ATTACHMENT 21

Preliminary

Drainage Report

Engineering ABOVE The Standard.

Benjamin Estates Residential Plat and Hill Property Development Redmond, WA

Prepared By:
LDC, Inc.
14201 NE 200th Street, #100
Woodinville, WA 98072

Prepared For:
Benjamin 13, LLC
15 Lake Bellevue Drive
Bellevue, Washington 98005

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THE CIVIL ENGINEERING GROUP

Civil Engineering • Land Survey • Land Use Planning

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ATTACHMENT 21

Preliminary Drainage Report

for

Benjamin Estates Residential Plat and Hill Property Development

Prepared for

Benjamin 13, LLC.
15 Lake Bellevue Dr.
Bellevue, WA 98005
(425) 869-1300

Prepared by

Land Development Consultants, Inc
14201 NE 200th Street
Suite 100
Woodinville, WA 98072
(425) 806-1869

October 23, 2013
Job No: 12-166

TABLE OF CONTENTS

1.0 PROJECT OVERVIEW

The Benjamin Estates and Hill Property Residential Plats are located at 13640 NE 100th St, Redmond, WA and 13625 NE 100th ST, Redmond, WA, respectively, and both lie within the southeast quarter of the southwest quarter of Section 34, Township 26 N, Range 5 E, W.M. See the Vicinity Map, Figure 1, for the exact location of the sites.

The Benjamin Residential Plat (Benjamin) is 2.66 acres of which approximately 2.31 acres will be disturbed during development. The project proposes to construct as many as 14 single-family lots and associated infrastructure, including rustic roads street standards which include open roadside swales for conveyance. The remaining area (0.35 acres) will be left undisturbed in its present forested condition as open space.

Of the 1.72 acre Hill Property (Hill) 1.51 acres will be disturbed during development. The project proposes to construct 9 single-family lots and associated infrastructure, a public street (rustic road standards) with open road side swales for conveyance. The remaining area (0.22 acres) will be left as open space in its present forested land cover.

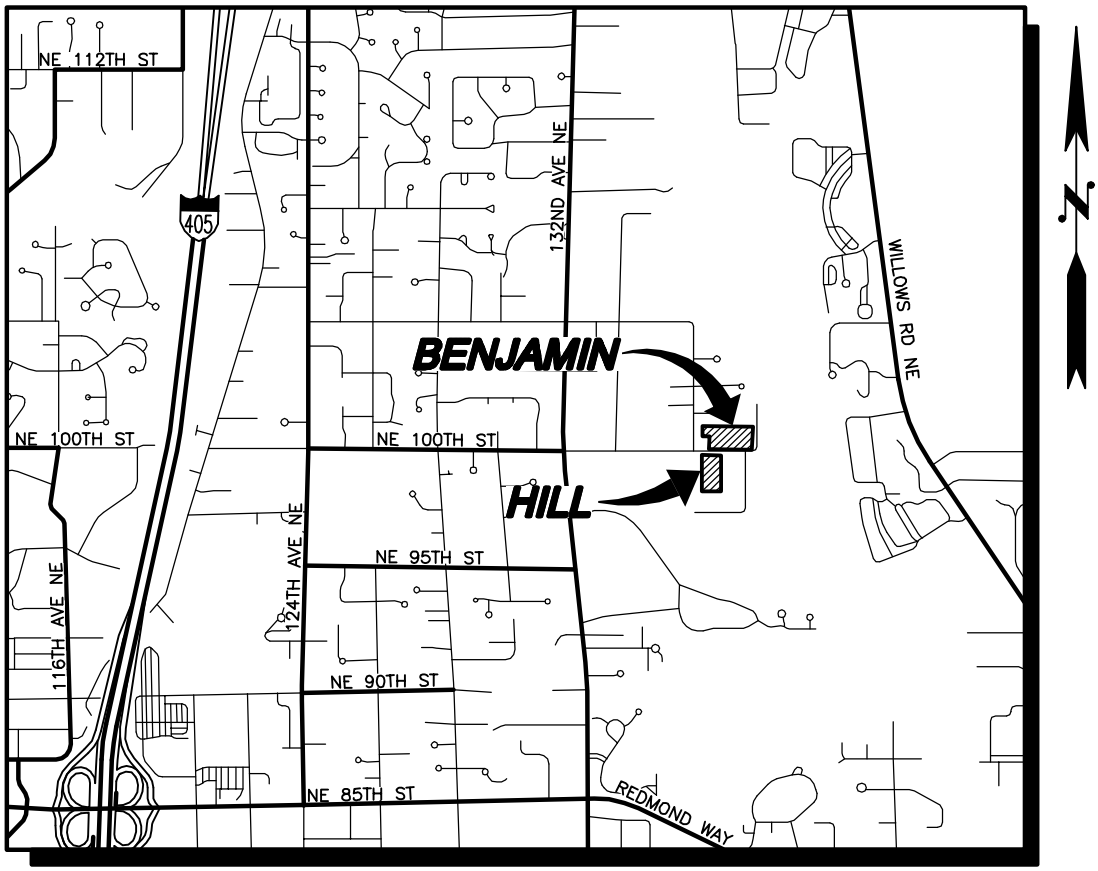
According to the King County Soil Survey, both sites are underlain with Alderwood Gravelly Sandy Loam, 0 to 6 percent slopes and 6 to 15 percent slopes, refer to Appendix 3-C for detailed soil information. The soil has slow to moderate runoff potential and a slight to moderate erosion potential. Slopes on the areas to be developed range from 0 to 20 percent.

Runoff currently exits the Benjamin site via overland flow across the eastern property boundary via two culverts which cross underneath a private road/drive adjacent to the east property line. Flows continue easterly down a steep grade where they enter the City of Redmond storm drainage network in an office complex at the base of the slope. Flows eventually reach the Sammamish River.

Flows for the Hill Property currently drain overland east and north to 138th AVE NE, and are collected and piped northeast to the NE 100th St ROW extension. Runoff flows down a steep easterly grade and enter the City of Redmond storm drainage network in an office complex at the base of the slope. Flows eventually reach the Sammamish River.

No specific watershed management plans were found for those basins. The site is not located in a City wellhead protection area.

Flow control will be achieved by means of a detention pond on the Benjamin Estates property for both Benjamin and Hill projects. The flow control will comply with the City of Redmond 2012 Stormwater Management Technical Notebook and the 2005 DOE Manual. Water quality will be achieved by Contech storm filter downstream of pond discharge.



VICINITY MAP

SCALE: 1"=2000'

Drawing: P:\2012\12-169 Hill Property\Drawings\Preliminary\Working\BenjaminHill-VM.dwg Plotted: May 15, 2013 - 1:31pm

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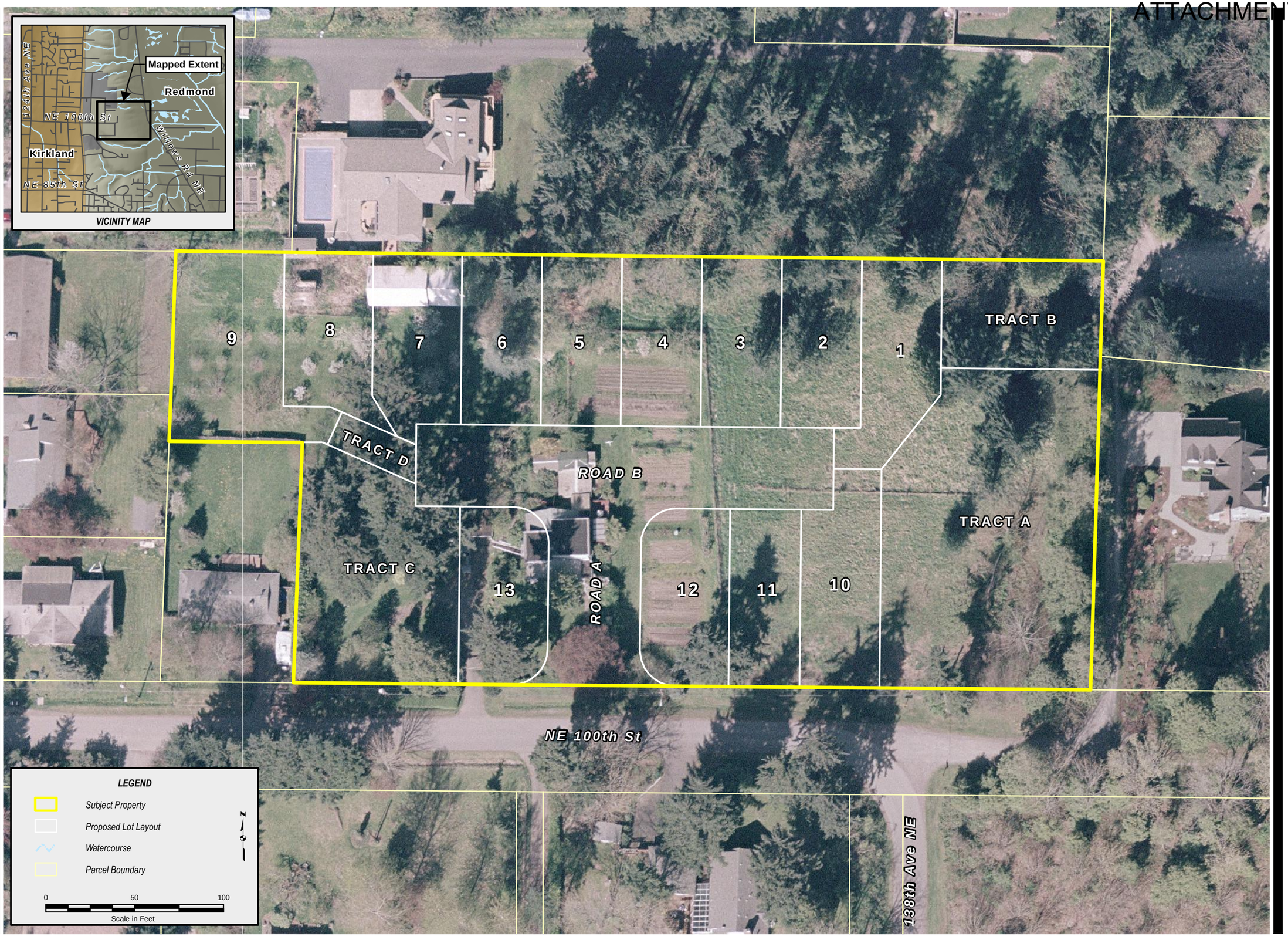
BENJAMIN AND HILL PROPERTIES

VICINITY MAP

FIGURE 1

ATTACHMENT 21



12-109F03.mxd | MOD: 5/14/2013 | IGM

SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
CITY OF REDMOND	COLOR AERIAL PHOTOGRAPHY (2004)
KING COUNTY GIS	PARCEL BOUNDARIES

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TAYLOR DEVELOPMENT, INC.

BENJAMIN PROPERTY

PROPOSED SITE LAYOUT

PROJECTION: WASHINGTON STATE PLANE, NORTH ZONE, NAD 83 HARN, FEET

REVISION:	
JOB NUMBER:	12-166
DRAWING NAME:	12-166F03
DESIGNER:	A. BENTON
DRAWING BY:	I. MIERAU
DATE:	5-14-13
SCALE:	AS SHOWN
JURISDICTION:	REDMOND

FIGURE:

2.0

12-169F01.mxd | MOD: 5/15/2013 | IGM

SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
CITY OF REDMOND	COLOR AERIAL PHOTOGRAPHY (2004)
CITY OF REDMOND	HYDROLOGY
KING COUNTY GIS	PARCEL BOUNDARIES

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TAYLOR DEVELOPMENT, INC.

HILL PROPERTY

PROPOSED SITE LAYOUT

PROJECTION: WASHINGTON STATE PLANE, NORTH ZONE, NAD 83 HARN, FEET

REVISION:	
JOB NUMBER:	12-169
DRAWING NAME:	12-169F01
DESIGNER:	A. BENTON
DRAWING BY:	I. MIERAU
DATE:	11-01-12
SCALE:	AS SHOWN
JURISDICTION:	REDMOND

FIGURE:

3.0

2.0 CONDITIONS AND REQUIREMENTS SUMMARY

This project is vested under the Redmond Municipal Code (RMC), Redmond Zoning Code (RZC) and Redmond Stormwater Technical Notebook. The 2005 Ecology Manual as modified by the Western Washington Phase II Municipal Stormwater Permit regulates issues not addressed by the RMC, RZC and Stormwater Notebook. Though existing residential construction exists on the properties currently, this project will be considered a new-development. Figure 3.2 of the Redmond Stormwater Technical Notebook was utilized to determine the minimum requirements for the project which will add more than 5,000 square feet of new/replaced impervious surface. See copy of Figure 3.2 attached on the following pages for reference. All minimum requirements apply to the new impervious surfaces and converted pervious surfaces. The minimum requirements are addressed as follows.

Requirement #1: Preparation of Stormwater Site Plans

This drainage report contains all of information and requirements for Stormwater Site Plans listed in Chapter 3, Volume I of the 2005 Ecology Manual.

Requirement #2: Construction Stormwater Pollution Prevention Plan (SWPPP)

See Section 8 of this report for how this minimum requirement is addressed.

Requirement #3: Source Control of Pollution

Source control BMPs are not required for residential development per the 2005 Ecology Manual.

Requirement #4: Preservation of Natural Drainage System and Outfalls

Natural drainage patterns will be maintained and discharges from the project site will occur at the natural location. The proposed discharge of the site's runoff will not cause significant adverse impact to downstream receiving waters and down gradient properties. The proposed runoff control facility will provide the required flow control and water quality treatment.

Requirement #5: On-Site Stormwater Management

See Section 4 of this report for how this minimum requirement is addressed.

The existing on-site soils are cemented glacial-till, and are, according to the geotechnical engineering report, unsuitable for infiltration on any scale. This geotechnical/soil limitation removes all runoff and downspout infiltration options from feasibility. The site layouts do not allow concentrated runoff dispersion. According to Figure 3.1 of Volume 3 of the DOE Manual, perforated stub-outs are the only downspout management tools from Chapter 3 which are functional. BMPT5.13 (City of Redmond Soil Augmentation) will be implemented on all disturbed ground area to be landscaped.

Requirement #6: Runoff Treatment

See Section 4 of this report for how this minimum requirement is addressed. A Basic Treatment level is required for stormwater quality treatment – but the StormFilter proposed for treatment will provide Enhanced Level treatment.

Requirement #7: Flow Control

See Section 4 of this report for how this minimum requirement is addressed. Flow Control will be met for both Benjamin Estates and Willow Hill developments with an open pond at the east end of the Benjamin Estates property.

Requirement #8: Wetlands Protection

Per the City's Critical Areas Mapping, there are no wetlands on the project site.

Requirement #9: Operations and Maintenance

A Maintenance and Operations Manual has been created for this project. Please refer to Appendix 10-A in Section 10.0 for this document.

