Arlington Townhomes

Construction Drainage Report

Prepared for

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Stanwood, WA 98292

Prepared by

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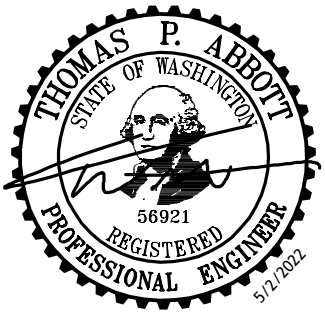

May 2022

Job No: 19-169A

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APPENDICES

SECTION 1: PROJECT OVERVIEW

The proposed Arlington Townhomes project is comprised of parcel numbers 31051100407600. Total site parcel area equals approximately 0.97 acres. The project proposes a multifamily townhome development of 18 units across three townhome buildings. The site currently contains an existing single-family residence and an existing duplex residence on the two lots not being developed, the lot proposed for development contains abandoned wooden outbuildings in the existing condition. Development will also include frontage improvements, access to the proposed residences, and utility services. The project area address is 606 E Highland Dr in Arlington, WA. The site is located within the NE ¼ of the SE ¼ of Section 11, Township 31 N, Range 05 E, W.M. See Vicinity Map in the following pages for visual representation of the subject property.

1.1 EXISTING SITE

The project parcel is subdivided into 3 lots. Lots 1 and 2 are occupied by a single-family home, a duplex, and driveways. Lots 1 & 2 were developed as part of a previous different project. Lot 3 is occupied by undeveloped land and various unused wooden outbuildings. Existing pervious in Lot 3 cover includes landscaped and pasture area as well as limited tree coverage. Lots 1 and 2 will not be disturbed by development and are not considered part of this project. The outbuildings on lot 3 will be demolished.

Site soils are classified as Ragnar fine sandy loam (0 to 8 percent slopes) which is classified as a Hydrologic Soil Group A and high infiltration potential. According to GTS Geotechnical Report site soils are consistent with USGS soil data and exhibit a design infiltration rate of 9.36 in/hr. Existing site slopes vary from mild to flat graded southward.

1.2 DOWNSTREAM ANALYSIS

Drainage from the existing site flows to the south. Runoff flows overland through heavy shrubbery into an unnamed stream that heads west and outside of the 0.25-mile buffer. Refer to Section 3.0 "Downstream Analysis Report" for a more in-depth description as well as Figure 4.0 in Appendix 3 for a visual depiction of the downstream flow paths.

1.3 PROPOSED DEVELOPMENT

Lot 1 and 2 will remain undisturbed. Development activities are proposed for Lot 3. Development will disturb 1.304 acres; this consists of the developed lot and an access tract which will serve the proposed development. Frontage improvements along E Highland Drive include the creation of an access point to the proposed lots, and the rest of the frontage is already built out to city standards. This proposed development is designed under the City of Arlington Engineering Standards (COAES) and 2012 Department of Ecology SMWWM as amended in 2014 (2014 DOE) and will be required to meet flow control and runoff treatment requirements as the project exceeds the 10,000 sf effective impervious and 5,000 sf pollution generating hard surface (PGHS) thresholds.

1.4 PROPOSED DRAINAGE SYSTEM

The project is required to meet flow control and water quality treatment requirements. This project proposes 27,379 sf of pollution generating hard surface and 41,251 sf of impervious surfaces. All flows from newly developed impervious surfaces are proposed be collected and conveyed to an infiltration gallery located in the southern portion of the site which will infiltrate 100% of developed site runoff. The infiltration gallery is designed to provide flow control and water quality treatment to the proposed development. Refer to Section 5.0 Stormwater Management for WWHM sizing output and more detail on facility design.

1.5 EROSION/SEDIMENTATION CONTROL

Erosion control measures that will be utilized during construction will include a combination of silt fence, plastic covering, a sediment trap, and storm drain inlet protection. See Section 2.0 for detailed discussion of how SWPPP Elements are addressed.

1.6 MINIMUM REQUIREMENTS

Per the 2014 DOE, this project is new development and Minimum Requirements 1-9 apply to the proposed development.

Minimum Requirement #1: Preparation of Stormwater Site Plans: This Report along with the Construction Plans satisfies this minimum requirement.

Minimum Requirement #2: Construction Stormwater Pollution Prevention: See Section 2 of this Report for the SWPPP BMP Elements, and the SWPPP (submitted as a separate document) for a complete discussion of erosion control BMP's and their use specific to the site.

Minimum Requirement #3: Source Control of Pollution: Permanent source control BMPs are not applicable for the subject site since the associated activities for the new residence do not fall within the types of facilities listed within Volume IV of the Drainage Manual (Residential developments are not required to implement source control BMP's). BMPs for erosion and sedimentation control are specified in the Construction Plans and the SWPPP.

Minimum Requirement #4: Preservation of Natural Drainage Systems and Outfalls:
Existing drainage flows primarily southwest off the site. In the developed condition, the site will infiltrate developed surfaces runoff. Collected surface runoff will generally convey in the same direction as the predeveloped conditions outfall direction. See Downstream Analysis in Section 3 of this report for further information regarding the location of existing natural outfalls.

Minimum Requirement #5: On-site Stormwater Management:
Geotechnical investigation of site soils and underlying geology reveal soils that are consistent with recessional and proglacial sand with minor gravel or silt with a design infiltration rate of 9.36 in/hr per GTG Geotech. An infiltration gallery is proposed to manage on-site storm water. See Section 4.3 for additional information.

Minimum Requirement #6: Runoff Treatment: The project is required to provide Runoff Treatment as the 27,379 sf of proposed PGHS exceeds the 5,000 sf PGHS threshold. However, infiltration facilities have been designed to infiltrate 100% of contributing flows and according to the GTG Geotech Report, site soils at varying depths contain levels of CEC and organic content that provide adequate treatment. The top 2' of existing site soils have at minimum 12.6 meg/100g of Cation Exchange Capacity and at minimum contain 4.27% of Organic Content. These measured quantities exceed the 5.0 meg/100g and 1.0% respective thresholds set by the 2014 DOE manual.

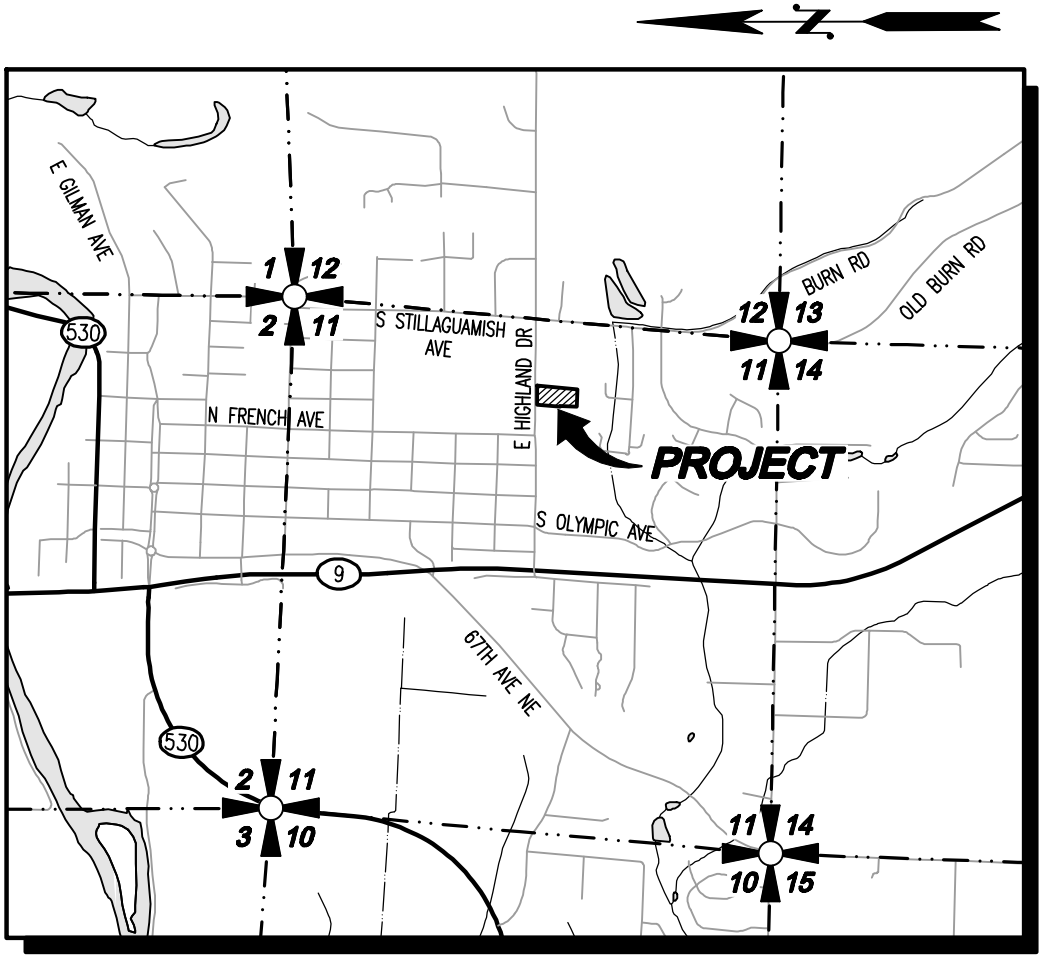
Minimum Requirement #7: Flow Control: The project is required to provide flow control as the 41,251 sf of proposed total effective impervious surfaces exceeds the 10,000-sf threshold. Flow control is proposed via a gravel infiltration gallery sized to detain and infiltrate 100% of the developed condition runoff.

