PRELIMINARY STORMWATER TECHNICAL INFORMATION REPORT

LEICHNER CAMPUS MASTER PLAN
AREA 1

Prepared for
CLARK COUNTY
October 7, 2016
Project No. 0862.01.01

Prepared by
Maul Foster & Alongi, Inc.
400 E Mill Plain Blvd., Suite 400, Vancouver WA 98660

MAUL
FOSTER
ALONGI

PRELIMINARY STORMWATER TECHNICAL INFORMATION REPORT

LEICHNER CAMPUS MASTER PLAN

To the best of my knowledge and understanding, all information required by Clark County Stormwater and Erosion Control Ordinance Chapter 40.386 is included in this report, and the proposed stormwater facilities are feasible.

The material and data in this report were prepared under the supervision and direction of the undersigned.

MAUL FOSTER & ALONGI, INC.

Zachary Pyle, EIT
Staff Engineer

This digital seal certifies the signatory and document content.

10-07-2016

Stacy J. Frost, PE
Senior Engineer

CONTENTS

SECTION A PROJECT OVERVIEW 1
A.1 DESCRIBE THE SITE LOCATION. 1
A.2 DESCRIBE THE TOPOGRAPHY, NATURAL DRAINAGE PATTERNS, VEGETATIVE GROUND COVER, AND PRESENCE OF CRITICAL AREAS (CCC CHAPTER 40.440). CRITICAL AREAS THAT RECEIVE RUNOFF FROM THE SITE SHALL BE DESCRIBED TO A MINIMUM OF ¼ MILE AWAY FROM THE SITE BOUNDARY. 1
A.3 IDENTIFY AND DISCUSS EXISTING ON-SITE STORMWATER SYSTEMS AND THEIR FUNCTIONS. 1
A.4 IDENTIFY AND DISCUSS SITE PARAMETERS THAT INFLUENCE STORMWATER SYSTEM DESIGN. 1
A.5 DESCRIBE DRAINAGE TO AND FROM ADJACENT PROPERTIES. 1
A.6 FOR AGRICULTURAL SITES WITH DRAIN TILES, DISCUSS THE IMPACT OF CONSTRUCTION ON THE DRAIN TILES, SITE DRAINAGE, AND THE IMPACT OF THE DRAINAGE TILES ON PROPOSED STORMWATER FACILITIES. 2
A.7 DESCRIBE ADJACENT AREAS, INCLUDING STREAMS, LAKES, WETLAND AREAS, RESIDENTIAL AREAS, AND ROADS THAT MIGHT BE AFFECTED BY THE CONSTRUCTION PROJECT. 2
A.8 GENERALLY DESCRIBE PROPOSED SITE CONSTRUCTION, SIZE OF IMPROVEMENTS, AND PROPOSED METHODS OF MITIGATING STORMWATER RUNOFF QUANTITY AND QUALITY IMPACTS. 2

SECTION B MINIMUM REQUIREMENTS 2
B.1 DESCRIBE THE LAND-DISTURBING ACTIVITY AND DOCUMENT THE APPLICABLE MINIMUM REQUIREMENTS FOR THE PROJECT SITE. 2
B.2 PROVIDE A STATEMENT THAT CONFIRMS THE MINIMUM REQUIREMENTS THAT WILL APPLY TO THE DEVELOPMENT ACTIVITY. 3
B.3 FOR LAND-DISTURBING ACTIVITIES WHERE MINIMUM REQUIREMENTS 1 THROUGH 9 MUST BE MET: 5

SECTION C SOILS EVALUATION 6
C.1 DESCRIBE THE SITE'S SUITABILITY FOR STORMWATER INFILTRATION FOR FLOW CONTROL, RUNOFF TREATMENT, AND LOW IMPACT DEVELOPMENT (LID) MEASURES. 6
C.2 IDENTIFY WATER TABLE ELEVATIONS, FLOW DIRECTIONS (WHERE AVAILABLE), AND DATA ON SEASONAL WATER TABLE FLUCTUATIONS WITH MINIMUM AND MAXIMUM WATER TABLE ELEVATIONS WHERE THESE MAY AFFECT STORMWATER FACILITIES. 6
C.3 IDENTIFY AND DESCRIBE SOIL PARAMETERS AND DESIGN METHODS FOR USE IN HYDROLOGIC AND HYDRAULIC DESIGN OF PROPOSED FACILITIES. 6
C.4 REPORT FINDINGS OF TESTING AND ANALYSIS USED TO DETERMINE THE INFILTRATION RATE. 6
C.5 WHERE UNSTABLE OR COMPLEX SOIL CONDITIONS EXIST THAT MAY SIGNIFICANTLY AFFECT THE DESIGN OF STORMWATER FACILITIES, THE RESPONSIBLE OFFICIAL MAY REQUIRE A PRELIMINARY SOILS REPORT THAT ADDRESSES STORMWATER DESIGN CONSIDERATIONS ARISING FROM SOIL CONDITIONS. 7

SECTION D SOURCE CONTROL 8
D.1 IF THE DEVELOPMENT ACTIVITY INCLUDES ANY OF THE ACTIVITIES LISTED IN SECTION 2.2 OF VOLUME IV OF THE SMMWW, IDENTIFY THE SOURCE CONTROL BMPS TO BE USED WITH THE LAND-DISTURBING ACTIVITY. 8

CONTENTS (CONTINUED)

SECTION E ONSITE STORMWATER MANAGEMENT BMPS 9

E.1 ON THE PRELIMINARY DEVELOPMENT PLAN OR OTHER MAPS, SHOW THE SITE AREAS WHERE ONSITE STORMWATER MANAGEMENT BMPS WILL BE EFFECTIVELY IMPLEMENTED. THE PLAN MUST SHOW THE AREAS OF RETAINED NATIVE VEGETATION AND REQUIRED FLOW LENGTHS AND VEGETATED FLOW PATHS, AS REQUIRED FOR PROPER IMPLEMENTATION OF EACH ONSITE STORMWATER BMP. ARROWS MUST SHOW THE STORMWATER FLOW PATH TO EACH BMP. 9

E.2 IDENTIFY AND DESCRIBE GEOTECHNICAL STUDIES OR OTHER INFORMATION USED TO COMPLETE THE ANALYSIS AND DESIGN OF EACH ONSITE STORMWATER BMP. 9

E.3 IDENTIFY THE CRITERIA (AND THEIR SOURCES) USED TO COMPLETE ANALYSES FOR EACH ONSITE STORMWATER BMP. 9

E.4 DESCRIBE HOW DESIGN CRITERIA WILL BE MET FOR EACH PROPOSED ONSITE STORMWATER MANAGEMENT BMP. 10

E.5 DESCRIBE ANY ONSITE APPLICATION OF LID MEASURES PLANNED FOR THE PROJECT. PROVIDE A PLAN THAT SHOWS THE PROPOSED LOCATION AND APPROXIMATE SIZE OF EACH LID FACILITY. 10

E.6 IDENTIFY AND DESCRIBE ANY ASSUMPTIONS USED TO COMPLETE THE ANALYSIS. 10

E.7 DESCRIBE SITE SUITABILITY, INCLUDING HYDROLOGIC SOIL GROUPS, SLOPES, AREA OF NATIVE VEGETATION, AND ADEQUATE LOCATION OF EACH BMP. 10

SECTION F RUNOFF TREATMENT ANALYSIS AND DESIGN 11

F.1 FOR LAND-DISTURBING ACTIVITIES WHERE THE THRESHOLDS WITHIN MINIMUM REQUIREMENT 6 INDICATE THAT RUNOFF TREATMENT FACILITIES ARE REQUIRED: 11

SECTION G FLOW CONTROL ANALYSIS AND DESIGN 12

G.1 FOR LAND-DISTURBING ACTIVITIES WHERE THE THRESHOLDS WITHIN MINIMUM REQUIREMENT 7 INDICATE THAT FLOW CONTROL FACILITIES ARE REQUIRED: 12

G.2 IDENTIFY AND DESCRIBE GEOTECHNICAL OR OTHER STUDIES USED TO COMPLETE THE ANALYSIS AND DESIGN. 12

G.3 IF INFILTRATION CANNOT BE PROVIDED FOR FLOW CONTROL, PROVIDE THE FOLLOWING ADDITIONAL INFORMATION: 12

G.4 SUBMIT ELECTRONIC COPIES OF THE WWHM (.WDM, .PRJ, .USI) PROJECT FILES UPON REQUEST. 13

SECTION H WETLANDS PROTECTION 14

H.1 FOR PROJECTS WITH STORMWATER DISCHARGES TO A WETLAND, EITHER DIRECTLY OR INDIRECTLY THROUGH A CONVEYANCE SYSTEM, THE PRELIMINARY TIR SHALL DESCRIBE WETLAND PROTECTION MEASURES TO BE IMPLEMENTED IN ACCORDANCE WITH MINIMUM REQUIREMENT 8. THE NARRATIVE SHALL DESCRIBE THE MEASURES THAT WILL MAINTAIN THE HYDROLOGIC CONDITIONS, HYDROPHYTIC VEGETATION, AND SUBSTRATE CHARACTERISTICS NECESSARY TO SUPPORT EXISTING AND DESIGNATED USES. 14

LIMITATIONS

APPENDIX A

PRE-DEVELOPMENT DRAINAGE BASIN MAP

POST-DEVELOPMENT DRAINAGE BASIN MAP

PRELIMINARY STORMWATER PLAN

CONTENTS (CONTINUED)

APPENDIX B
WWHM REPORT

APPENDIX C
PRELIMINARY GEOTECHNICAL REPORT

APPENDIX D
OPERATIONS & MAINTENANCE MANUAL

SECTION A PROJECT OVERVIEW

A.1 Describe the site location.

The project site is located in northeast Vancouver, Washington at 8713 NE 94th Avenue. The Leichner Campus is composed of four parcels (account numbers 105740000, 199863000, 199864000, and 199845000). The Leichner Campus is part of the larger Master Planned Development application area. The Leichner Campus will eventually be sold to a private developer and redeveloped for light industrial uses allowed as described in Section 6, Application Narrative. Development in the other areas of the Master Planned Development application area will be determined at a future date.

A.2 Describe the topography, natural drainage patterns, vegetative ground cover, and presence of critical areas (CCC Chapter 40.440). Critical areas that receive runoff from the site shall be described to a minimum of ¼ mile away from the site boundary.

The portion of the site that will be developed is largely flat, with a maximum slope of 3 percent. The steepest slope on the edge of the site is approximately 30 percent, acting as engineered fill that cover the adjacent landfill. Ground cover generally consists of a grassy field. There are no critical areas on site.

A.3 Identify and discuss existing on-site stormwater systems and their functions.

There are no existing on-site stormwater systems

A.4 Identify and discuss site parameters that influence stormwater system design.

The stormwater system design was influenced by site soils, existing topography, adjacency to a closed landfill, and proposed development improvements.

A.5 Describe drainage to and from adjacent properties.

Clark County GIS (Geographical Information Systems) contours were used to identify existing drainage patterns. Due to the flat area and good infiltration rates, obvious drainage patterns are not prevalent. See Pre-developed Drainage Basin Map in Appendix A.

A.6 For agricultural sites with drain tiles, discuss the impact of construction on the drain tiles, site drainage, and the impact of the drainage tiles on proposed stormwater facilities.

Not applicable; the site has no known drain tiles.

A.7 Describe adjacent areas, including streams, lakes, wetland areas, residential areas, and roads that might be affected by the construction project.

No streams, lakes, wetland areas, or residential areas will be affected.

A.8 Generally describe proposed site construction, size of improvements, and proposed methods of mitigating stormwater runoff quantity and quality impacts.

The proposed improvements include the construction of an internal private road network on the Leichner campus. The network includes approximately 2,200 lineal feet of road, with two roundabouts. Stormwater, sanitary sewer, and water will be provided within the roadway. Stormwater quality treatment will be provided using roadside bioretention facilities (Best Management Practice [BMP] T5.14B). After treatment, stormwater will be infiltrated on-site. This stormwater technical information report refers to only Area 1-Leichner Campus and does not address the remaining master plan development area that have not yet been designed.

SECTION B MINIMUM REQUIREMENTS

B.1 Describe the land-disturbing activity and document the applicable minimum requirements for the project site.

Include the following information in table format:

1. The amount of existing impervious surface.

2. The amount of new impervious surface.

3. The amount of replaced impervious surface.

4. The amount of native vegetation converted to lawn or landscaping.

5. The amount of native vegetation converted to pasture.

6. The total amount of land-disturbing activity.

Table 1: Site Characteristics

Land-Disturbing Activity	Area (Acres)
Existing Impervious Surface	0.000
New Impervious Surface	2.624
Bioretention	0.590
Replaced Impervious Surface	0.000
Native Vegetation Converted to Lawn or Landscaping	0
Native Vegetation Converted to Pasture	0
Total Amount of Land-Disturbing Activity	3.214

B.2 Provide a statement that confirms the minimum requirements that will apply to the development activity.

In accordance with the Clark County Stormwater Manual, minimum requirements 1 through 9 apply to this project, and are being addressed as follows:

1. Preparation of Stormwater Site Plans

Plans detailing the collection, conveyance, treatment, and infiltration of stormwater runoff will be prepared as part of the final design. A preliminary plan showing the approximate location of stormwater system components is included in the preliminary site plan submittal packet.

2. Construction Stormwater Pollution Prevention

A stormwater pollution prevention plan addressing Elements 1 through 15 outlined in Volume I, Section 2.5.2 of the 2012 Stormwater Management Manual for Western Washington (SMMWW) will be completed prior to construction.

3. Source Control of Pollution

See Section D.

4. Preservation of Natural Drainage Systems and Outfalls

Natural drainage systems will be preserved to the extent practicable. There are no existing outfalls on the site.

5. Onsite Stormwater Management (Low Impact Development)

See Section E.

6. Runoff Treatment

All stormwater will be treated using on-site bioretention facilities prior to infiltration. Overflow discharge will occur through a connection to existing stormwater facilities in NE 94th Avenue. See Section F.

7. Flow Control

Stormwater runoff will be infiltrated on-site after treatment. See Section G.

8. Wetlands Protection

Not applicable.

9. Operation and Maintenance

The bioretention facilities will be privately owned and maintained; access easements will be provided to the County. Maintenance will be in accordance with the Clark County Public Works Department Stormwater Facility Maintenance Manual.

B.3 For land-disturbing activities where minimum requirements 1 through 9 must be met:

B.3.1 Provide the amount of effective impervious area in each threshold discharge area (TDA), and document through an approved continuous runoff simulation model the increase in the 100-year flood frequency from pre-developed to developed conditions for each TDA.

Table 2: Effective Impervious Area

TDA	Effective Impervious Area (Square Feet)
TDA 1 (internal road network)	98,700 SQ. FT.

B.3.2 List the TDAs that must meet the runoff control requirements listed in Minimum Requirement 6.

TDA 1 must meet the runoff control requirements in Minimum Requirement 6.

B.3.3 List the TDAs that must meet the flow control requirements listed in Minimum Requirement 7.

Not applicable.

B.3.4 List the TDAs that must meet the wetlands protection requirements listed in Minimum Requirement 8.

Not applicable.

SECTION C SOILS EVALUATION

C.1 Describe the site's suitability for stormwater infiltration for flow control, runoff treatment, and low impact development (LID) measures.

According to the Web Soil Survey, all of the soil found on the site is sifton gravelly loam. These soils make infiltration very suitable, as the soils are described as "well drained; very slow runoff; very rapid permeability." Infiltration testing completed by Hart Crowser for the County's NE 94th Avenue improvements found an in-situ tested infiltration rate of 20 in/hour.

C.2 Identify water table elevations, flow directions (where available), and data on seasonal water table fluctuations with minimum and maximum water table elevations where these may affect stormwater facilities.

The "Geotechnical Data Review and Geologic Reconnaissance" completed by PBS Environmental on June 17, 2015 states that groundwater was observed at 12-19 feet below ground surface (bgs) in the eastern portion of the site and 19-37 feet bgs in the western part of the site.

C.3 Identify and describe soil parameters and design methods for use in hydrologic and hydraulic design of proposed facilities.

According to the Web Soil Survey, all of the soil found on the site is sifton gravelly loam. These soils make infiltration very suitable, as the soils are described as "well drained; very slow runoff; very rapid permeability." Infiltration testing completed by Hart Crowser for the County's NE 94th Avenue improvements found an in-situ tested infiltration rate of 20 in/hour.

For purposes of the Western Washington Hydrology Model (WWHM), the limiting factor in infiltration is assumed to be standard bioretention soil media mix.

C.4 Report findings of testing and analysis used to determine the infiltration rate.

No infiltration testing was performed.

C.5 Where unstable or complex soil conditions exist that may significantly affect the design of stormwater facilities, the responsible official may require a preliminary soils report that addresses stormwater design considerations arising from soil conditions.

A preliminary geotechnical report was conducted by PBS in June, 2015. Prior to final design, further geotechnical study will be conducted as deemed necessary by a professional engineer.

SECTION D SOURCE CONTROL

D.1 If the development activity includes any of the activities listed in Section 2.2 of Volume IV of the SMMWW, identify the source control BMPs to be used with the land-disturbing activity.

The following source control BMPs will be used with the land-disturbing activity:

BMPs for Landscaping and Lawn/Vegetation Management

- Collected vegetation will be properly disposed of, and will not be placed in waterways or storm drainage facilities.

BMPs for Maintenance of Stormwater Drainage and Treatment Systems

- Inspect and clean bioretention facilities as needed; determine whether improvements in operation and maintenance are needed.
- Promptly repair any deterioration threatening the structural integrity of the facilities.
- Ensure that storm sewer capacities are not exceeded and that heavy sediment discharges to the sewer system are prevented.

BMPs for Urban Streets

- Regularly sweep paved areas to collect dirt, waste, and debris.

SECTION E ONSITE STORMWATER MANAGEMENT BMPs

E.1 On the preliminary development plan or other maps, show the site areas where onsite stormwater management BMPs will be effectively implemented. The plan must show the areas of retained native vegetation and required flow lengths and vegetated flow paths, as required for proper implementation of each onsite stormwater BMP. Arrows must show the stormwater flow path to each BMP.

Stormwater runoff in the disturbed areas will be directed to roadside bioretention facilities. See Sheet C2.3 for the location of those facilities.

E.2 Identify and describe geotechnical studies or other information used to complete the analysis and design of each onsite stormwater BMP.

PBS produced a geotechnical report stating historical groundwater data collected as part of the Leichner Landfill post-closure monitoring program indicate groundwater occurs beneath the property between depths ranging from 12 to 19 feet bgs in the eastern portion and 17 to 37 feet bgs in the western portion with flow generally toward the west-southwest.

According to the Web Soil Survey, all of the soil found on the site is sifton gravelly loam. These soils make infiltration very suitable, as the soils are described as "well drained; very slow runoff; very rapid permeability." This information was used to determine bioretention facilities were feasible on site.