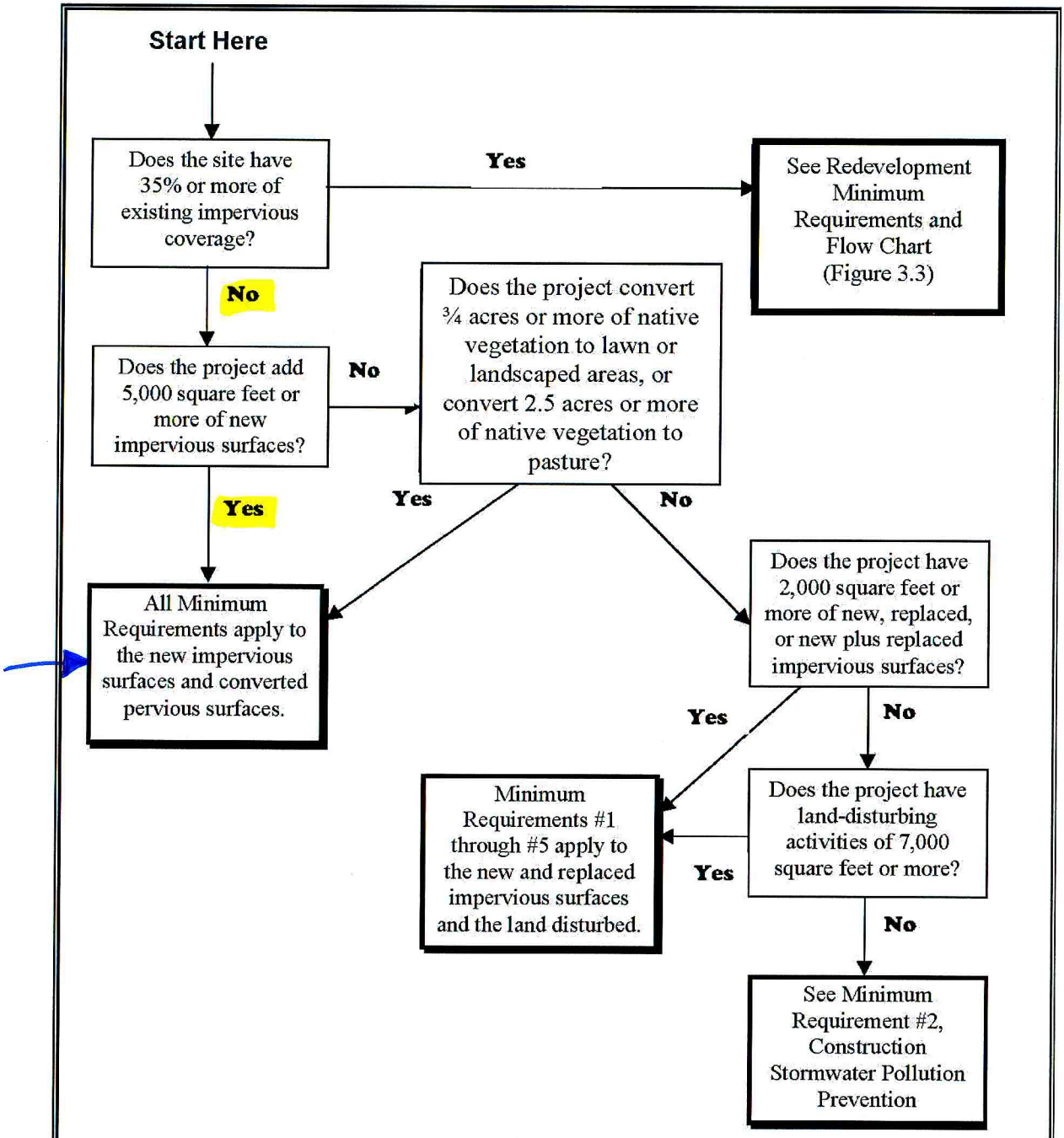

Figure 3.2 Flow Chart for Determining Requirements for New Development

3.0 OFF-SITE ANALYSIS

On Friday November 2, 2012, Upstream and Downstream Analyses were performed at the site. The weather was cloudy with light rain and approximately 50°F. The ground was saturated due to continual rain over the previous days, no overland flow or pooling was observed. The following observations were verified during this visit.

Upstream Analysis

BENJAMIN ESTATES

From the site observation, King County LiDAR and aerial photography, the upstream area for the Benjamin Residential Plat lies west of the project. Runoff from this upstream area enters the site via overland sheet flow from adjacent lots. Approximately 0.55 acres of the adjacent backyards are contributing runoff to Benjamin Residential Plat (See Figure 4). Additionally, it should be noted that in the current condition, flows from the north roadside ditch in the NE 100th St. ROW flow onto the Benjamin Estates property at the approximate location of the alignment of 138th AVE SE, south of NE 100th St.

HILL PROPERTY

Though no area is identified as being immediately upstream of the Hill property, there is an area within NE 100th St ROW upstream of the Hill property frontage. Runoff from this upstream area (0.2 acres) starts at the high point of NE 100th ST (just west of 136th Ave NE) and is carried west in the southern roadside ditch and culverts with NE 100th St (See Figure 5). This flow combines with the ROW flows within the Hill property frontage and continues west within the NE 100th St. ROW.

Field Inspection/Downstream Analysis

BENJAMIN ESTATES

Onsite stormwater runoff flows generally west to east. On the east side of the property there are two drainage paths that carry runoff from the site; (1) Northwestern Culvert, (2) Southwestern Culvert. Both travel easterly from the eastern

property boundary and travel through pipes under the private road, 138th Ave NE (north or NE 100th St.).

Runoff from the (1) northwestern portion of the site enters a 12" concrete culvert❶ and travels southeasterly to where the culvert outfalls into an open drainage channel. Flows follow this channel easterly down a steep slope to where they enter the City of Redmond storm drainage network via structure with trash rack❺ at the base of the slope. Stormwater flows through a 12" PVC pipe from the structure to a catch basin❻ in the parking lot behind PRO Sports Club. The flows collected in the City of Redmond MS4, cross Willows Road and are conveyed east to the Sammamish River.

Runoff collected at the (2) southwestern portion of the site enters a 12" concrete culvert and travels east to a catch basin within the private road❷ (138th Ave NE). As this system is not public, the exact conveyance path easterly is unclear, but an outfall was located approximately 100ft east of the catch basin in the private road, on private property. This discharge is at the head of a ravine which carries flow to down the hill to a catch basin ❸just behind the retaining wall at the back of the PRO Sports Club. Once collected by this catch basin, flows are directed into the 12" public conveyance system ❹which carries flow north around the Willow Commerce Park (with flows collected as part of the Northwest culvert routing) and then east across Willows Road, and toward the Sammamish River.

HILL PROPERTY

The existing Hill site drains west to east, and flows overland across residential properties to the east and north until joining with flows within the private road (138th Ave NE) south of NE 100th St. These flows combine with flows in the south roadside ditch of NE 100th St. at the southwest corner of the intersection of NE 100th St and 138th Ave NE, and cross 138th AVE NE in a culvert to the east. Runoff then flows toward the extension of the NE 100th St. ROW, and down the hill roughly within the ROW.

See Figure 6, Downstream Analysis Map, located in Appendix 3-A, for a detailed map of the downstream flow paths.

APPENDIX 3-A

UPSTREAM AND DOWNSTREAM

ANALYSIS & MAPPING

12-166F04.mxd | MOD: 1/17/2013 | IGM

SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
CITY OF REDMOND	COLOR AERIAL PHOTOGRAPHY (2004)
KING COUNTY GIS	FIVE FOOT CONTOUR - GENERATED FROM BARE EARTH LIDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.
KING COUNTY GIS	PARCEL BOUNDARIES
LDC SURVEY	STORM DRAIN NETWORK

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BENJAMIN PROPERTY

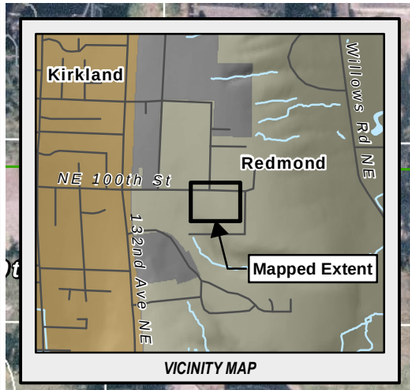
UPSTREAM ANALYSIS MAP

PROJECTION: WASHINGTON STATE PLANE, NORTH ZONE, NAD 83 HARN, FEET

REVISION:	
JOB NUMBER:	12-166
DRAWING NAME:	12-166F04
DESIGNER:	A. BENTON
DRAWING BY:	I. MIERAU
DATE:	01-17-13
SCALE:	AS SHOWN
JURISDICTION:	REDMOND

FIGURE:

4.0



NE 100th St

Off-Site
Upstream
0.20 AC

300

280

LEGEND

- Subject Property
- Storm System
- Watercourse
- Parcel Boundary

Contours

- 25 Foot Contour
- 5 Foot Contour

0 50 100
Scale in Feet

N

12-169F03.mxd | MOD: 5/15/2013 | IGM

SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
CITY OF REDMOND	COLOR AERIAL PHOTOGRAPHY (2004)
KING COUNTY GIS	FIVE FOOT CONTOUR - GENERATED FROM BARE EARTH LIDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.
CITY OF REDMOND	HYDROLOGY, STORM NETWORK
KING COUNTY GIS	PARCEL BOUNDARIES

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HILL PROPERTY

FRONTAGE UPSTREAM MAP

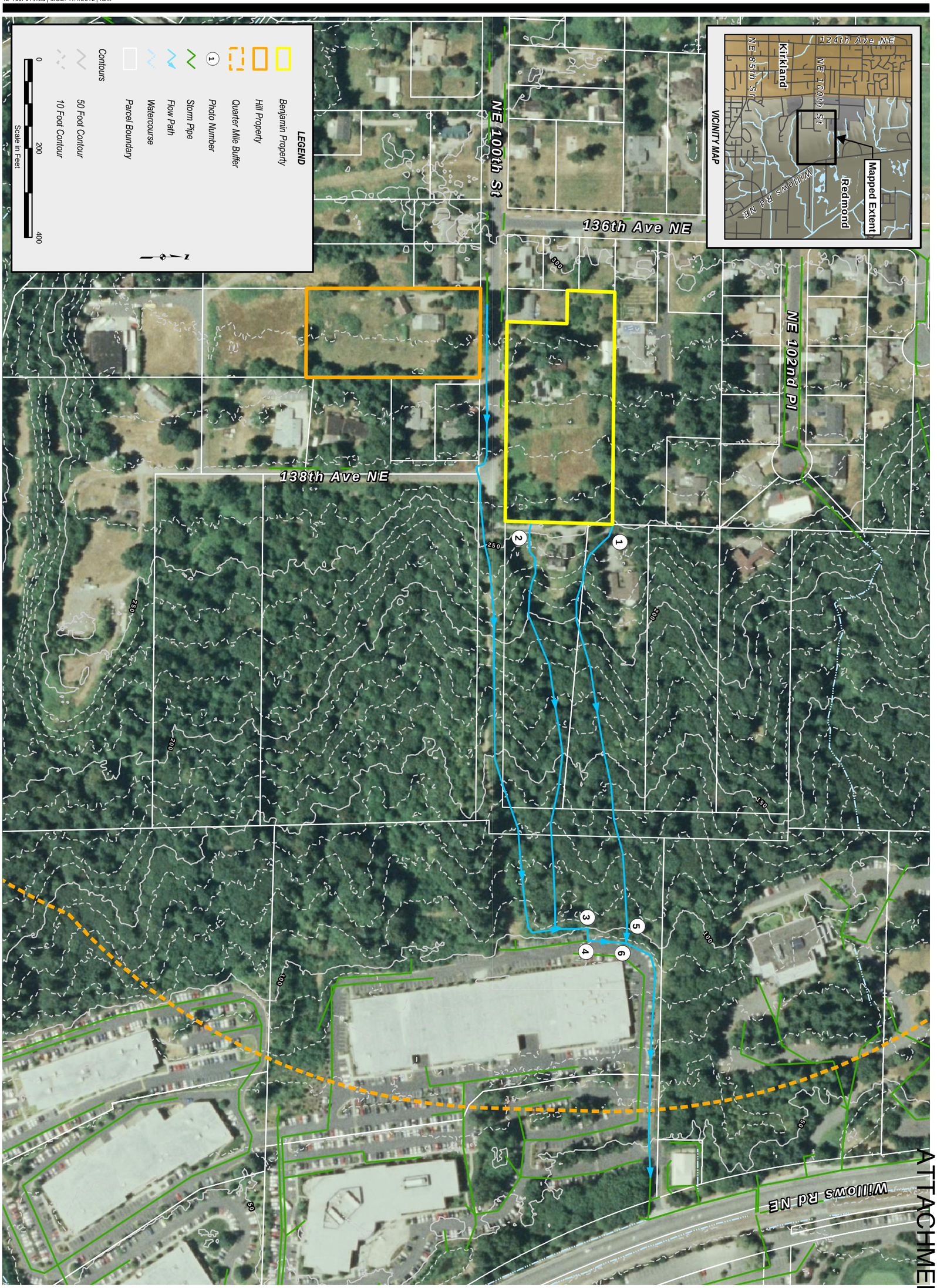
PROJECTION: WASHINGTON STATE PLANE, NORTH ZONE, NAD 83 HARN, FEET

REVISION:
JOB NUMBER: 12-169
DRAWING NAME: 12-169F03
DESIGNER: A. BENTON
DRAWING BY: I. MIERAU
DATE: 5-15-13
SCALE: AS SHOWN
JURISDICTION: REDMOND

FIGURE:

5.0

12-109F01.mxd | MOD: 11/1/2012 | IGM



ATTACHMENT 21

FIGURE: 6.0

TAYLOR DEVELOPMENT, INC.

BENJAMIN & HILL PROPERTIES

DOWNSTREAM ANALYSIS MAP

PROJECTION: WASHINGTON STATE PLANE, NORTH ZONE, NAD 83 HARN, FEET
REVISION:
JOB NUMBER: 12-166
DRAWING NAME: 12-166F01
DESIGNED: A. BENTON
DRAWING BY: I. MERAU
DATE: 11-01-12
SCALE: AS SHOWN
JURISDICTION: REDMOND

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SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
USDA	COLOR AERIAL PHOTOGRAPHY (2006)
KING COUNTY GIS	TEN FOOT CONTOUR - GENERATED FROM BARE EARTH LiDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.
CITY OF REDMOND	HYDROLOGY, STORM DRAIN SYSTEM
KING COUNTY GIS	PARCEL BOUNDARIES

Stormwater flows under 138th Ave NE here via a culvert❶. The culvert outfalls into the brush in the center of the photo.

