefore our opinion that an infiltration system roughly three feet deep should satisfy the design manual. If native sandy material is not encountered at that depth, the unsuitable soil should be over-excavated to expose the clean sand and gravel, and the excavation backfilled with washed rock. We should be retained to evaluate the infiltration system design and observe trench excavations.

If rain gardens are used for stormwater management, we recommend that the rain garden system be designed and sized in accordance with the recommendations presented in the design manual and the City of Arlington Development Code. Based on the material observed in our explorations, we recommend using an overall infiltration rate of 0.5 inches per hour for the rain garden design. The bottom of the rain gardens should expose the sandy soils, prior to the placement of the amended soils within the rain garden. We also recommend that an appropriate overflow system be incorporated into the design of the rain gardens. The inside and outside slopes of the rain gardens should be no steeper than 2 Horizontal to 1 Vertical (2H:1V). The rain garden slopes should be covered with erosion control material, as needed, and then planted with approved vegetation. We should review final rain garden system design and monitor the system installation.

USE OF THIS LETTER

This letter was prepared for the Dennis Jones and his agents, for their use in planning and budgeting the above-referenced project only. Our services included an evaluation of the infiltration capability of the site soils at specific locations, and should not be considered as an in-depth geotechnical study. This letter may be used for bidding and estimating purposes, but our letter, conclusions, and interpretations should not be construed as a warranty of the subsurface conditions. The subsurface conditions between explorations may vary. A contingency for changed conditions should be incorporated into the project plans.

We recommend that NGA be retained to provide monitoring and consultation services during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the

work differ from those anticipated, and to evaluate whether or not earthwork activities comply with contract plans and specifications. We should be contacted a minimum of one week prior to construction activities and could attend pre-construction meetings if requested.

Within the limitations of scope, schedule, and budget, our services have been performed in accordance with generally accepted geotechnical engineering practices in effect in this area at the time this letter was prepared. No other warranty, expressed or implied, is made. Our observations, findings, and opinions are a means to identify and reduce the inherent risks to the owner.

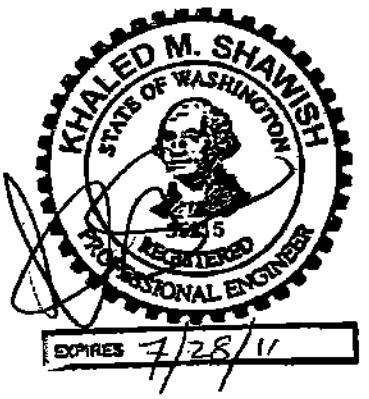
o-O-o

We appreciate the opportunity to provide service to you on this project. If you have any questions or require further information, please call.

Sincerely,

NELSON GEOTECHNICAL ASSOCIATES, INC.

Bala Dodoye-Alali
Project Geologist



1/29/10

Khaled M. Shawish, PE
Principal

BD:KMS:bd

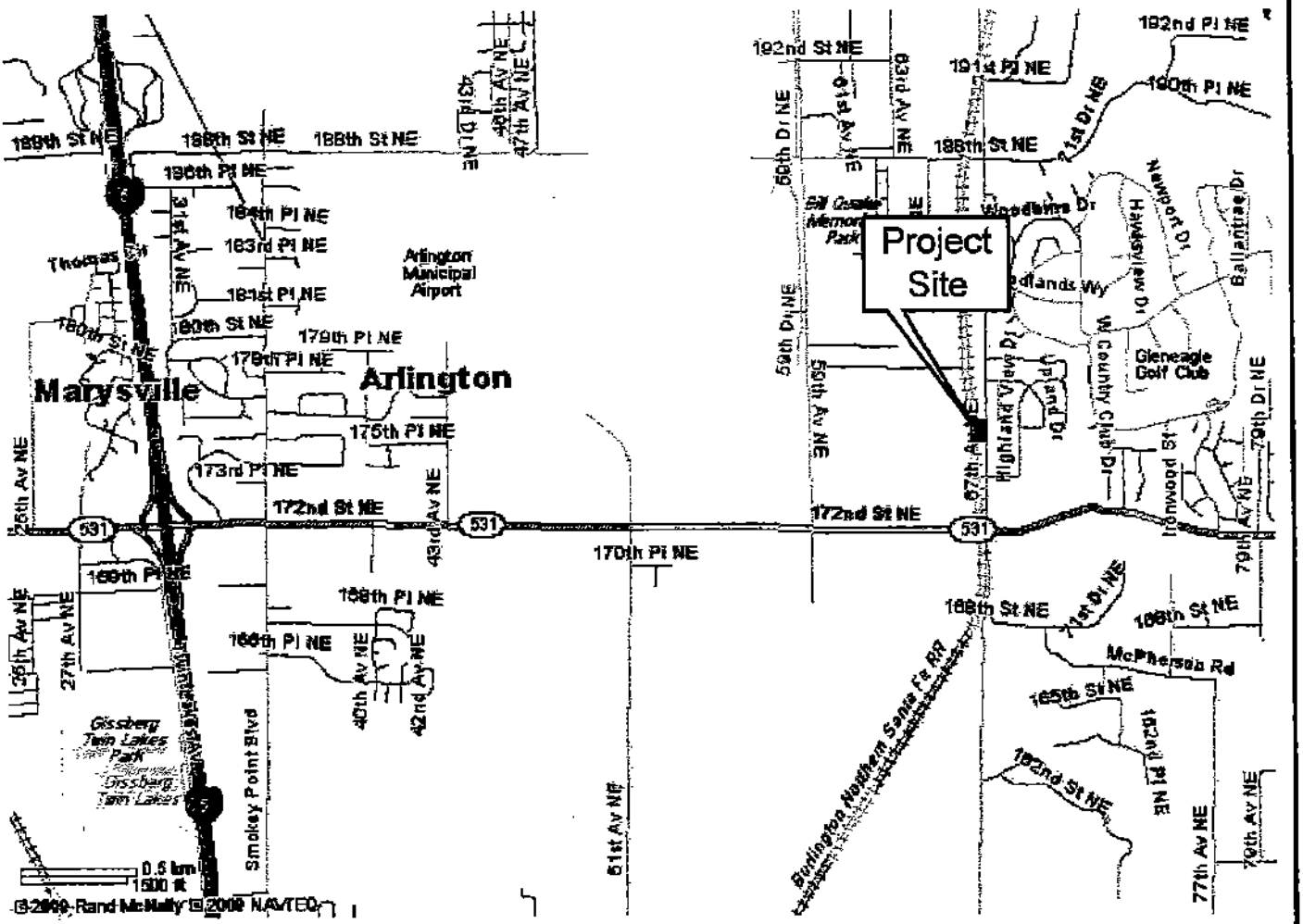
Seven Figures Attached

Three Copies Submitted

cc: David Harmsen – Harmsen and Associates, Inc. (one copy)

VICINITY MAP

Not to Scale



Arlington, WA

Project Number 822910	Mountain Top Commercial Development Vicinity Map	NELSON GEOTECHNICAL ASSOCIATES, INC. NGA GEOTECHNICAL ENGINEERS & GEOLOGISTS	No.	Date	Revision	By	CK
Figure 1			1	1/27/10	Original	LSB	BD