Infiltration testing was completed by Hart Crowser for the County's NE 94th Avenue improvements. They found an in-situ tested infiltration rate of 20 in/hour. For design purposes, a safety factor or 4 was applied.

E.3 Identify the criteria (and their sources) used to complete analyses for each onsite stormwater BMP.

Bioretention facilities are designed in accordance with the Clark County Stormwater Manual (BMP T5.14B).

E.4 Describe how design criteria will be met for each proposed onsite stormwater management BMP.

Bioretention facilities will be sized based on WWHM modeling at the time of final proposal. Preliminary sizing to ensure feasibility was conducted for this proposal. See the WWHM report (Appendix B) of this application.

E.5 Describe any onsite application of LID measures planned for the project. Provide a plan that shows the proposed location and approximate size of each LID facility.

Stormwater runoff in the disturbed areas will be directed to roadside bioretention facilities. See Sheet C2.3 for the location of those facilities.

E.6 Identify and describe any assumptions used to complete the analysis.

Assumptions used to preliminarily design the bioretention facilities include the use of the Web Soil Survey data. Infiltration testing completed by Hart Crowser for the County's NE 94th Avenue improvements found am in-situ tested infiltration rate of 20 in/hour. These assumptions suggest infiltration is feasible on site.

E.7 Describe site suitability, including hydrologic soil groups, slopes, area of native vegetation, and adequate location of each BMP.

According to the Web Soil Survey, all of the soil found on the site is sifton gravelly loam. These soils make infiltration very suitable, as the soils are described as "well drained; very slow runoff; very rapid permeability." This information was used to determine bioretention facilities were feasible on site. Infiltration testing completed by Hart Crowser for the County's NE 94th Avenue improvements found am in-situ tested infiltration rate of 20 in/hour.

SECTION F RUNOFF TREATMENT ANALYSIS AND DESIGN

F.1 For land-disturbing activities where the thresholds within Minimum Requirement 6 indicate that runoff treatment facilities are required:

F.1.1 Document the level of treatment required (basic, enhanced, phosphorus, oil/water separation), based on procedures in Volume V, Chapter 2 of the SMMWW.

Consistent with the flowchart in Figure 2.1, Volume V of the SMMWW, the following steps were analyzed to determine level of treatment required:

Step 1: Determine Receiving Waters and Pollutants of Concern

The site will act as a single basin (TDA 1) that is collected in to roadside bioretention facilities, treated, and infiltrated on site. In the instance of an emergency overflow, runoff will be directed to existing stormwater infrastructure within the NE 94th Avenue right-of-way.

Step 2: Determine if an Oil Control Facility is required

The site does not trigger any of the requirements for an oil control facility.

Step 3: Determine if Infiltration for Pollutant Removal is Practicable

Infiltration is feasible and being utilized at the site.

Step 4: Determine if Phosphorus Control is required

The site does not meet the criteria for phosphorus control outlined in Volume V, Chapter 2 of the SMMWW.

Step 5: Determine if Enhanced Treatment is required

Enhanced treatment will be utilized by designing the bioretention facilities to infiltrate 91% of runoff through the imported soil mix.

Step 6: Select a Basic Treatment Facility

The site will act as a single basin (TDA 1) that is collected in to roadside bioretention facilities, treated, and infiltrated on site. In the event of a storm event that causes bypassing of the bioretention facilities, runoff will be directed to existing stormwater infrastructure within the NE 94th Avenue right-of-way.

SECTION G FLOW CONTROL ANALYSIS AND DESIGN

G.1 For land-disturbing activities where the thresholds within Minimum Requirement 7 indicate that flow control facilities are required:

G.1.1 Identify the site's suitability for stormwater infiltration for flow control, including tested infiltration rates, logs of soil borings, and other information.

According to the Web Soil Survey, all of the soil found on the site is sifton gravelly loam. These soils make infiltration very suitable, as the soils are described as "well drained; very slow runoff; very rapid permeability." Infiltration testing completed by Hart Crowser for the County's NE 94th Avenue improvements found an in-situ tested infiltration rate of 20 in/hour.

G.2 Identify and describe geotechnical or other studies used to complete the analysis and design.

The findings from the Web Soil Survey were used to determine that infiltration is feasible at the site. Infiltration testing completed by Hart Crowser for the County's NE 94th Avenue improvements found an in-situ tested infiltration rate of 20 in/hour.

G.3 If infiltration cannot be provided for flow control, provide the following additional information:

G.3.1 Identify the areas where flow control credits can be obtained for dispersion, LID, or other measures, per the requirements in the SMMWW.

The entire site is suitable for LID stormwater control measures.

G.3.2 Provide the approximate sizing and location of flow control facilities for each TDA, per Volume III of the SMMWW.

See Appendix A for preliminary stormwater plan and detail sheets.

Complete a hydrologic analysis for existing and developed site conditions, in accordance with the requirements of CCC Section 40.386.020(C) and Chapter 2, Volume III of the SMMWW, using an approved continuous runoff simulation model (the Clark County version of WWHM). Compute existing and developed flow durations for all subbasins. Provide an output table from the continuous flow model.

See attached WWHM output report in Appendix B.

G.3.3 Include and reference all hydrologic computations, equations, graphs, and any other aids necessary to clearly show the methodology and results.

See attached WWHM output report in Appendix B.

G.3.4 Include all maps, exhibits, graphics, and references used to determine existing and developed site hydrology.

See Appendix A.

G.4 Submit electronic copies of the WWHM (.wdm, .prj, .usi) project files upon request.

Electronic copies of the WWHM files will be furnished upon request.

SECTION H WETLANDS PROTECTION

H.1 For projects with stormwater discharges to a wetland, either directly or indirectly through a conveyance system, the preliminary TIR shall describe wetland protection measures to be implemented in accordance with Minimum Requirement 8. The narrative shall describe the measures that will maintain the hydrologic conditions, hydrophytic vegetation, and substrate characteristics necessary to support existing and designated uses.

Not applicable.

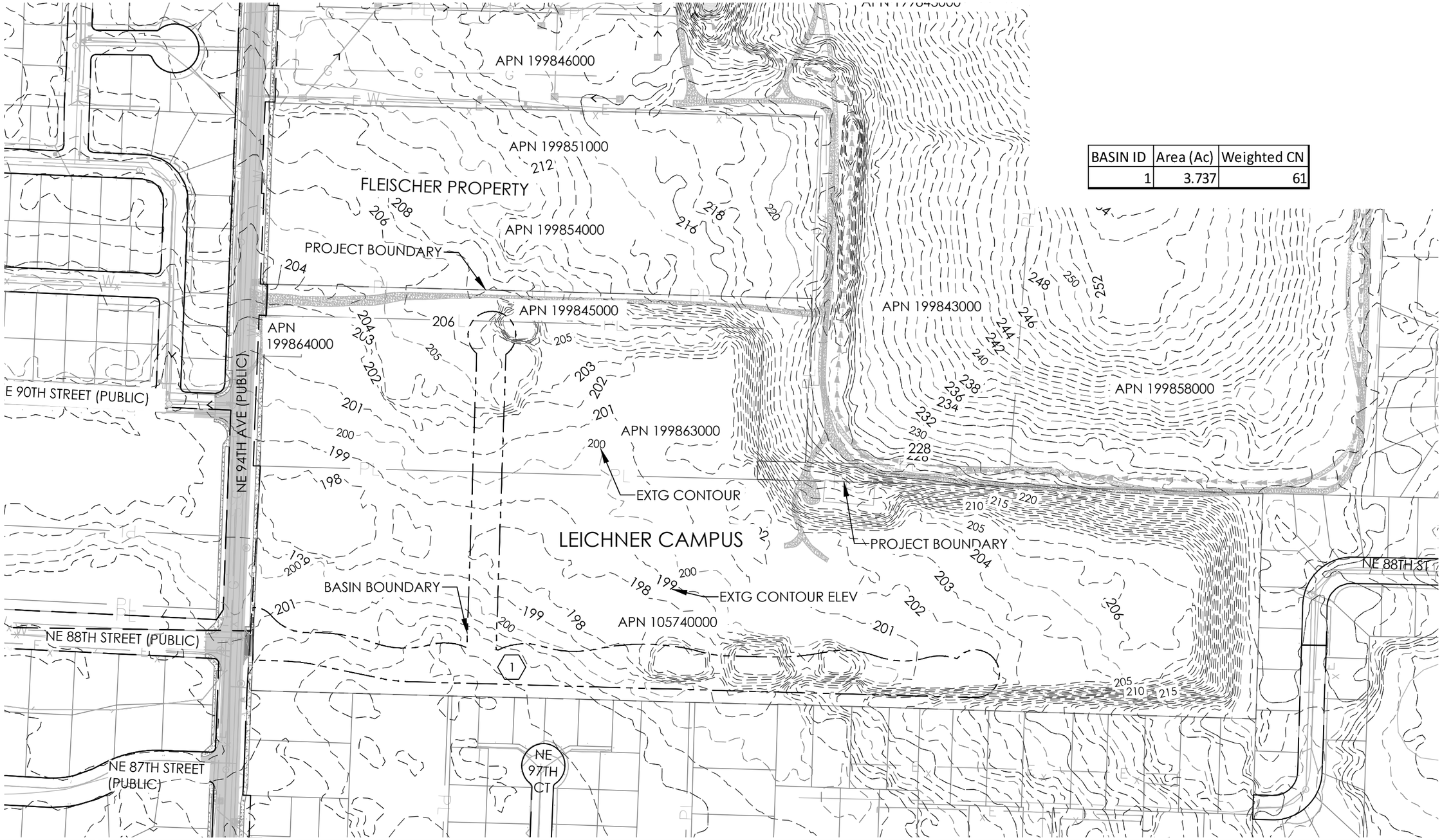
LIMITATIONS

The services undertaken in completing this report were performed consistent with generally accepted professional consulting principles and practices. No other warranty, express or implied, is made. These services were performed consistent with our agreement with our client. This report is solely for the use and information of our client unless otherwise noted. Any reliance on this report by a third party is at such party's sole risk.

Opinions and recommendations contained in this report apply to conditions existing when services were performed and are intended only for the client, purposes, locations, time frames, and project parameters indicated. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, or the use of segregated portions of this report.

APPENDIX A

PRE-DEVELOPMENT DRAINAGE BASIN MAP
POST-DEVELOPMENT DRAINAGE BASIN MAP
PRELIMINARY STORMWATER PLAN



BASIN ID	Area (Ac)	Weighted CN
1	3.737	61

Printed by: Zachary Pyle Filepath:G:\00_MFA Civil 3D\00_PROJECTS\9059.07 Leichner\EXHIBIT\Basin Maps.dwg Date:7/26/2016 8:02:19 AM

MFA JOB #:	9059.07.03
ISSUE DATE:	07/25/2016
CHECKED:	S. FROST
DRAWN:	Z. PYLE

MAUL FOSTER ALONGI
400 EAST MILL PLAIN BLVD, SUITE 400
VANCOUVER, WA 98660
PHONE: 360.694.2691
www.maulfoster.com

PRE-DEVELOPED STORMWATER BASIN MAP

LEICHNER CAMPUS MASTER PLAN

CLARK COUNTY

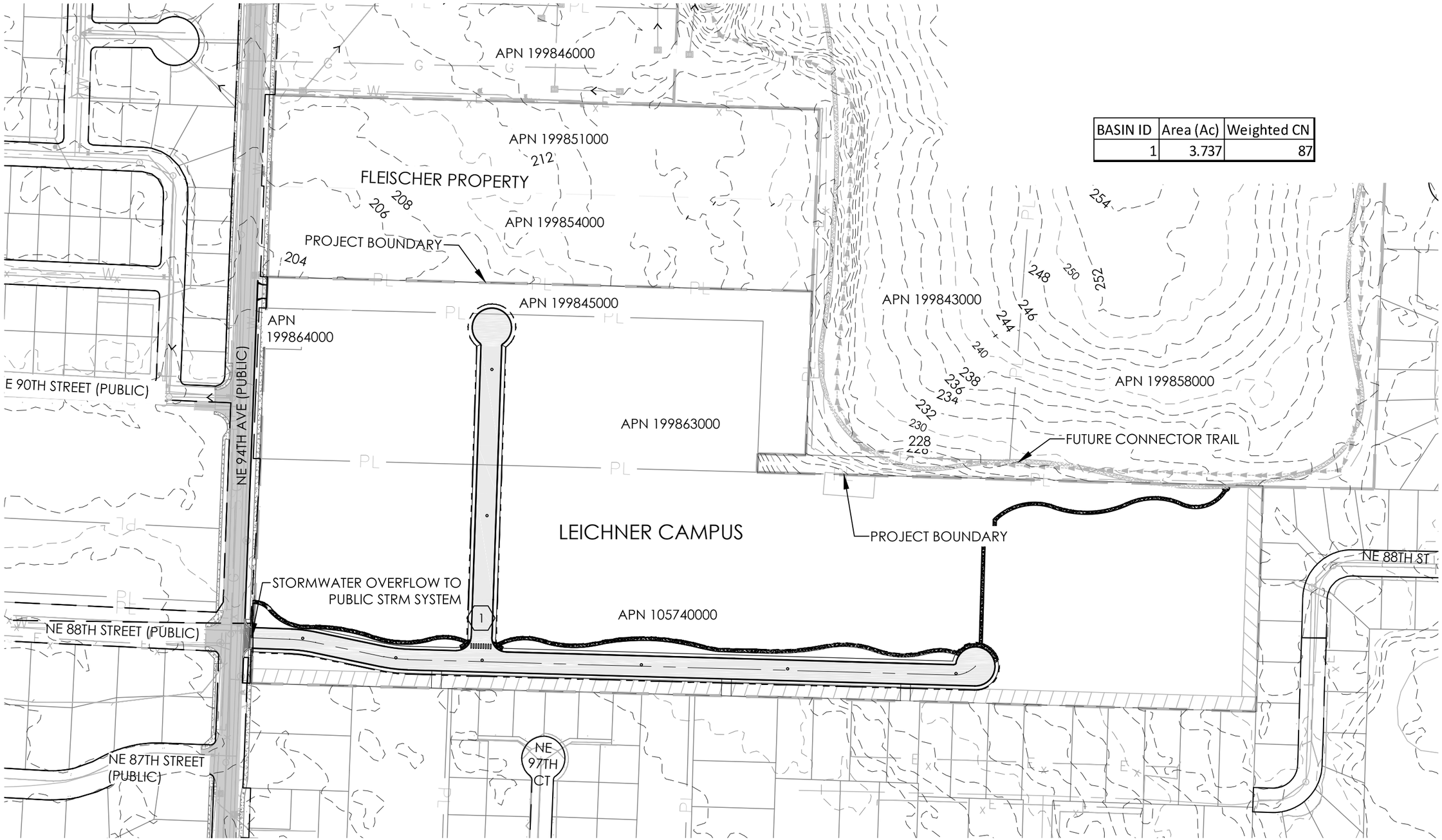
CLARK COUNTY, WA

0 200' 400'

NOTE: BAR IS ONE INCH ON ORIGINAL DRAWING. IF NOT ONE INCH ON THIS SHEET, ADJUST SCALE ACCORDINGLY.

EXHIBIT 1

BASIN ID	Area (Ac)	Weighted CN
1	3.737	87



Filepath:G:\00_MFA Civil 3D\00_PROJECTS\9059.07 Leichner\EXHIBIT\Basin Maps.dwg

Printed by: Zachary Pyle

Date:7/26/2016 8:07:32 AM

MFA JOB #:	9059.07.03
ISSUE DATE:	07/11/2016
CHECKED:	S. FROST
DRAWN:	Z. PYLE

MAUL FOSTER ALONGI
400 EAST MILL PLAIN BLVD, SUITE 400
VANCOUVER, WA 98660
PHONE: 360.694.2691
www.maulfoster.com

POST-DEVELOPMENT
STORMWATER BASIN MAP

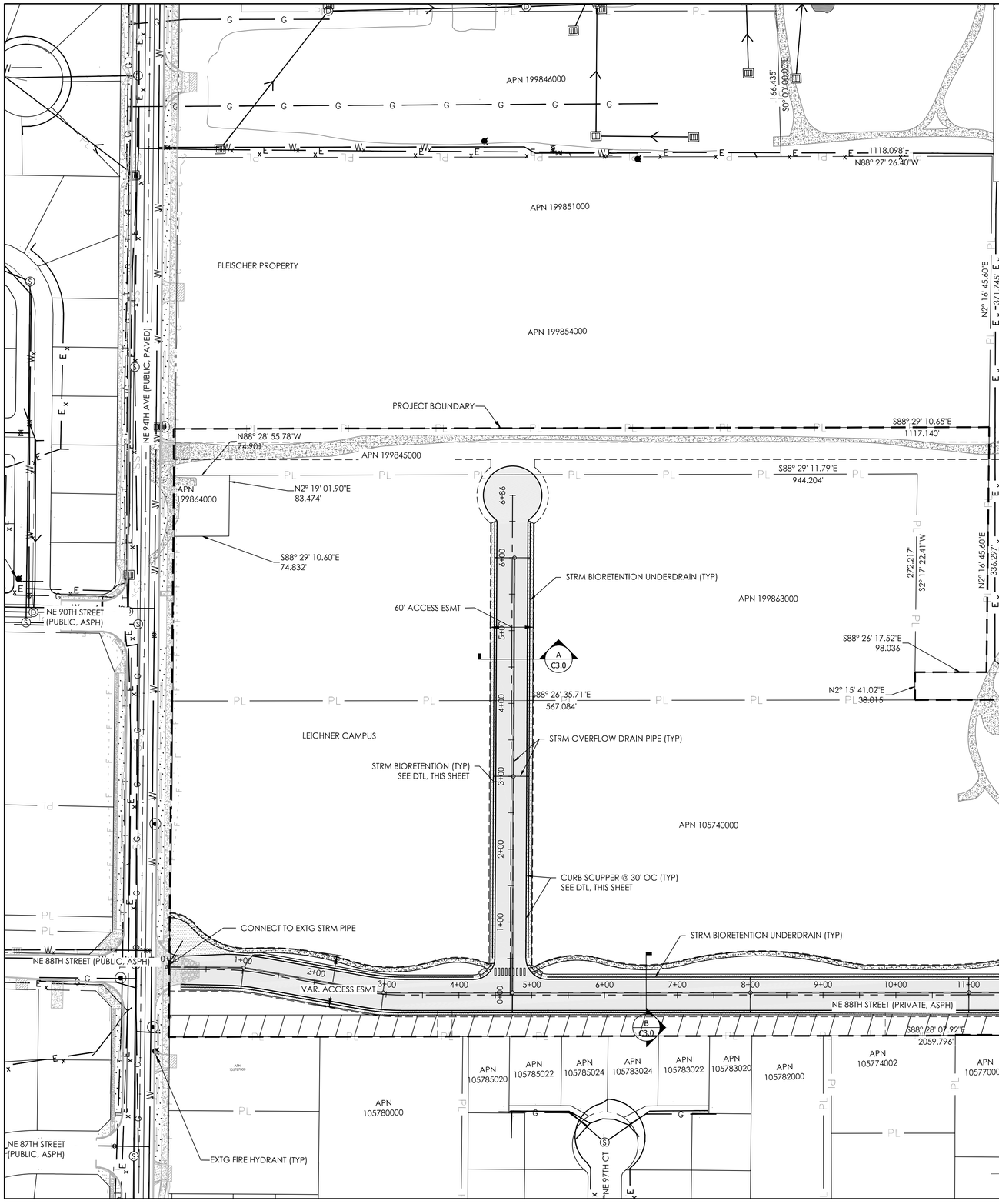
LEICHNER CAMPUS MASTER PLAN

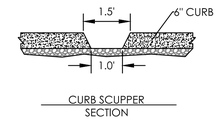
CLARK COUNTY
CLARK COUNTY, WA

0 200' 400'

NOTE: BAR IS ONE INCH ON ORIGINAL DRAWING. IF NOT ONE INCH ON THIS SHEET, ADJUST SCALE ACCORDINGLY.