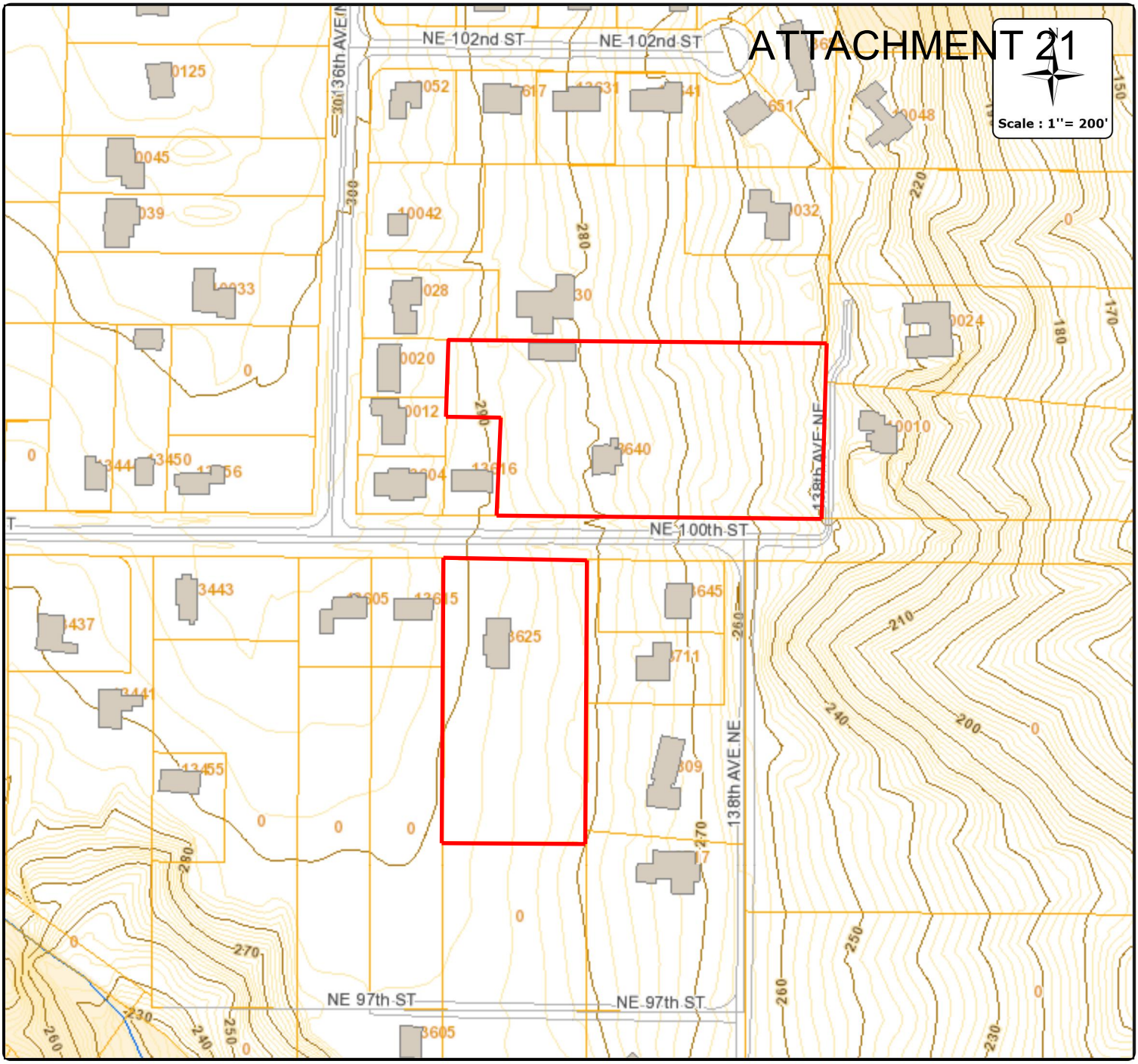
Flows enter this catch basin on the east side of 138th Ave NE❷

Stormwater enters this structure❸ at the base of the hill

Flows are directed through the` parking lot via the business park's storm system. Flows enter this catch basin just beyond the quarter mile buffer. Willows Rd NE is visible in the background of the photo.

APPENDIX 3-A

CRITICAL AREAS MAPPING



Legend

Contours
- INDEX
- INDEX-DEP
- INDEX-DEP-OB
- INDEX-OB
- INTER
- INTER-DEP
- INTER-DEP-OB
- INTER-OB

Streams Classification
- Class I Stream
- Class II Stream
- Class III Stream
- Class IV Stream

Shoreline Environments
- Aquatic
- High-Intensity/Multi-Use
- Natural
- Shoreline Residential
- Urban Conservancy

Class 1 Streams and Buffers

Frequently Flooded Areas
- 100 Year Floodplain
- FEMA Floodway

Wellhead Protection Zones
- Wellhead Protection Zone 1
- Wellhead Protection Zone 2
- Wellhead Protection Zone 3
- Wellhead Protection Zone 4

Stream

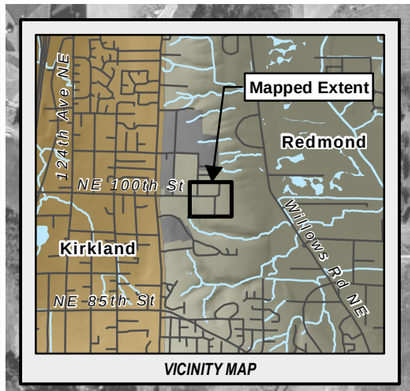
Rivers

Pond

House Number

APPENDIX 3-B

SCS SOIL SURVEY MAPPING



VICINITY MAP

AgB

AgC

AgD

LEGEND

- Benjamin Property
- Hill Property
- Soil Boundary

N

Soil Description

AgB - Alderwood Gravelly Sandy Loam
0 to 6 percent slopes

AgC - Alderwood Gravelly Sandy Loam
6 to 15 percent slopes

0 100 200

Scale in Feet

SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
CITY OF REDMOND	HIGH RESOLUTION AERIAL PHOTO (2004)
NRCS	KING COUNTY SOIL SURVEY
KING COUNTY GIS	PARCEL BOUNDARY

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TAYLOR DEVELOPMENT, INC.

BENJAMIN & HILL PROPERTIES

KING COUNTY SOIL SURVEY

PROJECTION: WASHINGTON STATE PLANE, NORTH ZONE, NAD 83 HARN, FEET

REVISION:
JOB NUMBER: 12-166
DRAWING NAME: 12-166F05
DESIGNER: A. BENTON
DRAWING BY: I. MIERAU
DATE: 1-17-13
SCALE: AS SHOWN
JURISDICTION: REDMOND

FIGURE:

7.0

12-166F05.mxd | MOD: 1/17/2013 | GM

King County Area, Washington

AgC—Alderwood gravelly sandy loam, 6 to 15 percent slopes

Map Unit Setting

Elevation: 50 to 800 feet
Mean annual precipitation: 25 to 60 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 180 to 220 days

Map Unit Composition

Alderwood and similar soils: 95 percent
Minor components: 5 percent

Description of Alderwood

Setting

Landform: Moraines, till plains
Parent material: Basal till with some volcanic ash

Properties and qualities

Slope: 6 to 15 percent
Depth to restrictive feature: 24 to 40 inches to densic material
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 18 to 37 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 2.5 inches)

Interpretive groups

Farmland classification: Farmland of statewide importance
Land capability (nonirrigated): 4s
Hydrologic Soil Group: B

Typical profile

0 to 12 inches: Gravelly ashy sandy loam
12 to 27 inches: Very gravelly sandy loam
27 to 60 inches: Very gravelly sandy loam

Minor Components

Norma

Percent of map unit: 1 percent
Landform: Depressions

Bellingham

Percent of map unit: 1 percent
Landform: Depressions

Seattle

Percent of map unit: 1 percent
Landform: Depressions

Tukwila
Percent of map unit: 1 percent
Landform: Depressions

Shalcar
Percent of map unit: 1 percent
Landform: Depressions

Data Source Information

Soil Survey Area: King County Area, Washington
Survey Area Data: Version 7, Jul 2, 2012

King County Area, Washington

AgB—Alderwood gravelly sandy loam, 0 to 6 percent slopes

Map Unit Setting

Elevation: 50 to 800 feet
Mean annual precipitation: 25 to 60 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 180 to 220 days

Map Unit Composition

Alderwood and similar soils: 75 percent
Minor components: 25 percent

Description of Alderwood

Setting

Landform: Moraines, till plains
Parent material: Basal till with some volcanic ash

Properties and qualities

Slope: 0 to 6 percent
Depth to restrictive feature: 24 to 40 inches to densic material
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 18 to 37 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 2.5 inches)

Interpretive groups

Farmland classification: Prime farmland if irrigated
Land capability (nonirrigated): 4s
Hydrologic Soil Group: B

Typical profile

0 to 12 inches: Gravelly ashy sandy loam
12 to 27 inches: Very gravelly sandy loam
27 to 60 inches: Very gravelly sandy loam

Minor Components

Buckley

Percent of map unit: 10 percent
Landform: Depressions

Norma

Percent of map unit: 4 percent
Landform: Depressions

Bellingham

Percent of map unit: 4 percent
Landform: Depressions

Tukwila
Percent of map unit: 4 percent
Landform: Depressions

Shalcar
Percent of map unit: 3 percent
Landform: Depressions

Data Source Information

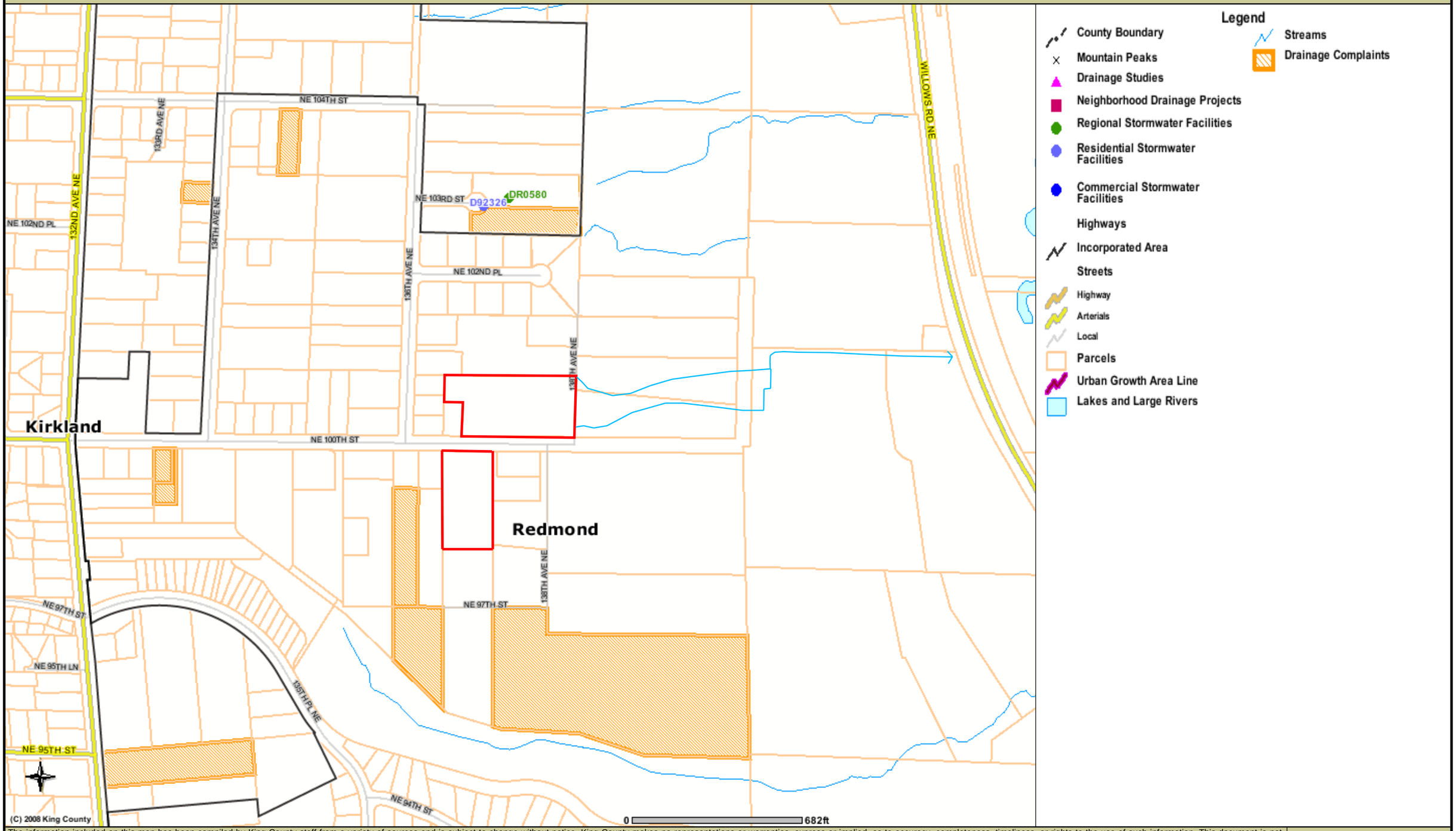
Soil Survey Area: King County Area, Washington
Survey Area Data: Version 7, Jul 2, 2012

APPENDIX 3-C

DRAINAGE COMPLAINTS

ATTACHMENT 21

Drainage Complaint Map



Date: 1/17/2013 Source: King County iMAP - Stormwater (http://www.metrokc.gov/GIS/iMAP)

King County

4.0 FLOW CONTROL AND WATER QUALITY FACILITY ANALYSIS AND DESIGN

The flow control and water quality requirements are vested under the Redmond Municipal Code (RMC), Redmond Zoning Code (RZC) and Redmond Stormwater Technical Notebook. The 2005 Ecology Manual as modified by the Western Washington Phase II Municipal Stormwater Permit regulates issues not addressed by the RMC, RZC and Stormwater Notebook.

4.1 Existing Site Hydrology

The on-site basin representing the Benjamin Estates (Benjamin) is comprised of the property within the Benjamin Estates Boundary (2.66 acres). The 0.55 acre upstream area adjacent to and west of Benjamin is analyzed in its existing condition. The Hill Property (Hill) on-site basin, is comprised of the entire Hill property (1.72 acres). The ROW frontage of NE 100th ST is analyzed as a separate basin, and includes the frontage contribution from both Benjamin and Hill. The frontage of Benjamin is approximately 450 feet along NE 100th St. Approximately 85ft of the most easterly Benjamin frontage will necessarily bypass the proposed pond due to road grades below detained Water surface elevations within the pond. The newly added impervious cover bypass area (0.03 acres) will be compensated in the WWHM model with a reduction of existing impervious cover within NE 100th St upstream of Hill (note 0.03 acres identified as "forested" within the upstream 'offsite' NE 100th St. ROW for Hill).

The frontage for Hill is approximately 200 feet. The off-site upstream for Hill is located within the NE 100th ST ROW, west of Hill. The off-site upstream area for Hill flows with runoff from the south portion of NE 100th ROW toward 138th AVE NE, where it joins with flows from 138th AVE NE south of 100th and flows in a culvert northeast. All areas fronting Hill and Benjamin as well as the upstream offsite area within the NE 100th St ROW which are collected and routed to the pond are are included in a single basin for the purpose of modeling flow control and water quality facilities.