Minimum Requirement #8: Wetlands Protection: There are no wetlands onsite or immediately adjacent.

Minimum Requirement #9: Operation and Maintenance: See Operations and Maintenance in Section 6 of this report.

Appendix 1: Project Overview

1. Figure 1.0 – Vicinity Map
2. Figure 2.0 – Existing Conditions Map
3. Figure 3.0 – Proposed Development Map



VICINITY MAP

SCALE: 1"=2000'

Drawing: P:\Civil\2019\C19-169 Stewart Apartments\Drawings\Exhibits\C19169E-EX-VM.dwg Plotted: May 15, 2020 - 12:35pm

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LAND PRO GROUP

STEWART SHORT PLAT

VICINITY MAP

ExistingConditionsMap.mxd | MOD: 4/27/2022 | eallen

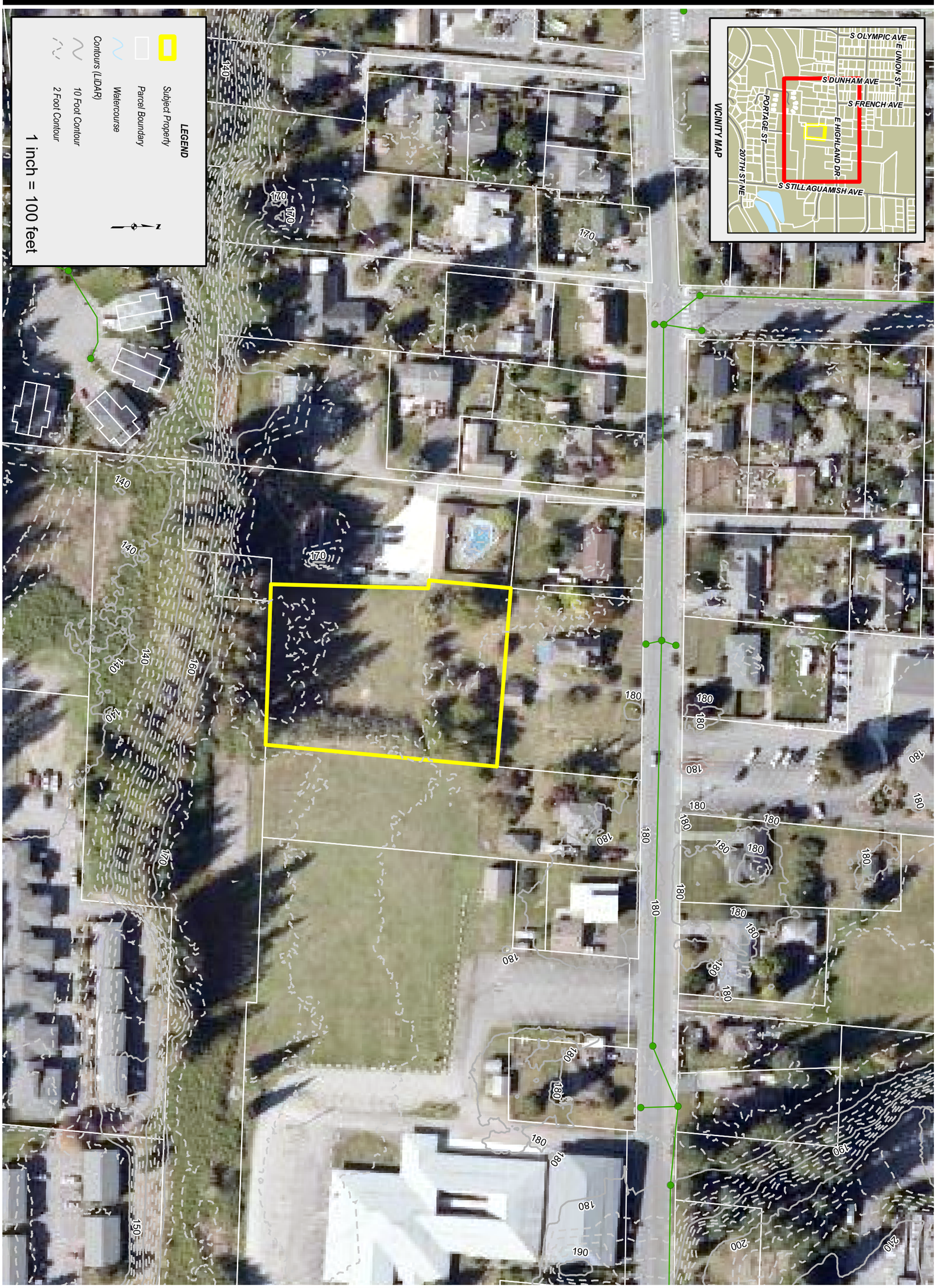

FIGURE: 2.0

NAD 1983 HARN
STATEPLANE WASHINGTON
NORTH FIPS 4601 FEET

REVISION:
JOB NUMBER: C19-169A
DRAWING NAME: C19-169A-2.0
DESIGNER: EALLEN
DRAWING BY: EALLEN
DATE: 4/27/2022
SCALE: AS SHOWN
JURISDICTION: ARLINGTON

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STEWART TOWNHOMES

EXISTING CONDITIONS

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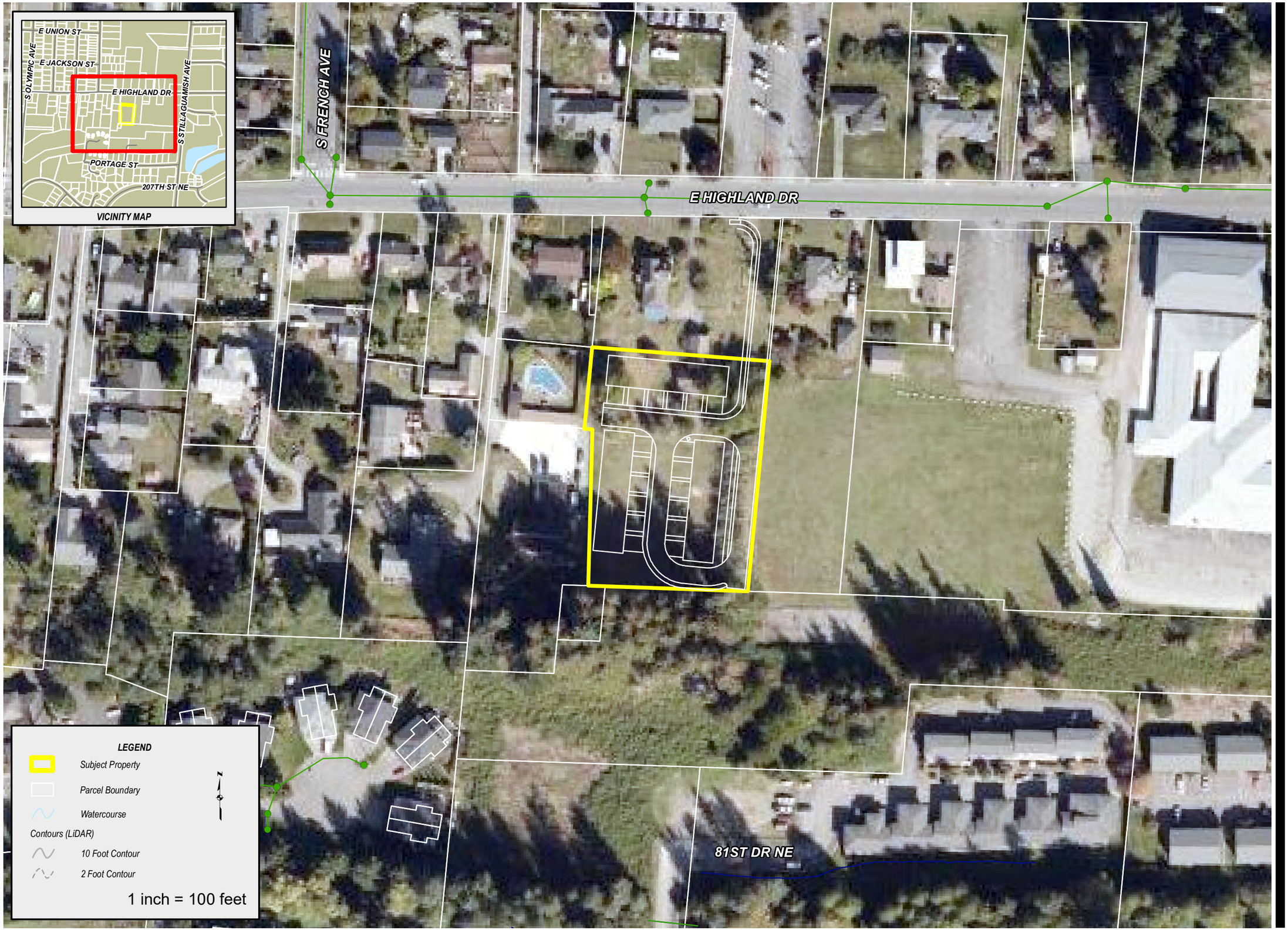
SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
ARLINGTON GIS	PARCEL BOUNDARY,HYDROLOGY
SNOHOMISH COUNTY GIS	CONTOURS GENERATED FROM BARE EARTH LiDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.



SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
ARLINGTON GIS	PARCEL BOUNDARY/HYDROLOGY
SNOHOMISH COUNTY GIS	CONTOURS GENERATED FROM BARE EARTH LIDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.

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PROPOSED DEVELOPMENT MAP

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NORTH FIPS 4601 FEET

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DRAWING BY: EALLEN
DATE: 4/27/2022
SCALE: AS SHOWN
JURISDICTION: ARLINGTON

FIGURE:
3.0

ProposedDevMap.mxd | MOD: 4/27/2022 | eallen

SECTION 2: RISK ASSESSMENT ANALYSIS AND TEMPORARY EROSION AND SEDIMENT CONTROL DESIGN

2.1 TEMPORARY EROSION AND SEDIMENT CONTROL

A Stormwater Pollution Prevention Plan (SWPPP) has been provided as a separate document. The SWPPP report is modeled under the guidelines of Volume II, Section 3 of the 2014 Stormwater Management Manual for Western Washington. Construction SWPPP Elements #1 through #13 are addressed below.

Element #1 – Mark Clearing Limits: All clearing limits will be delineated with high visibility plastic fence or silt fence. See sheets ER-01 of the construction plans for locations and details.

Element #2 – Establish Construction Access: Stabilized construction accesses will be installed as shown on the construction plans. See sheets ER-01 and ER-02 of the construction plans for locations and details.

Element #3 – Control Flow Rates: Flow control is not required for the site. Any runoff produced during construction will disperse across native vegetation.

Element #4 – Install Sediment Controls: Silt fence and catch basin protection will be utilized to contain sediments within the project's clearing limits. See sheets ER-01 and ER-02 of the plans for locations and details.

Element #5 – Stabilize Soils: Exposed soils will be stabilized as specified in the Grading and Erosion Control Notes. See sheet ER-02 of the construction plans for notes.

Element #6 – Protect Slopes: Slopes are flat to mild on the subject site. Slopes shall be protected as specified under Element #5.

Element #7 – Protect Drain Inlets: Storm drain inlet protection will be utilized to contain sediments within the project's impact limits. See sheets ER-01 and ER-02 of the construction plans for locations and details.

Element #8 – Stabilize Channels and Outlets: Channel stabilization will not be required as no swales are proposed.

Element #9 – Control Pollutants: Pollutants shall be controlled as specified in the Pollutant Control Notes. See sheet ER-02 of the construction plans for notes.

Element #10 – Control De-Watering: Disposal options for de-watering water are as specified in the De-Watering Control Notes. See sheet ER-02 of the construction plans for notes.

Element #11 – Maintain BMPs: Maintenance of the BMPs is specified within the Construction Sequence and Grading and Erosion Control Notes. See sheets ER-01 and ER-02 of the construction plans for the Construction Sequence and notes.

Element #12: Manage the Project: The Grading and Erosion Control Notes specify seasonal work limitations. Maintenance of the BMPs is specified within the Construction Sequence and Grading and Erosion Control Notes. See sheets ER-01 and ER-02 of the construction plans for the Construction Sequence and notes.

Element #13: Protect LID BMPs: The proposed infiltration areas shall be protected from over compaction throughout construction. Plastic covering or a protective fencing shall be used as necessary to protect the infiltration areas from sedimentation or compaction.

SECTION 3: DOWNSTREAM ANALYSIS REPORT

3.1 TASK 1: STUDY AREA DEFINITION AND MAPS

Snohomish County Bare Earth LiDAR, survey, and 2012 aerial photography were the best topographical references available for the area containing the site. The limits of the downstream analysis extend roughly 0.25 miles beyond the subject property's natural discharge location (See Figure 4.0, Downstream Analysis Map).

3.2 TASK 2: RESOURCE REVIEW

All of the resources below have been reviewed for existing and potential issues near the project site:

- **Adopted Basin Plans**
  No Adopted Basin Plans were located that include the project site.
- **Drainage Basin**
  This site is located within the Stillaguamish drainage basin and Kruger and Butler sub-basins.
- **Floodplain / Floodway (FEMA) maps**
  According to FEMA floodplain mapping, the subject property is not within a floodplain. Reference the FEMA FIS study map 53061C0405E and 53061C0415E.
- **Critical Areas Map**
  No wetlands or critical areas were found onsite.
- **Drainage Complaints**
  No drainage complaints have been reported for the site.
- **Road Drainage Problems**
  No drainage problems were recorded.
- **Soil Survey**
  According to the USGS Soil survey, the site is Ragnar with 0 to 8 percent slopes and is considered Hydrologic Group A soils. A GTG Geotech Infiltration study confirmed this data and provided a design infiltration rate of 9.36 in/hr. See Appendix 3-C for USDA Soil Map and the soil classification description.
- **Wetland Inventory Maps**
  There are no wetlands located onsite.
- **Migrating River Studies**

Migrating River Studies are not applicable to the proposed site development.

- **Section 303d List of Polluted Waters**
  Washington State Department of Ecology's Water Quality Assessment for Washington shows no impacted or polluted waters within 0.25 miles of the site.
- **Water Quality Problems**
  No known water quality problems are present within the site or anywhere within the 0.25-mile downstream flow path.
- **Stormwater Compliance Plans**
  Not applicable to the proposed project.

3.3 TASK 3: FIELD INSPECTION/DOWNSTREAM ANALYSIS

On May 8, 2020, a Downstream Analysis was performed at the site. The weather consisted of 67ºF and clear skies. The following observations were verified during the visit.

The subject property is currently developed with a paved access from E Highland Dr within the right of way.

The natural discharge locations exist on-site and currently leave the site in one flowpath. Flows generally discharge overland southwestward and south across property lines and continue southward until entering an unnamed stream. See Figure 4.0, "Downstream Analysis Map" for a map exhibit of the discharge from the project site. The onsite flow path will convey all developed flows as described below.

Developed Flow Path

Runoff leaves the site southward via overland flow for 430 LF②. Flows travel through steep slopes and heavy shrubbery before entering an unnamed stream③④⑤. Flows continues southwestward for another 1,050 LF before leaving the quarter mile boundary of analysis⑥.

3.4 TASK 4: DRAINAGE SYSTEM DESCRIPTION AND PROBLEM DESCRIPTIONS

Based on the resources available and the anticipated downstream flow paths, there is no evidence of existing downstream drainage problems. All downstream appurtenances and open channels are adequately sized to sufficiently convey flows resulting from large storm events.

3.5 TASK 5: MITIGATION OF EXISTING OR POTENTIAL DRAINAGE PROBLEMS

No existing drainage issues occur onsite or downstream of the site.

Appendix 3: Resource Review

1. Figure 4.0 - Downstream Analysis Map
2. Downstream Analysis Photos
3. FEMA Floodplain Maps
4. USGS Soils Map
5. USGS Soils Description