EXHIBIT
2



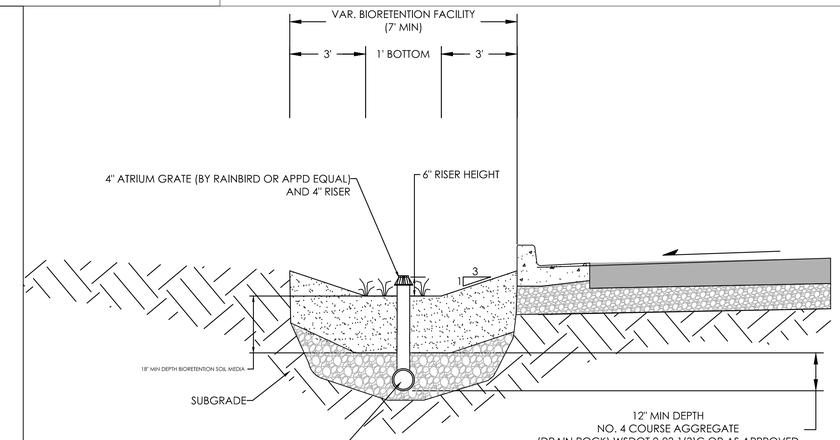


CURB SCUPPER SECTION

QUANTITIES

TOTAL PROJECT AREA: 35.190 AC (1,533,000 SQ. FT.)
EXISTING IMPERVIOUS AREA: 0.000 AC (0 SQ. FT.)
MAINTAIN EXISTING VEGETATION: 32.566 (1,419,000 SQ. FT.)
NEW IMPERVIOUS AREA: 2.624 (114,000 SQ. FT.)
TOTAL IMPERVIOUS AREA: 2.624 AC (114,000 SQ. FT.)

STORMWATER BIORETENTION FACILITY AREA: 0.590 AC (25,690 SQ. FT.)



PRELIMINARY BIORETENTION DESIGN

NTS

MAUL FOSTER ALONGI
400 EAST MILL PLAIN BLVD, SUITE 400
VANCOUVER, WA 98660
PHONE: 360.694.2691
www.maulfoster.com

CLARK COUNTY, WASHINGTON

This digital seal certifies the signatory and document content.

10-07-2016

LEICHNER CAMPUS MASTER PLAN

CLARK COUNTY WA

VANCOUVER, WA

ISSUE	DATE	DESCRIPTION
B	09/14/2016	MASTER PLAN RESUBMITTAL
A	07/25/2016	MASTER PLAN APPLICATION

PROJECT: 9059.07.03
DESIGNED: Z. PYLE
DRAWN: Z. PYLE
CHECKED: S. FROST

SCALE
0 80' 160

NOTE: BAR IS ONE INCH ON ORIGINAL DRAWING. IF NOT ONE INCH ON THIS SHEET, ADJUST SCALE ACCORDINGLY.

SHEET TITLE

PRELIMINARY STORMWATER PLAN

SHEET

C2.3

PLOTTED BY: Brooke Harmon FILENAME: G:\100_MFA Civil 3D\00_PROJECTS\9059.07 Leichner\PLANS\Conceptual Site Plan\C2.X Extg Cond & Site Plans_Rev.dwg
PLOTTED ON: 2016-10-03 3:54 PM

APPENDIX B

WWHM REPORT

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	Master Plan Stormwater Analysis
Site Name:	Leichner
Site Address:	9411 NE 94th Avenue
City:	Vancouver
Report Date:	7/25/2016
Gage:	Orchards
Data Start:	1948/10/01
Data End:	2008/09/30
Timestep:	15 Minute
Precip Scale:	1.14
Version:	2015/07/29

POC Thresholds

Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year

Landuse Basin Data

Predeveloped Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
A B, Pasture, Flat	2.624
Pervious Total	2.624
Impervious Land Use	Acres
Impervious Total	0
Basin Total	2.624

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
Pervious Total	0
Impervious Land Use	Acres
ROADS FLAT	2.266
SIDEWALKS FLAT	0.358
Impervious Total	2.624
Basin Total	2.624

Element Flows To:

Surface	Interflow	Groundwater
Surface retention 1	Surface retention 1	

Routing Elements
Predeveloped Routing

Mitigated Routing

Bioretention 1

Bottom Length:	2500.00 ft.
Bottom Width:	1.00 ft.
Material thickness of first layer:	1.5
Material type for first layer:	SMMWW 12 in/hr
Material thickness of second layer:	1.5
Material type for second layer:	Sand
Material thickness of third layer:	0.25
Material type for third layer:	GRAVEL
Infiltration On	
Infiltration rate:	20
Infiltration safety factor:	0.25
Total Volume Infiltrated (ac-ft):	451.28
Total Volume Through Riser (ac-ft):	0
Total Volume Through Facility (ac-ft):	451.28
Percent Infiltrated:	100
Total Precip Applied to Facility:	15.467
Total Evap From Facility:	7.887
Underdrain not used	
Vertical orifice Outlet Structure	
Vertical orifice Diameter (in):	12
Vertical orifice Elevation (in):	6
Width of overroad flow (ft):	5
Element Flows To:	
Outlet 1 Outlet 2	

Bioretention Hydraulic Table

Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	Infilt(cfs)
0.0000	0.0574	0.0000	0.0000	0.0000
0.0583	0.0775	0.0018	0.2894	0.0000
0.1167	0.0976	0.0041	0.2894	0.0000
0.1750	0.1177	0.0070	0.2894	0.0001
0.2333	0.1378	0.0104	0.2894	0.0001
0.2917	0.1579	0.0144	0.2894	0.0003
0.3500	0.1780	0.0188	0.2894	0.0003
0.4083	0.1981	0.0239	0.2894	0.0007
0.4667	0.2182	0.0294	0.2894	0.0009
0.5250	0.2383	0.0355	0.2894	0.0013
0.5833	0.2584	0.0421	0.2894	0.0017
0.6417	0.2786	0.0493	0.2894	0.0023
0.7000	0.2987	0.0570	0.2894	0.0029
0.7583	0.3188	0.0652	0.2894	0.0035
0.8167	0.3389	0.0740	0.2894	0.0046
0.8750	0.3591	0.0833	0.2894	0.0052
0.9333	0.3792	0.0931	0.2894	0.0067
0.9917	0.3993	0.1035	0.2894	0.0072
1.0500	0.4195	0.1145	0.2894	0.0093
1.1083	0.4396	0.1259	0.2894	0.0096
1.1667	0.4598	0.1379	0.2894	0.0124
1.2250	0.4799	0.1504	0.2894	0.0125
1.2833	0.5001	0.1635	0.2894	0.0158
1.3417	0.5202	0.1771	0.2894	0.0162
1.4000	0.5404	0.1913	0.2894	0.0196

1.4583	0.5606	0.2060	0.2894	0.0205
1.5167	0.5807	0.2193	0.2894	0.0239
1.5750	0.6009	0.2331	0.2894	0.0254
1.6333	0.6210	0.2473	0.2894	0.0288
1.6917	0.6412	0.2620	0.2894	0.0310
1.7500	0.6614	0.2772	0.2894	0.0341
1.8083	0.6816	0.2929	0.2894	0.0372
1.8667	0.7018	0.3090	0.2894	0.0401
1.9250	0.7219	0.3257	0.2894	0.0442
1.9833	0.7421	0.3427	0.2894	0.0466
2.0417	0.7623	0.3603	0.2894	0.0519
2.1000	0.7825	0.3783	0.2894	0.0538
2.1583	0.8027	0.3968	0.2894	0.0603
2.2167	0.8229	0.4158	0.2894	0.0615
2.2750	0.8431	0.4352	0.2894	0.0695
2.3333	0.8633	0.4551	0.2894	0.0699
2.3917	0.8835	0.4755	0.2894	0.0789
2.4500	0.9037	0.4963	0.2894	0.0796
2.5083	0.9239	0.5177	0.2894	0.0886
2.5667	0.9441	0.5395	0.2894	0.0904
2.6250	0.9643	0.5617	0.2894	0.0990
2.6833	0.9846	0.5845	0.2894	0.1021
2.7417	1.0048	0.6077	0.2894	0.1101
2.8000	1.0250	0.6313	0.2894	0.1146
2.8583	1.0452	0.6555	0.2894	0.1218
2.9167	1.0655	0.6801	0.2894	0.1281
2.9750	1.0857	0.7052	0.2894	0.1342
3.0333	1.1059	0.7318	0.2894	0.1342
3.0917	1.1262	0.7588	0.2894	0.1342
3.1500	1.1464	0.7863	0.2894	0.1342
3.2083	1.1667	0.8143	0.2894	0.1342
3.2667	1.1869	0.8829	0.2894	0.1342
3.3250	1.2072	0.9527	0.2894	0.1342
3.3833	1.2274	1.0238	0.2894	0.2894
3.4417	1.2477	1.0959	0.2894	0.2894
3.5000	1.2679	1.1693	0.2894	0.2894
3.5583	1.2882	1.2439	0.2894	0.2894
3.6167	1.3085	1.3196	0.2894	0.2894
3.6750	1.3287	1.3965	0.2894	0.2894
3.7333	1.3490	1.4746	0.2894	0.2894
3.7917	1.3693	1.5539	0.2894	0.2894
3.8500	1.3895	1.6344	0.2894	0.2894
3.9083	1.4098	1.7160	0.2894	0.2894
3.9667	1.4301	1.7989	0.2894	0.2894
4.0250	1.4504	1.8829	0.2894	0.2894
4.0833	1.4707	1.9681	0.2894	0.2894
4.1417	1.4910	2.0544	0.2894	0.2894
4.2000	1.5113	2.1420	0.2894	0.2894
4.2583	1.5315	2.2308	0.2894	0.2894
4.3167	1.5518	2.3207	0.2894	0.2894
4.3750	1.5721	2.4118	0.2894	0.2894
4.4333	1.5924	2.5041	0.2894	0.2894
4.4917	1.6128	2.5976	0.2894	0.2894
4.5500	1.6331	2.6923	0.2894	0.2894
4.6083	1.6534	2.7881	0.2894	0.2894
4.6667	1.6737	2.8852	0.2894	0.2894
4.7250	1.6940	2.9834	0.2894	0.2894
4.7833	1.7143	3.0828	0.2894	0.2894

4.8417	1.7347	3.1834	0.2894	0.2894
4.9000	1.7550	3.2852	0.2894	0.2894
4.9583	1.7753	3.3881	0.2894	0.2894
5.0167	1.7956	3.4923	0.2894	0.2894
5.0750	1.8160	3.5976	0.2894	0.2894
5.1333	1.8363	3.7041	0.2894	0.2894
5.1917	1.8567	3.8119	0.2894	0.2894

Bioretention Hydraulic Table

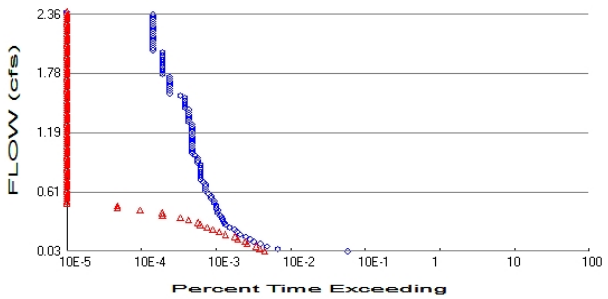
Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	To Amended(cfs)	Infilt(cfs)
5.1917	0.0574	3.8119	0.0000	0.2894	0.0000
5.2500	1.8770	3.9208	0.0000	0.2894	0.0000
5.3083	1.8973	4.0308	0.0000	0.2894	0.0000
5.2500	1.8887	3.9091	0.0000	0.1342	0.0000

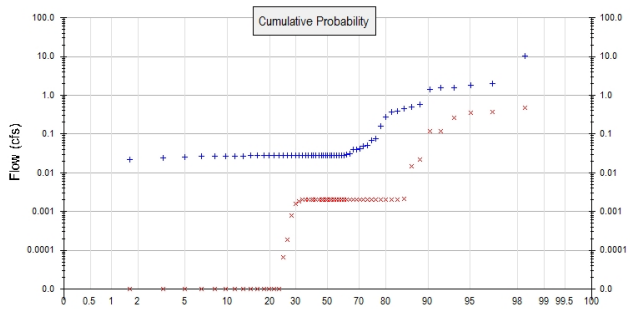
Surface retention 1

Element Flows To:

Outlet 1	Outlet 2
	Bioretention 1

Analysis Results
POC 1





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 2.624
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0
Total Impervious Area: 2.624

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.050874
5 year	0.197061
10 year	0.450347
25 year	1.194262
50 year	2.364274
100 year	4.531166

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.019334
5 year	0.072432
10 year	0.125258
25 year	0.203731
50 year	0.265534
100 year	0.326891

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	0.028	0.002
1950	0.050	0.002
1951	1.770	0.002
1952	0.028	0.002
1953	0.040	0.000
1954	0.050	0.002
1955	0.028	0.000
1956	1.424	0.022
1957	0.028	0.002
1958	0.028	0.002

1959	0.028	0.000
1960	0.027	0.002
1961	0.041	0.002
1962	0.028	0.002
1963	0.028	0.002
1964	0.028	0.000
1965	0.030	0.002
1966	0.027	0.002
1967	0.028	0.002
1968	0.027	0.002
1969	0.386	0.347
1970	10.115	0.119
1971	0.028	0.000
1972	1.569	0.000
1973	0.028	0.002
1974	0.367	0.120
1975	0.040	0.000
1976	0.275	0.002
1977	0.021	0.000
1978	0.077	0.002
1979	0.025	0.002
1980	0.028	0.000
1981	0.032	0.002
1982	0.593	0.015
1983	1.546	0.002
1984	0.027	0.000
1985	0.028	0.002
1986	0.028	0.002
1987	0.028	0.002
1988	0.028	0.001
1989	0.027	0.000
1990	0.027	0.000
1991	0.028	0.000
1992	0.028	0.000
1993	0.028	0.002
1994	0.028	0.002
1995	0.028	0.375
1996	2.006	0.256
1997	0.492	0.485
1998	0.028	0.002
1999	0.159	0.002
2000	0.028	0.000
2001	0.028	0.000
2002	0.441	0.002
2003	0.028	0.002
2004	0.026	0.002
2005	0.022	0.002
2006	0.028	0.000
2007	0.070	0.002
2008	0.027	0.002

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	10.1150	0.4847
2	2.0056	0.3753
3	1.7699	0.3466
4	1.5690	0.2562

5	1.5463	0.1197
6	1.4238	0.1189
7	0.5928	0.0221
8	0.4921	0.0147
9	0.4411	0.0022
10	0.3856	0.0020
11	0.3668	0.0020
12	0.2754	0.0020
13	0.1589	0.0020
14	0.0775	0.0020
15	0.0697	0.0020
16	0.0498	0.0020
17	0.0496	0.0020
18	0.0409	0.0020
19	0.0404	0.0020
20	0.0402	0.0020
21	0.0317	0.0020
22	0.0299	0.0020
23	0.0284	0.0020
24	0.0284	0.0020
25	0.0284	0.0020
26	0.0284	0.0020
27	0.0283	0.0020
28	0.0283	0.0020
29	0.0283	0.0020
30	0.0283	0.0020
31	0.0282	0.0020
32	0.0282	0.0020
33	0.0282	0.0020
34	0.0281	0.0020
35	0.0281	0.0020
36	0.0281	0.0020
37	0.0280	0.0020
38	0.0280	0.0020
39	0.0280	0.0020
40	0.0280	0.0020
41	0.0279	0.0018
42	0.0279	0.0016
43	0.0278	0.0008
44	0.0278	0.0002
45	0.0278	0.0001
46	0.0276	0.0000
47	0.0276	0.0000
48	0.0275	0.0000
49	0.0275	0.0000
50	0.0275	0.0000
51	0.0274	0.0000
52	0.0271	0.0000
53	0.0271	0.0000
54	0.0270	0.0000
55	0.0268	0.0000
56	0.0268	0.0000
57	0.0258	0.0000
58	0.0246	0.0000
59	0.0222	0.0000
60	0.0207	0.0000

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0254	1231	94	7	Pass
0.0491	141	81	57	Pass
0.0727	101	72	71	Pass
0.0963	82	55	67	Pass
0.1199	67	51	76	Pass
0.1436	60	41	68	Pass
0.1672	52	38	73	Pass
0.1908	44	28	63	Pass
0.2144	40	23	57	Pass
0.2381	37	19	51	Pass
0.2617	32	16	50	Pass
0.2853	28	13	46	Pass
0.3089	27	12	44	Pass
0.3326	26	9	34	Pass
0.3562	25	7	28	Pass
0.3798	24	4	16	Pass
0.4034	22	4	18	Pass
0.4271	22	2	9	Pass
0.4507	21	1	4	Pass
0.4743	21	1	4	Pass
0.4979	20	0	0	Pass
0.5216	20	0	0	Pass
0.5452	18	0	0	Pass
0.5688	18	0	0	Pass
0.5924	17	0	0	Pass
0.6161	15	0	0	Pass
0.6397	15	0	0	Pass
0.6633	15	0	0	Pass
0.6869	15	0	0	Pass
0.7106	14	0	0	Pass
0.7342	13	0	0	Pass
0.7578	13	0	0	Pass
0.7814	13	0	0	Pass
0.8050	13	0	0	Pass
0.8287	13	0	0	Pass
0.8523	13	0	0	Pass
0.8759	13	0	0	Pass
0.8995	12	0	0	Pass
0.9232	12	0	0	Pass
0.9468	12	0	0	Pass
0.9704	11	0	0	Pass
0.9940	10	0	0	Pass
1.0177	10	0	0	Pass
1.0413	10	0	0	Pass
1.0649	10	0	0	Pass
1.0885	10	0	0	Pass
1.1122	10	0	0	Pass
1.1358	10	0	0	Pass
1.1594	10	0	0	Pass
1.1830	10	0	0	Pass
1.2067	10	0	0	Pass
1.2303	10	0	0	Pass
1.2539	10	0	0	Pass