Benjamin Estates (On-Site)

Benjamin is approximately 2.66 acres and is primarily covered with pasture and trees.

Modeled Land Coverage:

Till Forested = 2.66 Acres

Benjamin Off-site Upstream (Existing Condition)

Basin Benjamin OS Upstream is approximately 0.55 acres. The project site's runoff flows from the adjacent backyard lots west of the project.

Modeled Land Coverage:

Till Lawn = 0.39 Acres

Impervious = 0.16 Acres

Hill Property (On-Site)

Hill is approximately 1.72 acres and is primarily covered with pasture and trees.

Modeled Land Coverage:

Till Forested = 1.72 Acres

Basin NE 100th ST

Basin NE 100th ST is approximately 0.59 acres. This basin is a combined basin with the frontage for Benjamin, Hill and the upstream off-site for Hill. The frontage runoff flows from west to east. Approximately 0.03 acres are taken into account as forested in the upstream off-site for Hill to compensate for the Bypass area associated with the far easterly end of the Benjamin Frontage which cannot be routed to the pond due to grade differential.

Modeled Land Coverage:

Till Forested = 0.03 Acres

Till Lawn (ROW) = 0.35 Acres

Impervious (ROW) = 0.21 Acres

Existing Site(s) Total / Pond Tributary Area Summary:

Each of the basins above is part of the site aggregate area which is used to size and evaluate the flow control pond. The existing aggregate land use for the entire area tributary to the pond is summarized in the pond model as follows:

Till Forested =	4.41 Acres
Till Lawn =	0.74 Acres
Impervious =	0.37 Acres

Total Existing Area Tributary to Proposed Pond = 5.52 acres

Basin areas and land covers are additionally itemized and quantified in the spreadsheets below.

ATTACHMENT 21

Basin Calcs	*LDC, Inc.*	
	142201 NE 200th St. # 100 Woodinville, WA 98072	Tel: (425) 806-1869 Fax: (425) 482-2893

Project Name:	Benjamin w/ Hill(Redmond)	Project No.:	12-166
Description:	Basin Calculations	Date:	10/23/2013
		Calc. By:	MWM

Pre-Developed

Benjamin Estates

	Area (Acres)	Impervious (%)	Impervious (Acres)	Lawn (Acres)	Forested (Acres)
On Site (Predeveloped)	2.66	0%	0.000	0.00	2.660
Total	**2.660**	**0%**	**0.000**	**0.000**	**2.660**
Offsite/Upstream (Existing)	0.55	30%	0.165	0.39	0.000
Total	**0.551**	**30%**	**0.165**	**0.386**	**0.000**
ROW (NE 100th) Frontage	**0.25**	**39%**	**0.10**	**0.15**	**0.00**
Benjamin Frontage					
Total Pavement	0.097	100%	0.097	0.000	0.000
Sidewalk	0.000	100%	0.000	0.000	0.000
Lawn/Landscape	0.153	0%	*0.000*	0.153	0.000

ATTACHMENT 21

Basin Calcs	*LDC, Inc.*	
	142201 NE 200th St. # 100 Woodinville, WA 98072	Tel: (425) 806-1869 Fax: (425) 482-2893

Project Name:	Benjamin w/ Hill(Redmond)	Project No.:	12-166
Description:	Basin Calculations	Date:	10/23/2013
		Calc. By:	MWM

Pre-Developed

Hill Property	Area (Acres)	Impervious (%)	Impervious (Acres)	Lawn (Acres)	Forest/Wetland (acres)
On Site (Predeveloped)	1.72	0%	0.000	0.00	1.72
Total	**1.72**	**0%**	**0.00**	**0.00**	**1.72**
ROW (NE 100th) Frontage	**0.14**	**35%**	**0.05**	**0.09**	**0.00**
Hill Frontage					
Total Pavement	0.05	100%	0.048	0.000	0.000
Sidewalk	0.00	100%	0.000	0.000	0.000
Lawn/Landscape	0.09	0%	0.000	0.089	0.000
***Upstream (Off-Site) NE 100th ST**	**0.20**	**30%**	**0.06**	**0.11**	**0.028**
Off-Site					
Total Pavement	0.09	100%	0.060	0.000	0.028
Sidewalk	0.00	100%	0.000	0.000	0.000
Lawn/Landscape	0.11	0%	0.000	0.110	0.000

*Shown as Forested to compensate for Bypass Area

ATTACHMENT 21

Basin Calcs	*LDC, Inc.*	
	142201 NE 200th St. # 100 Woodinville, WA 98072	Tel: (425) 806-1869 Fax: (425) 482-2893

Project Name:	Benjamin w/ Hill(Redmond)	Project No.:	12-166
Description:	Basin Calculations	Date:	10/23/2013
		Calc. By:	MWM

Pre-Developed

TOTAL ROW (NE 100th)	**0.585**	**35%**	**0.21**	**0.35**	**0.028**
Total					
Total Pavement	0.23	88%	0.21	0.00	0.028
Sidewalk	0.00	100%	0.00	0.00	0.00
Lawn/Landscape	0.35	0%	0.00	0.35	0.00

ATTACHMENT 21

VICINITY MAP

BASIN AREAS

BASIN A	
IMPERVIOUS	0.00 AC.
FORESTED	2.66 AC.
TOTAL =	2.66 AC.

On Site Basin
2.66 AC

LEGEND

- Subject Property
- Storm Drain Network
- Watercourse
- Parcel Boundary

Contours

- 25 Foot Contour
- 5 Foot Contour

0 50 100
Scale in Feet

N

SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
CITY OF REDMOND	COLOR AERIAL PHOTOGRAPHY (2004)
KING COUNTY GIS	FIVE FOOT CONTOUR - GENERATED FROM BARE EARTH LIDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.
KING COUNTY GIS	PARCEL BOUNDARIES
LDC SURVEY	STORM DRAIN NETWORK

LDC
THE CIVIL ENGINEERING GROUP
14201 NE 200th St., #100
Woodinville, WA 98072
Ph. 425.806.1869
Fx. 425.482.2893
www.LDCcorp.com

Commercial
Infrastructure
Residential

TAYLOR DEVELOPMENT, INC.

BENJAMIN PROPERTY

EXISTING SITE HYDROLOGY

PROJECTION: WASHINGTON STATE PLANE, NORTH ZONE, NAD 83 HARN, FEET

REVISION:
JOB NUMBER: 12-166
DRAWING NAME: 12-166F06
DESIGNER: A. BENTON
DRAWING BY: I. MIERAU
DATE: 05-15-13
SCALE: AS SHOWN
JURISDICTION: REDMOND

FIGURE:
8.0

12-166F06.mxd | MOD: 5/15/2013 | IGM

ATTACHMENT 21

BASIN AREAS

BASIN A	
IMPERVIOUS	0.00 AC.
FOREST / WETLAND	1.72 AC.
TOTAL =	1.72 AC.

LEGEND

- Subject Property
- Storm System
- Watercourse
- Parcel Boundary

Contours

- 25 Foot Contour
- 5 Foot Contour

0 50 100
Scale in Feet

N

SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
CITY OF REDMOND	COLOR AERIAL PHOTOGRAPHY (2004)
KING COUNTY GIS	FIVE FOOT CONTOUR - GENERATED FROM BARE EARTH LiDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.
CITY OF REDMOND	HYDROLOGY, STORM NETWORK
KING COUNTY GIS	PARCEL BOUNDARIES

LDC
THE CIVIL ENGINEERING GROUP
14201 NE 200th St., #100
Woodinville, WA 98072
Ph. 425.806.1869
Fx. 425.482.2893
www.LDCcorp.com

Commercial
Infrastructure
Residential

TAYLOR DEVELOPMENT, INC.

HILL PROPERTY

EXISTING SITE HYDROLOGY

PROJECTION: WASHINGTON STATE PLANE, NORTH ZONE, NAD 83 HARN, FEET

REVISION:	
JOB NUMBER:	12-169
DRAWING NAME:	12-169F02
DESIGNER:	A. BENTON
DRAWING BY:	I. MIERAU
DATE:	5-15-13
SCALE:	AS SHOWN
JURISDICTION:	REDMOND

FIGURE:
9.0

12-169F02.mxd | MOD: 5/15/2013 | IGM

4.2 Developed Site Hydrology

The developed sites for Benjamin and Hill will consist of impervious surface (houses, driveways, roadway entrances), landscaped areas and open spaces that will remain forested. The Developed Site Hydrology for Benjamin and Hill are shown in Figure 10. The detention and water quality facility located on the Benjamin Estates Property (Benjamin) will also detain and treat runoff from the Hill Property Development (Hill).

The area tributary to the pond is divided into 4 Basins (Benjamin Estates On-Site, Benjamin OS Upstream, Hill Property and NE 100th ST). All developed basin runoff is conveyed to a single pond for detention. Individual Basins are identified below, and are the basis for the developed condition pond sizing in WWHM.

Impervious cover within lots is determined based on 35% or less structural cover consistent with RIN zoning.

Benjamin Estates Total Average Lot Impervious Cover: 50%
Willow Hill Total Average Lot Impervious Cover: 46%

<u>Benjamin Estates On-Site</u>

Basin Benjamin is approximately 2.66 acres and includes the developed project site, open space and the new on site ROW. The detention pond will be constructed on the open space located on south east portion of Benjamin. This detention pond will also detain and treat runoff from Hill. The project site's runoff will continue to flow west to east.

Modeled Land Coverage:

Till Forested (Open Space) = 0.35 Acres
Till Lawn = 1.02 Acres
Impervious = 1.07 Acres
Proposed Pond = 0.22 Acres

Benjamin Off-Site

Benjamin Off-Site (upstream) is approximately 0.55 acres. The offsite runoff will sheet flow over the north property line and combine with developed condition on-site runoff.

Modeled Land Coverage:

Till Lawn = 0.39 Acres

Impervious = 0.16 Acres

Hill Property (On-site)

Hill is approximately 1.72 acres and includes the developed project site, open space and new on site ROW. The runoff from this site will be detained and treated by the detention pond located on Benjamin. Runoff from Hill will be collected via open swales that will take the runoff flow to a catch basin on the west side of the roadway entrance to Hill Development. This catch basin will be connected to a proposed storm line across NE 100th ST to a catch basin at the edge of the proposed north open swale. Flows will then travel east under the open swale of the north NE 100th ST ROW towards the solid locking lid catch basin located at the entrance of the access roadway for the pond (Benjamin Plat). From there the storm line carrying the runoff from Hill and the frontage will travel north and connect to a catch basin collecting the runoff from Benjamin On-Site. From this catch basin the storm will travel northeast and connect to a Type 2 catch basin before discharging to the pond.

Modeled Land Coverage:

Till Forested = 0.21 Acres

Till Lawn = 0.71 Acres

Impervious = 0.80 Acres

NE 100th ST

NE 100th ST is approximately 0.59 acres, and is comprised of the existing paving of NE 100th St. within the frontage for both Benjamin and Hill, the proposed frontage improvements in the Benjamin and Hill frontage(s), and the upstream off-site for Hill. The NE 100th St. bypass area at the easterly NE 100th St. Benjamin frontage is approximately 0.03 acres, and is offset by counting an equivalent existing impervious area in the upstream off-site for Hill as to forrested.

Modeled Land Coverage:

Till Lawn (ROW) = 0.17 Acres

Impervious (ROW) = 0.42 Acres

Developed Sites Total / Pond Tributary Area Summary:

Each of the Basins above is part of the site aggregate area which is used to size and evaluate the flow control pond. The total Developed Site Basin is summarized as follows:

Till Forested =	0.56 Acres
Till Lawn =	2.29 Acres
Impervious =	2.45 Acres
Proposed Pond =	0.22 Acres

Total Area Tributary to Proposed Pond = 5.52 Acres

Upstream Off-Site (Northwest of Benjamin Residential Plat)

The runoff within the northern roadside ditch of NE 100th St. west of the Benjamin frontage will be collected prior to roadway improvements and routed to the east so that it will not be collected with proposed improvements for Benjamin and Hill for detention. The bypass area consists of area located west of the 136th Ave NE centerline and east of the proposed Kirkmond Development (on the east side of 134th north of NE 100th St.) between NE 100th St and NE 104th St (See Figure 11). This area drains roughly west to east and north to south, collecting 1st in the west roadside ditch of 136th Ave NE and ultimately in the north ditch of NE 100th St. The flow from this 10.84 acre upstream offsite area, will be collected in the north NE 100th St. ROW just upstream of the Benjamin west property line, and piped to the east beyond Benjamin frontage being collected and routed to proposed detention. The upstream offsite flows will enter an offsite storm pipe just east of the Benjamin Estates pond outfall and will be conveyed to an existing catch basin at the base of the bluff/hill to the east. The existing catch basin terminus of the proposed offsite conveyance is part of the existing Willows Commerce Park (public) drainage system.

The upstream bypass area is comprised in the existing condition of 2.89 acres impervious cover (27%) and the 7.95 acres of lawn/landscape.

NE 100th St Improvements Pond Bypass (Easterly Frontage))

A small area within the NE 100th ST ROW will bypass detention as it cannot be collected and detained due to grade differential. The total new impervious cover bypassing detention is approximately 0.03 acres. Since the area bypassing is less than 5,000 SF of impervious no water quality treatment is required. An equivalent existing impervious area upstream/offsite from Willow Hill in the NE 100th ST ROW is accounted as forested in the existing condition to address the bypass area.