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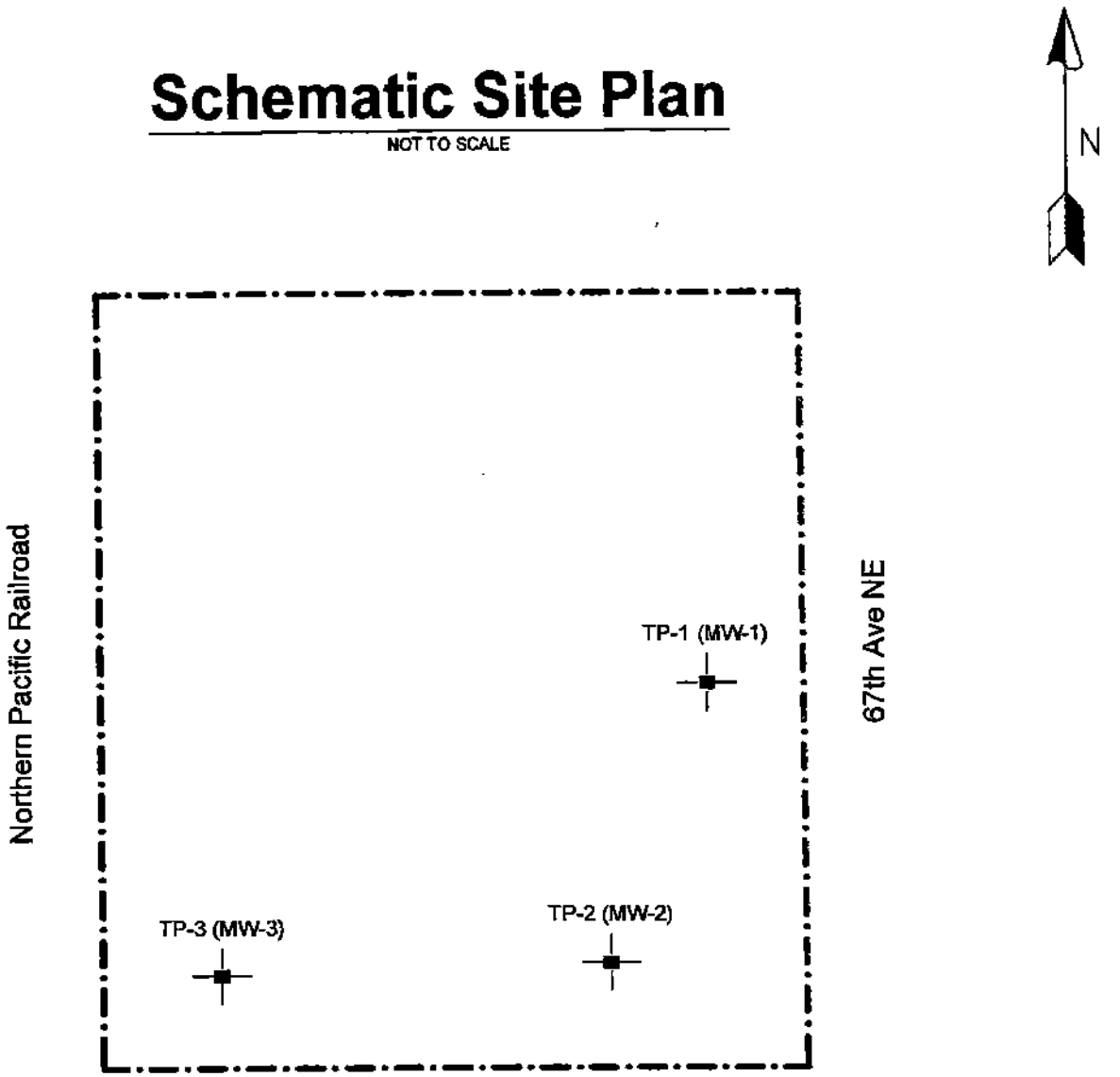
Schematic Site Plan

NOT TO SCALE



*Note: Infiltration system should be a minimum of 50 feet from pond slopes.

Approximate location of detention pond

LEGEND

Property line

TP-1 (MW-1)

Number and approximate location of test pit and groundwater monitoring well

Reference: Site Plan based on field measurements, observations, and aerial photo review.

Project Number	Mountain Top Commercial Development Site Plan	NELSON GEOTECHNICAL ASSOCIATES, INC. NGA GEOTECHNICAL ENGINEERS & GEOLOGISTS	No.	Date	Revision	By	CK
822910			1	1/26/10	Original	LSB	BD
Figure 2							

V:\CA Drafting 2010\822910 Mountain Top\Schematic SP.dwg

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE - GRAINED SOILS MORE THAN 50 % RETAINED ON NO. 200 SIEVE	GRAVEL MORE THAN 50 % OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVEL	GW	WELL-GRADED, FINE TO COARSE GRAVEL
			GP	POORLY-GRADED GRAVEL
		GRAVEL WITH FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SAND MORE THAN 50 % OF COARSE FRACTION PASSES NO. 4 SIEVE	CLEAN SAND	SW	WELL-GRADED SAND, FINE TO COARSE SAND
			SP	POORLY GRADED SAND
		SAND WITH FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE - GRAINED SOILS MORE THAN 50 % PASSES NO. 200 SIEVE	SILT AND CLAY LIQUID LIMIT LESS THAN 50 %	INORGANIC	ML	SILT
			CL	CLAY
		ORGANIC	OL	ORGANIC SILT, ORGANIC CLAY
	SILT AND CLAY LIQUID LIMIT 50 % OR MORE	INORGANIC	MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
			CH	CLAY OF HIGH PLASTICITY, FLAT CLAY
		ORGANIC	OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS			PT	PEAT

NOTES:

1) Field classification is based on visual examination of soil in general accordance with ASTM D 2488-93.

2) Soil classification using laboratory tests is based on ASTM D 2488-93.

3) Descriptions of soil density or consistency are based on interpretation of blowcount data, visual appearance of soils, and/or test data.

SOIL MOISTURE MODIFIERS:

Dry - Absence of moisture, dusty, dry to the touch

Moist - Damp, but no visible water.

Wet - Visible free water or saturated, usually soil is obtained from below water table

Project Number	Mountain Top Commercial Development Soil Classification Chart
822910	
Figure 3	

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No.	Date	Revision	By	CK
1	01/25/10	Original	BD	BD

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LOG OF EXPLORATION

DEPTH (FEET)	USC	SOIL DESCRIPTION
TEST PIT ONE		
0.0 – 1.0		TOPSOIL
1.0 – 3.0	SP-SM	ORANGE-BROWN, FINE TO MEDIUM SAND WITH SILT AND TRACE ROOTS (MEDIUM DENSE, MOIST)
3.0 – 7.5	SP-SM	LIGHT BROWN-GRAY, FINE TO MEDIUM SAND WITH SILT AND TRACE GRAVEL (MEDIUM DENSE TO DENSE, MOIST)
		SAMPLES WERE COLLECTED AT 4.0, 5.5, AND 7.2 FEET GROUNDWATER SEEPAGE WAS NOT ENCOUNTERED TEST PIT CAVING WAS NOT ENCOUNTERED TEST PIT WAS COMPLETED AT 7.5 FEET ON 01/15/10
TEST PIT TWO		
0.0 – 1.0		TOPSOIL
1.0 – 2.5	SP-SM	ORANGE-BROWN, FINE TO MEDIUM SAND WITH SILT AND TRACE ROOTS (MEDIUM DENSE, MOIST)
2.5 – 8.5	SP	LIGHT BROWN-GRAY, FINE TO MEDIUM SAND WITH TRACE GRAVEL (DENSE TO DENSE, MOIST)
		SAMPLES WERE COLLECTED AT 4.0 AND 8.5 FEET MINOR GROUNDWATER SEEPAGE WAS ENCOUNTERED AT 8.5 FEET TEST PIT CAVING WAS NOT ENCOUNTERED TEST PIT WAS COMPLETED AT 8.5 FEET ON 01/15/10
TEST PIT THREE		
0.0 – 0.6		TOPSOIL
0.6 – 1.5	SM	GRAY, SILTY FINE TO MEDIUM SAND (MEDIUM DENSE, MOIST) (FILL)
1.5 – 4.5		BROWN, SILTY FINE TO MEDIUM SAND (LOOSE TO MEDIUM DENSE, MOIST) (BURIED TOPSOIL/MODIFIED GROUND)
4.5 – 8.0	SP	LIGHT BROWN-GRAY, FINE TO COARSE SAND WITH TRACE GRAVEL (MEDIUM DENSE TO DENSE, MOIST)
		SAMPLES WERE COLLECTED AT 6.0 AND 8.0 FEET GROUNDWATER SEEPAGE WAS NOT ENCOUNTERED TEST PIT CAVING WAS ENCOUNTERED BETWEEN 4.5 TO 8.0 FEET TEST PIT WAS COMPLETED AT 8.0 FEET ON 01/15/10