1.2775	10	0	0	Pass
1.3012	9	0	0	Pass
1.3248	9	0	0	Pass
1.3484	9	0	0	Pass
1.3720	9	0	0	Pass
1.3957	9	0	0	Pass
1.4193	9	0	0	Pass
1.4429	8	0	0	Pass
1.4665	8	0	0	Pass
1.4902	8	0	0	Pass
1.5138	8	0	0	Pass
1.5374	8	0	0	Pass
1.5610	7	0	0	Pass
1.5847	5	0	0	Pass
1.6083	5	0	0	Pass
1.6319	5	0	0	Pass
1.6555	5	0	0	Pass
1.6792	5	0	0	Pass
1.7028	5	0	0	Pass
1.7264	5	0	0	Pass
1.7500	5	0	0	Pass
1.7737	4	0	0	Pass
1.7973	4	0	0	Pass
1.8209	4	0	0	Pass
1.8445	4	0	0	Pass
1.8682	4	0	0	Pass
1.8918	4	0	0	Pass
1.9154	4	0	0	Pass
1.9390	4	0	0	Pass
1.9627	4	0	0	Pass
1.9863	4	0	0	Pass
2.0099	3	0	0	Pass
2.0335	3	0	0	Pass
2.0572	3	0	0	Pass
2.0808	3	0	0	Pass
2.1044	3	0	0	Pass
2.1280	3	0	0	Pass
2.1517	3	0	0	Pass
2.1753	3	0	0	Pass
2.1989	3	0	0	Pass
2.2225	3	0	0	Pass
2.2462	3	0	0	Pass
2.2698	3	0	0	Pass
2.2934	3	0	0	Pass
2.3170	3	0	0	Pass
2.3406	3	0	0	Pass
2.3643	3	0	0	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0.537 acre-feet
On-line facility target flow:	3.3878 cfs.
Adjusted for 15 min:	3.3878 cfs.
Off-line facility target flow:	2.2473 cfs.
Adjusted for 15 min:	2.2473 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
retention 1 POC	☐	411.00			☐	99.92			
Total Volume Infiltrated		411.00	0.00	0.00		99.92	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Passed

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Appendix

Predeveloped Schematic

Mitigated Schematic

Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2008 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                               ***
WDM        26   Master Plan Stormwater Analysis.wdm
MESSU      25   PreMaster Plan Stormwater Analysis.MES
           27   PreMaster Plan Stormwater Analysis.L61
           28   PreMaster Plan Stormwater Analysis.L62
           30   POCMaster Plan Stormwater Analysis1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND       4
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin  1                   MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                           in  out           ***
    4     A/B, Pasture, Flat      1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections ****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
    4         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags **************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
    4         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO
```

```
  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
    4         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
    4              0         5       1.5       400      0.05       0.3     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
    4              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                                ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
    4           0.15       0.5       0.3         0       0.7       0.4
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
               ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
    4              0         0         0         0         3         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                       in  out           ***
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections ****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
  END IWAT-STATE1
```

```
END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND   4                       35.19     COPY   501     12
PERLND   4                       35.19     COPY   501     13

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                       in  out                                ***
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections ****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *      *  *  *  *  *         ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1.14           PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.14           IMPLND   1 999 EXTNL  PREC
```

```
WDM      1 EVAP     ENGL    0.8            PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.8            IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    501 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2008 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                    UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                               ***
WDM        26   Master Plan Stormwater Analysis.wdm
MESSU      25   MitMaster Plan Stormwater Analysis.MES
           27   MitMaster Plan Stormwater Analysis.L61
           28   MitMaster Plan Stormwater Analysis.L62
           30   POCMaster Plan Stormwater Analysis1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      IMPLND       1
      IMPLND       8
      RCHRES       1
      RCHRES       2
      COPY         1
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Surface retention  1        MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                           in  out           ***
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections ****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags **************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
  END PRINT-INFO
```

```
  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                              ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
               ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                       in  out           ***
    1      ROADS/FLAT             1    1    1   27    0
    8      SIDEWALKS/FLAT         1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections ****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    1         0    0    1    0    0    0
    8         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    1         0    0    4    0    0    0    1    9
    8         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    1         0    0    0    0    0
    8         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    1            400      0.01       0.1       0.1
    8            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    1              0         0
```

```
    8              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    1              0         0
    8              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin  1***
IMPLND   1                       2.266     RCHRES   1      5
IMPLND   8                       0.358     RCHRES   1      5

******Routing******
RCHRES   1                           1     RCHRES   2      8
RCHRES   2                           1     COPY   501     17
RCHRES   1                           1     COPY   501     17
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                ***
    # -  #<-----------------><---> User T-series  Engl Metr LKFG            ***
                                          in  out                            ***
    1     Surface retentio-014    3    1    1    1   28    0    1
    2     Bioretention  1         2    1    1    1   28    0    1
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections ****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
    1         1    0    0    0    0    0    0    0    0    0
    2         1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
    1         4    0    0    0    0    0    0    0    0    0    1    9
    2         4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                  ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
    1        0  1  0  0    4  5  6  0  0       0  0  0  0  0       2  2  2  2  2
    2        0  1  0  0    4  5  0  0  0       0  0  0  0  0       2  2  2  2  2
  END HYDR-PARM1

  HYDR-PARM2
```

```
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
    1              1      0.01       0.0       0.0       0.5       0.0
    2              2      0.01       0.0       0.0       0.5       0.0
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                          ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
    1            0         4.0  5.0  6.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    2            0         4.0  5.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE      2
   53    5
     Depth      Area    Volume  Outflow1  Outflow2  Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)      (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.110887  0.000000  0.000000  0.000000
  0.063187  0.110362  0.000835  0.000000  0.000000
  0.126374  0.109158  0.001684  0.000000  0.000000
  0.189560  0.107961  0.002545  0.000000  0.000069
  0.252747  0.106771  0.003418  0.000000  0.000095
  0.315934  0.105587  0.004305  0.000000  0.000316
  0.379121  0.104410  0.005205  0.000000  0.000417
  0.442308  0.103239  0.006118  0.000000  0.000820
  0.505495  0.102075  0.007044  0.000000  0.001072
  0.568681  0.100918  0.007984  0.000000  0.001641
  0.631868  0.099767  0.008937  0.000000  0.002135
  0.695055  0.098623  0.009903  0.000000  0.002828
  0.758242  0.097485  0.011863  0.000000  0.003671
  0.821429  0.096354  0.013851  0.000000  0.004423
  0.884615  0.095230  0.015866  0.000000  0.005735
  0.947802  0.094112  0.017909  0.000000  0.006467
  1.010989  0.093001  0.019980  0.000000  0.008379
  1.074176  0.091896  0.022080  0.000000  0.008994
  1.137363  0.090798  0.024207  0.000000  0.011648
  1.200549  0.089707  0.026364  0.000000  0.012039
  1.263736  0.088622  0.028549  0.000000  0.015587
  1.326923  0.087544  0.030763  0.000000  0.015633
  1.390110  0.086472  0.033006  0.000000  0.019805
  1.453297  0.085407  0.035278  0.000000  0.020235
  1.516484  0.084349  0.037292  0.000000  0.024584
  1.579670  0.083297  0.039331  0.000000  0.025632
  1.642857  0.082252  0.041397  0.000000  0.029997
  1.706044  0.081213  0.043489  0.000000  0.031813
  1.769231  0.080181  0.045608  0.000000  0.036068
  1.832418  0.079155  0.047753  0.000000  0.038814
  1.895604  0.078137  0.049925  0.000000  0.042824
  1.958791  0.077124  0.052124  0.000000  0.046667
  2.021978  0.076119  0.054351  0.000000  0.050288
  2.085165  0.075120  0.056604  0.000000  0.055405
  2.148352  0.074127  0.058885  0.000000  0.058483
  2.211538  0.073142  0.061194  0.000000  0.065059
  2.274725  0.072162  0.063531  0.000000  0.067431
  2.337912  0.071190  0.065895  0.000000  0.075659
  2.401099  0.070224  0.068288  0.000000  0.077153
  2.464286  0.069264  0.070709  0.000000  0.087232
  2.527473  0.068311  0.073159  0.000000  0.087669
  2.590659  0.067365  0.075637  0.000000  0.098999
  2.653846  0.066425  0.078144  0.000000  0.099807
  2.717033  0.065492  0.080680  0.000000  0.111158
  2.780220  0.064566  0.083246  0.000000  0.113409
  2.843407  0.063646  0.085840  0.000000  0.124156
  2.906593  0.062733  0.088464  0.000000  0.132062
  2.969780  0.061826  0.091118  0.000000  0.134195
```

```
  3.032967  0.060926  0.093903  0.000000  0.134195
  3.096154  0.060033  0.096718  0.000000  0.134195
  3.159341  0.059146  0.099565  0.000000  0.134195
  3.222527  0.058266  0.102443  0.000000  0.134195
  3.250000  0.057392  0.217779  0.000000  0.134195
  END FTABLE  2
  FTABLE      1
   41    6
     Depth      Area    Volume  Outflow1  Outflow2  outflow 3 Velocity  Travel
Time***
      (ft)   (acres) (acre-ft)   (cfs)      (cfs)     (cfs)   (ft/sec)
(Minutes)***
  0.000000  0.057392  0.000000  0.000000  0.000000  0.012868
  0.063187  0.112100  0.007045  0.000000  0.134195  0.012868
  0.126374  0.113320  0.014167  0.000000  0.134195  0.025816
  0.189560  0.114546  0.021366  0.000000  0.134195  0.038845
  0.252747  0.115779  0.028643  0.000000  0.134195  0.051952
  0.315934  0.117019  0.035997  0.000000  0.134195  0.065140
  0.379121  0.118265  0.043431  0.000000  0.134195  0.078408
  0.442308  0.119517  0.050943  0.000000  0.134195  0.091755
  0.505495  0.120777  0.058535  0.000000  0.134195  0.105182
  0.568681  0.122043  0.066206  0.000000  0.134195  0.118690
  0.631868  0.123315  0.073958  0.000000  0.134195  0.132277
  0.695055  0.124594  0.081790  0.000000  0.134195  0.145943
  0.758242  0.125880  0.089704  0.000000  0.134195  0.159690
  0.821429  0.127172  0.097698  0.000000  0.134195  0.173517
  0.884615  0.128471  0.105775  0.000000  0.134195  0.187423
  0.947802  0.129776  0.113934  0.000000  0.134195  0.201409
  1.010989  0.131088  0.122176  0.002000  0.134195  0.215475
  1.074176  0.132407  0.130500  0.002000  0.134195  0.229621
  1.137363  0.133732  0.138909  0.002000  0.134195  0.243847
  1.200549  0.135064  0.147401  0.002000  0.134195  0.258153
  1.263736  0.136403  0.155977  0.002000  0.134195  0.272538
  1.326923  0.137748  0.164639  0.002000  0.134195  0.287004
  1.390110  0.139099  0.173385  0.002000  0.134195  0.301549
  1.453297  0.140458  0.182217  0.002000  0.134195  0.316174
  1.516484  0.141822  0.191136  0.002000  0.134195  0.330879
  1.579670  0.143194  0.200140  0.002000  0.134195  0.345664
  1.642857  0.144572  0.209232  0.002000  0.134195  0.360528
  1.706044  0.145957  0.218410  0.027000  0.134195  0.375473
  1.769231  0.147348  0.227677  0.095000  0.134195  0.390497
  1.832418  0.148746  0.237032  0.202000  0.134195  0.405601
  1.895604  0.150150  0.246475  0.346000  0.134195  0.420785
  1.958791  0.151561  0.256007  0.523000  0.134195  0.436049
  2.021978  0.152979  0.265628  0.730000  0.134195  0.451393
  2.085165  0.154403  0.275340  0.963000  0.134195  0.466816
  2.148352  0.155834  0.285141  1.221000  0.134195  0.482320
  2.211538  0.157271  0.295033  1.499000  0.134195  0.497903
  2.274725  0.158716  0.305016  1.796000  0.134195  0.513566
  2.337912  0.160166  0.315091  2.109000  0.134195  0.529309
  2.401099  0.161623  0.325257  2.437000  0.134195  0.545132
  2.464286  0.163087  0.335516  2.963907  0.134195  0.561035
  2.500000  0.163918  0.341355  2.963907  0.134195  0.570058
  END FTABLE  1
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1.14           PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.14           IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.8            PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.8            IMPLND   1 999 EXTNL  PETINP
WDM      2 PREC     ENGL    1.14           RCHRES   1     EXTNL  PREC
WDM      1 EVAP     ENGL    0.5            RCHRES   1     EXTNL  POTEV
WDM      1 EVAP     ENGL    0.8            RCHRES   2     EXTNL  POTEV

END EXT SOURCES

EXT TARGETS
```

```
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
RCHRES   2 HYDR   RO     1 1        1      WDM   1004 FLOW     ENGL      REPL
RCHRES   2 HYDR   O      1 1        1      WDM   1008 FLOW     ENGL      REPL
RCHRES   2 HYDR   O      2 1        1      WDM   1009 FLOW     ENGL      REPL
RCHRES   2 HYDR   STAGE  1 1        1      WDM   1005 STAG     ENGL      REPL
RCHRES   1 HYDR   STAGE  1 1        1      WDM   1006 STAG     ENGL      REPL
RCHRES   1 HYDR   O      1 1        1      WDM   1007 FLOW     ENGL      REPL
COPY     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK        5
IMPLND     IWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    5

  MASS-LINK        8
RCHRES     OFLOW  OVOL   2                 RCHRES         INFLOW IVOL
  END MASS-LINK    8

  MASS-LINK       17
RCHRES     OFLOW  OVOL   1                 COPY           INPUT  MEAN
  END MASS-LINK   17


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

Disclaimer

Legal Notice

This program and accompanying documentation are provided 'as-is' without warranty of any kind. The entire risk regarding the performance and results of this program is assumed by End User. Clear Creek Solutions Inc. and the governmental licensee or sublicensees disclaim all warranties, either expressed or implied, including but not limited to implied warranties of program and accompanying documentation. In no event shall Clear Creek Solutions Inc. be liable for any damages whatsoever (including without limitation to damages for loss of business profits, loss of business information, business interruption, and the like) arising out of the use of, or inability to use this program even if Clear Creek Solutions Inc. or their authorized representatives have been advised of the possibility of such damages. Software Copyright © by : Clear Creek Solutions, Inc. 2005-2016; All Rights Reserved.

Clear Creek Solutions, Inc.
6200 Capitol Blvd. Ste F
Olympia, WA. 98501
Toll Free 1(866)943-0304
Local (360)943-0304

www.clearcreeksolutions.com

APPENDIX C

PRELIMINARY GEOTECHNICAL REPORT

PBS | Engineering + Environmental

June 17, 2015

Clark County Department of Environmental Services
Attn: Mr. Mike Davis, Leichner Landfill Project Manager
1300 Franklin Street
Vancouver, Washington 98660-9810

Re: Geotechnical Data Review and Geologic Site Reconnaissance – Phase 1_Updated
Leichner Campus Development – Koski Property
8713 Northeast 94th Avenue, Vancouver, Washington
PBS Project No. 72971.006

INTRODUCTION AND BACKGROUND

PBS Engineering and Environmental Inc. (PBS) is pleased to provide this letter report for geotechnical engineering services in support of a feasibility/due diligence review for the approximately 25-acre Leichner Campus Development Koski Property (project site) located along Northeast 88th Street in Clark County, Washington (Figure 1, Vicinity Map). The geotechnical services are being performed in two phases and this report provides our Phase 1 Geotechnical Data Review.

PBS understands Clark County (County) is currently planning to develop the approximately 25-acre project site that may be split into six 3- to 6-acre lots for commercial and/or light industrial development (Figure 2, Site Plan). The project site is part of the larger and adjacent closed Leichner Landfill property located at 9411 94th Avenue. A majority of the Leichner Landfill property, including the project site, was purchased by the County in December 2012, and the County has begun the master planning process to guide decisions about the future use of the site. The Leichner Campus Development–Koski Property is planned to be sold or developed by the County separately from other portions of the overall Leichner Landfill property.

PREVIOUS WORK SUMMARY

Due to its historical uses, the Leichner Landfill area, of which the proposed Leichner Campus Development–Koski Property is part, has been thoroughly studied for potential environmental impacts since the 1980s. These studies have included environmental-related research, borings, and remediation for Environmental Site Assessment (ESA) Phases I, II, and III. Where appropriate, the previous environmental work was used to provide preliminary geotechnical information for the Leichner Campus Development–Koski Property.

The project site has had several uses, with the most recent activities connected with maintaining and closing the Leichner Landfill. Current and historical uses have included the following:

- The approximately 25-acre project site is currently undeveloped except for a residence (McPerhson residence) located in the northeast corner.
- Historical residential (former Koski residence), livestock grazing, and agricultural uses.
- Soil borrow source for clean fill soil used at the adjacent Leichner Landfill.
- Historical (1940s) refuse burning and landfilling along the project site's northern boundary.
- Historical (from at least 1981 to 1990) stormwater retention pond for the Leichner Landfill located in the north-central portion of the project site.

4412 SW Corbett Avenue, Portland, OR 97239
503.248.1939 Main
866.727.0140 Fax
888.248.1939 Toll-Free
www.pbsenv.com

Bend | Boise | Coos Bay | Eugene | Portland | Seattle | Tri-Cities | Vancouver

The primary data sources used for this letter-report were prepared by other consultants working with the Leichner Landfill site, and included those shown below. Additional sources are referenced as footnotes.