ATTACHMENT 21

Basin Calcs	LDC, Inc.	
	142201 NE 200th St. # 100 Woodinville, WA 98072	Tel: (425) 806-1869 Fax: (425) 482-2893

Project Name:	Benjamin w/ Hill(Redmond)	Project No.:	12-166
Description:	Basin Calculations	Date:	10/23/2013
		Calc. By:	MWM

Developed Basin

Benjamin Estates (On-Site)

	Area SF	Area (Acres)	Impervious (%)	Impervious (Acres)	Lawn (Acres)	Forest (acres)	Pond (acres)
Open Space (w/out pond)	23327.89	0.536	0%	0.000	0.187	0.348	-
Pond	9851.11	0.226	4%	0.009	-	-	0.218
Tract D	1003.00	0.023	83%	0.019	0.004	-	-
TOTAL	34182.00	0.785	4%	0.028	0.191	0.348	0.218
Lots (w/out lot driveways) (home/pateo/walkway)	58433.20	1.341	44%	0.591	0.750	-	-
Driveways (not including tract D)	5600	0.129	100%	0.129	-	-	-
ROW (On-Site)	17643.76	0.405	80%	0.323	0.082		
Pavment	11813.22	0.271	100%	0.271		-	-
Sidewalk	2269.52	0.052	100%	0.052		-	-
Lawn/Landscape	3561.02	0.082	0%	0	0.082	-	-
Total On-site Tributary Area	**115859**	**2.66**	**0.40**	**1.07**	**1.02**	**0.35**	**0.22**
ROW (NE 100th) Frontage (total)	**10890.00**	**0.250**	**83%**	**0.208**	**0.042**	**0.000**	**0.000**
Additional Pavment	*3060.09*	*0.07*	100%	0.070	-	-	-
Sidewalk	1741.76	0.04	100%	0.040	-	-	-
Lawn/Landscape	1846.50	0.04	0%	0.000	0.042	-	-
Existing Pavement	4241.66	0.10	100%	0.097	-	-	-
Benjamin Off-Site	**24002**	**0.551**	**30%**	**0.165**	**0.39**	**0.000**	**0.000**

Basin Calcs	LDC, Inc.	
	142201 NE 200th St. # 100 Woodinville, WA 98072	Tel: (425) 806-1869 Fax: (425) 482-2893

Project Name:	Benjamin w/ Hill(Redmond)	Project No.:	12-166
Description:	Basin Calculations	Date:	10/23/2013
		Calc. By:	MWM

Developed Basin

Hill Property (On-Site)

	Area SF	Area (Acres)	Impervious (%)	Impervious (Acres)	Lawn (Acres)	Forest (acres)	Pond (acres)
Open Space	9350.00	0.215	0%	0.000	0.000	0.215	0.000
Tract B (IC shown in Driveways)	207.55	0.005		0.000	0.005	-	-
TOTAL	9557.55	0.219	0%	0.000	0.005	0.215	0.000
Lots (w/out lot driveways) (home/pateo/walkway)	45251.60	1.039	41%	0.423	0.616	-	-
Driveways (All) including Tract B	5186	0.119	100%	0.119	0.000	-	-
ROW (On-Site)	15093.84	0.347	74%	0.258	0.088	0	0
Pavment	9401.23	0.216	100%	0.216		-	-
Sidewalk	1843.50	0.042	100%	0.042		-	-
Lawn/Landscape	3849.11	0.088	0%	0	0.088	-	-
Total On-site Tributary Area	**75089**	**1.72**	**46%**	**0.80**	**0.71**	**0.21**	**0.00**
ROW (NE 100th) Frontage	**6000.00**	**0.138**	**86%**	**0.119**	**0.019**	**0.000**	**0.000**
Additional Pavment	*2171.20*	*0.05*	100%	0.050	-	-	-
Sidewalk	902.54	0.02	100%	0.021	-	-	-
Lawn/Landscape	816.03	0.02	0%	0.000	0.019	-	-
Existing Pavement	2110.23	0.05	100%	0.048	-	-	-
***Hill Off-Site (Upstream) NE 100th ST**	**8579.3**	**0.197**	**44%**	**0.087**	**0.110**	**-**	**-**
Total Pavement		0.09	100%	0.087	0.000	-	-
Sidewalk		0.00	100%	0.000	0.000	-	-
Lawn/Landscape		0.11	0%	0.000	0.110	-	-

ATTACHMENT 21

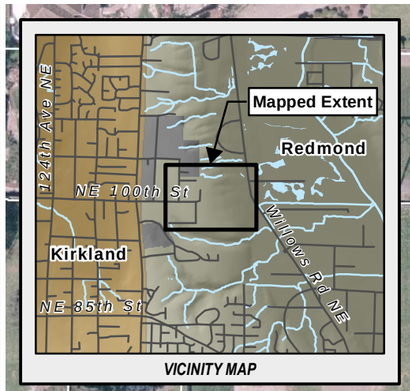
Basin Calcs	*LDC, Inc.*	
	142201 NE 200th St. # 100 Woodinville, WA 98072	Tel: (425) 806-1869 Fax: (425) 482-2893

Project Name:	Benjamin w/ Hill(Redmond)	Project No.:	12-166
Description:	Basin Calculations	Date:	10/23/2013
		Calc. By:	MWM

Developed Basin

Developed Hill and Benjamin total	Area SF	Area (Acres)	Impervious (%)	Impervious (Acres)	Lawn (Acres)	Forest (acres)	Pond (acres)
***TOTAL ROW (NE 100th)**	**25469.29**	**0.585**	**71%**	**0.414**	**0.171**	**0.000**	**0.000**
Total Pavement		0.35	100%	0.353	0.000	-	-
Sidewalk		0.06	100%	0.061	0.000	-	-
Lawn/Landscape		0.17	0%	0.000	0.171	-	-

***Includes Upstream (Off-Site) for Hill (NE 100th ST)**



VICINITY MAP

136th Ave NE

NE 100th St

Benjamin
On Site Basin
2.66 AC

Detention Pond

Hill
On Site Basin
1.72 AC

NE 100th St Improvements
Pond Bypass
(Easterly Frontage)
0.06 AC

138th Ave NE

BASIN AREAS

BENJAMIN ON-SITE	
IMPERVIOUS	1.09 AC.
LAWN	0.97 AC.
FOREST	0.39 AC.
POND	0.21 AC.
TOTAL =	2.66 AC.
HILL ON-SITE	
IMPERVIOUS	0.82 AC.
LAWN	0.69 AC.
FORESTED	0.21 AC.
TOTAL =	1.72 AC.
NE 100TH ST IMPROVEMENTS POND BYPASS (EASTERLY FRONTAGE)	
IMPERVIOUS	0.04 AC.
LAWN	0.02 AC.
TOTAL =	0.06 AC.

LEGEND

- Subject Property
- Propoosed Storm Drain Network
- Watercourse
- Parcel Boundary

0 100 200
Scale in Feet

N

SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
CITY OF REDMOND	COLOR AERIAL PHOTOGRAPHY (2004)
KING COUNTY GIS	FIVE FOOT CONTOUR - GENERATED FROM BARE EARTH LiDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.
KING COUNTY GIS	PARCEL BOUNDARIES
LDC SURVEY	STORM DRAIN NETWORK

LDC
THE CIVIL ENGINEERING GROUP
14201 NE 200th St., #100
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Ph. 425.806.1869
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www.LDCcorp.com

Commercial
Infrastructure
Residential

TAYLOR DEVELOPMENT, INC.

BENJAMIN & HILL PROPERTIES

DEVELEOPED SITE HYDROLOGY

PROJECTION: WASHINGTON STATE PLANE, NORTH ZONE, NAD 83 HARN, FEET

REVISION:	
JOB NUMBER:	12-166
DRAWING NAME:	12-166F06
DESIGNER:	A. BENTON
DRAWING BY:	I. MIERAU
DATE:	05-15-13
SCALE:	AS SHOWN
JURISDICTION:	REDMOND

FIGURE:
10.0

12-166F06.mxd | MOD: 5/15/2013 | IGM

4.3 Design Standards for Water Quality

As mentioned previously in this report, the flow control and water quality requirements are vested under the 2012 Redmond Stormwater Technical Notebook and the 2005 DOE Manual.

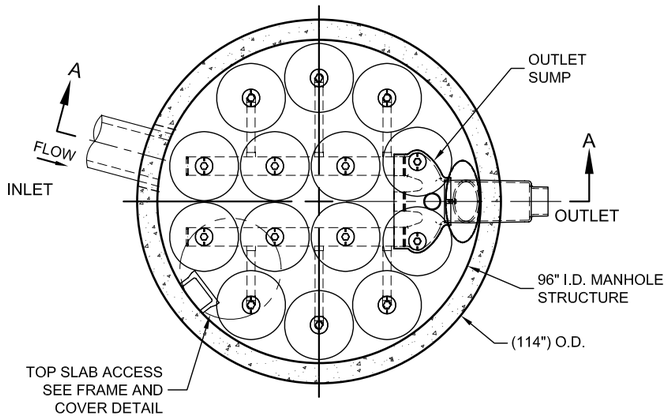
LID BMP's such as infiltration, permeable pavement, and biofiltration and bio-retention are not feasible on either the Benjamin or Hill sites due to hard-pan glacial till soils according to the geotechnical assessments. As LID BMP's are not feasible, other than perforated downspout stubs and the application of BMP T5.13 on landscaped areas, the water quality minimum requirements will be met for both Benjamin and Hill through the use of a stormwater filtration vault downstream of the detention facility. Neither Enhanced nor phosphorus treatment is required; basic treatment is the required treatment level. The use of StormFilter technology employed downstream of detention will provide enhanced level treatment for all runoff tributary to the pond, including runoff collected from the collected portion of NE 100th St.

Contech has provided sizing for the filtration vault based on the 2yr mitigated release from the proposed pond and have determined that a 96" structure is sufficient to serve the required flows and pollutant loading. See the sizing calculations and the vault detail in Appendix 4-A.

APPENDIX 4-A

WATER QUALITY FACILITY DESIGN AND SUPPORTING DOCUMENTS

ATTACHMENT 21



PLAN VIEW

STANDARD OUTLET RISER
FLOWKIT: 43A

STORMFILTER DESIGN NOTES

STORMFILTER TREATMENTCAPACITY IS A FUNCTION OF THE CARTRIDGE SELECTION AND THE NUMBER OF CARTRIDGES. THE STANDARD MANHOLE STYLE IS SHOWN WITH THE MAXIMUM NUMBER OF CARTRIDGES (14). VOLUME SYSTEM IS ALSO AVAILABLE WITH MAXIMUM 14 CARTRIDGES. Ø96" MANHOLE STORMFILTER PEAK HYDRAULIC CAPACITY IS 1.8 CFS. IF THE SITE CONDITIONS EXCEED 1.8 CFS AN UPSTREAM BYPASS STRUCTURE IS REQUIRED.

CARTRIDGE SELECTION

CARTRIDGE HEIGHT	27"		18"		LOW DROP	
RECOMMENDED HYDRAULIC DROP (H)	3.05'		2.3'		1.8'	
SPECIFIC FLOW RATE (gpm/sf)	2 gpm/ft²	1 gpm/ft²	2 gpm/ft²	1 gpm/ft²	2 gpm/ft²	1 gpm/ft²
CARTRIDGE FLOW RATE (gpm)	22.5	11.25	15	7.5	10	5

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID	*
WATER QUALITY FLOW RATE (cfs)	*
PEAK FLOW RATE (cfs)	*
RETURN PERIOD OF PEAK FLOW (yrs)	*
# OF CARTRIDGES REQUIRED	*
CARTRIDGE FLOW RATE	*
MEDIA TYPE (CSF, PERLITE, ZPG, GAC, PHS)	*

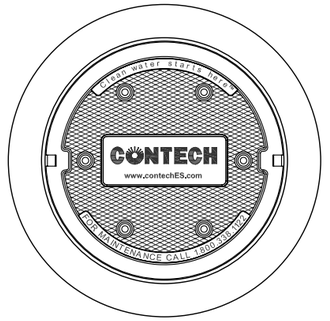
PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE #1	*	*	*
INLET PIPE #2	*	*	*
OUTLET PIPE	*	*	*

RIM ELEVATION	*

ANTI-FLOTATION BALLAST	WIDTH	HEIGHT
	*	*

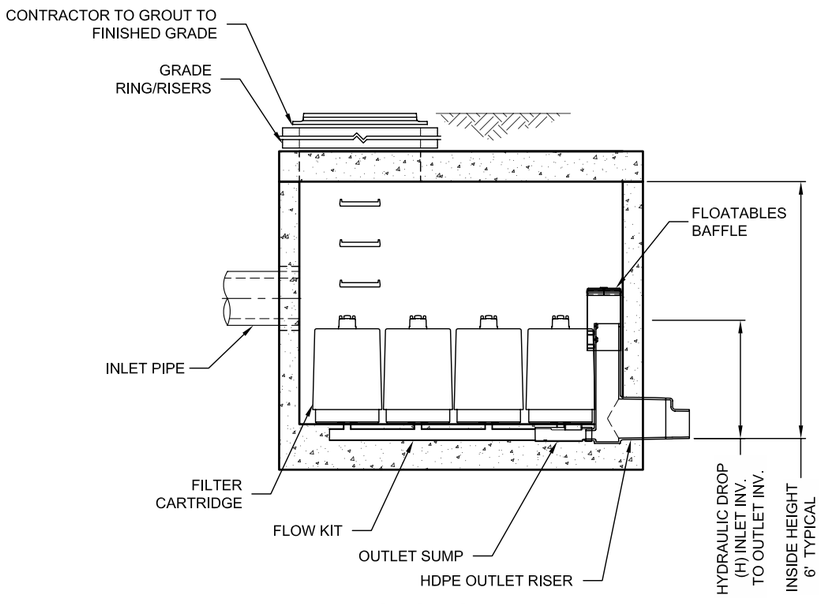
NOTES/SPECIAL REQUIREMENTS:

* PER ENGINEER OF RECORD



FRAME AND COVER

(DIAMETER VARIES)
N.T.S.



SECTION A-A

GENERAL NOTES

1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. DIMENSIONS MARKED WITH ( ) ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. FOR SITE SPECIFIC DRAWINGS WITH DETAILED VAULT DIMENSIONS AND WEIGHTS, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.contechES.com
4. STORMFILTER WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING.
5. STRUCTURE SHALL MEET AASHTO HS20 LOAD RATING, ASSUMING EARTH COVER OF 0' - 5' AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO.
6. FILTER CARTRIDGES SHALL BE MEDIA-FILLED, PASSIVE, SIPHON ACTUATED, RADIAL FLOW, AND SELF CLEANING. RADIAL MEDIA DEPTH SHALL BE 7-INCHES. FILTER MEDIA CONTACT TIME SHALL BE AT LEAST 39 SECONDS.
7. SPECIFIC FLOW RATE IS EQUAL TO THE FILTER TREATMENT CAPACITY (gpm) DIVIDED BY THE FILTER CONTACT SURFACE AREA (sq ft).

INSTALLATION NOTES

1. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
2. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE STORMFILTER STRUCTURE (LIFTING CLUTCHES PROVIDED).
3. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
4. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT INLET PIPE(S).
5. CONTRACTOR TO PROVIDE AND INSTALL CONNECTOR TO THE OUTLET RISER STUB. STORMFILTER EQUIPPED WITH A DUAL DIAMETER HDPE OUTLET STUB AND SAND COLLAR. IF OUTLET PIPE IS LARGER THAN 8 INCHES, CONTRACTOR TO REMOVE THE 8 INCH OUTLET STUB AT MOLDED IN CUT LINE. COUPLING BY FERNCO OR EQUAL AND PROVIDED BY CONTRACTOR.
6. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO PROTECT CARTRIDGES FROM CONSTRUCTION-RELATED EROSION RUNOFF.

The Stormwater Management StormFilter®
THIS PRODUCT MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS: 5,322,629; 5,324,579; 5,707,527; 5,985,157; 6,027,639; 6,649,048; RELATED FOREIGN PATENTS, OR OTHER PATENTS PENDING.