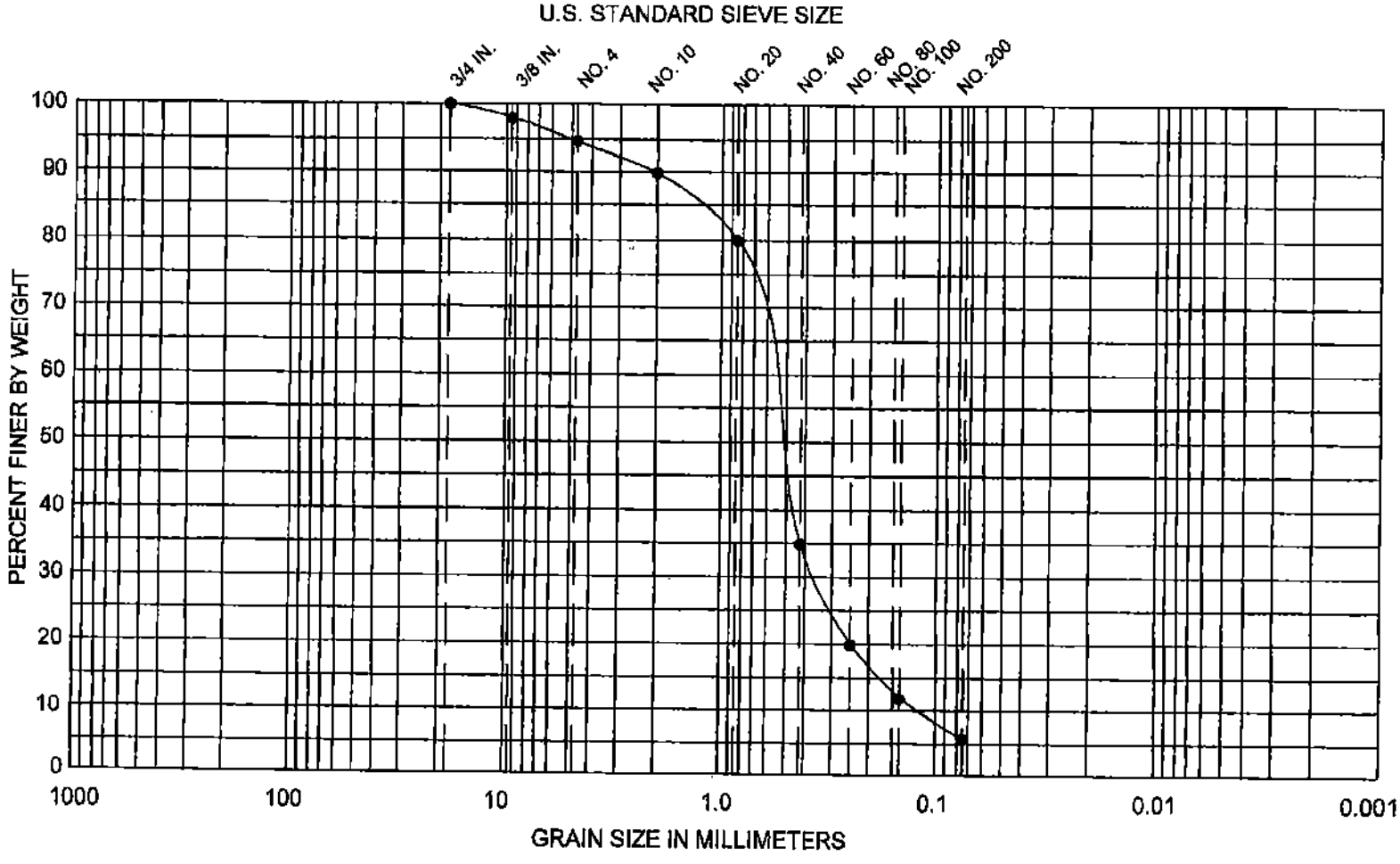
Project Number 822910

Figure 5

Mountain Top
Commercial Development
Sieve Analysis

NELSON GEOTECHNICAL ASSOCIATES, INC.
NGA
GEOTECHNICAL ENGINEERS & GEOLOGISTS

No.	Date	Revision	By	CK
1	01/25/10	Original	BD	BD



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

U.S.C. SYMBOL	EXPLORATION NUMBER	SAMPLE DEPTH	SOIL DESCRIPTION	SOIL DISTRIBUTION
●SP-SM	TP-1	5.5 feet	Light brown-gray, fine to medium sand with silt	Gravel = 5% Sand = 89% Sil/Clay = 6%