DownstreamMap.mxd | MOD: 4/27/2022 | eallen

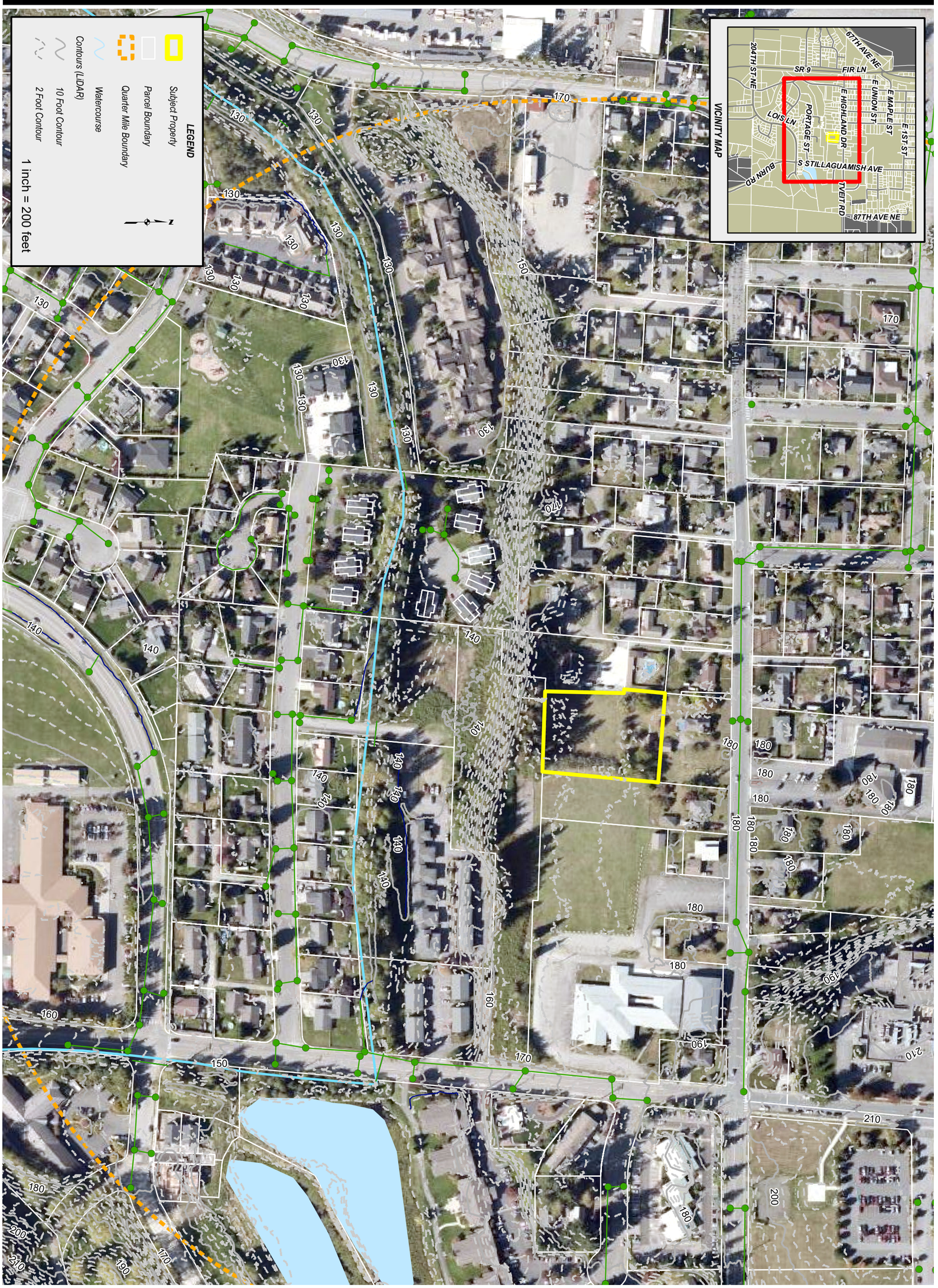

FIGURE: **4.0**

NAD 1983 HARN
STATEPLANE WASHINGTON
NORTH FIPS 4601 FEET

REVISION:
JOB NUMBER: C19-169A
DRAWING NAME: C19-169A-4.0
DESIGNER: EALLEN
DRAWING BY: EALLEN
DATE: 4/27/2022
SCALE: AS SHOWN
JURISDICTION: BOTHELL

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DOWNSTREAM ANALYSIS MAP

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SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
KING COUNTY GIS	PARCEL BOUNDARY
KING COUNTY GIS	CONTOURS GENERATED FROM BARE EARTH LiDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.

Image ① E Highland Dr Frontage Catch Basin. Onsite flows flow away from frontage

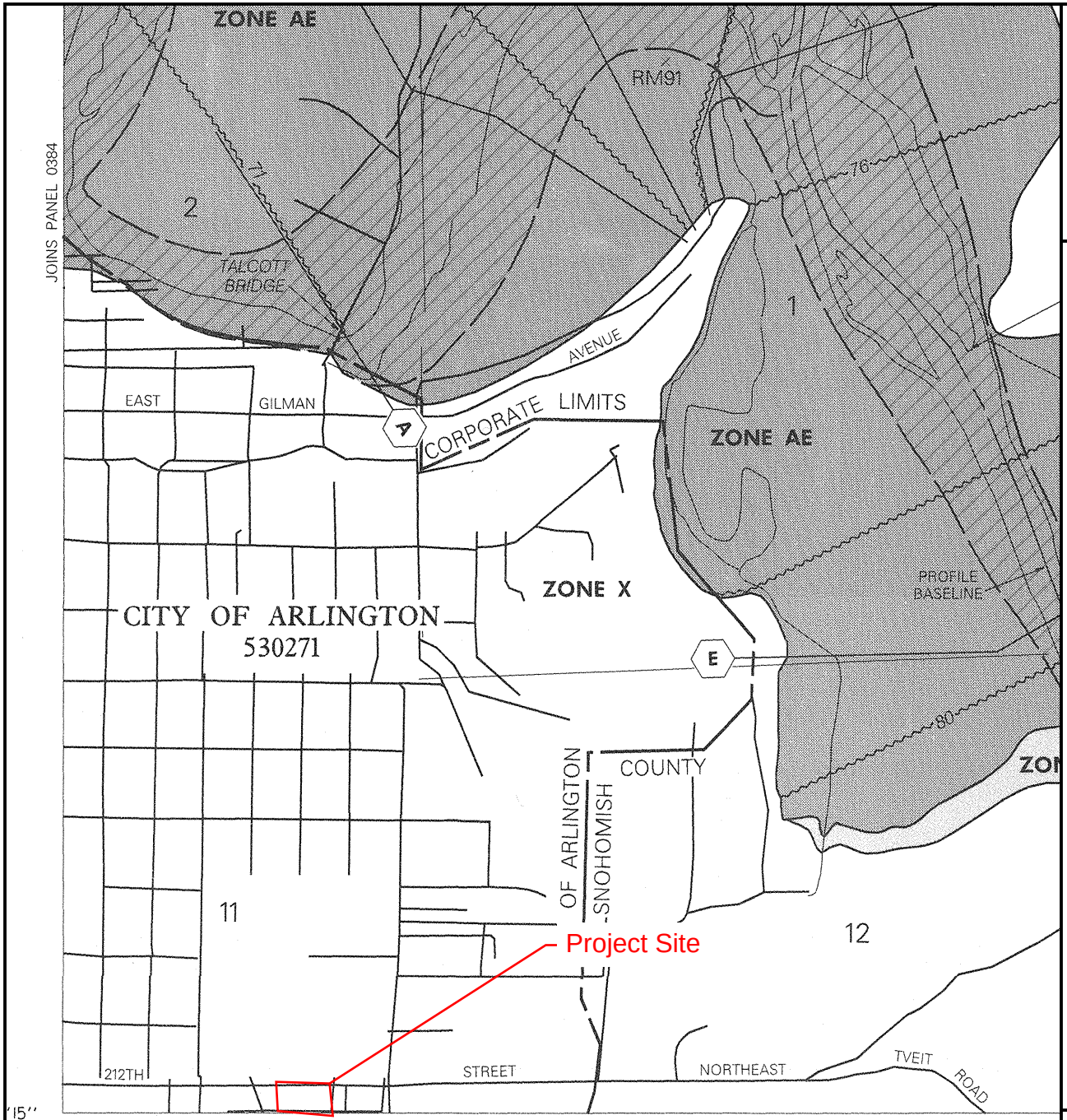
Image ② Onsite looking east. Flows travel overland eastward.

Image ③ Towards the back of the property looking east at blackberry bush overgrowth there site slopes

Image ④ Photo on adjacent property looking west to property where heavy bushes and sloping is present

Image ⑤ Flows continue overland west through heavy shrubbery (right to left)

Image ⑥ Flows continue into an unnamed stream west



APPROXIMATE SCALE IN FEET

1000 0 1000

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

SNOHOMISH COUNTY, WASHINGTON AND INCORPORATED AREAS

PANEL 405 OF 1575

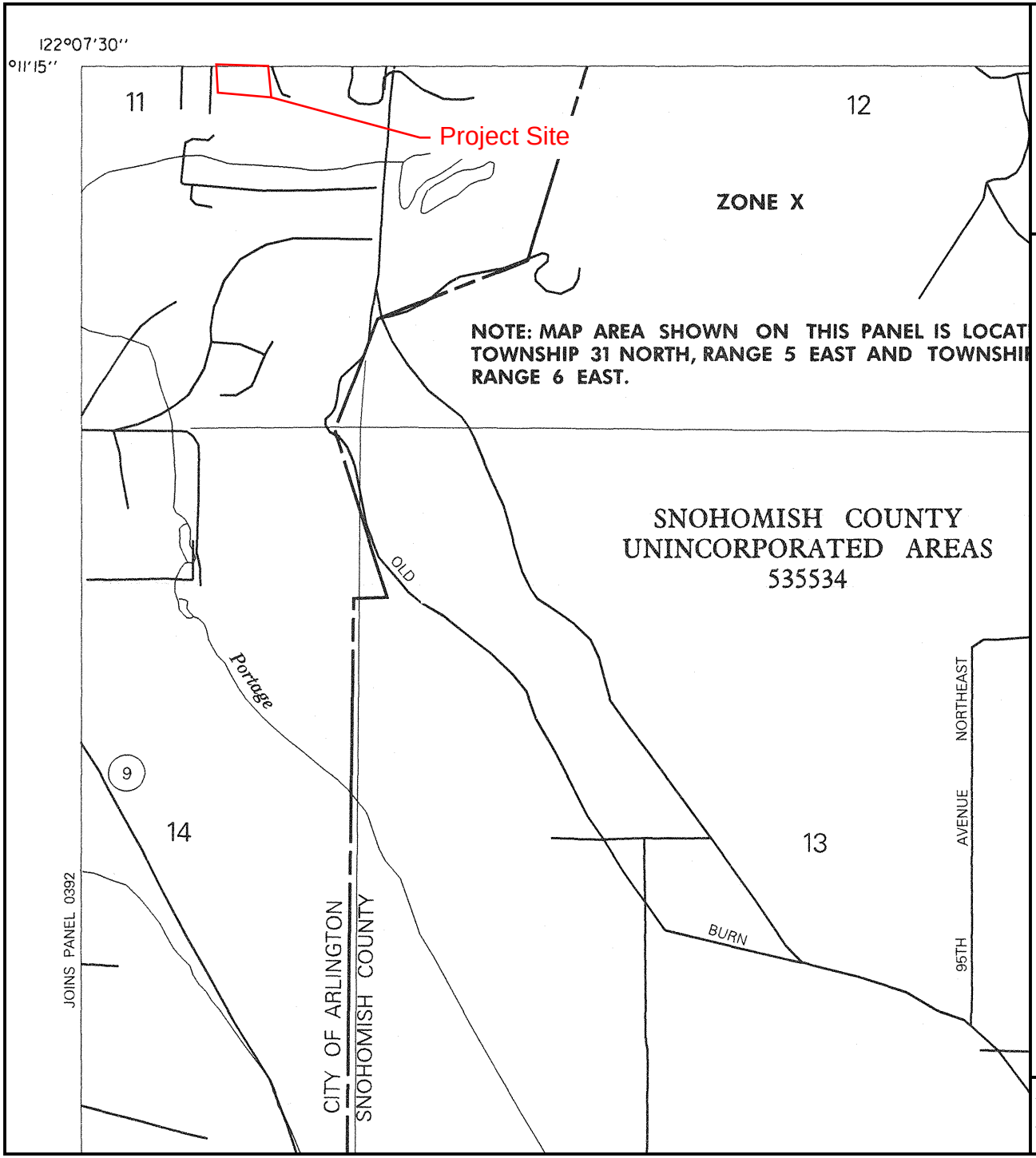
(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS: COMMUNITY	NUMBER	PANEL	SUFFIX
ARLINGTON, CITY OF	530271	0405	E
SNOHOMISH COUNTY, UNINCORPORATED AREAS	535534	0405	E