CONTECH® ENGINEERED SOLUTIONS LLC
www.contechES.com
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800-338-1122 513-645-7000 513-645-7993 FAX

SFMH96
STORMFILTER
STANDARD DETAIL

Determining Number of Cartridges for Systems Downstream of Detention

CONTECH Stormwater Solutions Inc. Engineer:	**CRH**	
Date	**9/27/2013**	
Site Information		
Project Name	**Benjamin**	
Project State	**Washington**	
Project Location	**Redmond**	
Drainage Area, Ad	**5.52**	ac
Impervious Area, Ai	**2.46**	ac
Pervious Area, Ap	**3.06**	
% Impervious	**45%**	
Runoff Coefficient, Rc	**0.45**	
Upstream Detention System		
Peak release rate from detention, $Q_{release\ peak}$	**0.56**	cfs
Treatment release rate from detention, $Q_{release\ treat}$	**0.13**	cfs
Detention pretreatment credit (from removal efficiency calcs)	**50%**	
Mass loading calculations		
Mean Annual Rainfall, P	**36**	in
Agency required % removal	**80%**	
Percent Runoff Capture	**90%**	
Mean Annual Runoff,V_t	**292,854**	ft^3
Event Mean Concentration of Pollutant, EMC	**60**	mg/l
Annual Mass Load, M_{total}	**1096.27**	lbs
Filter System		
Filtration brand	**StormFilter**	
Cartridge height	**18**	in
Specific Flow Rate	**1.00**	gpm/ft^2
Number of cartridges - mass loading		
Mass removed by pretreatment system, M_{pre}	**548.14**	lbs
Mass load to filters after pretreatment, M_{pass1}	**548.14**	lbs
Estimate the required filter efficiency, E_{filter}	**0.60**	
Mass to be captured by filters, M_{filter}	**328.88**	lbs
Allowable Cartridge Flow rate, Q_{cart}	**7.50**	
Mass load per cartridge, M_{cart} (lbs)	**36.00**	lbs
Number of Cartridges required, N_{mass}	**10**	
Treatment Capacity	**0.17**	cfs
Determine Critical Sizing Value		
Number of Cartridges using $Q_{release\ treat}$, N_{flow}	**8**	
Method to Use:	**MASS-LOADING**	

SUMMARY

Treatment Flow Rate, cfs	0.17
Cartridge Flow Rate, gpm	7.5
Number of Cartridges	10

4.4 Flow Control System

Flow control for the project site will be achieved through the use of one detention pond located in Tract A at the far south end of the Benjamin Estates Residential Plat. The detention facility was sized using WWHM4 and the total aggregate Site areas identified in the Existing and Developed Hydrology sections above. The flow control was designed as a standalone detention facility, meeting the release rates required for the proposed sites. The geotechnical report for both sites indicates that the till soils on-site cannot support LID applications including infiltration; the pond assumes no infiltration into underlying soils.

The detention facility was designed such that the berm elevation (264) is a minimum of 10ft setback away from any external property line, and all existing trees. The critical detention pond statistics as modeled in WWHM are as follows:

WWHM Modeled Pond

Pond Dimensions:	100'x26.1
Pond Bottom Area:	2,611ft^2
Pond Internal Sides:	3:1 (right side slope = vertical to represent internal wall)
Pond Bottom Elev.:	254.5
Pond Berm Elev.:	264
Effective Storage Depth:	9.5'
Riser Height:	8.5'
Top of Riser Elevation:	263.0
50yr WSE:	263.05

The pond as proposed includes and internal wall along the east side of the pond. The proposed wall dimensions are:

Wall Length:	97ft
Pond Perimeter:	411ft (at the internal pond crest)
Wall % Perimeter:	23%

The Pond design volumes as calculated with end area (see below), are greater than those required per WWHM by 7% - 11%. WWHM Model Results are located in Appendix 4-B.

ATTACHMENT 21

POND
VOLUME CALCULATIONS
LDC PROJECT NO. 12-166
PROJECT NAME: Banjamin Estates / Hill

2 yr[1]	260.65	Peak Stage Elev.
10 yr[1]	262.29	Peak Stage Elev.
50 yr[1]	263.00	Peak Stage Elev.
100 yr[1]	263.05	Peak Stage Elev.

	ELEVATION / STAGE	POND STAGE AREA	INCREMENTAL VOLUME**	TOTAL VOLUME	DEAD/LIVE VOLUME
		SF	CF	CF	CF
Pond Bottom	254.0	2330			
Begin Live	254.5	2611.5	1,235	1,235	
	255.0	2893	1,376	2,612	1,376
	256.0	3519	4,598	**7,209**	4,598
	258.0	4761	8,280	15,489	12,878
	260.0	6128	10,889	26,378	23,767
2.0	260.65	6834.43	4,235	30,614	**28,002**
	262.0	8290	14,418	40,796	38,185
10.0	262.29	8639.06	2,487	43,283	**40,672**
50.0	263.00	9476.11	6,382	49,665	**47,054**
100.0	263.05	9540.17	513	50,178	**47,566**
	264.0	10666	18,956	59,752	57,141

Live Storage (Acre-ft)	Required Vol [1,2] (Acre-ft)	(cu.ft)	% oversize
0.643	0.599	26071	7.41%
0.934	0.850	37028	9.84%
1.080	0.972	42330	11.16%
1.092	0.981	42751	11.27%

1) As reported in the Targeted Drainage Report, volumes based on Volumes Calculated by WWHM4 - pond size 100x25
2) Volumes calculated by average end-area

APPENDIX 4-B

HYDROLOGIC MODELING
CALCULATIONS and DETENTION POND SIZING OUTPUT FROM WWHM4

WWHM4
PROJECT REPORT

Project Name: Benjamin Prelim_V5_Wall
Site Name:
Site Address:
City :
Report Date: 10/17/2013
Gage : Seatac
Data Start : 1948/10/01
Data End : 1998/09/30
(adjusted) **Precip Scale:** 0.00
Version : 2012/09/21

Low Flow Threshold for POC 1 : 50 Percent of the 2 Year

High Flow Threshold for POC 1: 50 year

PREDEVELOPED LAND USE

Name : Benjamin
Bypass: No

GroundWater: No

Pervious Land Use	Acres
C, Forest, Mod	2.66
Pervious Total	2.66

Impervious Land Use	Acres
Impervious Total	0
Basin Total	2.66

Element Flows To:

Surface	Interflow	Groundwater

Name : Hill
Bypass: No

GroundWater: No

Pervious Land Use	Acres
C, Forest, Mod	1.72

Pervious Total	1.72

Impervious Land Use	Acres
Impervious Total	0
Basin Total	1.72

Element Flows To:
Surface **Interflow** **Groundwater**

Name : NE 100th St.
Bypass: No

GroundWater: No

Pervious Land Use	Acres
C, Lawn, Mod	.352
C, Forest, Mod	.028
Pervious Total	0.38

Impervious Land Use	Acres
ROADS FLAT	0.21
Impervious Total	0.21
Basin Total	0.59

Element Flows To:
Surface **Interflow** **Groundwater**

Name : Benjamin OS Upstream
Bypass: No

GroundWater: No

Pervious Land Use	Acres
C, Lawn, Flat	.386
Pervious Total	0.386

Impervious Land Use	Acres
ROOF TOPS FLAT	0.165

Impervious Total	**0.165**
Basin Total	**0.551**

Element Flows To:

Surface	Interflow	Groundwater

MITIGATED LAND USE

Name : Hill
Bypass: No

GroundWater: No

Pervious Land Use	Acres
C, Forest, Flat	.21
C, Lawn, Flat	.71
Pervious Total	**0.92**

Impervious Land Use	Acres
ROADS FLAT	0.216
ROOF TOPS FLAT	0.423
DRIVEWAYS FLAT	0.119
SIDEWALKS FLAT	0.042
Impervious Total	**0.8**
Basin Total	**1.72**

Element Flows To:

Surface	Interflow	Groundwater
Trapezoidal Pond 1	Trapezoidal Pond 1	

Name : Benjamin
Bypass: No

GroundWater: No

Pervious Land Use	Acres
C, Lawn, Flat	1.023
C, Forest, Mod	.349
Pervious Total	**1.372**

Impervious Land Use	Acres
ROADS FLAT	0.271
ROOF TOPS FLAT	0.591
DRIVEWAYS FLAT	0.156

SIDEWALKS FLAT	**0.052**
POND	**0.218**
Impervious Total	**1.288**
Basin Total	**2.66**

Element Flows To:

Surface	**Interflow**	**Groundwater**
Trapezoidal Pond 1	Trapezoidal Pond 1	

Name : NE 100th St.
Bypass: No

GroundWater: No

Pervious Land Use	**Acres**
C, Lawn, Mod	**.171**
Pervious Total	**0.171**

Impervious Land Use	**Acres**
ROADS FLAT	**0.353**
SIDEWALKS FLAT	**0.061**
Impervious Total	**0.414**
Basin Total	**0.585**

Element Flows To:

Surface	**Interflow**	**Groundwater**
Trapezoidal Pond 1	Trapezoidal Pond 1	

Name : Benjamin Offsiite US
Bypass: No

GroundWater: No

Pervious Land Use	**Acres**
C, Lawn, Flat	**.386**
Pevious Total	**0.386**

Impervious Land Use	**Acres**
ROOF TOPS FLAT	**0.165**
Impervious Total	**0.165**
Basin Total	**0.551**

Element Flows To:

Surface	Interflow	Groundwater
Trapezoidal Pond 1	Trapezoidal Pond 1	

Name : Trapezoidal Pond 1
Bottom Length: 100.00 ft.
Bottom Width: 26.10 ft.
Depth: 9.5 ft.
Volume at riser head: 0.9815 acre-ft.
Side slope 1: 3 To 1
Side slope 2: 3 To 1
Side slope 3: 0 To 1
Side slope 4: 3 To 1
Discharge Structure
Riser Height: 8.5 ft.
Riser Diameter: 18 in.
Notch Type: Rectangular
Notch Width: 0.016 ft.
Notch Height: 2.050 ft.
Orifice 1 Diameter: 1.25 in. **Elevation:** 0 ft.
Orifice 2 Diameter: 1.03 in. **Elevation:** 5.525 ft.
Orifice 3 Diameter: 1.25 in. **Elevation:** 6.8 ft.

Element Flows To:

Outlet 1	Outlet 2

Pond Hydraulic Table

Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	Infilt(cfs)
0.0000	0.059	0.000	0.000	0.000
0.1056	0.061	0.006	0.013	0.000
0.2111	0.062	0.012	0.018	0.000
0.3167	0.063	0.019	0.023	0.000
0.4222	0.064	0.026	0.026	0.000
0.5278	0.065	0.033	0.029	0.000
0.6333	0.066	0.040	0.032	0.000
0.7389	0.067	0.047	0.035	0.000
0.8444	0.069	0.054	0.037	0.000
0.9500	0.070	0.061	0.040	0.000
1.0556	0.071	0.069	0.042	0.000
1.1611	0.072	0.076	0.044	0.000
1.2667	0.073	0.084	0.046	0.000
1.3722	0.075	0.092	0.048	0.000
1.4778	0.076	0.100	0.049	0.000
1.5833	0.077	0.108	0.051	0.000
1.6889	0.078	0.116	0.053	0.000
1.7944	0.080	0.125	0.055	0.000
1.9000	0.081	0.133	0.056	0.000
2.0056	0.082	0.142	0.058	0.000
2.1111	0.083	0.151	0.059	0.000
2.2167	0.085	0.160	0.061	0.000

2.3222	0.086	0.169	0.062	0.000	
2.4278	0.087	0.178	0.063	0.000	
2.5333	0.089	0.187	0.065	0.000	
2.6389	0.090	0.197	0.066	0.000	
2.7444	0.091	0.206	0.068	0.000	
2.8500	0.093	0.216	0.069	0.000	
2.9556	0.094	0.226	0.070	0.000	
3.0611	0.095	0.236	0.071	0.000	
3.1667	0.097	0.246	0.073	0.000	
3.2722	0.098	0.257	0.074	0.000	
3.3778	0.100	0.267	0.075	0.000	
3.4833	0.101	0.278	0.076	0.000	
3.5889	0.102	0.288	0.077	0.000	
3.6944	0.104	0.299	0.078	0.000	
3.8000	0.105	0.310	0.080	0.000	
3.9056	0.107	0.322	0.081	0.000	
4.0111	0.108	0.333	0.082	0.000	
4.1167	0.110	0.345	0.083	0.000	
4.2222	0.111	0.356	0.084	0.000	
4.3278	0.113	0.368	0.085	0.000	
4.4333	0.114	0.380	0.086	0.000	
4.5389	0.116	0.392	0.087	0.000	
4.6444	0.117	0.405	0.088	0.000	
4.7500	0.119	0.417	0.089	0.000	
4.8556	0.120	0.430	0.090	0.000	
4.9611	0.122	0.443	0.091	0.000	
5.0667	0.123	0.456	0.092	0.000	
5.1722	0.125	0.469	0.093	0.000	
5.2778	0.126	0.482	0.094	0.000	
5.3833	0.128	0.495	0.095	0.000	
5.4889	0.129	0.509	0.096	0.000	
5.5944	0.131	0.523	0.104	0.000	
5.7000	0.133	0.537	0.109	0.000	
5.8056	0.134	0.551	0.113	0.000	
5.9111	0.136	0.565	0.117	0.000	
6.0167	0.137	0.580	0.120	0.000	
6.1222	0.139	0.594	0.123	0.000	2yr=0.1236cfs Stage=260.65
6.2278	0.141	0.609	0.125	0.000	
6.3333	0.142	0.624	0.128	0.000	
6.4389	0.144	0.639	0.130	0.000	
6.5444	0.146	0.655	0.134	0.000	
6.6500	0.147	0.670	0.140	0.000	
6.7556	0.149	0.686	0.146	0.000	
6.8611	0.151	0.702	0.162	0.000	
6.9667	0.153	0.718	0.176	0.000	
7.0722	0.154	0.734	0.188	0.000	
7.1778	0.156	0.751	0.199	0.000	
7.2833	0.158	0.767	0.210	0.000	
7.3889	0.159	0.784	0.220	0.000	
7.4944	0.161	0.801	0.231	0.000	
7.6000	0.163	0.818	0.242	0.000	
7.7056	0.165	0.835	0.254	0.000	10yr=0.2632cfs Stage=262.29
7.8111	0.167	0.853	0.265	0.000	
7.9167	0.168	0.871	0.298	0.000	
8.0222	0.170	0.889	0.313	0.000	
8.1278	0.172	0.907	0.327	0.000	
8.2333	0.174	0.925	0.342	0.000	

8.3389	0.176	0.944	0.357	0.000	
8.4444	0.177	0.962	0.372	0.000	50yr=0.4608cfs Stage=263.0
8.5500	0.179	0.981	0.545	0.000	100yr=0.573cfs Stage=263.05
8.6556	0.181	1.000	1.282	0.000	
8.7611	0.183	1.019	2.338	0.000	
8.8667	0.185	1.039	3.635	0.000	
8.9722	0.187	1.059	5.135	0.000	
9.0778	0.189	1.078	6.813	0.000	
9.1833	0.191	1.098	8.652	0.000	
9.2889	0.192	1.119	10.64	0.000	
9.3944	0.194	1.139	12.76	0.000	
9.5000	0.196	1.160	15.01	0.000	
9.6056	0.198	1.181	17.39	0.000	