- SCS Engineers, September 29, 2014, Phase I Environmental Site Assessment, Koski Property, 8713 NE 94th Avenue, Vancouver, Washington 98662.
- Shaw Environmental, Inc., July 22, 2010, Two-Foot Contour Topographic Map, Leichner Brothers landfill, Clark County, Washington, 1: 1 800.
- Berger, August 6, 2014, Leichner Property Conceptual Planning Option 2, Industrial Subdivision – 88th Street Access.
- Environmental Borings within the Leichner Campus Development – Koski Property:[1]

Boring No.	Consulting Firm	Date Drilled	Total Depth (ft bgs)
LB-5C	Sweet-Edwards/EMCON	August 1989	94.5
LB-5D	Sweet, Edwards & Associates, Inc.	May 1987	135.7
LB-5S	Sweet, Edwards & Associates, Inc.	April 1987	93.5
LB-6S	Sweet, Edwards & Associates, Inc.	July 1987	44.5
LB-13C	Sweet-Edwards/EMCON	August 1989	201.5
LC-13D	Sweet-Edwards/EMCON	August 1989	96.0
LB-13I	Sweet-Edwards/EMCON	August 1989	54.3
LB-17C	Sweet-Edwards/EMCON	August 1989	81.1
LC-17D	Sweet-Edwards/EMCON	August 1989	105.3
LB-17I	Sweet-Edwards/EMCON	August 1989	60.5
LB-17S	Sweet-Edwards/EMCON	August 1989	213.9
LC-26D	EMCON Northwest, Inc.	August 1992	102.5
LB-26I	EMCON Northwest, Inc.	August 1992	56.0
LC-27D	EMCON Northwest, Inc.	August 1992	116.0
LB-27I	EMCON Northwest, Inc.	August 1992	56.0

[1] – Presented on Figure 3, Previous Borings with Site Annotations

HISTORICAL AERIAL PHOTOGRAPH AND TOPOGRAPHIC REVIEW

Aerial photographs were reviewed from those included in the SCS Engineers 2014 report, Google Earth images between 1990 and 2014, and Clark County's MapsOnline viewer. Detailed site changes from the aerial images reviewed by SCS were described in their 2014 report.

In addition, U.S. Geological Survey (USGS) historical topographic maps between 1961 and 2011 were reviewed. However, the contours shown on these maps are all similar and the site was used as a borrow source for the adjacent landfill. Therefore, we have used the Light Detection and Ranging (LiDAR) imagery contours provided in 2010 by the U.S. Army Corp of Engineers (USACE) to make an assessment of grading modifications. These data appear to be sourced from Clark County (2001) though this could not be confirmed.

Only pertinent aerial and topographic modifications that could affect future geotechnical engineering recommendations are summarized in Table 1. In addition to PBS' observations, information from SCS Engineers (2014) was also used (see Figure 3).

Table 1: Summary of Aerial Photograph and Topography Review

Year	Property
Up to 1981	Primarily used for agricultural purposes, but was otherwise predominantly undeveloped, except for the the Koski residence (two or three structures) located in the southwest corner and the McPerhson residence on the northwest corner of the property. A small area at the north-central boundary (where the northern boundary has a dogleg bend) appeared to be graded adjacent to the landfill. This is the location of a former stormwater retention pond. There are two areas along the northern portion of the subject property that have distinctive, semi-circular grass patterns and correlate with the approximate locations of the two former trash burn areas
1980 to 1990	Conditions were generally the same in the 1981 photograph, except that the site did not appear to be used for agriculture. In the 1990 photograph, a small dirt road was present that extended into the property at the approximate location of the former burn areas.
1990 to 2000	Conditions were generally the same in the 1990 photograph, including the Koski residence and McPerhson residence structures. One exception is a small area with a different grass appearance than the surrounding area. This feature was semicircular in shape and seems to correspond with the western former burn area. The stormwater retention pond was absent, presumably removed at the time the adjacent former burn areas were excavated. There appeared to be a depression within the semicircular grass area where an existing depression is located. The 1994[a] aerial image clearly shows the excavation of the eastern portion of the property as a borrow source area for the clean fill.
2000 to 2014	Conditions on the Subject Property and adjacent properties were generally the same as currently exists. The Koski residence structures were absent in the 2009 photograph.

[a] – 1994 Ortho, Clark County, Washington, http://gis.clark.wa.gov/mapsonline/?site=AerialPhotography&ext=1

LIDAR IMAGERY

LiDAR imagery was obtained from USACE covering the site. LiDAR is a remote sensing method that uses light in the form of a pulsed laser to measure ranges (variable distances) to the earth. The elevation contours derived from the LiDAR data are presented on Figure 3 and a hillshade image on Figure 4. These light pulses, combined with other data recorded by an airborne system, generate precise three-dimensional information about the shape of the earth and its surface characteristics.

Figure 4 shows the borrow source area and the associated slopes on the eastern portion of the property as well as three other excavations along the southern boundary. Linear lines and structure-related grading are discernible along the western boundary. Other visible undulations in the site topography may be indications of past cut-and-fill areas and correlate with observations from the aerial photograph review.

SITE RECONNAISSANCE

A Licensed Engineering Geologist (LEG) from PBS completed a walking reconnaissance of the project site on April 10, 2015, which was performed by traversing the property to observe the current conditions and compare these with the data review findings. Observed features were marked on the 1994 ortho aerial obtained from Clark County's MapsOnline. The site was photo-documented and select pictures are presented in Attachment B.

The general topography of the site is flat with slopes along the eastern perimeter descending toward the property from the landfill on the north and residential developments on the east and south. These

slopes were graded and for the most part appear to be about 2H:1V (horizontal: vertical). Several depressions were also observed on the site. Three rectangular depressions are located along the south perimeter; these appear to be primarily for stormwater detention and are lined with large trees and shrubs. A north-south linear berm separates the eastern and western portions of the site. The former Koski and existing McPerhson residential structures are located in this portion. In the northern portion, the area is elevated about 3 to 6 feet above the rest of the property with a circular depression near the middle of its perimeter adjacent to the access road. The elevated area consists of two portions (see Figure 3): (1) a linear bench that extends from the east and adjacent to the access road to the circular depression, and (2) a roughly circular area that extends south and west away from the circular depression.

Vegetation consists primarily of small shrubs, grasses, and trees. In an effort to assist in determining areas of previous site grading, the types and condition of the vegetation growing on the property was closely observed. These included:

- Cut Areas – Sparse, dry vegetation could indicate areas of cuts since the soil would not have developed topsoil and primarily consist of sand and gravel that are exceedingly well drained based on the boring logs. These areas would also be flatter with vegetation growing in striations created by the grading equipment.
- Natural or Fill Areas – Well-established, green vegetation with thick grasses and small shrubs could indicate natural or fill areas since topsoil would not have been removed or would have been placed in piles. These areas would be more undulating or at a higher elevation than the surrounding area.

In general, the eastern half of the site has sparse vegetation and sandy/gravelly surface soils that extend to a berm near the west-center of the property; this likely indicates the area has been cut. A small area west of South Landfill Gas Plant south of the linear bench does have well-established grasses, which is due to water seepage from the storm drain system. The northern portion of the site is elevated above most of the property (with the exception of the circular depression discussed above), has established vegetative growth, and concrete debris was observed at the surface, suggesting this to be an area of fill. The western portion, with the exception of the former Koski residence pad, is lower in elevation but did have strong vegetative growth, indicating this is likely the natural, or at least the agricultural cultivated, surface. All of these observations generally coincide with the site disturbance and related dimensions observed in the 1994 aerial image (see Figure 3).

In general, the areas of the property with green grasses had dark brown, fine-grained soils exposed at the surface. Surface soils in areas of sparse and dry vegetation had sandier matrices and fine gravel. A few piles of fine to coarse, round gravel and round cobbles were observed in the eastern portion of the site.

No indications of slope instabilities along the perimeter or water ponding throughout the property were observed during the site visit.

GEOLOGIC SETTING

The site is located in the northeastern portion of the Willamette Lowland, a broad alluvial basin bordered on the west by Tertiary marine sedimentary and volcanic rocks of the Coast Ranges and on the east by Tertiary and Quaternary volcanic and volcaniclastic rocks of the Cascade Range. The northern boundary of the Willamette Lowland is generally recognized as the uplifted area north of the

Lewis River in southwestern Washington. The southern boundary is generally defined as the convergence of the Coast and Cascade Ranges just south of Eugene, Oregon.

Specifically, the project area is located in the Portland Basin, one of four separate basins within the Willamette Lowland. These basins include, from north to south: (1) the Portland Basin, (2) the Tualatin Basin northeast of the Chehalem Mountains and southwest of the Tualatin Mountains, (3) the central Willamette Valley between Salem and the Waldo Hills and the Chehalem Mountains, and (4) the southern Willamette Valley south of and including the Salem and Waldo Hills.[1] Basins within the Willamette Lowland and the tributary valleys are filled with over 1,600 feet of unconsolidated alluvial deposits derived from the surrounding uplands and the Columbia River Basin.[2] These deposits rest unconformably on a basement complex composed principally of the Columbia River Basalt Group. Fine-grained Miocene and Pliocene fluvial-lacustrine deposits occur near the bottom of the basin-fill deposits; coarse-grained fluvial deposits derived from the Cascade Range and the Missoula Floods generally comprise the upper 300 feet of the basin-fill deposits.

Widespread inundation of the lowland area occurred during the Missoula Floods, a series of more than 50 Pleistocene-age catastrophic floods believed to have originated at ancient Lake Missoula, Montana. These large-volume glacial outburst floods, originating approximately 12,000 to 15,000 years ago, deposited up to 250 feet of silt, sand, and gravel in the Portland Basin. Within the project area, these catastrophic flood deposits are mapped as Upper Pleistocene Outburst Deposits of Glacial Lake Missoula Flood Gravel (Qfg) coarse-grained unit of gravel with cobbles, boulders, and sand layers[3] (Figure 3, Geology Map).

The site lies within a tectonically active area that has undergone multiple structural deformation events. Several potentially active Quaternary faults are located in the vicinity of the site that includes the Lacamas Lake, Portland Hills, and East Bank faults.[4] The estimated age of the most recent events?faults? suggest possible offset on the Lacamas Lake fault probably occurred at least 15,000 years ago, while the Portland Hills and East Bank faults occurred within the last 15,000 years. In addition to the local crustal faults, the Cascadia Subduction Zone (CSZ), a major zone of plate convergence located offshore, is located approximately 100 miles west of the site. The CSZ extends from offshore northern California to southern British Columbia and may have generated at least seven great earthquakes (those of magnitude M8 or greater) in the last 3,500 years, suggesting a recurrence interval of approximately 300 to 600 years. Detailed tsunami records from Japan indicated the last significant CSZ earthquake occurred on January 26, 1700.[5] Atwater and others (2005) estimated the earthquake had a magnitude of between M8.7 to 9.2

[1] Gannett, M. W. and Caldwell, R.R., 1998, Geologic Framework of the Willamette Lowlands and Aquifer System, Oregon and Washington: U.S. Geologic Survey Professional Paper 1424-BG, 82 p.
[2] O'Connor, J.E., Sarna-Wojcicki, A., Wozniak, K.C., Polette, D.J., and Fleck, R.J., 2001, Origin, Extent, and Thickness of Quaternary Geologic Units in the Willamette Valley, Oregon: U.S. Geological Survey Professional Paper 1620, 52 p.
[3] Walsh, Timothy J., Korosec, Michael A., Phillips, William M., Logan, Robert L., Schasse, Henry W., Digital database by Meagher, Karen L., Haugerud, Ralph A., 1999, Geologic map of Washington - southwest quadrant (digital edition): U. S. Geological Survey Open-File Report 99-382, http://pubs.usgs.gov/of/1999/0382/.
[4] Beeson, M. H., Tolan, T. L., and Madin, I. P., 1991, Geologic map of the Portland quadrangle, Multnomah and Washington counties, Oregon: Oregon Department of Geology and Mineral Industries Geologic Map Series GMS-75.
[5] Atwater, B.F., Musumi-Rokkaku Satoko, M-R., Kenji, S., Yoshinobu, T., Kazue, U., Yamaguchi, D.K., 2005, The Orphan Tsunami of 1700—Japanese Clues to a Parent Earthquake in North America, U.S. Geological Survey, Professional Paper 1707.

NRCS SOIL DESCRIPTIONS

The Natural Resources Conservation Service (NRCS) provides information from local soil surveys through the U.S. Department of Agriculture (USDA) Web Soil Survey portal.[6] The soil surveys provide the mapped shallow soil unit that includes soil type, soil profiles, soil quality, and soil engineering characteristics. In addition, the soil survey also has suitabilities and limitations for various land use purposes based on the mapped soil units. Please note the NRCS soil descriptions are generalizations of the soil characteristics and do not always provide site-specific information for features, such as the depth to groundwater, since the soil units may cover a larger area than that being studied.

Table 2 provides the soil units mapped at the site and other applicable information to assist in determining the suitability and limitations of development. In general, soils with **more than** 5 percent of the total area are included.

The NRCS uses a rating system that combines soil characteristics (soil type and slope) to determine the suitability or limitations of a soil unit. Definitions of the ratings and criteria for the soil characteristics, or suitability/limitations, are provided in Attachment A.

Table 2: Summary of Applicable Soil Information

Soil Unit	**SvA - Sifton gravelly loam, 0 to 3 percent slopes**
Parent Material	Gravelly alluvium
Typical Profile (inches)	0 to 5 inches: gravelly loam 5 to 16 inches: gravelly loam 16 to 60 inches: very gravelly coarse sand
Unified Soil Classification (Surface)	GM
AASHTO Group Classification (Surface)	A-4
Slope (percentage)	0 to 3
Depth to Restrictive Layer	Depth to restrictive feature: 8 to 20 inches to strongly contrasting textural stratification
Natural Drainage Class	Somewhat excessively drained
Capacity of Most Limiting Layer to transmit Water	Moderately high to high (0.57 to 1.98 in/hr)
Depth to Water Table	More than 80 inches
Frequency of Flooding	None
Frequency of Ponding	None
Linear Extensibility (Shrink-Swell)	1.5 percent
Hydrologic Soil Group	B
Corrosion to Steel	High
Corrosion to Concrete	High
Mechanical Site Preparation (Surface)	Well Suited
Mechanical Site Preparation (Deep)	Well Suited
Local Roads and Streets	Not limited

[6] http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

SUBSURFACE CONDITIONS

Environmental Soil Boring Logs

Based on the available information, 15 environmental borings grouped into six clusters have been drilled at the project site between 1987 and 1992. Subsurface conditions encountered in the environmental borings were summarized in a remedial investigation (RI) amendment report dated October 7, 1991,[7] that showed the site is underlain by two distinct geologic units:

1. *Pleistocene alluvium consisting of sand and sand with gravel that is locally silty or clayey from the ground surface to a depth of about 70 to 100 feet below ground surface (bgs).*

   Where blow counts were recorded with 2- or 3-inch split spoon samplers (Standard Penetration Test N-values), the relative densities of the soil layers were variable. In general, the soil layers in the upper 30 to 35 feet contained gravel (gravelly sand, sand with gravel, sand with trace gravel, etc.) and were medium dense to very dense. Soil layers below these depths and above the underlying Troutdale Formation were generally loose to medium dense and did not contain gravel (silty sand, sand, etc.). The types of hammers and its efficiencies on the various drill rigs used to drill the borings were not provided on the available logs.

   Based on our data review and site reconnaissance, fill containing rubble, debris, organics, and other deleterious materials may be present in the upper 10 feet in the northern portion of the project site. PBS understands burn materials were previously removed from the site[8,9,10,11].

   The borings on the eastern portion (LB-5C, LB-5D, and LB-5S) were drilled prior to the area's use as a clean fill source for the adjacent landfill. Therefore, the upper 10 to 20 feet shown in the boring logs has been removed and the depth to groundwater will be shallower than those indicated.

2. *Pliocene Troutdale Formation predominantly consisting of gravel with a fine sand and silt matrix that is weakly to moderately cemented.*

   Where the borings extended into the Troutdale Formation, relative densities were very dense with blow counts per foot typically being greater than 50 blows per 6 inches.

[7] Sweet-Edwards/EMCON, Inc., 1991, Leichner Landfill, Remedial Investigation Amendment, Volume 1, Administrative Order DE 89-S119, prepared for the Leichner Brothers Land Reclamation Corporation, Vancouver, Washington, October 7.

[8] EMCON Northwest, Inc., 1992a, Letter (Re: Burn Area Study, Leichner Landfill), prepared for Washington State Department of Ecology, Olympia, Washington, and Southwest Washington Health District, Vancouver, Washington, April 21, 1992.

[9] EMCON Northwest, Inc., 1992b, Memorandum (Re: Leichner Landfill, Burn Area Excavation/Remediation), prepared Leichner Brothers Landfill Reclamation Corporation, Vancouver, Washington, June 8.

[10] EMCON Northwest, Inc., 1992c, Letter (Re: June 1992 Progress Report for the Leichner Landfill Project), prepared for Washington State Department of Ecology, Olympia Washington, July 8.

[11] EMCON Northwest, Inc., 1992d, Letter (Re: August 1992 Progress Report for the Leichner Landfill Project), prepared for Washington State Department of Ecology, Olympia Washington, September 14.

Table 3. Depth to Troutdale Formation in the Borings Located on the Leichner Campus Development – Koski Property

Boring Number	Depth to Troutdale Formation (ft bgs)
LB-5C	94
LB-5D	87
LB-5S	87
LB-13D	70
LB-17C	80
LB-17D	80
LB-26D	68
LB-27D	82

Groundwater
The hydrostratigraphy at the site consists of an approximately 35-foot-thick unsaturated zone of sand and gravel, an unconfined to semi-confined zone about 35 to 55 feet thick, and a semi-confined to confined aquifer in the Troutdale Formation. However, historical groundwater data collected as part of the Leichner Landfill post-closure monitoring program indicate groundwater occurs beneath the property between depths ranging from 12 to 19 feet bgs in the eastern portion and 17 to 37 feet bgs in the western portion with flow generally toward the west-southwest (SCS, 2014).

GEOLOGIC AND SEISMIC HAZARDS

Geologic and seismic hazards are defined as those conditions associated with the geologic and seismic environment that could influence existing and/or proposed improvements. In general, the geologic and seismic hazards most commonly associated with the physical and chemical characteristics of near-surface soil, rock, and groundwater include:

Geologic Hazards:

- Slope stability
- Subsurface voids
- Erosion and sedimentation
- **Hazardous minerals and gases**
- Adverse soils
- **Hydrology and drainage**
- Permafrost and freeze-thaw
- Land subsidence
- Volcanic hazards
- Hydrogeology and groundwater

Seismic Hazards:

- **Liquefaction**
- Fault ground rupture
- **Earthquake-induced landslides**
- **Lateral spreading**
- Tsunami and Seiches
- **Ground shaking**
- Seismically-Induced Settlement

Those shown in **bold** above are geologic and seismic hazards that could affect the study areas' development and should be considered in the planning process. Specific hazards are presented below in Table 4. The "Level of Concern" is a qualitative assessment based on our engineering geology and engineering judgment. Where noted with footnotes, the terminology is taken from a specific source (i.e. HazVu).

Table 4: Summary of Potential Geologic and Seismic Hazards

Geologic and Seismic Hazard	Examples	Level of Concern
Adverse Soils	Artificial Fill Expansive Soil Compressible Soil Organic-Rich Soil Sensitive Clay	High Low Low to Moderate Low to Moderate None
Hydrology and Drainage	Flooding[a] Seiches or Standing Water Dam Inundation	Not mapped within a flood zone, unknown impacts in the eastern portion None Unknown
Hazardous Minerals and Gases	Methane gases	To be Considered
Seismic Hazards	Earthquake Hazard - NEHRP[b] Local Fault Rupture Liquefaction and Lateral Spread[b] Seismically-Induced Settlement Seismically-Induced Slope Instability Tsunami	Site Class C Very Low Very Low Low None None

[a] – FEMA Map Number 53011C0387D, effective on09/05/2012.
[b] – Clark County MapsOnline, http://gis.clark.wa.gov/mapsonline/?site=GeoHazards&ext=1

The primary geologic hazard to consider in the site's planning and development, in our current opinion, is the presence of variable and undocumented fill. These materials may consist of backfill and general undocumented fill throughout the area.