NGA Drafting 2010\822910\Mountain Top\Sieve.dwg

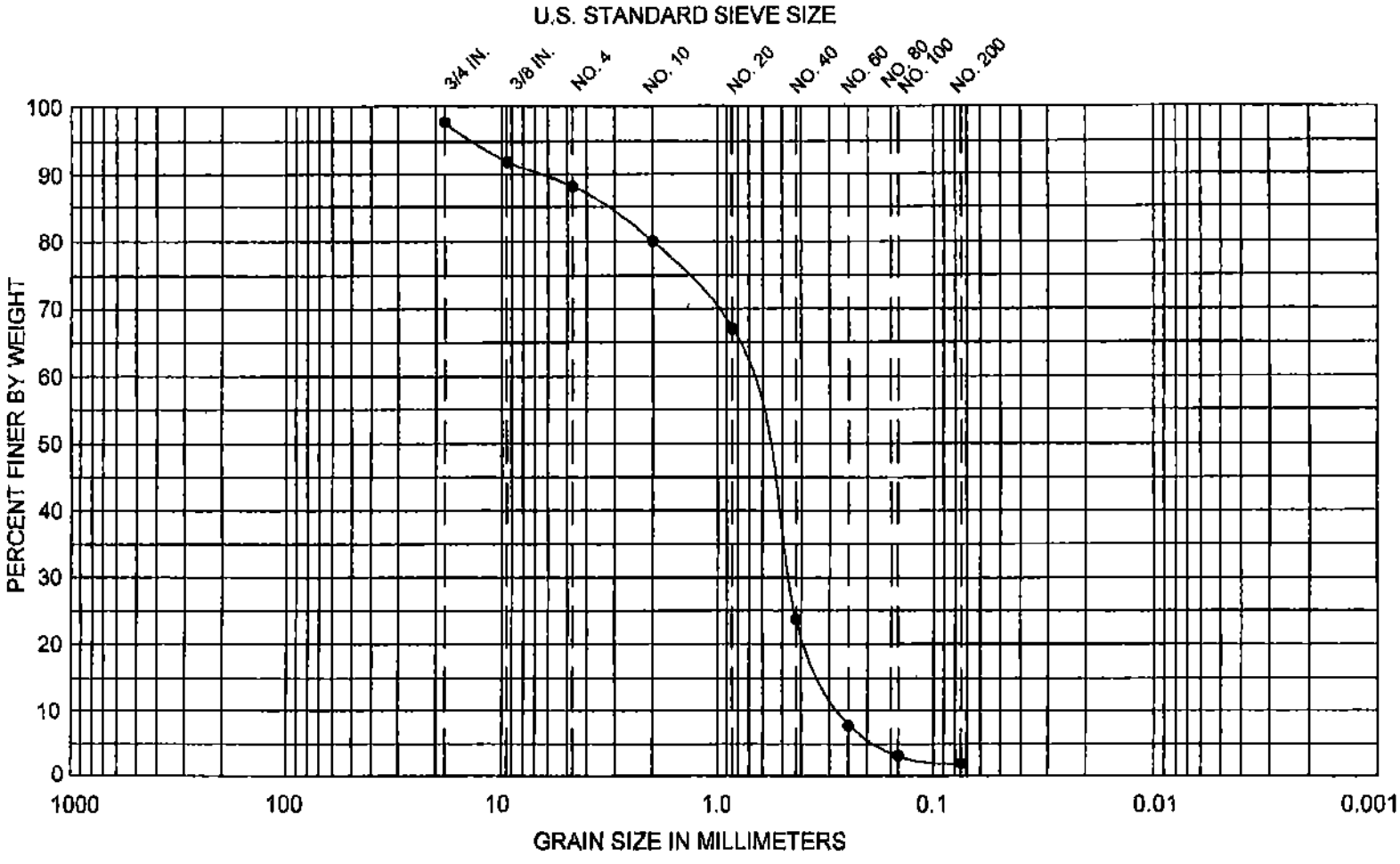
Project Number 822910

Figure 6

Mountain Top
Commercial Development
Sieve Analysis

NELSON GEOTECHNICAL ASSOCIATES, INC.
GEOTECHNICAL ENGINEERS & GEOLOGISTS

No.	Date	Revision	By	CK
1	01/25/10	Original	BD	BD



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

U.S.C. SYMBOL	EXPLORATION NUMBER	SAMPLE DEPTH	SOIL DESCRIPTION	SOIL DISTRIBUTION
●SP	TP-2	4.0 feet	Light brown-gray, fine to medium sand with trace silt and gravel	Gravel = 12% Sand = 86% Silt/Clay = 2%

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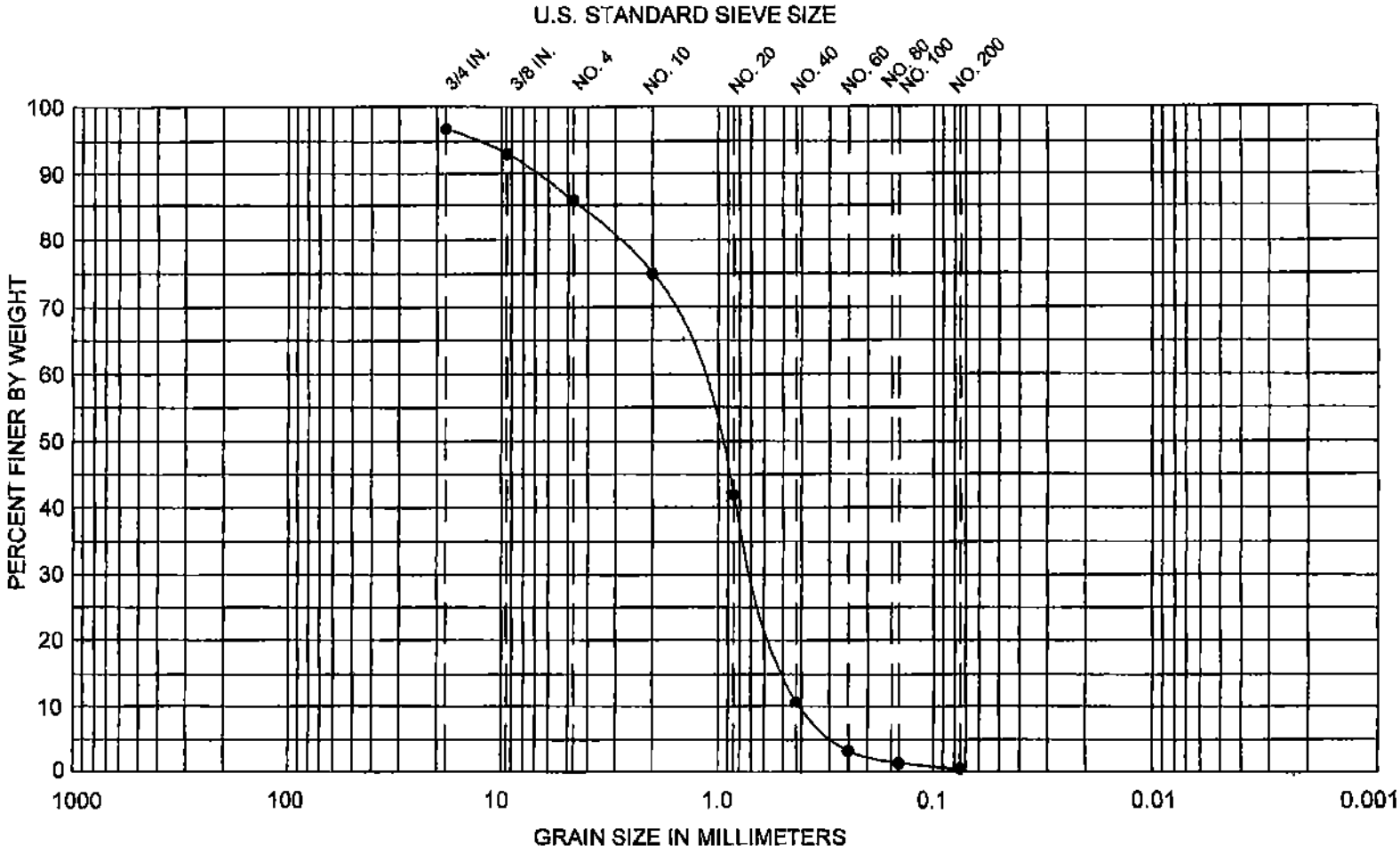
Project Number 822910

Figure 7

Mountain Top
Commercial Development
Sieve Analysis

NELSON GEOTECHNICAL ASSOCIATES, INC.
GEOTECHNICAL ENGINEERS & GEOLOGISTS

No.	Date	Revision	By	CK
1	01/25/10	Original	BD	BD



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

U.S.C. SYMBOL	EXPLORATION NUMBER	SAMPLE DEPTH	SOIL DESCRIPTION	SOIL DISTRIBUTION
•SP	TP-3	6.0 feet	Light brown-gray, fine to medium sand with trace gravel	Gravel = 14% Sand = 86% Silt/Clay = 0%