ANALYSIS RESULTS

Predeveloped Landuse Totals for POC #1
Total Pervious Area:5.146
Total Impervious Area:0.375

Mitigated Landuse Totals for POC #1
Total Pervious Area:2.849
Total Impervious Area:2.667

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.213112
5 year	0.309968
10 year	0.378601
25 year	0.470099
50 year	0.541597
100 year	0.615881

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0.123587
5 year	0.198254
10 year	0.263175
25 year	0.366294
50 year	0.460844
100 year	0.572821

Flow Frequency Pond-In Unmitigated 701 Data Series (WWHM)

Flow(cfs)	0701	
2 Year =	0.7806	
5 Year =	0.9832	
10 Year =	1.1177	– used in TESC Pons Sizing (DOE 2005)
25 Year =	1.2890	
50 Year =	1.4180	
100 Year =	1.5485	

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
	0.264	0.089
	0.517	0.134
	0.399	0.529
	0.181	0.080
	0.134	0.090
	0.197	0.116
	0.278	0.125
	0.278	0.182
	0.262	0.111
	0.207	0.120
	0.166	0.091
	0.302	0.329
	0.184	0.117
	0.121	0.076
	0.182	0.111
	0.209	0.093
	0.156	0.130
	0.186	0.091
	0.320	0.122
	0.198	0.092
	0.197	0.089
	0.192	0.091
	0.180	0.124
	0.377	0.220
	0.173	0.119
	0.180	0.124
	0.322	0.116
	0.201	0.122
	0.110	0.079
	0.189	0.120
	0.135	0.076
	0.233	0.258
	0.182	0.091
	0.366	0.254
	0.218	0.122
	0.187	0.084
	0.110	0.086
	0.360	0.216
	0.327	0.278
	0.141	0.087
	0.089	0.083
	0.543	0.366
	0.472	0.344
	0.194	0.120
	0.161	0.090
	0.078	0.072
	0.215	0.131
	0.425	0.501
	0.363	0.321
	0.149	0.088

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
	0.5429	0.5289

0.5174	0.5015
0.4722	0.3661
0.4249	0.3442
0.3994	0.3294
0.3768	0.3207
0.3664	0.2779
0.3632	0.2582
0.3601	0.2542
0.3269	0.2199
0.3218	0.2160
0.3197	0.1820
0.3021	0.1341
0.2782	0.1312
0.2780	0.1296
0.2638	0.1252
0.2619	0.1239
0.2331	0.1237
0.2184	0.1220
0.2148	0.1220
0.2085	0.1215
0.2070	0.1204
0.2011	0.1199
0.1978	0.1196
0.1967	0.1192
0.1967	0.1166
0.1944	0.1164
0.1917	0.1162
0.1890	0.1114
0.1867	0.1113
0.1861	0.0930
0.1840	0.0921
0.1819	0.0915
0.1819	0.0914
0.1812	0.0914
0.1800	0.0912
0.1796	0.0900
0.1734	0.0898
0.1660	0.0890
0.1613	0.0885
0.1555	0.0884
0.1493	0.0867
0.1412	0.0864
0.1351	0.0842
0.1339	0.0827
0.1207	0.0798
0.1104	0.0793
0.1098	0.0765
0.0888	0.0758
0.0775	0.0715

POC #1
The Facility PASSED

The Facility PASSED.

Flow(cfs) Predev Mit Percentage Pass/Fail

0.1066	2308	2264	98	Pass
0.1110	2117	2038	96	Pass
0.1153	1909	1679	87	Pass
0.1197	1742	1403	80	Pass
0.1241	1564	1129	72	Pass
0.1285	1447	961	66	Pass
0.1329	1343	839	62	Pass
0.1373	1216	748	61	Pass
0.1417	1139	696	61	Pass
0.1461	1033	637	61	Pass
0.1505	975	609	62	Pass
0.1549	914	587	64	Pass
0.1593	841	558	66	Pass
0.1637	791	540	68	Pass
0.1681	728	516	70	Pass
0.1725	680	496	72	Pass
0.1769	633	477	75	Pass
0.1813	575	452	78	Pass
0.1857	532	435	81	Pass
0.1900	480	411	85	Pass
0.1944	449	395	87	Pass
0.1988	414	375	90	Pass
0.2032	375	354	94	Pass
0.2076	342	338	98	Pass
0.2120	320	312	97	Pass
0.2164	302	292	96	Pass
0.2208	278	269	96	Pass
0.2252	260	250	96	Pass
0.2296	245	238	97	Pass
0.2340	231	220	95	Pass
0.2384	210	203	96	Pass
0.2428	197	190	96	Pass
0.2472	184	172	93	Pass
0.2516	178	153	85	Pass
0.2560	164	135	82	Pass
0.2604	157	121	77	Pass
0.2648	145	114	78	Pass
0.2691	128	107	83	Pass
0.2735	120	105	87	Pass
0.2779	115	101	87	Pass
0.2823	105	97	92	Pass
0.2867	96	91	94	Pass
0.2911	86	83	96	Pass
0.2955	84	82	97	Pass
0.2999	80	78	97	Pass
0.3043	71	69	97	Pass
0.3087	68	63	92	Pass
0.3131	61	54	88	Pass
0.3175	57	49	85	Pass
0.3219	52	44	84	Pass
0.3263	48	37	77	Pass
0.3307	40	36	90	Pass
0.3351	35	31	88	Pass
0.3395	33	31	93	Pass
0.3439	32	24	75	Pass
0.3482	30	22	73	Pass
0.3526	29	20	68	Pass

0.3570	27	16	59	Pass
0.3614	25	14	56	Pass
0.3658	23	11	47	Pass
0.3702	19	9	47	Pass
0.3746	19	9	47	Pass
0.3790	18	9	50	Pass
0.3834	18	8	44	Pass
0.3878	16	8	50	Pass
0.3922	14	8	57	Pass
0.3966	10	7	70	Pass
0.4010	8	7	87	Pass
0.4054	8	7	87	Pass
0.4098	8	7	87	Pass
0.4142	8	6	75	Pass
0.4186	8	6	75	Pass
0.4229	7	6	85	Pass
0.4273	6	6	100	Pass
0.4317	6	6	100	Pass
0.4361	6	5	83	Pass
0.4405	6	5	83	Pass
0.4449	6	5	83	Pass
0.4493	6	5	83	Pass
0.4537	6	4	66	Pass
0.4581	6	4	66	Pass
0.4625	6	3	50	Pass
0.4669	6	3	50	Pass
0.4713	6	3	50	Pass
0.4757	5	3	60	Pass
0.4801	5	3	60	Pass
0.4845	5	3	60	Pass
0.4889	5	3	60	Pass
0.4933	5	3	60	Pass
0.4977	5	3	60	Pass
0.5020	5	2	40	Pass
0.5064	5	1	20	Pass
0.5108	5	1	20	Pass
0.5152	5	1	20	Pass
0.5196	2	1	50	Pass
0.5240	2	1	50	Pass
0.5284	1	1	100	Pass
0.5328	1	0	0	Pass
0.5372	1	0	0	Pass
0.5416	1	0	0	Pass

Water Quality BMP Flow and Volume for POC #1
On-line facility volume: 0.1786 **acre-feet**
On-line facility target flow: 0.01 **cfs.**
Adjusted for 15 min: 0.0962 **cfs.**
Off-line facility target flow: 0.0608 **cfs.**
Adjusted for 15 min: 0.0646 **cfs.**

Perlnd and Implnd Changes

No changes have been made.

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This program and accompanying documentation is provided 'as-is' without warranty of any kind. The entire risk regarding the performance and results of this program is assumed by the user. Clear Creek Solutions, Inc. disclaims 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. has been advised of the possibility of such damages.

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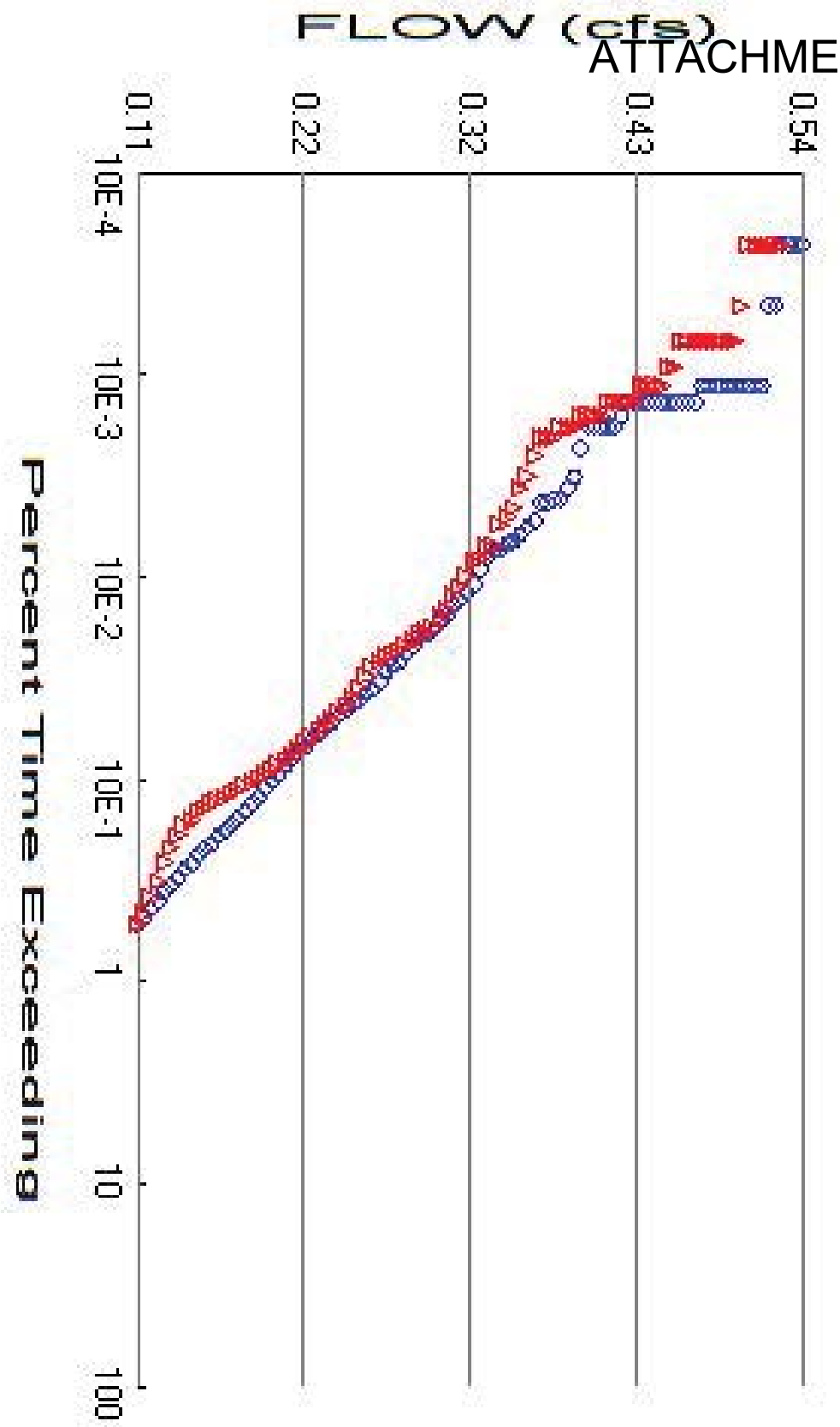

ATTACHMENT 21

5.0 CONVEYANCE SYSTEM ANALYSIS AND DESIGN

On-Site Conveyance

Calculations for the on-site conveyance pipes and swales for both Benjamin and Hill will be completed as the designs progress.

Off-site Conveyance

Two (2) primary offsite storm conveyances are proposed; 1) a pipe to collect and convey the Upstream Offsite are north and west of Benjamin around the proposed Benjamin/Hill detention, and 2), a continuation of the (1) Upstream-Offsite bypass pipe which after receiving the mitigated release from the Benjamin/Hill detention pond will collect addition tributary area before carrying all flows down the steep grade to the east and joining with the existing storm system at the base of the hill (Willows Commerce Park system).

Upstream-Offsite

The Upstream-Offsite conveyance will convey runoff from the upstream-offsite tributary area (10.8 acres) past collection for the Benjamin Hill Detention facility. The sizing for this conveyance pipe will be based on the existing condition land-use or may be up-sized by the City of Redmond, based on a larger scope Basin Drainage plan.

Downstream-Offsite:

The Downstream Off-site conveyance will carry runoff down the hill from the area currently tributary to the NE 100th St. pavement terminus: Upstream–Offsite tributary area (10.84 acres), the area mitigated by the Benjamin/Hill detention facility (5.52 acres), and a small 1.56 acre area south of NE 100th St. The conveyance will connect to the existing Willows Commerce Park (public) system at the base of the hill. The conveyance will be sized based on the existing basin and land-use, but may be up-sized based on City of Redmond conducted Basin Drainage evaluation/plan. However, as flows from the Benjamin Estates, and Willow Hill developments (including their frontage improvements) will be detained/controlled through the 50-year event to flow rates that are less than existing conditions (as mitigated release rates are based on

Forested land-use), the proposed development will have no negative impact on downstream conditions.

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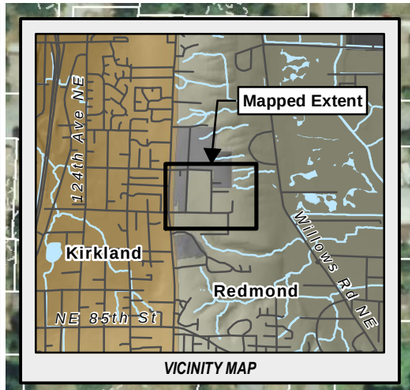

VICINITY MAP

NE 104th St

Upstream Off-Site 10.84 AC

136th Ave NE

NE 102nd Pl

134th Ave NE

Pond / Detention Mitigated Area 5.52 AC

NE 100th St Improvements Pond Bypass (Easterly Frontage) 0.06 AC

Existing Catch Basin In Willows Commerce Park

Off-Site Storm Tributary Area 1.56 AC

138th Ave NE

LEGEND

- Benjamin Property
- Hill Property
- Mitigated Project Site
- Proposed Storm System
- Watercourse
- Parcel Boundary

Contours

- 50 Foot Contour
- 10 Foot Contour

0 200 400

Scale in Feet

12-166F03.mxd | MOD: 5/15/2013 | IGM

SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
USDA	COLOR AERIAL PHOTOGRAPHY (2006)
KING COUNTY GIS	TEN FOOT CONTOUR - GENERATED FROM BARE EARTH LiDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.
CITY OF REDMOND	HYDROLOGY
KING COUNTY GIS	PARCEL BOUNDARIES

LDC
THE CIVIL ENGINEERING GROUP
Commercial
Infrastructure
Residential
14201 NE 200th St., #100
Woodinville, WA 98072
Ph. 425.806.1869
Fx. 425.482.2893
www.LDCcorp.com

TAYLOR DEVELOPMENT, INC.