The primary seismic hazards are most likely ground shaking and susceptibility to liquefaction (mapped as "very low"). The soils and soft sedimentary rocks near the surface can modify bedrock ground shaking caused by an earthquake. This modification can increase (or decrease) the strength of shaking or change the frequency of the shaking. The nature of the modifications is determined by the thickness of the geologic materials and their physical properties, such as stiffness or relative density.

The IBC-2012 methodology defines six soil categories that are based on average shear-wave velocity in the upper 100 feet (30 meters) of the soil column. The shear-wave velocity is the speed with which a particular type of ground vibration travels through a material, and can be measured directly by several techniques. The six soil categories are Hard Rock (A), Rock (B), Very Dense Soil and Soft Rock (C), Stiff Soil (D), Soft Soil (E), and Special Soils (F). Based on Clark County MapsOnline, the site is shown as a Site Class C. Additional seismic considerations are presented in the Preliminary Conclusions and Recommendations Section below.

Liquefaction is a phenomenon in which shaking of a saturated soil causes its material properties to change so that it behaves as a liquid. Soils that liquefy tend to be young, loose, granular soils that are saturated with water.[12] Unsaturated soils will not liquefy, but they may settle. Typical displacements can range from inches to feet. Thus, if the soil at a site liquefies, the damage resulting from an earthquake can be dramatically increased over what shaking alone might have caused. Although the area is

[12] National Research Council (U.S.), 1985, Liquefaction of soils during earthquakes, Committee on Earthquake Engineering Research, National Science Foundation (U.S.), Washington, D.C. : National Academy Press

mapped as “very low” liquefaction susceptibility, a more detailed analysis will be performed during Phase 2 per State of Washington code.

PRELIMINARY CONCLUSIONS AND RECOMMENDATIONS

Based on our research and reference information and documents, the site conditions, in our current opinion, are suitable for the proposed Leichner Campus Development–Koski Property but will require further specific geotechnical explorations and analyses during design and construction. The geotechnical-related considerations include:

- The site uses of the property throughout its history have resulted in variable, deleterious fill materials that will impact excavations and foundation performance. Potential areas of fill should be investigated and over-excavation and replacement may be required prior to or during construction (see Figure 3).
- Subsurface conditions on the eastern portion of the property will be 10 to 20 feet shallower than those represented on the boring logs because of apparent site cuts.
- The site is mapped as “very low” liquefaction susceptibility. However, liquefaction will need to be further evaluated based on the conditions encountered in additional geotechnical borings.
- Ground shaking will occur at the site during an earthquake and the site is mapped by Clark County as Site Class C. Actual site class will need to be further evaluated based on the actual conditions encountered in the geotechnical borings.

Seismic Considerations: New buildings will be designed in accordance with the requirements of the 2012 International Building Code (IBC) with Washington-specific amendments, or subsequent editions. The 2012 IBC requires buildings be designed to consider ground motions from the risk-targeted maximum considered earthquake (MCE_R), defined by the IBC as an earthquake with a 2,500-year return interval (probability of exceedance of 2 percent in 50 years). The IBC recommends that the effects of site conditions on building response be determined using site factors, Fa, and Fv, based on site classification defined as follows:

SITE CLASS A, HARD ROCK – a profile with rock characterized by a shear-wave velocity greater than 5,000 feet per second (ft/s).

SITE CLASS B, ROCK – a profile with rock characterized by a shear-wave velocity of 2,500 to 5,000 ft/s.

SITE CLASS C, VERY DENSE SOIL AND SOFT ROCK – a profile characterized by: average soil shear-wave velocity from 1,200 to 2,500 ft/s; average Standard Penetration Resistance, N, greater than 50 blows/ft; and average soil undrained shear strength, Su, greater than 2,000 pounds per square foot (psf).

SITE CLASS D, STIFF SOIL – a profile characterized by: average soil shear-wave velocity less than 600 ft/s; average Standard Penetration Resistance, N, less than 15 blows/ft; average soil undrained shear strength, Su, from 1,000 to 2,000 psf.

SITE CLASS E, SOIL – a profile characterized by: average soil shear-wave velocity from 600 to 1,200 ft/s; average Standard Penetration Resistance, N, of 15 to 50 blows/ft; and average soil undrained shear strength, Su, less than 1,000 psf, or any profile with more than 10 feet of soft

clay defined as soil with plasticity index, PI, greater than 20, water content greater than 40 percent and undrained shear strength, Su, less than 500 psf.

SITE CLASS F – a profile for any soils requiring site-specific evaluation, such as: more than 10 feet of peat or highly organic clays; more than 25 feet of very high plasticity clay with plasticity index, PI, greater than 75; or more than 120 feet of soft/ medium stiff clay.

Foundations Considerations: Our current understanding of the planned site development is that it will be for light industrial and commercial use. Depending on the building height and anticipated subsurface soils, we anticipate the foundation type most likely will be spread footings. Typical column loads and the estimated allowable soil bearing pressures for these conditions is provided in Table 5.

Table 5: Potential Foundation Type

Foundation Type	Column Load (kips)	Estimated Allowable Soil Bearing Pressure (psf)
Shallow Foundation – Spread Footing	Less than 200	2000 to 3000

Construction Considerations: In general, all vegetation, topsoil and existing structural elements (slabs, footings, etc.) should be removed from new building and pavement areas. Construction of the proposed new buildings may require areas of over-excavation.

Due to the presence of fine-grained silt and clay in the near-surface materials in some areas of the site, construction equipment may have difficulty operating on the near-surface soils when above the optimum moisture required for compaction. Construction of granular haul roads placed over geo-textile stabilization fabric may help reduce disturbance of site soils. The thickness of the granular material for haul roads and staging areas will depend on the amount and type of construction traffic.

All excavations should be made in accordance with applicable Occupational Safety and Health Administration (OSHA) and state regulations. The contractor is responsible for adherence to the OSHA requirements. Trench cuts may stand relatively vertical to a depth of approximately 4 feet, provided no groundwater seepage is present in the trench walls. Open excavation techniques may be used provided the excavation is configured in accordance with the OSHA requirements, groundwater seepage is not present, and with the understanding that some sloughing may occur. The trench walls should be flattened if sloughing (i.e., the raveling or breaking off of material from any sloped or vertical face) occurs or seepage is present. The use of a trench shield or other similar temporary shoring is not recommended for cuts that extend below the groundwater table or if vertical walls are desired for cuts deeper than 4 feet bgs without appropriate groundwater control.

A wide range of material may be used as structural fill; however, all material used should be free of organic matter or other unsuitable materials, and should meet the specifications provided in the 2014 Standard Specifications for Road, Bridge, and Municipal Construction, Washington State Department of Transportation (WSDOT), SS 2014, depending on the application

The silt/clay fraction of site soils is moisture sensitive and during wet weather, may become unworkable due to excess moisture content. In order to reduce moisture content, some aerating and drying of native or imported silty soils may be required. If moisture content of silty/clayey soils cannot be reduced by air drying, it may be necessary to grade the site with granular soils that do not contain more than five

percent passing the No. 200 Sieve (wet sieve analysis). We recommend that fills intended to support structures or pavement sections be placed in horizontal lifts not exceeding about eight inches in loose thickness and be compacted to at least 92 percent of the maximum dry density as determined by the standard proctor test method (ASTM D 1557).

Fill placed on slopes steeper than 5H:1V must be keyed/benched into the existing slopes and installed in horizontal lifts. Vertical steps between benches should be approximately 2 feet.

PHASE 2 SCOPE OF SERVICES

A typical Phase 2 scope that should be performed in order to provide geotechnical engineering recommendations for site development follows:

1. **Subsurface Exploration:** The proposed explorations should consist of test pits and/or borings in the area of the proposed new development. In addition, test pits should be performed to locate a potential High Density Polyethylene (HDPE) liner under rubble area. A member of the PBS engineering staff should log the test pits and borings and collect samples for laboratory testing.
2. **Soils Testing:** All samples should be returned to our PBS laboratory and classified in general accordance with the Unified Soil Classification, Visual-Manual Procedure. Laboratory tests should include natural moisture contents, grain-size analysis, and Atterberg limits, as appropriate.
3. **Geotechnical Engineering Analysis:** All data collected during the subsurface exploration, literature research, and testing should be evaluated and used to develop geotechnical design and construction recommendations.
4. **Deliverable:** A Phase 2 Geotechnical Engineering Report should be prepared summarizing the results of our explorations and analyses, including information relating to the following:

    - Exploration logs and site plan with exploration locations
    - Laboratory test results
    - Earthwork and grading, cut, and fill recommendations:
        - building pad preparation
        - utility trench backfill
        - structural fill materials and preparation
        - wet and cold weather conditions considerations
    - Shallow foundation design recommendations:
        - minimum embedment
        - allowable bearing pressure
        - estimated settlement
        - sliding coefficient
    - Groundwater consideration

- Seismic design criteria in accordance with the 2012 International Building Code (IBC) with State of Washington amendments
- Slab and pavement subgrade preparation
- Pavement section recommendations

LIMITATIONS

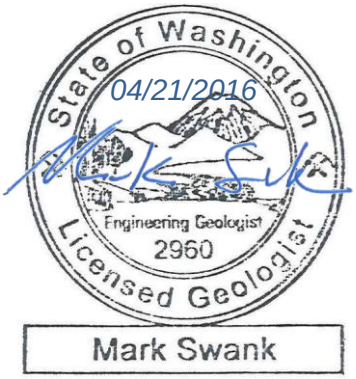
Our evaluations and recommendations are based upon limited review of the referenced documents. No subsurface explorations were completed during this work to verify the type and depth of fill, soil, bedrock, or depth of groundwater at the site. We should be contacted to review the proposed site development plan to evaluate their possible affect on the site property. A geotechnical engineering report that includes site-specific explorations and infiltration testing will be required prior to design.

The information provided in this letter report is only for your information, for use in feasibility planning associated with the site and that you will not hold PBS liable in any regard for decisions related to due diligence, purchase, or design and construction estimating. Site-specific exploration and engineering is required in order to refine the very general discussion of subsurface conditions (based on previous work by others) provided in this letter-report.

CLOSING

We trust this feasibility report meets your current needs. If you have any questions or wish to further discuss our observations, conclusions, and recommendations, please contact Mark Swank at 503.417.7738 or Ryan White at 503.417.7608.

Sincerely,
PBS Engineering and Environmental Inc.



Mark Swank, LG, LEG
Senior Engineering Geologist

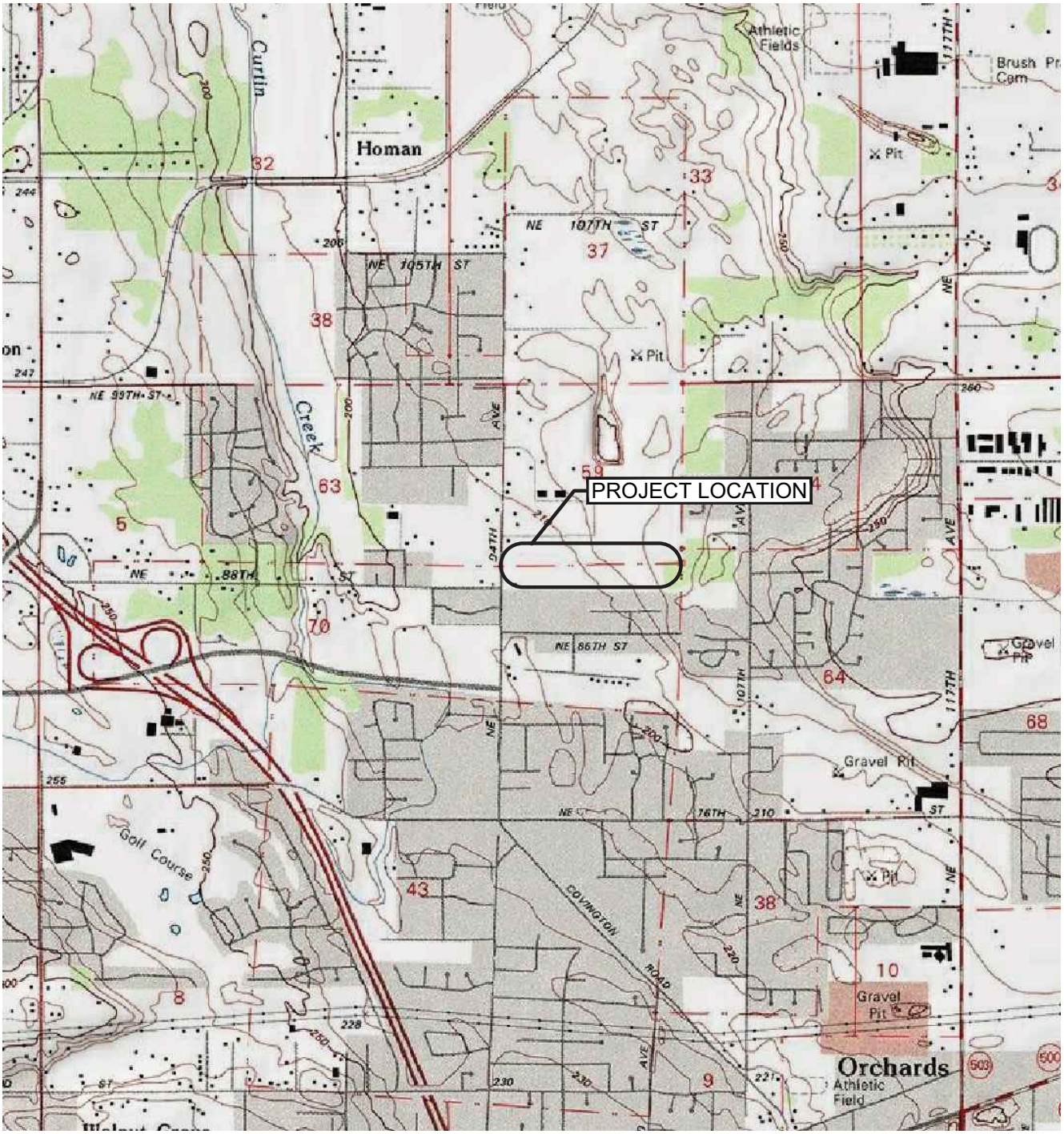
Ryan White, PE, GE
Geotechnical Discipline Lead

MQ/AR/ln

Figures: Figure 1 – Vicinity Map
Figure 2 – Site Plan
Figure 3 – Environmental Borings with Site Annotations
Figure 4 – LiDAR Hillshade Image

Attachment: A – Soil Classification Descriptions
B – Site Photographs

FIGURES



SOURCE: USGS ORCHARDS WA QUADRANGLE 1990.

WASHINGTON

0' 1,000' 2,000' 4,000'

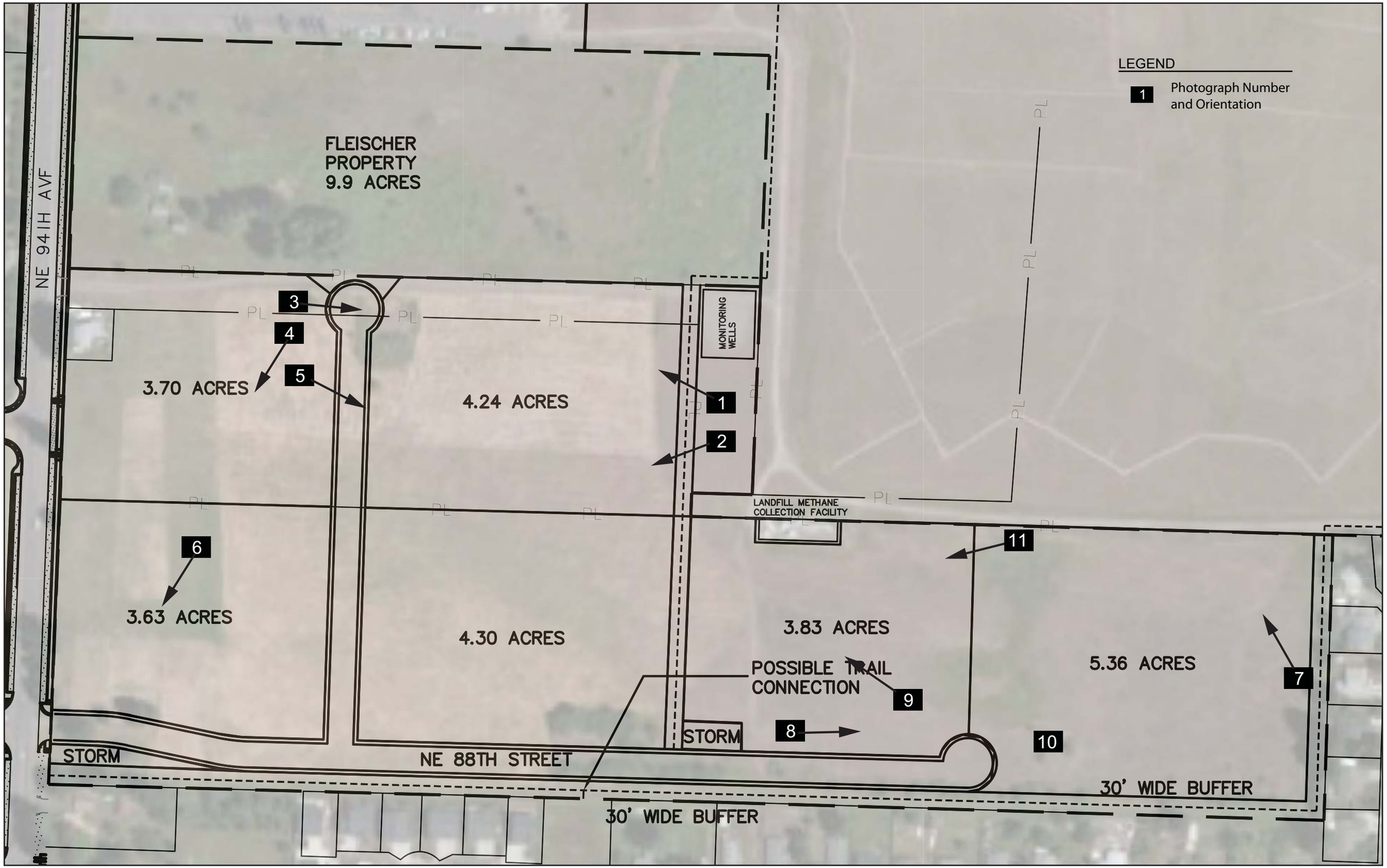
SCALE: 1" = 2,000'