MAP NUMBER
53061C0405 E

EFFECTIVE DATE:
NOVEMBER 8, 1999

Federal Emergency Management Agency



APPROXIMATE SCALE IN FEET

1000 0 1000

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

SNOHOMISH COUNTY, WASHINGTON AND INCORPORATED AREAS

PANEL 415 OF 1575

(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ARLINGTON, CITY OF	530271	0415	E
SNOHOMISH COUNTY, UNINCORPORATED AREAS	535534	0415	E

MAP NUMBER
53061C0415 E

EFFECTIVE DATE:
NOVEMBER 8, 1999

Federal Emergency Management Agency

Map Scale: 1:872 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 10 20 40 60

Feet: 0 40 80 160 240

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Snohomish County Area, Washington
Survey Area Data: Version 21, Sep 16, 2019

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 26, 2018—Oct 16, 2018

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
19	Everett very gravelly sandy loam, 15 to 30 percent slopes	0.1	6.8%
57	Ragnar fine sandy loam, 0 to 8 percent slopes	2.0	93.2%
Totals for Area of Interest		**2.1**	**100.0%**

Snohomish County Area, Washington

19—Everett very gravelly sandy loam, 15 to 30 percent slopes

Map Unit Setting

National map unit symbol: 2t62c
Elevation: 30 to 900 feet
Mean annual precipitation: 35 to 91 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 180 to 240 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Everett and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Everett

Setting

Landform: Kames, eskers, moraines
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Sandy and gravelly glacial outwash

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 3 inches: very gravelly sandy loam
Bw - 3 to 24 inches: very gravelly sandy loam
C1 - 24 to 35 inches: very gravelly loamy sand
C2 - 35 to 60 inches: extremely cobbly coarse sand

Properties and qualities

Slope: 15 to 30 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A

Forage suitability group: Droughty Soils (G002XN402WA), Droughty Soils (G002XS401WA)
Hydric soil rating: No

Minor Components

Alderwood

Percent of map unit: 10 percent
Landform: Ridges, hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope, nose slope, talf
Down-slope shape: Linear, convex
Across-slope shape: Convex
Hydric soil rating: No

Indianola

Percent of map unit: 10 percent
Landform: Eskers, kames, terraces
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Data Source Information

Soil Survey Area: Snohomish County Area, Washington
Survey Area Data: Version 21, Sep 16, 2019

Snohomish County Area, Washington

57—Ragnar fine sandy loam, 0 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2hzk
Elevation: 300 to 1,000 feet
Mean annual precipitation: 35 to 65 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 150 to 210 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Ragnar and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ragnar

Setting

Landform: Outwash plains
Parent material: Glacial outwash

Typical profile

H1 - 0 to 2 inches: ashy fine sandy loam
H2 - 2 to 24 inches: ashy sandy loam
H3 - 24 to 60 inches: loamy sand

Properties and qualities

Slope: 0 to 8 percent
Depth to restrictive feature: 20 to 40 inches to strongly contrasting textural stratification
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: A
Forage suitability group: Droughty Soils (G002XN402WA)
Hydric soil rating: No

Data Source Information

Soil Survey Area: Snohomish County Area, Washington
Survey Area Data: Version 21, Sep 16, 2019

SECTION 4: STORMWATER MANAGEMENT (MR # 5)

4.1 DEVELOPMENT AREAS

The project will disturb 1.304 acres of the 1.86-acre site. The remaining 0.556 acres will remain undisturbed throughout construction and therefore have not been considered in MR thresholds. Listed in Tables 4.1.a and 4.1.b are the predeveloped and developed site areas.

Table 4.1.a – Predeveloped Conditions Areas

Predeveloped Land Cover	**Area**
Forested, Flat	*1.304 AC*
Total	**1.304 AC**

Table 4.1.b –Developed Conditions Areas

Developed Land Cover	**Area**
Road, Flat	*0.388 AC*
Sidewalk, Flat	*0.087 AC*
Roof, Flat	*0.318 AC*
Driveway, Flat	*0.154 AC*
Pasture, Flat	*0.357 AC*
Total	**1.304 AC**

4.2 HYDROLOGIC ANALYSIS

Flow control is required as the developed site TDA exceeds the threshold requirements of 10,000 sf effective impervious surfaces. The site proposes 41,251 sf of effective impervious area.

New impervious surface runoff will be mitigated via infiltration. All flows from proposed hard surfaces will be collected and conveyed via a network of catch basins and sealed storm pipe. Flows will be conveyed to an infiltration gallery located in the southern open space area of the proposed lot development. This facility is sized to infiltrate 100% of runoff from the site.

According to the Geotechnical Report evaluation of site infiltration potential, GTG lists a design infiltration rate of 9.36 in/hr. All infiltration facilities have been designed and modeled in

WWHM2012 with a precipitation factor of 1.2 applied to the Everett Gauge. WWHM output from the modeling of each trench can be found in Appendix 4.

Infiltration Gallery

A gravel infiltration gallery will detain, and infiltrate runoff associated with site development. The following parameters have been modeled in WWHM for trench design:

Gallery Area Modeled:	1630 sf
Gallery Area Provided:	1633 sf
Effective Depth:	5 ft
Gravel Layer Depth:	4 ft
Bot Gallery EL:	83.25
Top Gallery EL:	87.25'
Minimum Cover:	2 ft
Porosity:	0.40
Infiltration Rate:	9.36 in/hr
Percent Infiltrated:	***100%***

4.3 WATER QUALITY

This project proposes 27,379 sf of PGHS. This exceeds the 5,000-sf threshold for water quality set in the DOE 2014. Therefore, this project will provide water quality treatment to all runoff from PGHS surfaces. The proposed infiltration gallery will provide water quality treatment by utilizing acceptable site soils to treat storm water as it infiltrates.

Soil Characteristics for Water Quality Treatment

There are two required soil characteristics set forth in Site Suitability Criteria 6 (SSC-6) from the 2014 DOE to use a soil to treat infiltrating runoff. The characteristics are Cation Exchange Capacity (CEC) and Organic Content (OC). The soil characteristic requirements set forth in SSC-6 and the measured quantities from the GTG Infiltration study are summarized below:

2014 DOE Minimum CEC:	5.0 meq/100 g
GTG Measured Onsite CEC:	12.6 meq/100 g

2014 DOE Minimum OC:	1.0%
GTG Measured Onsite OC:	4.27%

Proposed Soil Amendment for Water Quality Treatment

Soil characteristic measurements listed above were taken from samples sourced 1.25′ below ground surface (BGS) onsite. According to the GTG Infiltration Study site soils found less than 2′ BGS are suitable for providing treatment and anything deeper than 2′ will be inadequate. To meet infiltration treatment requirements with the infiltration gallery (Max Depth ~6′ BGS) the design proposes to amend surrounding soils with onsite topsoil. Per SSC-6 a minimum 18″ layer of adequate soil is required to provide treatment. An 18″ amendment with soils naturally found in the top 1.5′ of the onsite soil column is proposed. Please see the contract plans for detailed design of the proposed soil amendment. Post amendment the soils at the bottom of the infiltration trench must be tested during construction to prove adequate amendment performance.

4.4 LOW IMPACT DEVELOPMENT

The low impact development (LID) standards for on-site stormwater management from Volume 1, section 2.5.5 in the 2014 DOE, were considered for feasibility in the design of this project. The project is required to comply with Minimum Requirement #5 and will comply by applying achievable BMPs from List #2 as listed below:

Lawn and Landscaped Areas:

1. **BMP T5.13 Post-Construction Soil Quality and Depth**: This BMP will be applied to disturbed pervious surfaces and in accordance with BMP requirements.