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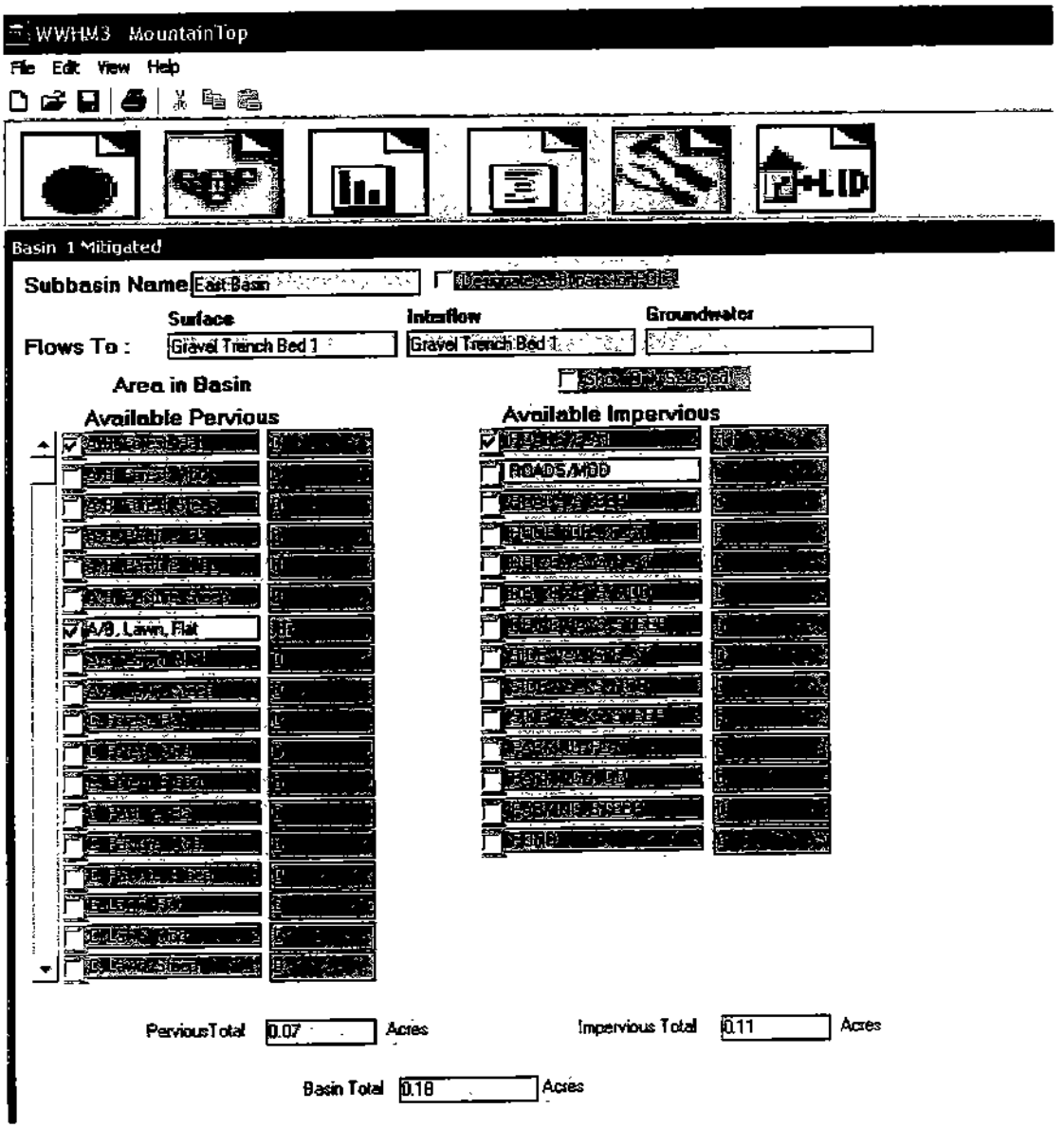
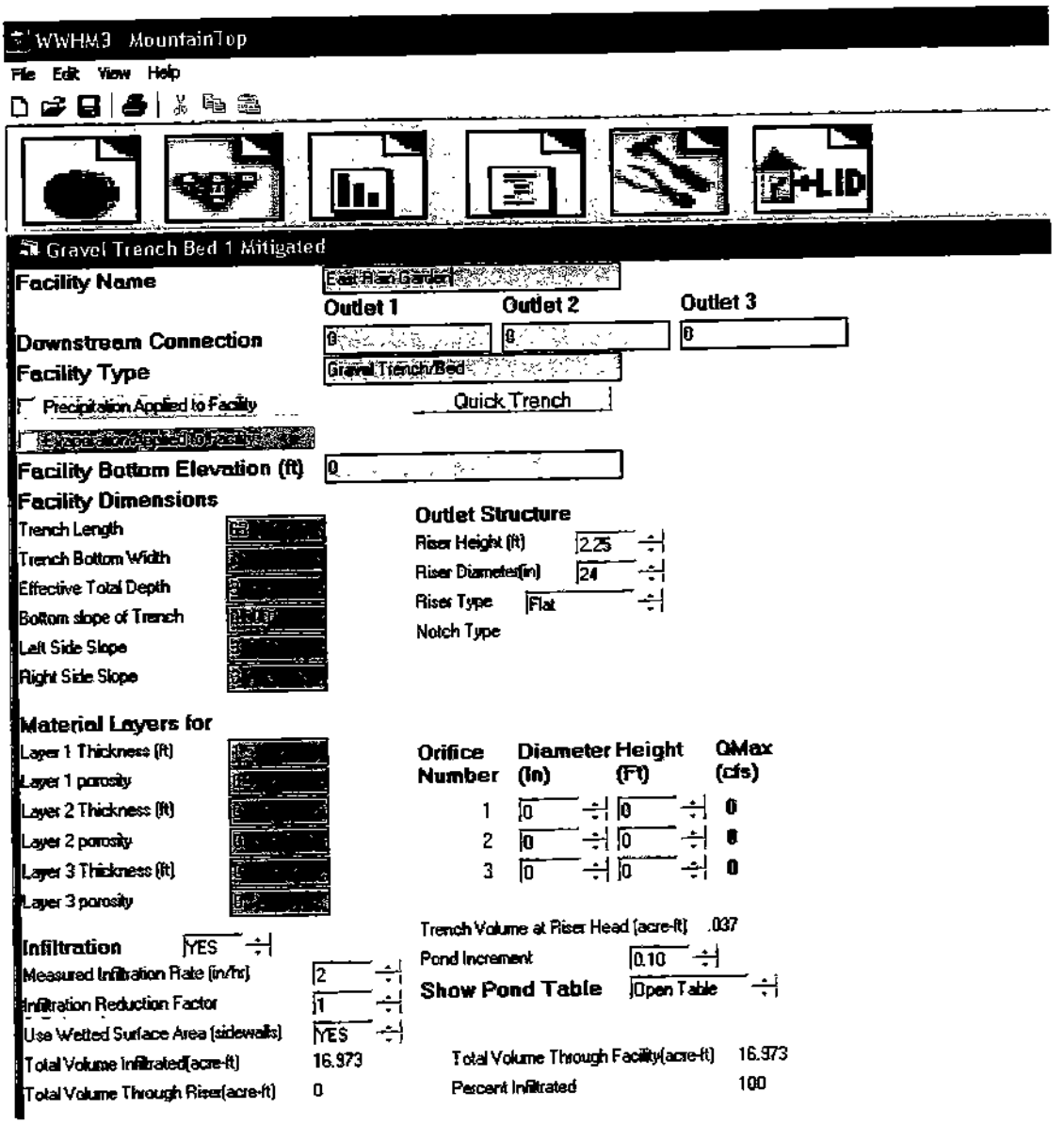
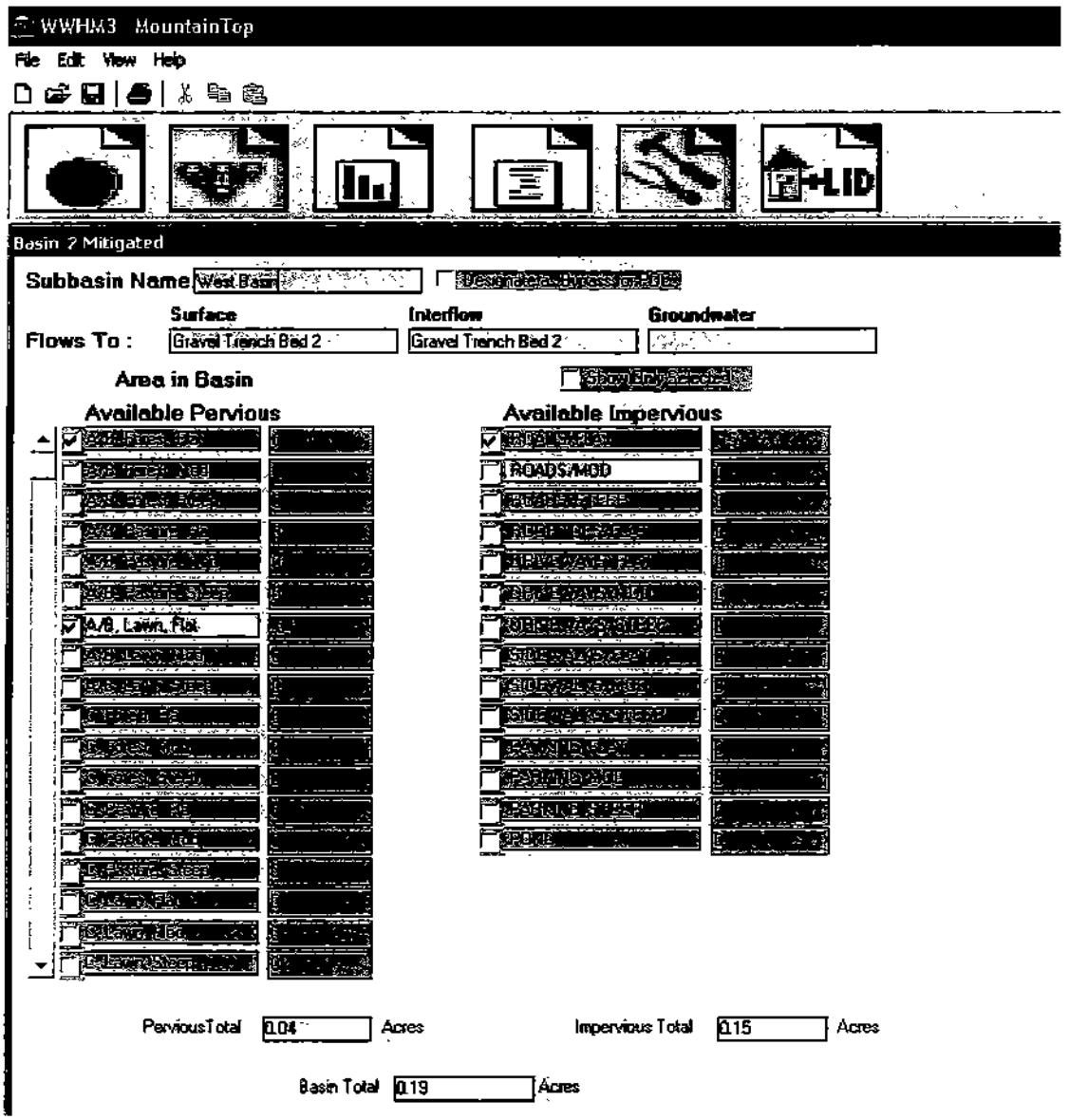
APPENDIX B:
WWHM3 INPUT & RESULTS