PREPARED FOR: CLARK COUNTY

PBS

PROJECT #	VICINITY MAP	FIGURE
72971.006	LEICHNER CAMPUS DEVELOPMENT - KOSKI PROPERTY VANCOUVER, WASHINGTON	1
DATE APRIL 2015		

L:\Projects\72000\72900-72999\72971_Clark County\72971.006_LeichnerProp\DWG\72971.006_FIGURES 1-2.dwg Apr 09, 2015 10:19am Jimb



SOURCES: Berger (August 6, 2014)

PREPARED FOR: Clark County

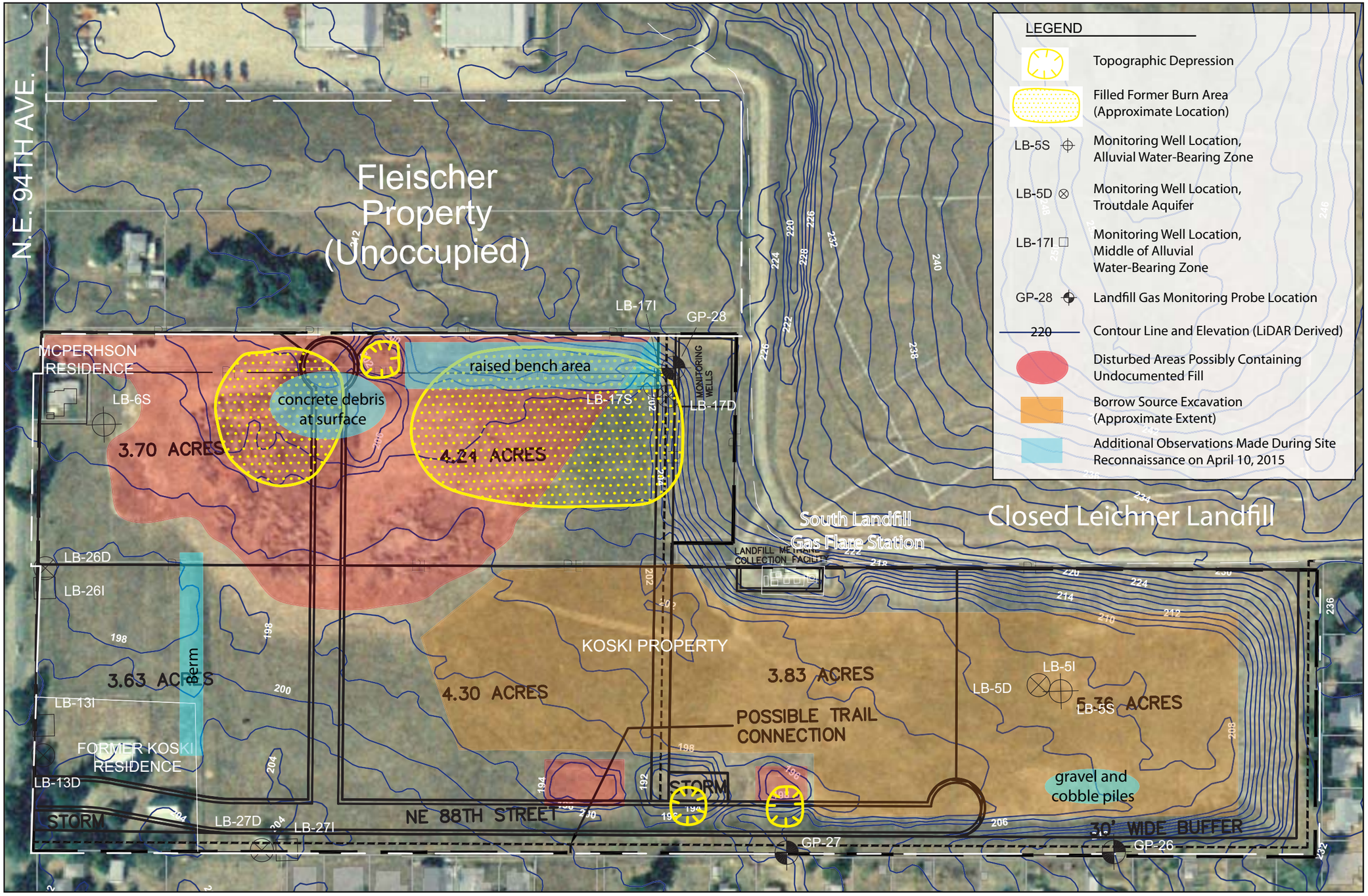
SITE PLAN

160 80 0 160
Feet
1 inch = 160 feet

PBS
Engineering + Environmental
4412 SW Corbett Ave
Portland, OR 97239
503.248.1939 Main
866.727.0140 Fax
www.pbsenv.com

LEICHNER CAMPUS DEVELOPMENT
KOSKI PROPERTY
8713 NORTHEAST 94TH AVENUE
VANCOUVER, WASHINGTON

PROJECT	72971.006
DATE	APR 2015
FIGURE	2



SOURCES: WGS_1984_Web_Mercator_Auxiliary_Sphere
Clark County, WA. GIS - http://gis.clark.wa.gov
This map was generated by Clark County's "MapsOnline" website using the 1994 Ortho
SCS Engineers (2014)
Berger (August 6, 2014)
Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community
USACE (2010)

PREPARED FOR: Clark County

ENVIRONMENTAL BORINGS WITH SITE ANNOTATIONS

160 80 0 160
Feet
1 inch = 160 feet

PBS
Engineering + Environmental
4412 SW Corbett Ave
Portland, OR 97239
503.248.1939 Main
866.727.0140 Fax
www.pbsenv.com

LEICHNER CAMPUS DEVELOPMENT
KOSKI PROPERTY
8713 NORTHEAST 94TH AVENUE
VANCOUVER, WASHINGTON

PROJECT	72971.006
DATE	APR 2015
FIGURE	3

PREPARED FOR: Clark County

LEGEND
taxlots

HILLSHADE DERIVED FROM USACE LIDAR

160 80 0 160
Feet
1 inch = 160 feet

PBS
Engineering + Environmental
4412 SW Corbett Ave
Portland, OR 97239
503.248.1939 Main
866.727.0140 Fax
www.pbsenv.com

LEICHNER CAMPUS DEVELOPMENT
KOSKI PROPERTY
8713 NORTHEAST 94TH AVENUE
VANCOUVER, WASHINGTON

PROJECT	72971.006
DATE	APR 2015
FIGURE	4

L:\Projects\72000\72900-72999\72971 Clark County\72971.006 LeichnerProp\GIS\Leichner LiDAR.mxd

ATTACHMENT A

Soil Classification Descriptions

ATTACHMENT A – SOIL CLASSIFICATION DESCRIPTIONS

AASHTO Group Classification

AASHTO group classification is a system that classifies soils specifically for geotechnical engineering purposes that are related to highway and airfield construction. It is based on particle-size distribution and Atterberg limits, such as liquid limit and plasticity index. This classification system is covered in AASHTO Standard No. M 145-82. The classification is based on that portion of the soil that is smaller than 3 inches in diameter.

The AASHTO classification system has two general classifications: (i) granular materials having 35 percent or less, by weight, particles smaller than 0.074 mm in diameter and (ii) silt-clay materials having more than 35 percent, by weight, particles smaller than 0.074 mm in diameter. These two divisions are further subdivided into seven main group classifications, plus eight subgroups, for a total of fifteen for mineral soils. Another class for organic soils is used.

For each soil horizon in the database one or more AASHTO Group Classifications may be listed. One is marked as the representative or most commonly occurring. The representative classification is shown here for the surface layer of the soil.

Depth to Restrictive Layer

A "restrictive layer" is a nearly continuous layer that has one or more physical, chemical, or thermal properties that significantly impede the movement of water and air through the soil or that restrict roots or otherwise provide an unfavorable root environment. Examples are bedrock, cemented layers, dense layers, and frozen layers.

This theme presents the depth to any type of restrictive layer that is described for each map unit. If more than one type of restrictive layer is described for an individual soil type, the depth to the shallowest one is presented. If no restrictive layer is described in a map unit, it is represented by the "> 200" depth class.

This attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Natural Drainage Class

"Drainage class (natural)" refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized-excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained, and very poorly drained. These classes are defined in the "Soil Survey Manual."

Capacity of Most Limiting Layer to transmit Water

Saturated hydraulic conductivity (Ksat) refers to the ease with which pores in a saturated soil transmit water. The estimates are expressed in terms of micrometers per second. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Saturated hydraulic conductivity is considered in the design of soil drainage systems and septic tank absorption fields.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

The numeric Ksat values have been grouped according to standard Ksat class limits.

Depth to Water Table
"Water table" refers to a saturated zone in the soil. It occurs during specified months. Estimates of the upper limit are based mainly on observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors (redoximorphic features) in the soil. A saturated zone that lasts for less than a month is not considered a water table.

This attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Frequency of Flooding
Flooding is the temporary inundation of an area caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, and water standing in swamps and marshes is considered ponding rather than flooding.

Frequency is expressed as none, very rare, rare, occasional, frequent, and very frequent.

"None" means that flooding is not probable. The chance of flooding is nearly 0 percent in any year. Flooding occurs less than once in 500 years.

"Very rare" means that flooding is very unlikely but possible under extremely unusual weather conditions. The chance of flooding is less than 1 percent in any year.

"Rare" means that flooding is unlikely but possible under unusual weather conditions. The chance of flooding is 1 to 5 percent in any year.

"Occasional" means that flooding occurs infrequently under normal weather conditions. The chance of flooding is 5 to 50 percent in any year.

"Frequent" means that flooding is likely to occur often under normal weather conditions. The chance of flooding is more than 50 percent in any year but is less than 50 percent in all months in any year.

"Very frequent" means that flooding is likely to occur very often under normal weather conditions. The chance of flooding is more than 50 percent in all months of any year.

Frequency of Ponding
Ponding is standing water in a closed depression. The water is removed only by deep percolation, transpiration, or evaporation or by a combination of these processes. Ponding

frequency classes are based on the number of times that ponding occurs over a given period. Frequency is expressed as none, rare, occasional, and frequent.

"None" means that ponding is not probable. The chance of ponding is nearly 0 percent in any year.

"Rare" means that ponding is unlikely but possible under unusual weather conditions. The chance of ponding is nearly 0 percent to 5 percent in any year.

"Occasional" means that ponding occurs, on the average, once or less in 2 years. The chance of ponding is 5 to 50 percent in any year.

"Frequent" means that ponding occurs, on the average, more than once in 2 years. The chance of ponding is more than 50 percent in any year.

Linear Extensibility (Shrink/Swell) (Figure 12)
Linear extensibility refers to the change in length of an unconfined clod as moisture content is decreased from a moist to a dry state. It is an expression of the volume change between the water content of the clod at 1/3- or 1/10-bar tension (33kPa or 10kPa tension) and oven dryness. The volume change is reported as percent change for the whole soil. The amount and type of clay minerals in the soil influence volume change.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Linear extensibility is used to determine the shrink-swell potential of soils. The shrink-swell potential is low if the soil has a linear extensibility of less than 3 percent; moderate if 3 to 6 percent; high if 6 to 9 percent; and very high if more than 9 percent. If the linear extensibility is more than 3, shrinking and swelling can cause damage to buildings, roads, and other structures and to plant roots. Special design commonly is needed.

Corrosion of Steel
"Risk of corrosion" pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens uncoated steel. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the steel in installations that are entirely within one kind of soil or within one soil layer.

The risk of corrosion is expressed as "low," "moderate," or "high."

Corrosion of Concrete
"Risk of corrosion" pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens concrete. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The concrete in installations that intersect soil boundaries or soil layers is more susceptible to

corrosion than the concrete in installations that are entirely within one kind of soil or within one soil layer.

The risk of corrosion is expressed as "low," "moderate," or "high."

Mechanical Site Preparation (Surface)
The ratings in this interpretation indicate the suitability for use of surface-altering soil tillage equipment during site preparation in forested areas. The ratings are based on slope, depth to a restrictive layer, plasticity index, rock fragments on or below the surface, depth to a water table, and ponding. The part of the soil from the surface to a depth of about 1 foot is considered in the ratings.

The ratings are both verbal and numerical. Rating class terms indicate the degree to which the soils are suited to this aspect of forestland management. The soils are described as "well suited," "poorly suited," or "unsuited" to this management activity. "Well suited" indicates that the soil has features that are favorable for the specified kind of site preparation and has no limitations. Good performance can be expected, and little or no maintenance is needed. "Poorly suited" indicates that the soil has one or more properties that are unfavorable for the specified kind of site preparation. Overcoming the unfavorable properties requires special design, extra maintenance, and costly alteration. "Unsuited" indicates that the expected performance of the soil is unacceptable for the specified kind of site preparation or that extreme measures are needed to overcome the undesirable soil properties.

Numerical ratings indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the specified aspect of forestland management (1.00) and the point at which the soil feature is not a limitation (0.00).

The map unit components listed for each map unit in the accompanying Summary by Map Unit table in Web Soil Survey or the Aggregation Report in Soil Data Viewer are determined by the aggregation method chosen. An aggregated rating class is shown for each map unit. The components listed for each map unit are only those that have the same rating class as listed for the map unit. The percent composition of each component in a particular map unit is presented to help the user better understand the percentage of each map unit that has the rating presented.

Other components with different ratings may be present in each map unit. The ratings for all components, regardless of the map unit aggregated rating, can be viewed by generating the equivalent report from the Soil Reports tab in Web Soil Survey or from the Soil Data Mart site. Onsite investigation may be needed to validate these interpretations and to confirm the identity of the soil on a given site.

Mechanical Site Preparation (Deep)
The ratings in this interpretation indicate the suitability for the use of deep soil tillage equipment during site preparation in forested areas. The ratings are based on slope, depth to a restrictive layer, rock fragments on or below the surface, depth to a water table, and ponding. The part of the soil from the surface to a depth of about 3 feet is considered in the ratings.

The ratings are both verbal and numerical. Rating class terms indicate the degree to which the soils are suited to this aspect of forestland management. The soils are described as "well suited," "poorly suited," or "unsuited" to this management activity. "Well suited" indicates that

the soil has features that are favorable for the specified kind of site preparation and has no limitations. Good performance can be expected, and little or no maintenance is needed. "Poorly suited" indicates that the soil has one or more properties that are unfavorable for the specified kind of site preparation. Overcoming the unfavorable properties requires special design, extra maintenance, and costly alteration. "Unsuited" indicates that the expected performance of the soil is unacceptable for the specified kind of site preparation or that extreme measures are needed to overcome the undesirable soil properties.

Numerical ratings indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the specified aspect of forestland management (1.00) and the point at which the soil feature is not a limitation (0.00).

The map unit components listed for each map unit in the accompanying Summary by Map Unit table in Web Soil Survey or the Aggregation Report in Soil Data Viewer are determined by the aggregation method chosen. An aggregated rating class is shown for each map unit. The components listed for each map unit are only those that have the same rating class as listed for the map unit. The percent composition of each component in a particular map unit is presented to help the user better understand the percentage of each map unit that has the rating presented.

Other components with different ratings may be present in each map unit. The ratings for all components, regardless of the map unit aggregated rating, can be viewed by generating the equivalent report from the Soil Reports tab in Web Soil Survey or from the Soil Data Mart site. Onsite investigation may be needed to validate these interpretations and to confirm the identity of the soil on a given site.

Local Roads and Streets

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material; a base of gravel, crushed rock, or soil material stabilized by lime or cement; and a surface of flexible material (asphalt), rigid material (concrete), or gravel with a binder. The ratings are based on the soil properties that affect the ease of excavation and grading and the traffic-supporting capacity. The properties that affect the ease of excavation and grading are depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, depth to a water table, ponding, flooding, the amount of large stones, and slope. The properties that affect the traffic-supporting capacity are soil strength (as inferred from the AASHTO group index number), subsidence, linear extensibility (shrink-swell potential), the potential for frost action, depth to a water table, and ponding.

The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect the specified use. "Not limited" indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. "Somewhat limited" indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. "Very limited" indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

The map unit components listed for each map unit in the accompanying Summary by Map Unit table in Web Soil Survey or the Aggregation Report in Soil Data Viewer are determined by the aggregation method chosen. An aggregated rating class is shown for each map unit. The components listed for each map unit are only those that have the same rating class as listed for the map unit. The percent composition of each component in a particular map unit is presented to help the user better understand the percentage of each map unit that has the rating presented.

Other components with different ratings may be present in each map unit. The ratings for all components, regardless of the map unit aggregated rating, can be viewed by generating the equivalent report from the Soil Reports tab in Web Soil Survey or from the Soil Data Mart site. Onsite investigation may be needed to validate these interpretations and to confirm the identity of the soil on a given site.

ATTACHMENT B

Site Photographs

Photo 1. Looking west from upper slope

Photo 2. Looking southwest showing vegetation transition

Photo 3. Circular depression along northern perimeter

Photo 4. Elevated area in northern portion

Photo 5. Panoramic view looking east

Photo 6. Looking southwest at Koski building pad

Photo 7. General slope grade on eastern perimeter

Photo 8. Depression in eastern portion looking east

Photo 9. Sparse vegetation looking west

Photo 10. Gravel and cobble pile in eastern portion

Photo 11. Looking southwest showing vegetation transition

APPENDIX D

OPERATIONS & MAINTENANCE MANUAL

No. 21 - Maintenance Standards and Procedures for Bioretention Facilities.

Note that the inspection and routine maintenance frequencies listed below are recommended by Ecology. They do not supersede or replace the municipal stormwater permit requirements for inspection frequency required of municipal stormwater permittees for "stormwater treatment and flow control BMPs/facilities."