BENJAMIN & HILL PROPERTIES

OFF-SITE STORM TRIBUTARY AREA MAP

PROJECTION: WASHINGTON STATE PLANE, NORTH ZONE, NAD 83 HARN, FEET

REVISION:
JOB NUMBER: 12-166
DRAWING NAME: 12-166F01
DESIGNER: A. BENTON
DRAWING BY: I. MIERAU
DATE: 11-01-12
SCALE: AS SHOWN
JURISDICTION: REDMOND

FIGURE:

11.0

ATTACHMENT 21

Basin Calcs	*LDC, Inc.*	
	142201 NE 200th St. # 100 Woodinville, WA 98072	Tel: (425) 806-1869 Fax: (425) 482-2893

Project Name: Kirkmond (Benjamin and Hill)
Description: Basin Calculations
Project No.: 12-166 & 12-169
Date: 10/23/2013
Calc. By: MWM

By-Pass

Upstream-Offsite			**98.00**	**86.00**	**81**
	Area (Acres)	Impervious (%)	Impervious (Acres)	Lawn (Acres)	Forested (Acres)
NW of Benjamin	10.84	27%	2.89	7.95	0.000
Total	**10.84**		**2.89**	**7.95**	**0.000**

	Area (Acres)	Impervious (%)	Impervious (Acres)	Lawn (Acres)	Forested (Acres)
NE 100th St Pond Bypass	0.06	47%	0.03	0.03	0.000
Total	**0.06**		**0.03**	**0.03**	**0.000**

ATTACHMENT 21

Basin Calcs	*LDC, Inc.*	
	142201 NE 200th St. # 100 Woodinville, WA 98072	Tel: (425) 806-1869 Fax: (425) 482-2893

Project Name: Kirkmond (Benjamin and Hill)
Description: Basin Calculations

Project No.: 12-166 & 12-169
Date: 5/16/2013
Calc. By: MWM

Off-Site Storm Tributary Area

	Area (Acres)	Impervious (%)	Impervious (Acres)	Lawn (Acres)	Forested (Acres)
Off-site Storm Tributary Area	1.56	30%	0.47	1.09	0.000
Total	**1.56**		**0.47**	**1.09**	**0.000**

6.0 SPECIAL REPORTS AND STUDIES

- Geotechnical Engineering Report; Benjamin Residential Plat, dated May 6, 2013, prepared by the Riley Group, Inc.

7.0 OTHER PERMITS

Other permits required for the proposed development are as follows:

- Clearing and Grading Permit
- National Pollution Discharge Elimination System (NPDES)
- Right-of-Way permit
- Utility Permit
- Building Permits

8.0 EROSION AND SEDIMENT CONTROL ANALYSIS AND DESIGN

The Stormwater Pollution Prevention Plan for the project, which is modeled under the guidelines of Volume II, Section 3 of the Stormwater Management Manual for Western Washington, issued by the Washington State Department of Ecology in 2005 and the requirements of the 2012 Redmond Stormwater Technical Notebook, will be submitted as a separate document as project design progresses.

9.0 BOND QUANTITIES, FACILITY SUMMARIES, AND DECLARATION OF COVENANT

A Bond Quantities Worksheet will be completed upon request.

10.0 OPERATIONS AND MAINTENANCE MANUAL

An Operations and Maintenance Manual is included in Appendix 10-A, This manual will be updated and revised to meet City of Redmond O&M manual requirements as project design progresses.

APPENDIX 10-A

OPERATIONS AND MAINTENANCE MANUAL

NO. 1 - DETENTION PONDS

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash & Debris	Any trash and debris which exceed 1 cubic foot per 1,000 square feet (this is about equal to the amount of trash it would take to fill up one standard size office garbage can). In general, there should be no visual evidence of dumping.	Trash and debris cleared from site.
	Poisonous Vegetation	Any poisonous or nuisance vegetation which may constitute a hazard to County personnel or the public.	No danger of poisonous vegetation where County personnel or the public might normally be. (Coordination with Seattle-King County Health Department)
	Pollution	Oil, gasoline, or other contaminants of one gallon or more or any amount found that could: 1) cause damage to plant, animal, or marine life; 2) constitute a fire hazard; or 3) be flushed downstream during rain storms.	No contaminants present other than a surface film. (Coordination with Seattle/King County Health Department)
	Unmowed Grass/ Ground Cover	If facility is located in private residential area, mowing is needed when grass exceeds 18 inches in height. In other areas, the general policy is to make the pond site match adjacent ground cover and terrain as long as there is no interference with the function of the facility.	When mowing is needed, grass/ground cover should be mowed to 2 inches in height. Mowing of selected higher use areas rather than the entire slope may be acceptable for some situations.
	Rodent Holes	Any evidence of rodent holes if facility is acting as a dam or berm, or any evidence of water piping through dam or berm via rodent holes.	Rodents destroyed and dam or berm repaired. (Coordination with Seattle/King County Health Department)
	Insects	When insects such as wasps and hornets interfere with maintenance activities.	Insects destroyed or removed from site.
	Tree Growth	Tree growth does not allow maintenance access or interferes with maintenance activity (i.e., slope mowing, silt removal, vactoring, or equipment movements). If trees are not interfering with access, leave trees alone.	Trees do not hinder maintenance activities. Selectively cultivate trees such as alders for firewood.
Side Slopes of Pond	Erosion	Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion.	Slopes should be stabilized by using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction.
Storage Area	Sediment	Accumulated sediment that exceeds 10% of the designed pond depth.	Sediment cleaned out to designed pond shape and depth; pond reseeded if necessary to control erosion.
Pond Dikes	Settlements	Any part of dike which has settled 4 inches lower than the design elevation.	Dike should be built back to the design elevation.
Emergency Overflow/Spillway	Rock Missing	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil at the top of out flow path of spillway. Rip-rap on inside slopes need not be replaced.	Replace rocks to design standards.

NO. 4 - CONTROL STRUCTURE/FLOW RESTRICTOR

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris (Includes Sediment)	Distance between debris build-up and bottom of orifice plate is less than 1-1/2 feet.	All trash and debris removed.
	Structural Damage	Structure is not securely attached to manhole wall and outlet pipe structure should support at least 1,000 lbs of up or down pressure.	Structure securely attached to wall and outlet pipe.
		Structure is not in upright position (allow up to 10% from plumb).	Structure in correct position.
		Connections to outlet pipe are not watertight and show signs of rust.	Connections to outlet pipe are water tight; structure repaired or replaced and works as designed.
		Any holes--other than designed holes--in the structure.	Structure has no holes other than designed holes.
Cleanout Gate	Damaged or Missing	Cleanout gate is not watertight or is missing.	Gate is watertight and works as designed.
		Gate cannot be moved up and down by one maintenance person.	Gate moves up and down easily and is watertight.
		Chain leading to gate is missing or damaged.	Chain is in place and works as designed.
		Gate is rusted over 50% of its surface area.	Gate is repaired or replaced to meet design standards..
Orifice Plate	Damaged or Missing	Control device is not working properly due to missing, out of place, or bent orifice plate.	Plate is in place and works as designed.
	Obstructions	Any trash, debris, sediment, or vegetation blocking the plate.	Plate is free of all obstructions and works as designed.
Overflow Pipe	Obstructions	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Pipe is free of all obstructions and works as designed.
Manhole		See “Closed Detention Systems” Standards No. 3	See “Closed Detention Systems’ Standards No. 3
Catch Basin		See “Catch Basins” Standards No. 5	See ‘Catch Basins” Standards No. 5

NO. 5 - CATCH BASINS

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
General	Trash & Debris (Includes Sediment)	Trash or debris of more than 1/2 cubic foot which is located immediately in front of the catch basin opening or is blocking capacity of the basin by more than 10%	No Trash or debris located immediately in front of catch basin opening.
		Trash or debris (in the basin) that exceeds 1/3 the depth from the bottom of basin to invert the lowest pipe into or out of the basin.	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.
		Deposits of garbage exceeding 1 cubic foot in volume	No condition present which would attract or support the breeding of insects or rodents.
	Structure Damage to Frame and/or Top Slab	Corner of frame extends more than 3/4 inch past curb face into the street (If applicable).	Frame is even with curb.
		Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch (intent is to make sure all 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 is sitting flush on top slab.
	Cracks in Basin Walls/ Bottom	Cracks wider than 1/2 inch and longer than 3 feet, any evidence of soil particles entering catch basin through cracks, or maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.
		Cracks 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.	No cracks more than 1/4 inch wide at the joint of inlet/outlet pipe.
	Sediment/ Misalignment	Basin has settled more than 1 inch or has rotated more than 2 inches out of alignment.	Basin replaced or repaired to design standards.

NO. 5 - CATCH BASINS (*CONTINUED*)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
	Fire Hazard	Presence of chemicals such as natural gas, oil and gasoline.	No flammable chemicals present.
	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.
	Pollution	Nonflammable chemicals of more than 1/2 cubic foot per three feet of basin length.	No pollution present other than surface film.
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 on 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 80 lbs. of lift; 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, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
Metal Grates (If Applicable)		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.	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. 10 - CONVEYANCE SYSTEMS (PIPES & DITCHES)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Pipes	Sediment & Debris	Accumulated sediment that exceeds 20% of the diameter of the pipe.	Pipe cleaned of all sediment and debris.
	Vegetation	Vegetation that reduces free movement of water through pipes.	All vegetation removed so water flows freely through pipes.
	Damaged	Protective coating is damaged; rust is causing more than 50% deterioration to any part of pipe.	Pipe repaired or replaced.
		Any dent that decreases the cross section area of pipe by more than 20%.	Pipe repaired or replaced.
Open Ditches	Trash & Debris	Trash and debris exceeds 1 cubic foot per 1,000 square feet of ditch and slopes.	Trash and debris cleared from ditches.
	Sediment	Accumulated sediment that exceeds 20 % of the design depth.	Ditch cleaned/ flushed of all sediment and debris so that it matches design.
	Vegetation	Vegetation that reduces free movement of water through ditches.	Water flows freely through ditches.
	Erosion Damage to Slopes	See “Ponds” Standard No. 1	See “Ponds” Standard No. 1
	Rock Lining Out of Place or Missing (If Applicable).	Maintenance person can see native soil beneath the rock lining.	Replace rocks to design standards.
Catch Basins		See “Catch Basins: Standard No. 5	See “Catch Basins” Standard No. 5
Debris Barriers (e.g., Trash Rack)		See “Debris Barriers” Standard No.6	See “Debris Barriers” Standard No. 6

NO. 11 - GROUNDS (LANDSCAPING)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Weeds (Nonpoisonous)	Weeds growing in more than 20% of the landscaped area (trees and shrubs only).	Weeds present in less than 5% of the landscaped area.
	Safety Hazard	Any presence of poison ivy or other poisonous vegetation.	No poisonous vegetation present in landscaped area.
	Trash or Litter	Paper, cans, bottles, totaling more than 1 cubic foot within a landscaped area (trees and shrubs only) of 1,000 square feet.	Area clear of litter.
Trees and Shrubs	Damaged	Limbs or parts of trees or shrubs that are split or broken which affect more than 25% of the total foliage of the tree or shrub.	Trees and shrubs with less than 5% of total foliage with split or broken limbs.
		Trees or shrubs that have been blown down or knocked over.	Tree or shrub in place free of injury.
		Trees or shrubs which are not adequately supported or are leaning over, causing exposure of the roots.	Tree or shrub in place and adequately supported; remove any dead or diseased trees.

NO. 12 - ACCESS ROADS/ EASEMENTS

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris	Trash and debris exceeds 1 cubic foot per 1,000 square feet i.e., trash and debris would fill up one standards size garbage can.	Roadway free of debris which could damage tires.
	Blocked Roadway	Debris which could damage vehicle tires (glass or metal).	Roadway free of debris which could damage tires.
		Any obstruction which reduces clearance above road surface to less than 14 feet.	Roadway overhead clear to 14 feet high.
		Any obstruction restricting the access to a 10 to 12 foot width for a distance of more than 12 feet or any point restricting access to less than a 10 foot width.	Obstruction removed to allow at least a 12 foot access.
Road Surface	Settlement, Potholes, Mush Spots, Ruts	When any surface defect exceeds 6 inches in depth and 6 square feet in area. In general, any surface defect which hinders or prevents maintenance access.	Road surface uniformly smooth with no evidence of settlement, potholes, mush spots, or ruts.
	Vegetation in Road Surface	Weeds growing in the road surface that are more than 6 inches tall and less than 6 inches tall and less than 6 inches apart within a 400-square foot area.	Road surface free of weeds taller than 2 inches.
	Modular Grid Pavement	Build-up of sediment mildly contaminated with petroleum hydrocarbons.	Removal of sediment and disposal in keeping with Health Department recommendations for mildly contaminated soils or catch basin sediments.
Shoulders and Ditches	Erosion Damage	Erosion within 1 foot of the roadway more than 8 inches wide and 6 inches deep.	Shoulder free of erosion and matching the surrounding road.
	Weeds and Brush	Weeds and brush exceed 18 inches in height or hinder maintenance access.	Weeds and brush cut to 2 inches in height or cleared in such a way as to allow maintenance access.

NO. 13 - WATER QUALITY FACILITIES (*CONTINUED*)

E.) Wetvaults

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
Wetvault	Trash/ Debris Accumulation	Trash and debris accumulated in vault, pipe or inlet/ outlet, (includes floatables and non-floatables).	Remove trash and debris from vault.
	Sediment Accumulation in Vault	Sediment accumulation in vault bottom exceeds the depth of the sediment zone plus 6-inches.	Remove sediment from vault.
	Damaged Pipes	Inlet/ outlet piping damaged or broken and in need of repair.	Pipe repaired and/ or replaced.
	Access Cover Damaged/ Not Working	Cover cannot be opened or removed, especially by one person.	Pipe repaired or replaced to proper working specifications.
	Ventilation	Ventilation area blocked or plugged	Remove or clear blocking material from ventilation area. A specified % of the vault surface area must provide ventilation to the vault interior (see p. 6-82 for required %).
	Vault Structure Damaged	Vault: Cracks wider than 1/2-inch and any evidence of soil particles entering the structure through the cracks, or maintenance/ inspection personnel determines that the vault is not structurally sound.	Repair cracks wider than 1/4-inch at the joint of the inlet/ outlet pipe. Make repairs so that vault is structurally sound.
	Baffles	Baffles corroding, cracking, warping and/ or showing signs of failure as determined by maintenance/ inspection staff.	Repair or replace baffles to specifications.
	Access Ladder Damage	Ladder is corroded or deteriorated, not functioning properly, missing rungs, has cracks and/ or misaligned. Confined space warning sign missing.	Ladder replaced or repaired to specifications, and is safe to use as determined by inspection personnel. Replace sign warning of confined space entry requirements.

ATTACHMENT 21

LDC, Inc.
The Civil Engineering Group

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