EAST BASIN INPUT



EAST RAIN GARDEN SIZING



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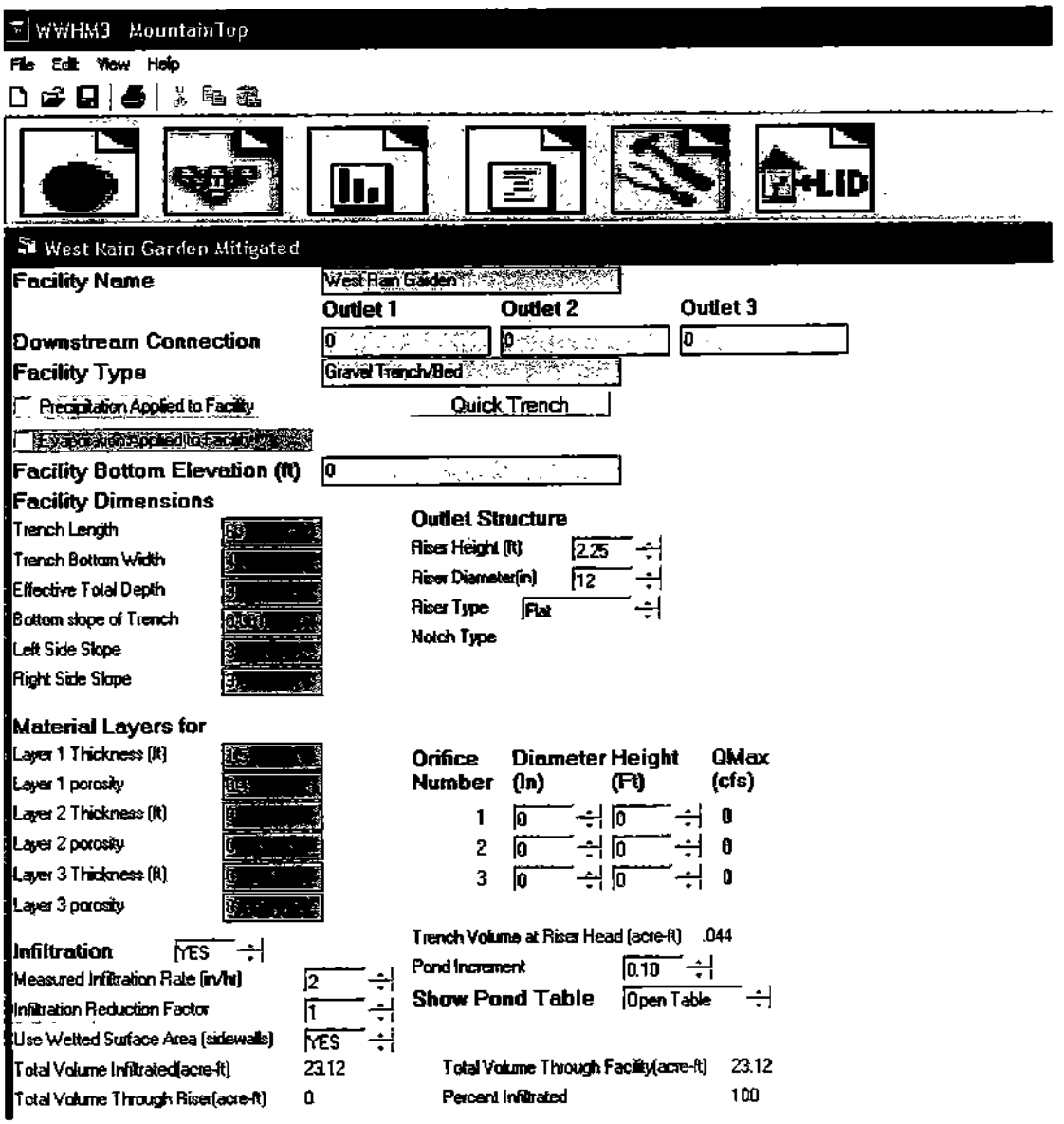
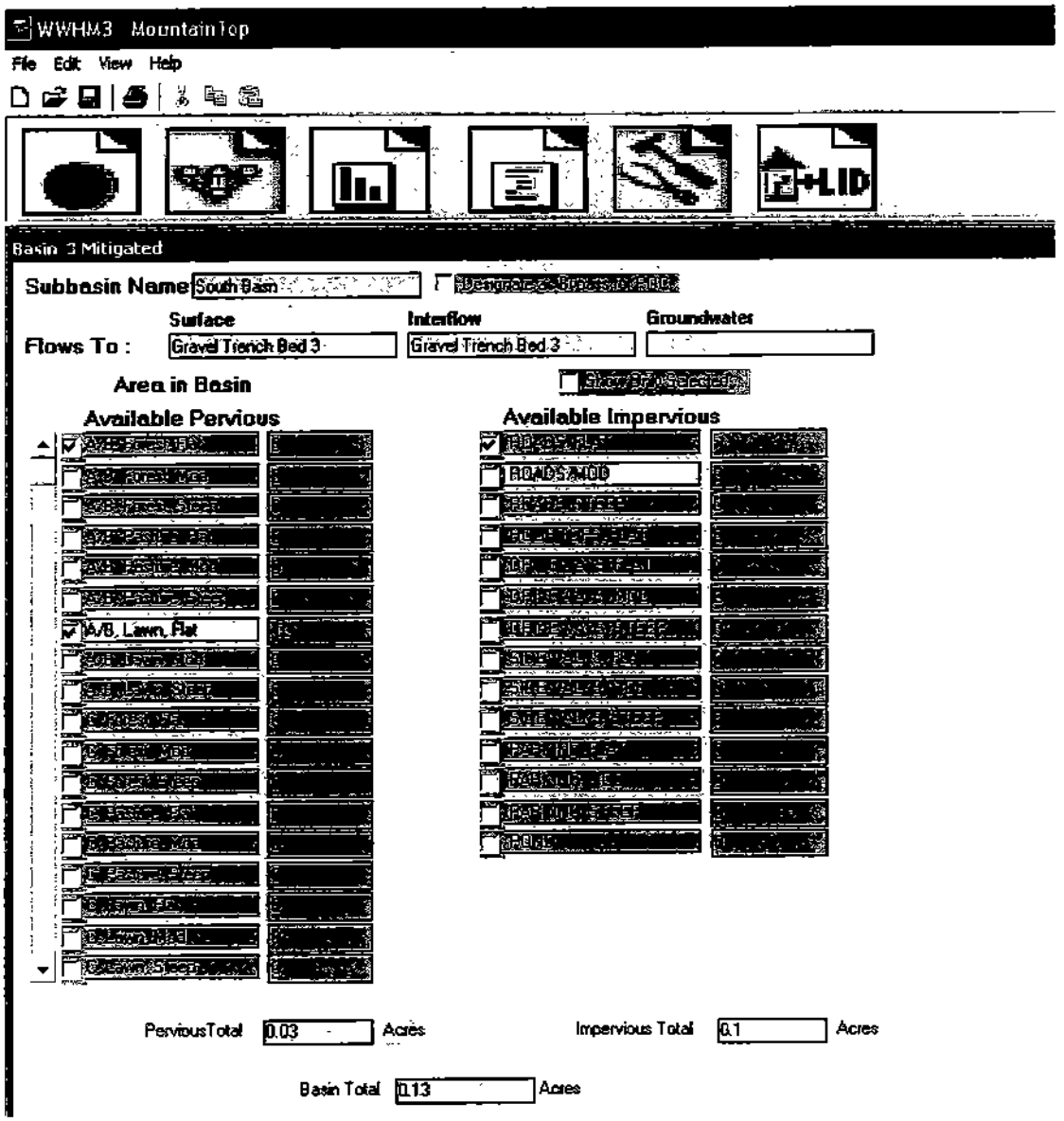
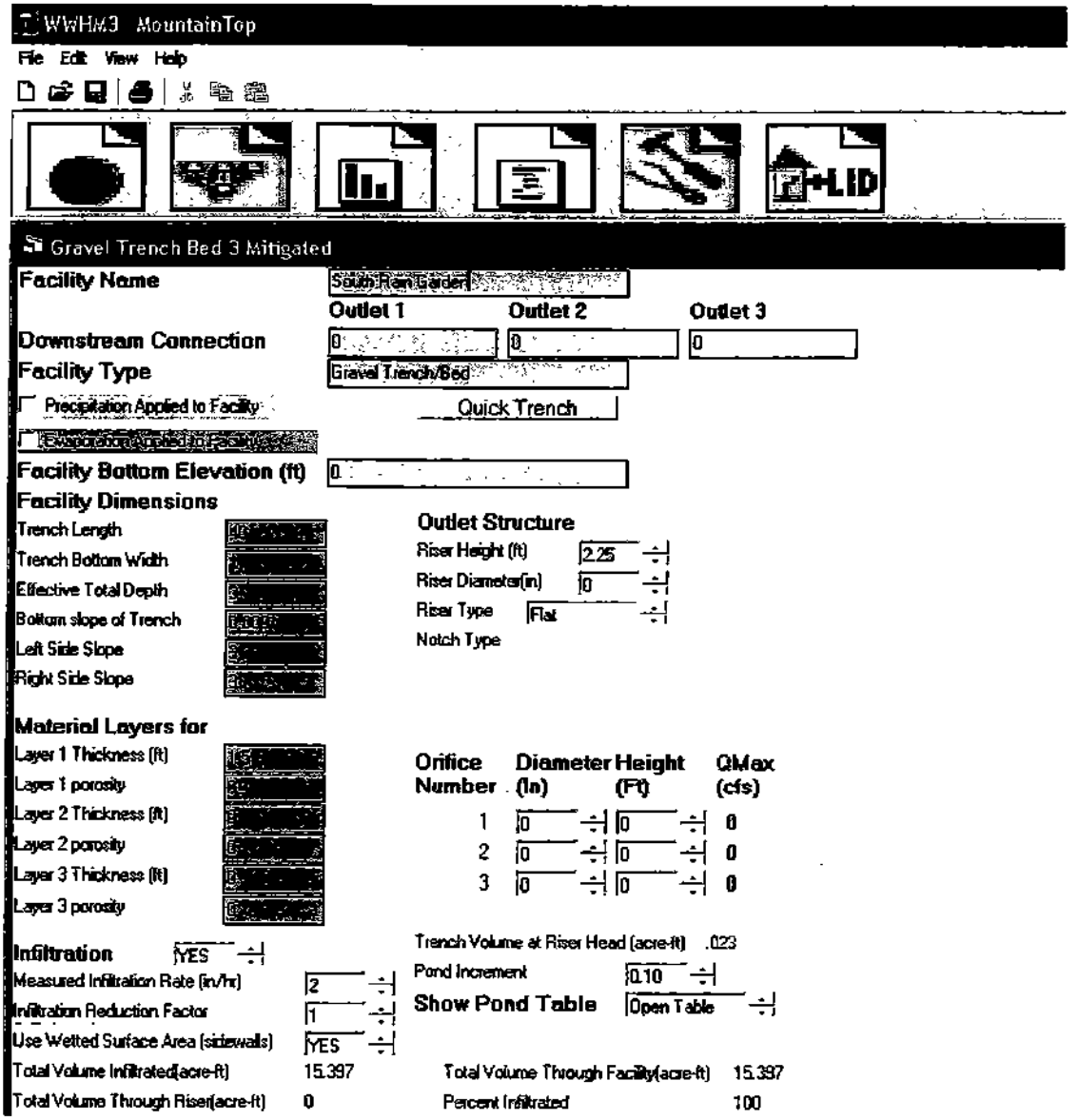


WEST RAIN GARDEN SIZING



SOUTH BASIN INPUT



SOUTH RAIN GARDEN SIZING

APPENDIX C:
OPERATIONS & MAINTENANCE

MAINTENANCE REQUIREMENTS:

The text below provides general guidelines for the maintenance of facilities and a description of specific requirements for on-site facilities.