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Facility Footprint				
Earthen side slopes and berms	B, S		Erosion (gullies/ rills) greater than 2 inches deep around inlets, outlet, and alongside slopes	• Eliminate cause of erosion and stabilize damaged area (regrade, rock, vegetation, erosion control matting) • For deep channels or cuts (over 3 inches in ponding depth), temporary erosion control measures should be put in place until permanent repairs can be made. • Properly designed, constructed and established facilities with appropriate flow velocities should not have erosion problems except perhaps in extreme events. If erosion problems persist, the following should be reassessed: (1) flow volumes from contributing areas and bioretention facility sizing; (2) flow velocities and gradients within the facility; and (3) flow dissipation and erosion protection strategies at the facility inlet.
	A		Erosion of sides causes slope to become a hazard	Take actions to eliminate the hazard and stabilize slopes
	A, S		Settlement greater than 3 inches (relative to undisturbed sections of berm)	Restore to design height
	A, S		Downstream face of berm wet, seeps or leaks evident	Plug any holes and compact berm (may require consultation with engineer, particularly for larger berms)
	A		Any evidence of rodent holes or water piping in berm	• Eradicate rodents (see "Pest control") • Fill holes and compact (may require consultation with engineer, particularly for larger berms)
Concrete sidewalls	A		Cracks or failure of concrete sidewalls	• Repair/ seal cracks • Replace if repair is insufficient
Rockery sidewalls	A		Rockery side walls are insecure	Stabilize rockery sidewalls (may require consultation with engineer, particularly for walls 4 feet or greater in height)
Facility area		All maintenance visits (at least biannually)	Trash and debris present	Clean out trash and debris
Facility bottom area	A, S		Accumulated sediment to extent that infiltration rate is reduced (see "Ponded water") or surface storage capacity significantly impacted	• Remove excess sediment • Replace any vegetation damaged or destroyed by sediment accumulation and removal • Mulch newly planted vegetation • Identify and control the sediment source (if feasible) • If accumulated sediment is recurrent, consider adding presettlement or installing berms to create a forebay at the inlet
		During/after fall leaf drop	Accumulated leaves in facility	Remove leaves if there is a risk to clogging outlet structure or water flow is impeded
Low permeability check dams and weirs	A, S		Sediment, vegetation, or debris accumulated at or blocking (or having the potential to block) check dam, flow control weir or orifice	Clear the blockage
	A, S		Erosion and/or undercutting present	Repair and take preventative measures to prevent future erosion and/or undercutting
	A		Grade board or top of weir damaged or not level	Restore to level position

[a] Frequency: A = Annually; B = Biannually (twice per year); M = Monthly; W = At least one visit should occur during the wet season (for debris/clog related maintenance, this inspection/maintenance visit should occur in the early fall, after deciduous trees have lost their leaves); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).

IPM – Integrated Pest Management

ISA – International Society of Arboriculture

No. 21 (continued) - Maintenance Standards and Procedures for Bioretention Facilities.

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Facility Footprint (cont'd)				
Ponded water	B, S		Excessive ponding water: Water overflows during storms smaller than the design event or ponded water remains in the basin 48 hours or longer after the end of a storm.	Determine cause and resolve in the following order: 1) Confirm leaf or debris buildup in the bottom of the facility is not impeding infiltration. If necessary, remove leaf litter/debris. 2) Ensure that underdrain (if present) is not clogged. If necessary, clear underdrain. 3) Check for other water inputs (e.g., groundwater, illicit connections). 4) Verify that the facility is sized appropriately for the contributing area. Confirm that the contributing area has not increas ed. If steps #1-4 do not solve the problem, the bioretention soil is likely clogged by sediment accumulation at the surface or has become overly compacted. Dig a small hole to observe soil profile and identify compaction depth or clogging front to help determine the soil depth to be removed or otherwise rehabilitated (e.g., tilled). Consultation with an engineer is recommended.
Bioretention soil media	As needed		Bioretention soil media protection is needed when performing maintenance requiring entrance into the facility footprint	• Minimize all loading in the facility footprint (foot traffic and other loads) to the degree feasible in order to prevent compaction of bioretention soils. • Never drive equipment or apply heavy loads in facility footprint. • Because the risk of compaction is higher during saturated soil conditions, any type of loading in the cell (including foot traffic) should be minimized during wet conditions. • Consider measures to distribute loading if heavy foot traffic is required or equipment must be placed in facility. As an example, boards may be placed across soil to distribute loads and minimize compaction. • If compaction occurs, soil must be loosened or otherwise rehabilitated to original design state.
Inlets/Outlets/Pipes				
Splash block inlet	A		Water is not being directed properly to the facility and away from the inlet structure	Reconfigure/ repair blocks to direct water to facility and away from structure
Curb cut inlet/outlet	M during the wet season and before severe storm is forecasted	Weekly during fall leaf drop	Accumulated leaves at curb cuts	Clear leaves (particularly important for key inlets and low points along long, linear facilities)
Pipe inlet/outlet	A		Pipe is damaged	Repair/ replace
	W		Pipe is clogged	Remove roots or debris
	A, S		Sediment, debris, trash, or mulch reducing capacity of inlet/outlet	• Clear the blockage • Identify the source of the blockage and take actions to prevent future blockages
		Weekly during fall leaf drop	Accumulated leaves at inlets/outlets	Clear leaves (particularly important for key inlets and low points along long, linear facilities)
		A	Maintain access for inspections	• Clear vegetation (transplant vegetation when possible) within 1 foot of inlets and outlets, maintain access pathways • Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants
Erosion control at inlet	A		Concentrated flows are causing erosion	Maintain a cover of rock or cobbles or other erosion protection measure (e.g., matting) to protect the ground where concentrated water enters the facility (e.g., a pipe, curb cut or swale)

No. 21 (continued) - Maintenance Standards and Procedures for Bioretention Facilities.

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Inlets/Outlets/Pipes (cont'd)				
Trash rack	S		Trash or other debris present on trash rack	Remove/dispose
	A		Bar screen damaged or missing	Repair/replace
Overflow	A, S		Capacity reduced by sediment or debris	Remove sediment or debris/dispose
Underdrain pipe	Clean pipe as needed	Clean orifice at least biannually (may need more frequent cleaning during wet season)	• Plant roots, sediment or debris reducing capacity of underdrain • Prolonged surface ponding (see "Ponded water")	• Jet clean or rotary cut debris/roots from underdrain(s) • If underdrains are equipped with a flow restrictor (e.g., orifice) to attenuate flows, the orifice must be cleaned regularly.
Vegetation				
Facility bottom area and upland slope vegetation	Fall and Spring		Vegetation survival rate falls below 75% within first two years of establishment (unless project O&M manual or record drawing stipulates more or less than 75% survival rate).	• Determine cause of poor vegetation growth and correct condition • Replant as necessary to obtain 75% survival rate or greater. Refer to original planting plan, or approved jurisdictional species list for appropriate plant replacements (See Appendix 3 - Bioretention Plant List, in the LID Technical Guidance Manual for Puget Sound). • Confirm that plant selection is appropriate for site growing conditions • Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants
Vegetation (general)	As needed		Presence of diseased plants and plant material	• Remove any diseased plants or plant parts and dispose of in an approved location (e.g., commercial landfill) to avoid risk of spreading the disease to other plants • Disinfect gardening tools after pruning to prevent the spread of disease • See Pacific Northwest Plant Disease Management Handbook for information on disease recognition and for additional resources • Replant as necessary according to recommendations provided for "facility bottom area and upland slope vegetation".
Trees and shrubs		All pruning seasons (timing varies by species)	Pruning as needed	• Prune trees and shrubs in a manner appropriate for each species. Pruning should be performed by landscape professionals familiar with proper pruning techniques • All pruning of mature trees should be performed by or under the direct guidance of an ISA certified arborist
	A		Large trees and shrubs interfere with operation of the facility or access for maintenance	• Prune trees and shrubs using most current ANSI A300 standards and ISA BMPs. • Remove trees and shrubs, if necessary.
	Fall and Spring		Standing dead vegetation is present	• Remove standing dead vegetation • Replace dead vegetation within 30 days of reported dead and dying plants (as practical depending on weather/planting season) • If vegetation replacement is not feasible within 30 days, and absence of vegetation may result in erosion problems, temporary erosion control measures should be put in place immediately. • Determine cause of dead vegetation and address issue, if possible • If specific plants have a high mortality rate, assess the cause and replace with appropriate species. Consultation with a landscape architect is recommended.
	Fall and Spring		Planting beneath mature trees	• When working around and below mature trees, follow the most current ANSI A300 standards and ISA BMPs to the extent practicable (e.g., take care to minimize any damage to tree roots and avoid compaction of soil). • Planting of small shrubs or groundcovers beneath mature trees may be desirable in some cases; such plantings should use mainly plants that come as bulbs, bare root or in 4-inch pots; plants should be in no larger than 1-gallon containers.

No. 21 (continued) - Maintenance Standards and Procedures for Bioretention Facilities.

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Vegetation (cont'd)				
Trees and shrubs (cont'd)	Fall and Spring		Planting beneath mature trees	• When working around and below mature trees, follow the most current ANSI A300 standards and ISA BMPs to the extent practicable (e.g., take care to minimize any damage to tree roots and avoid compaction of soil). • Planting of small shrubs or groundcovers beneath mature trees may be desirable in some cases; such plantings should use mainly plants that come as bulbs, bare root or in 4-inch pots; plants should be in no larger than 1-gallon containers.
	Fall and Spring		Presence of or need for stakes and guys (tree growth, maturation, and support needs)	• Verify location of facility liners and underdrain (if any) prior to stake installation in order to prevent liner puncture or pipe damage • Monitor tree support systems: Repair and adjust as needed to provide support and prevent damage to tree. • Remove tree supports (stakes, guys, etc.) after one growing season or maximum of 1 year. • Backfill stake holes after removal.
Trees and shrubs adjacent to vehicle travel areas (or areas where visibility needs to be maintained)	A		Vegetation causes some visibility (line of sight) or driver safety issues	• Maintain appropriate height for sight clearance • When continued, regular pruning (more than one time/ growing season) is required to maintain visual sight lines for safety or clearance along a walk or drive, consider relocating the plant to a more appropriate location. • Remove or transplant if continual safety hazard • Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants
Flowering plants		A	Dead or spent flowers present	Remove spent flowers (deadhead)
Perennials		Fall	Spent plants	Cut back dying or dead and fallen foliage and stems
Emergent vegetation		Spring	Vegetation compromises conveyance	• Hand rake sedges and rushes with a small rake or fingers to remove dead foliage before new growth emerges in spring or earlier only if the foliage is blocking water flow (sedges and rushes do not respond well to pruning)
Ornamental grasses (perennial)		Winter and Spring	Dead material from previous year's growing cycle or dead collapsed foliage	• Leave dry foliage for winter interest • Hand rake with a small rake or fingers to remove dead foliage back to within several inches from the soil before new growth emerges in spring or earlier if the foliage collapses and is blocking water flow
Ornamental grasses (evergreen)		Fall and Spring	Dead growth present in spring	• Hand rake with a small rake or fingers to remove dead growth before new growth emerges in spring • Clean, rake, and comb grasses when they become too tall • Cut back to ground or thin every 2-3 years as needed
Noxious weeds		M (March – October, preceding seed dispersal)	Listed noxious vegetation is present (refer to current county noxious weed list)	• By law, class A & B noxious weeds must be removed, bagged and disposed as garbage immediately • Reasonable attempts must be made to remove and dispose of class C noxious weeds • It is strongly encouraged that herbicides and pesticides not be used in order to protect water quality; use of herbicides and pesticides may be prohibited in some jurisdictions • Apply mulch after weed removal (see "Mulch")

[a] Frequency: A = Annually; B = Biannually (twice per year); M = Monthly; W = At least one visit should occur during the wet season (for debris/clog related maintenance, this inspection/maintenance visit should occur in the early fall, after deciduous trees have lost their leaves); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).

IPM – Integrated Pest Management

ISA – International Society of Arboriculture

No. 21 (continued) - Maintenance Standards and Procedures for Bioretention Facilities.

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Vegetation (cont'd)				
Weeds		M (March – October, preceding seed dispersal)	Weeds are present	• Remove weeds with their roots manually with pincer-type weeding tools, flame weeders, or hot water weeders as appropriate • Follow IPM protocols for weed management (see "Additional Maintenance Resources" section for more information on IPM protocols)
Excessive vegetation		Once in early to mid-May and once in early- to mid-September	Low-lying vegetation growing beyond facility edge onto sidewalks, paths, or street edge poses pedestrian safety hazard or may clog adjacent permeable pavement surfaces due to associated leaf litter, mulch, and soil	• Edge or trim groundcovers and shrubs at facility edge • Avoid mechanical blade-type edger and do not use edger or trimmer within 2 feet of tree trunks • While some clippings can be left in the facility to replenish organic material in the soil, excessive leaf litter can cause surface soil clogging
	As needed		Excessive vegetation density inhibits stormwater flow beyond design ponding or becomes a hazard for pedestrian and vehicular circulation and safety	• Determine whether pruning or other routine maintenance is adequate to maintain proper plant density and aesthetics • Determine if planting type should be replaced to avoid ongoing maintenance issues (an aggressive grower under perfect growing conditions should be transplanted to a location where it will not impact flow) • Remove plants that are weak, broken or not true to form; replace in-kind • Thin grass or plants impacting facility function without leaving visual holes or bare soil areas • Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants
	As needed		Vegetation blocking curb cuts, causing excessive sediment buildup and flow bypass	• Remove vegetation and sediment buildup
Mulch				
Mulch		Following weeding	Bare spots (without mulch cover) are present or mulch depth less than 2 inches	• Supplement mulch with hand tools to a depth of 2 to 3 inches • Replenish mulch per O&M manual. Often coarse compost is used in the bottom of the facility and arborist wood chips are used on side slopes and rim (above typical water levels) • Keep all mulch away from woody stems
Watering				
Irrigation system (if any)		Based on manufacturer's instructions	Irrigation system present	• Follow manufacturer's instructions for O&M
	A		Sprinklers or drip irrigation not directed/located to properly water plants	• Redirect sprinklers or move drip irrigation to desired areas
Summer watering (first year)		Once every 1-2 weeks or as needed during prolonged dry periods	Trees, shrubs and groundcovers in first year of establishment period	• 10 to 15 gallons per tree • 3 to 5 gallons per shrub • 2 gallons water per square foot for groundcover areas • Water deeply, but infrequently, so that the top 6 to 12 inches of the root zone is moist • Use soaker hoses or spot water with a shower type wand when irrigation system is not present o Pulse water to enhance soil absorption, when feasible o Pre-moisten soil to break surface tension of dry or hydrophobic soils/mulch, followed by several more passes. With this method , each pass increases soil absorption and allows more water to infiltrate prior to runoff • Add a tree bag or slow-release watering device (e.g., bucket with a perforated bottom) for watering newly installed trees when irrigation system is not present

[a] Frequency: A = Annually; B = Biannually (twice per year); M = Monthly; W = At least one visit should occur during the wet season (for debris/clog related maintenance, this inspection/maintenance visit should occur in the early fall, after deciduous trees have lost their leaves); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).

IPM – Integrated Pest Management

ISA – International Society of Arboriculture

No. 21 (continued) - Maintenance Standards and Procedures for Bioretention Facilities.

Maintenance Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Watering (cont'd)				
Summer watering (second and third years)		Once every 2-4 weeks or as needed during prolonged dry periods	Trees, shrubs and groundcovers in second or third year of establishment period	• 10 to 15 gallons per tree • 3 to 5 gallons per shrub • 2 gallons water per square foot for groundcover areas • Water deeply, but infrequently, so that the top 6 to 12 inches of the root zone is moist • Use soaker hoses or spot water with a shower type wand when irrigation system is not present o Pulse water to enhance soil absorption, when feasible o Pre-moisten soil to break surface tension of dry or hydrophobic soils/mulch, followed by several more passes. With this method , each pass increases soil absorption and allows more water to infiltrate prior to runoff
Summer watering (after establishment)		As needed	Established vegetation (after 3 years)	• Plants are typically selected to be drought tolerant and not require regular watering after establishment; however, trees may take up to 5 years of watering to become fully established • Identify trigger mechanisms for drought-stress (e.g., leaf wilt, leaf senescence, etc.) of different species and water immediately after initial signs of stress appear • Water during drought conditions or more often if necessary to maintain plant cover
Pest Control				
Mosquitoes	B, S		Standing water remains for more than 3 days after the end of a storm	• Identify the cause of the standing water and take appropriate actions to address the problem (see "Ponded water") • To facilitate maintenance, manually remove standing water and direct to the storm drainage system (if runoff is from non pollution-generating surfaces) or sanitary sewer system (if runoff is from pollution-generating surfaces) after getting approval from sanitary sewer authority. • Use of pesticides or *Bacillus thuringiensis israelensis* (Bti)may be considered only as a temporary measure while addressing the standing water cause. If overflow to a surface water will occur within 2 weeks after pesticide use, apply for coverage under the Aquatic Mosquito Control NPDES General Permit.
Nuisance animals	As needed		Nuisance animals causing erosion, damaging plants, or depositing large volumes of feces	• Reduce site conditions that attract nuisance species where possible (e.g., plant shrubs and tall grasses to reduce open areas for geese, etc.) • Place predator decoys • Follow IPM protocols for specific nuisance animal issues (see "Additional Maintenance Resources" section for more information on IPM protocols) • Remove pet waste regularly • For public and right-of-way sites consider adding garbage cans with dog bags for picking up pet waste.
Insect pests	Every site visit associated with vegetation management		Signs of pests, such as wilting leaves, chewed leaves and bark, spotting or other indicators	• Reduce hiding places for pests by removing diseased and dead plants • For infestations, follow IPM protocols (see "Additional Maintenance Resources" section for more information on IPM protocols)

[a] Frequency: A = Annually; B = Biannually (twice per year); M = Monthly; W = At least one visit should occur during the wet season (for debris/clog related maintenance, this inspection/maintenance visit should occur in the early fall, after deciduous trees have lost their leaves); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).

IPM – Integrated Pest Management

ISA – International Society of Arboriculture

No. 5 – Catch Basins

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
General	Trash & Debris	Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by more than 10%.	No Trash or debris located immediately in front of catch basin or on grate opening.
		Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the invert of the lowest pipe.	No trash or debris in the catch basin.
		Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height.	Inlet and outlet pipes free of trash or debris.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No dead animals or vegetation present within the catch basin.
	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the catch basin
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch (Intent is to make sure no material is running into basin).	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached	Frame is sitting flush on the riser rings or top slab and firmly attached.
	Fractures or Cracks in Basin Walls/ Bottom	Maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.
		Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Pipe is regrouted and secure at basin wall.
	Settlement/ Misalignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
	Vegetation	Vegetation growing across and blocking more than 10% of the basin opening.	No vegetation blocking opening to basin.
		Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation or root growth present.
	Contamination and Pollution	See "Detention Ponds" (No. 1).	No pollution present.

No. 5 – Catch Basins

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
Catch Basin Cover	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Catch basin cover is closed
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread.	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. (Intent is keep cover from sealing off access to maintenance.)	Cover can be removed by one maintenance person.
Ladder	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, not securely attached to basin wall, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
Metal Grates (If Applicable)	Grate opening Unsafe	Grate with opening wider than 7/8 inch.	Grate opening meets design standards.
	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing.	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.

No. 6 – Debris Barriers (e.g., Trash Racks)

Maintenance Components	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris	Trash or debris that is plugging more than 20% of the openings in the barrier.	Barrier cleared to design flow capacity.
Metal	Damaged/ Missing Bars.	Bars are bent out of shape more than 3 inches.	Bars in place with no bends more than 3/4 inch.
		Bars are missing or entire barrier missing.	Bars in place according to design.
		Bars are loose and rust is causing 50% deterioration to any part of barrier.	Barrier replaced or repaired to design standards.
	Inlet/Outlet Pipe	Debris barrier missing or not attached to pipe	Barrier firmly attached to pipe