Roofs:

1. **BMP T5.30 Full Dispersion:** Due to project constraints, full dispersion is not feasible for the project**.**
2. **BMP T5.10A Downspout Full Infiltration:** BMP is feasible for the site and has been applied to all proposed roof surfaces via an infiltration gallery.
3. **BMP T5.10B Downspout Dispersion Systems:** Downspout dispersion is feasible for the site, however, full infiltration of roof runoff per BMP T5.10A will be applied.

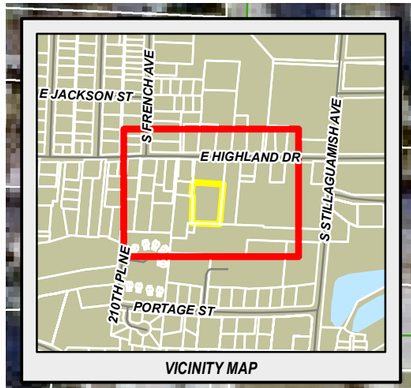
4. **BMP T5.10C Perforated Stub-out Connections:** Feasible and will be applied in conjunction with BMP T 5.10A to roof runoff.
5. **BMP 7.30 Bioretention:** Sufficient area for bioretention is not available onsite. This BMP is not feasible.

Other Hard Surfaces:

1. **BMP T5.30 Full Dispersion:** Sufficient flow paths and native retention are not available due to site layout. This BMP is infeasible.
2. **BMP T5.15 Permeable Pavement**: Pavement flows will be fully infiltrated via an infiltration gallery; this is a higher priority LID technique therefore permeable pavements are not proposed.
3. **BMP T5.12 Sheet Flow Dispersion:** Sufficient flow paths and native retention are not available due to site layout. This BMP is infeasible.

Appendix 4: Stormwater Management

1. Figure 5.0: Predeveloped Hydrology Map
2. Figure 6.0: Developed Hydrology Map
3. WWHM Infiltration Gallery Output



VICINITY MAP

PREDEVELOPED BASIN AREAS

ONSITE BASIN	
FORESTED	1.304 AC
TOTAL	1.304 AC

ONSITE BASIN = 1.304 AC

LEGEND

- Subject Property
- Parcel Boundary
- Watercourse

Contours (LiDAR)

- 10 Foot Contour
- 2 Foot Contour

1 inch = 80 feet

N

PreDevConditions.mxd | MOD: 4/27/2022 | eallen

SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
ARLINGTON GIS	PARCEL BOUNDARY/HYDROLOGY
SNOHOMISH COUNTY GIS	CONTOURS GENERATED FROM BARE EARTH LIDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.

LDC
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Kent, WA 98030
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TIC TOC, LLC

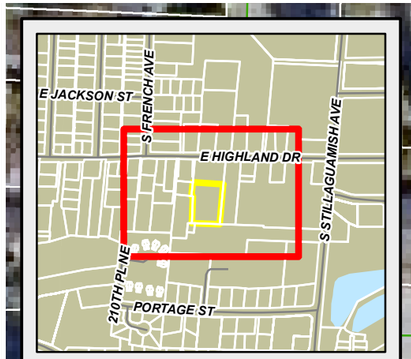
STEWART TOWNHOMES

PREDEVELOPED CONDITIONS

NAD 1983 HARN
STATEPLANE WASHINGTON
NORTH FIPS 4601 FEET

REVISION:
JOB NUMBER: C19-169A
DRAWING NAME: C19-169A-5.0
DESIGNER: EALLEN
DRAWING BY: EALLEN
DATE: 4/27/2022
SCALE: AS SHOWN
JURISDICTION: ARLINGTON

FIGURE:
5.0



VICINITY MAP

DEVELOPED BASIN AREAS

ONSITE BASIN	
ROAD	0.314 AC
SIDEWALK	0.073 AC
ROOF	0.301 AC
DRIVEWAY	0.147 AC
PASTURE	0.469 AC
TOTAL	1.304 AC

ONSITE BASIN = 1.304 AC

LEGEND

- Subject Property
- Parcel Boundary
- Watercourse

Contours (LiDAR)

- 10 Foot Contour
- 2 Foot Contour

1 inch = 80 feet

SOURCE INFORMATION

SOURCE AGENCY	DESCRIPTION
ARLINGTON GIS	PARCEL BOUNDARY/HYDROLOGY
SNOHOMISH COUNTY GIS	CONTOURS GENERATED FROM BARE EARTH LIDAR (KING COUNTY). THIS DATA HAS A STATED VERTICAL ACCURACY OF APPROXIMATELY 1 FOOT.

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DEVELOPED CONDITIONS

NAD 1983 HARN
STATEPLANE WASHINGTON
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DATE: 4/27/2022
SCALE: AS SHOWN
JURISDICTION: ARLINGTON

FIGURE:
6.0

DevConditions.mxd | MOD: 4/27/2022 | eallen

WWHM2012
PROJECT REPORT

Project Name: 20220502_Infill Passing
Site Name: Arlington Townhomes
Site Address:
City : Arlington
Report Date: 5/2/2022
Gage : Everett
Data Start : 1948/10/01
Data End : 2009/09/30
Precip Scale: 1.20
Version Date: 2019/09/13
Version : 4.2.17

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

High Flow Threshold for POC 1: 50 year

PREDEVELOPED LAND USE

Name : Basin 1
Bypass: No

GroundWater: No

Pervious Land Use	acre
C, Forest, Flat	1.304
Pervious Total	1.304

Impervious Land Use	acre
Impervious Total	0
Basin Total	1.304

Element Flows To:

Surface	Interflow	Groundwater

MITIGATED LAND USE

Name : Basin 1
Bypass: No

GroundWater: No

Pervious Land Use	acre
C, Pasture, Flat	.357
Pervious Total	0.357

Impervious Land Use	acre
ROADS FLAT	0.388
ROOF TOPS FLAT	0.318
DRIVEWAYS FLAT	0.154
SIDEWALKS FLAT	0.087
Impervious Total	0.947
Basin Total	1.304

Element Flows To:

Surface	Interflow	Groundwater
Gravel Trench Bed 1	Gravel Trench Bed 1	

Name : Gravel Trench Bed 1
Bottom Length: 163.00 ft.
Bottom Width: 10.00 ft.
Trench bottom slope 1: 0 To 1
Trench Left side slope 0: 0 To 1
Trench right side slope 2: 0 To 1
Material thickness of first layer: 4
Pour Space of material for first layer: 0.4
Material thickness of second layer: 0
Pour Space of material for second layer: 0
Material thickness of third layer: 0
Pour Space of material for third layer: 0
Infiltration On
Infiltration rate: 9.36
Infiltration safety factor: 1
Total Volume Infiltrated (ac-ft.): 210.103
Total Volume Through Riser (ac-ft.): 0
Total Volume Through Facility (ac-ft.): 210.103
Percent Infiltrated: 100
Total Precip Applied to Facility: 0
Total Evap From Facility: 0
Discharge Structure
Riser Height: 4 ft.
Riser Diameter: 10000 in.

Element Flows To:

Outlet 1	Outlet 2

Gravel Trench Bed Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.037	0.000	0.000	0.000
0.0556	0.037	0.000	0.000	0.353
0.1111	0.037	0.001	0.000	0.353
0.1667	0.037	0.002	0.000	0.353
0.2222	0.037	0.003	0.000	0.353
0.2778	0.037	0.004	0.000	0.353
0.3333	0.037	0.005	0.000	0.353
0.3889	0.037	0.005	0.000	0.353
0.4444	0.037	0.006	0.000	0.353
0.5000	0.037	0.007	0.000	0.353
0.5556	0.037	0.008	0.000	0.353
0.6111	0.037	0.009	0.000	0.353
0.6667	0.037	0.010	0.000	0.353
0.7222	0.037	0.010	0.000	0.353
0.7778	0.037	0.011	0.000	0.353
0.8333	0.037	0.012	0.000	0.353
0.8889	0.037	0.013	0.000	0.353
0.9444	0.037	0.014	0.000	0.353
1.0000	0.037	0.015	0.000	0.353
1.0556	0.037	0.015	0.000	0.353
1.1111	0.037	0.016	0.000	0.353
1.1667	0.037	0.017	0.000	0.353
1.2222	0.037	0.018	0.000	0.353
1.2778	0.037	0.019	0.000	0.353
1.3333	0.037	0.020	0.000	0.353
1.3889	0.037	0.020	0.000	0.353
1.4444	0.037	0.021	0.000	0.353
1.5000	0.037	0.022	0.000	0.353
1.5556	0.037	0.023	0.000	0.353
1.6111	0.037	0.024	0.000	0.353
1.6667	0.037	0.024	0.000	0.353
1.7222	0.037	0.025	0.000	0.353
1.7778	0.037	0.026	0.000	0.353
1.8333	0.037	0.027	0.000	0.353
1.8889	0.037	0.028	0.000	0.353
1.9444	0.037	0.029	0.000	0.353
2.0000	0.037	0.029	0.000	0.353
2.0556	0.037	0.030	0.000	0.353
2.1111	0.037	0.031	0.000	0.353
2.1667	0.037	0.032	0.000	0.353
2.2222	0.037	0.033	0.000	0.353
2.2778	0.037	0.034	0.000	0.353
2.3333	0.037	0.034	0.000	0.353
2.3889	0.037	0.035	0.000	0.353
2.4444	0.037	0.036	0.000	0.353
2.5000	0.037	0.037	0.000	0.353
2.5556	0.037	0.038	0.000	0.353
2.6111	0.037	0.039	0.000	0.353
2.6667	0.037	0.039	0.000	0.353
2.7222	0.037	0.040	0.000	0.353
2.7778	0.037	0.041	0.000	0.353
2.8333	0.037	0.042	0.000	0.353
2.8889	0.037	0.043	0.000	0.353
2.9444	0.037	0.044	0.000	0.353
3.0000	0.037	0.044	0.000	0.353
3.0556	0.037	0.045	0.000	0.353