General:

1. Proper maintenance of public and private stormwater facilities is necessary to ensure they serve their intended function
2. Drainage systems shall be inspected at least annually. A representative of the local government shall also inspect private facilities at least annually to ensure compliance by the owner of the following maintenance requirements.
3. Any deterioration threatening the structural integrity of the facilities shall be immediately repaired. These include such things as replacement of clean-out grates, catchbasin lids, and rock in emergency spillways.
4. Warning signs (e.g. "Dump No Waste - Drains to Puget Sound") shall be painted or embossed on or adjacent to all storm drain inlets. They shall be repainted as needed.
5. Debris shall be regularly removed from surface basins used for either peak-rate control or stormwater treatment.
6. Parking lots shall be swept when necessary to remove debris.

Bioretention Cell: This facility has maintenance requirements that are similar to a detention pond. The standard DOE maintenance for Detention Ponds is provided for reference. In addition, the following maintenance items are specific to bioretention cells:

Bioretention areas require annual plant, soil, and mulch layer maintenance to ensure optimum infiltration, storage, and pollutant removal capabilities. In general, bioretention maintenance requirements are typical landscape care procedures and include:

1. *Watering*: Plants should be selected to be drought tolerant and not require watering after establishment (2 to 3 years). Watering may be required during prolonged dry periods after plants are established.
2. *Erosion control*: Inspect flow entrances, ponding area, and surface overflow areas periodically, and replace soil, plant material, and/or mulch layer in areas if erosion has occurred. Properly designed facilities with appropriate flow velocities should not have erosion problems except perhaps in extreme events. If erosion problems occur the following should be reassessed: (1) flow volumes from contributing areas and bioretention cell sizing; (2) flow velocities and gradients within the cell; and (3) flow dissipation and erosion protection strategies in the pretreatment area and flow entrance. If sediment is deposited in the bioretention area, immediately determine the source within the contributing area, stabilize, and remove excess surface deposits.
3. *Plant material*: Depending on aesthetic requirements, occasional pruning and removing dead plant material may be necessary. Replace all dead plants and if

specific plants have a high mortality rate, assess the cause and replace with appropriate species. Periodic weeding is necessary until plants are established. The weeding schedule should become less frequent if the appropriate plant species and planting density have been used and, as a result, undesirable plants excluded.

4. *Nutrient and pesticides*: The soil mix and plants are selected for optimum fertility, plant establishment, and growth. Nutrient and pesticide inputs should not be required and may degrade the pollutant loads to receiving waters. By design, bioretention facilities are located in areas where phosphorous and nitrogen levels are often elevated and these should not be limiting nutrients. If in question, have soil analyzed for fertility.
5. *Mulch*: Replace mulch annually in bioretention facilities where heavy metal deposition is likely (e.g., contributing areas that include parking lots and roads). In residential lots or other areas where metal deposition is not a concern, replace or add mulch as needed to maintain a 2 to 3 inch depth at least once every two years.
6. *Soil*: Soil mixes for bioretention facilities are designed to maintain long-term fertility and pollutant processing capability. Estimates from metal attenuation research suggest that metal accumulation should not present an environmental concern for at least 20 years in bioretention systems (see Performance section). Replacing mulch in bioretention facilities where heavy metal deposition is likely provides an additional level of protection for prolonged performance. If in question, have soil analyzed for fertility and pollutant levels.

4.6 Maintenance Standards for Drainage Facilities

The facility-specific maintenance standards contained in this section are intended to be conditions for determining if maintenance actions are required as identified through inspection. They are not intended to be measures of the facility's required condition at all times between inspections. In other words, exceedence of these conditions at any time between inspections and/or maintenance does not automatically constitute a violation of these standards. However, based upon inspection observations, the inspection and maintenance schedules shall be adjusted to minimize the length of time that a facility is in a condition that requires a maintenance action.

Table 4.5 – Maintenance Standards

No. 1 – Detention Ponds

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash & Debris	Any trash and debris which exceed 5 cubic feet per 1,000 square feet (this is about equal to the amount of trash it would take to fill up one standard size garbage can). In general, there should be no visual evidence of dumping. If less than threshold all trash and debris will be removed as part of next scheduled maintenance.	Trash and debris cleared from site.
	Poisonous Vegetation and noxious weeds	Any poisonous or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined by State or local regulations. (Apply requirements of adopted IPM policies for the use of herbicides).	No danger of poisonous vegetation where maintenance personnel or the public might normally be. (Coordinate with local health department) Complete eradication of noxious weeds may not be possible. Compliance with State or local eradication policies required
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants (Coordinate removal/cleanup with local water quality response agency).	~~No contaminants or pollutants present.~~
	Rodent Holes	Any evidence of rodent holes if facility is acting as a dam or berm, or any evidence of water piping through dam or berm via rodent holes.	Rodents destroyed and dam or berm repaired. (Coordinate with local health department; coordinate with Ecology Dam Safety Office if pond exceeds 10 acre-feet.)

No. 1 – Detention Ponds

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
	Beaver Dams	Dam results in change or function of the facility.	Facility is returned to design function. (Coordinate trapping of beavers and removal of dams with appropriate permitting agencies)
	Insects	When insects such as wasps and hornets interfere with maintenance activities.	Insects destroyed or removed from site. Apply insecticides in compliance with adopted IPM policies
	Tree Growth and Hazard Trees	Tree growth does not allow maintenance access or interferes with maintenance activity (i.e., slope mowing, silt removal, vactoring, or equipment movements). If trees are not interfering with access or maintenance, do not remove If dead, diseased, or dying trees are identified (Use a certified Arborist to determine health of tree or removal requirements)	Trees do not hinder maintenance activities. Harvested trees should be recycled into mulch or other beneficial uses (e.g., alders for firewood). Remove hazard Trees
Side Slopes of Pond	Erosion	Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion. Any erosion observed on a compacted berm embankment.	Slopes should be stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction. If erosion is occurring on compacted berms a licensed civil engineer should be consulted to resolve source of erosion.
Storage Area	Sediment	Accumulated sediment that exceeds 10% of the designed pond depth unless otherwise specified or affects inletting or outletting condition of the facility.	Sediment cleaned out to designed pond shape and depth; pond reseeded if necessary to control erosion.
	Liner (If Applicable)	Liner is visible and has more than three 1/4-inch holes in it.	Liner repaired or replaced. Liner is fully covered.

No. 1 – Detention Ponds

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Pond Berms (Dikes)	Settlements	Any part of berm which has settled 4 inches lower than the design elevation. If settlement is apparent, measure berm to determine amount of settlement. Settling can be an indication of more severe problems with the berm or outlet works. A licensed civil engineer should be consulted to determine the source of the settlement.	Dike is built back to the design elevation.
	Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Goethechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential resolved.
Emergency Overflow/ Spillway and Berms over 4 feet in height.	Tree Growth	Tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping. Tree growth on berms over 4 feet in height may lead to piping through the berm which could lead to failure of the berm.	Trees should be removed. If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A licensed civil engineer should be consulted for proper berm/spillway restoration.
	Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Goethechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential resolved.
Emergency Overflow/ Spillway	Emergency Overflow/ Spillway	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil at the top of out flow path of spillway. (Rip-rap on inside slopes need not be replaced.)	Rocks and pad depth are restored to design standards.
	Erosion	See "Side Slopes of Pond"	