3.1111	0.037	0.046	0.000	0.353
3.1667	0.037	0.047	0.000	0.353
3.2222	0.037	0.048	0.000	0.353
3.2778	0.037	0.049	0.000	0.353
3.3333	0.037	0.049	0.000	0.353
3.3889	0.037	0.050	0.000	0.353
3.4444	0.037	0.051	0.000	0.353
3.5000	0.037	0.052	0.000	0.353
3.5556	0.037	0.053	0.000	0.353
3.6111	0.037	0.054	0.000	0.353
3.6667	0.037	0.054	0.000	0.353
3.7222	0.037	0.055	0.000	0.353
3.7778	0.037	0.056	0.000	0.353
3.8333	0.037	0.057	0.000	0.353
3.8889	0.037	0.058	0.000	0.353
3.9444	0.037	0.059	0.000	0.353
4.0000	0.037	0.059	0.000	0.353
4.0556	0.037	0.062	115.9	0.353
4.1111	0.037	0.064	327.8	0.353
4.1667	0.037	0.066	602.2	0.353
4.2222	0.037	0.068	927.2	0.353
4.2778	0.037	0.070	1295.	0.353
4.3333	0.037	0.072	1703.	0.353
4.3889	0.037	0.074	2146.	0.353
4.4444	0.037	0.076	2622.	0.353
4.5000	0.037	0.078	3129.	0.353
4.5556	0.037	0.080	3665.	0.353
4.6111	0.037	0.082	4228.	0.353
4.6667	0.037	0.084	4817.	0.353
4.7222	0.037	0.086	5432.	0.353
4.7778	0.037	0.089	6071.	0.353
4.8333	0.037	0.091	6733.	0.353
4.8889	0.037	0.093	7417.	0.353
4.9444	0.037	0.095	8123.	0.353
5.0000	0.037	0.097	8850.	0.353

ANALYSIS RESULTS

Stream Protection Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:1.304
Total Impervious Area:0

Mitigated Landuse Totals for POC #1
Total Pervious Area:0.357
Total Impervious Area:0.947

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**

2 year	0.044823
5 year	0.06876
10 year	0.08722
25 year	0.113633
50 year	0.13563
100 year	0.159687

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0
5 year	0
10 year	0
25 year	0
50 year	0
100 year	0

Stream Protection Duration
Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1949	0.045	0.000
1950	0.046	0.000
1951	0.041	0.000
1952	0.032	0.000
1953	0.027	0.000
1954	0.146	0.000
1955	0.058	0.000
1956	0.051	0.000
1957	0.063	0.000
1958	0.046	0.000
1959	0.045	0.000
1960	0.042	0.000
1961	0.080	0.000
1962	0.039	0.000
1963	0.065	0.000
1964	0.047	0.000
1965	0.039	0.000
1966	0.023	0.000
1967	0.046	0.000
1968	0.056	0.000
1969	0.137	0.000
1970	0.032	0.000
1971	0.051	0.000
1972	0.038	0.000
1973	0.036	0.000
1974	0.077	0.000
1975	0.031	0.000
1976	0.032	0.000
1977	0.027	0.000
1978	0.032	0.000
1979	0.090	0.000
1980	0.042	0.000
1981	0.033	0.000
1982	0.043	0.000
1983	0.073	0.000
1984	0.044	0.000
1985	0.053	0.000

1986	0.125	0.000
1987	0.060	0.000
1988	0.031	0.000
1989	0.032	0.000
1990	0.042	0.000
1991	0.043	0.000
1992	0.033	0.000
1993	0.027	0.000
1994	0.030	0.000
1995	0.044	0.000
1996	0.075	0.000
1997	0.148	0.000
1998	0.027	0.000
1999	0.036	0.000
2000	0.027	0.000
2001	0.011	0.000
2002	0.041	0.000
2003	0.032	0.000
2004	0.054	0.000
2005	0.037	0.000
2006	0.099	0.000
2007	0.079	0.000
2008	0.110	0.000
2009	0.034	0.000

Stream Protection Duration
Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.1485	0.0000
2	0.1464	0.0000
3	0.1366	0.0000
4	0.1252	0.0000
5	0.1104	0.0000
6	0.0994	0.0000
7	0.0897	0.0000
8	0.0796	0.0000
9	0.0786	0.0000
10	0.0769	0.0000
11	0.0747	0.0000
12	0.0728	0.0000
13	0.0648	0.0000
14	0.0631	0.0000
15	0.0597	0.0000
16	0.0577	0.0000
17	0.0562	0.0000
18	0.0536	0.0000
19	0.0532	0.0000
20	0.0509	0.0000
21	0.0509	0.0000
22	0.0466	0.0000
23	0.0462	0.0000
24	0.0458	0.0000
25	0.0456	0.0000
26	0.0452	0.0000
27	0.0448	0.0000
28	0.0440	0.0000

29	0.0438	0.0000
30	0.0430	0.0000
31	0.0427	0.0000
32	0.0421	0.0000
33	0.0420	0.0000
34	0.0418	0.0000
35	0.0409	0.0000
36	0.0407	0.0000
37	0.0393	0.0000
38	0.0389	0.0000
39	0.0375	0.0000
40	0.0373	0.0000
41	0.0357	0.0000
42	0.0355	0.0000
43	0.0336	0.0000
44	0.0329	0.0000
45	0.0328	0.0000
46	0.0323	0.0000
47	0.0322	0.0000
48	0.0322	0.0000
49	0.0322	0.0000
50	0.0319	0.0000
51	0.0315	0.0000
52	0.0313	0.0000
53	0.0309	0.0000
54	0.0299	0.0000
55	0.0273	0.0000
56	0.0272	0.0000
57	0.0271	0.0000
58	0.0271	0.0000
59	0.0268	0.0000
60	0.0228	0.0000
61	0.0108	0.0000

Stream Protection Duration
POC #1
The Facility PASSED

The Facility PASSED.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0224	19599	0	0	Pass
0.0236	16996	0	0	Pass
0.0247	14677	0	0	Pass
0.0258	12724	0	0	Pass
0.0270	10930	0	0	Pass
0.0281	9443	0	0	Pass
0.0293	8168	0	0	Pass
0.0304	7078	0	0	Pass
0.0316	6126	0	0	Pass
0.0327	5311	0	0	Pass
0.0338	4656	0	0	Pass
0.0350	4066	0	0	Pass
0.0361	3548	0	0	Pass
0.0373	3138	0	0	Pass
0.0384	2757	0	0	Pass

0.0396	2447	0	0	Pass
0.0407	2145	0	0	Pass
0.0419	1893	0	0	Pass
0.0430	1657	0	0	Pass
0.0441	1508	0	0	Pass
0.0453	1370	0	0	Pass
0.0464	1250	0	0	Pass
0.0476	1154	0	0	Pass
0.0487	1069	0	0	Pass
0.0499	1009	0	0	Pass
0.0510	949	0	0	Pass
0.0521	888	0	0	Pass
0.0533	825	0	0	Pass
0.0544	777	0	0	Pass
0.0556	733	0	0	Pass
0.0567	686	0	0	Pass
0.0579	648	0	0	Pass
0.0590	622	0	0	Pass
0.0602	602	0	0	Pass
0.0613	583	0	0	Pass
0.0624	561	0	0	Pass
0.0636	538	0	0	Pass
0.0647	507	0	0	Pass
0.0659	487	0	0	Pass
0.0670	473	0	0	Pass
0.0682	457	0	0	Pass
0.0693	440	0	0	Pass
0.0704	424	0	0	Pass
0.0716	409	0	0	Pass
0.0727	394	0	0	Pass
0.0739	380	0	0	Pass
0.0750	368	0	0	Pass
0.0762	353	0	0	Pass
0.0773	341	0	0	Pass
0.0784	333	0	0	Pass
0.0796	322	0	0	Pass
0.0807	313	0	0	Pass
0.0819	302	0	0	Pass
0.0830	293	0	0	Pass
0.0842	284	0	0	Pass
0.0853	276	0	0	Pass
0.0865	265	0	0	Pass
0.0876	257	0	0	Pass
0.0887	241	0	0	Pass
0.0899	234	0	0	Pass
0.0910	226	0	0	Pass
0.0922	212	0	0	Pass
0.0933	205	0	0	Pass
0.0945	195	0	0	Pass
0.0956	187	0	0	Pass
0.0967	177	0	0	Pass
0.0979	166	0	0	Pass
0.0990	160	0	0	Pass
0.1002	151	0	0	Pass
0.1013	146	0	0	Pass
0.1025	135	0	0	Pass
0.1036	128	0	0	Pass

0.1048	121	0	0	Pass
0.1059	111	0	0	Pass
0.1070	100	0	0	Pass
0.1082	86	0	0	Pass
0.1093	75	0	0	Pass
0.1105	63	0	0	Pass
0.1116	59	0	0	Pass
0.1128	56	0	0	Pass
0.1139	49	0	0	Pass
0.1150	42	0	0	Pass
0.1162	40	0	0	Pass
0.1173	37	0	0	Pass
0.1185	36	0	0	Pass
0.1196	30	0	0	Pass
0.1208	28	0	0	Pass
0.1219	26	0	0	Pass
0.1231	20	0	0	Pass
0.1242	16	0	0	Pass
0.1253	13	0	0	Pass
0.1265	9	0	0	Pass
0.1276	6	0	0	Pass
0.1288	5	0	0	Pass
0.1299	4	0	0	Pass
0.1311	4	0	0	Pass
0.1322	3	0	0	Pass
0.1333	3	0	0	Pass
0.1345	3	0	0	Pass
0.1356	3	0	0	Pass

Water Quality BMP Flow and Volume for POC #1
On-line facility volume: 0 **acre-feet**
On-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**
Off-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**

LID Report

LID Technique	Used for Treatment?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft.)	Cumulative Infiltration Credit	Percent Water Quality Treated	Percent Volume Infiltrated	Comment
Gravel Trench Bed 1 POC	N	191.19			N	100.00		
Total Volume Infiltrated		191.19	0.00	0.00		100.00	0.00	0% No Treat. Credit

Compliance with LID Standard 8
Duration Analysis Result = Passed

Perlnd and Implnd Changes

No changes have been made.

SECTION 5: CONVEYANCE ANALYSIS AND DESIGN

The proposed collection and conveyance systems are comprised of catch basins, storm drainage pipe and an infiltration system. Catch basins have been located such that each section of storm drainage pipe can adequately convey associated tributary area flows. Conveyance analysis has been performed for the detention system.

The onsite collection and conveyance systems were designed for the 50-year, 24-hour storm event (precipitation rate = 3.20 in. obtained from the NOAA ATLAS 2, Volume IX), using the Rational Method with Everett IDF Tables. The Uniform Flow Method (Manning's Equation) was performed to ensure that during the 50-year, 24-hour storm event, no catch basin structures would be overtopping without an adequate location for collection. The conveyance analysis for the drainage system was performed using StormShed3G. For a visual representation of contributing conveyance basins used in analysis, see Figure 5.0 "Conveyance Basin Map" in Appendix 5. Pervious surfaces were modeled as "Pasture" while impervious surfaces were modeled as "Pavement and roofs". A fixed time of concentration of 5 minutes was used for all basins.

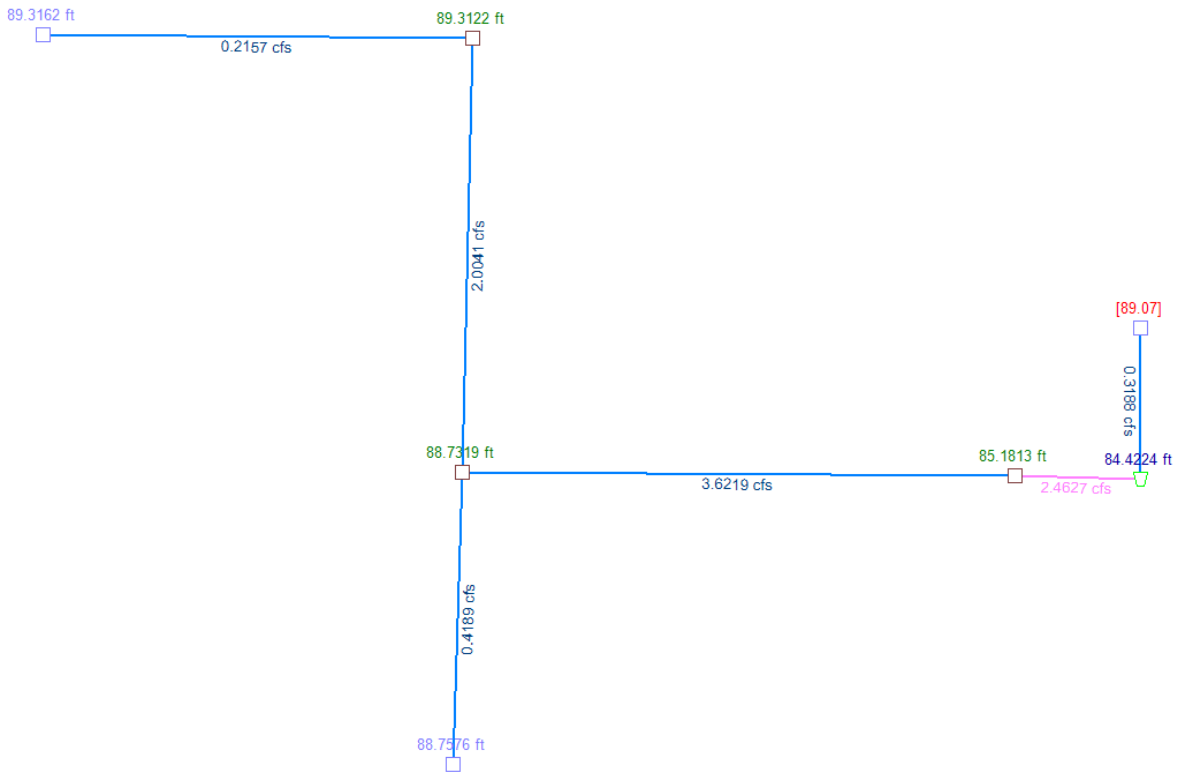
The following catch basin summary tables show that in the 50-year, 24-hour storm design event, no rims will be overtopping for the system's tributary drainage lines. A table for each tributary conveyance line is shown below for verification. A summary is found below along with the Stormshed3G layout. The Conveyance Basin Map can be found in Appendix 5.

ARLINGTON TOWNHOMES STORMWATER SYSTEM			
CB #	Rim	HGL	Distance to Overtopping (ft)
CB-1	88.57	85.10	3.47
CB-2	91.03	87.03	4.00
CB-2A	90.33	87.04	3.29
CB-3	90.79	87.80	2.99
CB-4	91.85	88.61	3.24
CB-5	88.97	85.19	3.78

Appendix 5: Conveyance Analysis and Design

1. Figure 7.0: Conveyance Basin Map
2. Stormshed3G Output Data

Figure 7.0 - Stormshed3G Layout



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ROUTEHYD [] THRU [Stewart Townhomes] USING [25 yr] AND [Everett] NOTZERO RELATIVE RATIONAL

Rational Method analysis

Reach ID	Area (ac)	TC (min)	i (in/hr)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Size	nVel (ft/s)	fVel (ft/s)	CArea
5-Gallery	0.152	0.00	3.0687	0.3188	11.2955	0.0282	0.1156	12 in Diam	6.3066	14.3819	B-005
4-3	0.089	0.00	3.0687	0.2157	6.4582	0.0334	0.1251	12 in Diam	3.8043	8.2228	B-004
3-2	0.227	0.495	11.789	2.0041	5.7166	0.3506	0.4085	12 in Diam	6.6416	7.2786	B-003
2A-2	0.203	0.00	3.0687	0.4189	5.1601	0.0812	0.1923	12 in Diam	3.9622	6.5701	B-002A
2-1	0.525	0.7159	9.5114	3.6219	5.3464	0.6775	0.6036	12 in Diam	7.3087	6.8072	B-002
1-Gallery	1.062	5.00	3.0687	2.4627	4.585	0.5371	0.522	12 in Diam	5.9388	5.8378	B-001

HGL Analysis

From Node	To Node	HG El (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	Adjusted HG El (ft)	Max El (ft)
							83.9827
CB-5	Infiltration Gallery	85.1920	------	------	------	85.1920	88.9700
CB-1	Infiltration Gallery	85.0937	------	0.0023	------	85.0960	88.5700
CB-2	CB-1	86.8785	------	0.1375	0.0161	87.0321	91.0300
CB-3	CB-2	87.4922	------	0.3049	------	87.7971	90.7900
CB-4	CB-3	88.6097	------	------	------	88.6097	91.8500
CB-2A	CB-2	87.0420	------	------	------	87.0420	90.3300
CB-5	Infiltration Gallery	85.1920	------	------	------	85.1920	88.9700
CB-1	Infiltration Gallery	85.0937	------	0.0023	------	85.0960	88.5700
CB-2	CB-1	86.8785	------	0.1375	0.0161	87.0321	91.0300
CB-3	CB-2	87.4922	------	0.3049	------	87.7971	90.7900
CB-4	CB-3	88.6097	------	------	------	88.6097	91.8500
CB-2A	CB-2	87.0420	------	------	------	87.0420	90.3300

Conduit Notes

Reach	HW Depth (ft)	HW/D ratio	Q (cfs)	TW Depth (ft)	Dc (ft)	Dn (ft)	Comment
5-Gallery	0.2920	0.2920	0.32	0.2327	0.2327	0.1156	SuperCrit flow, Inlet end controls
1-Gallery	1.0437	1.0437	2.46	0.6724	0.6724	0.5220	SuperCrit flow, Inlet end controls
2-1	1.3685	1.3685	3.62	1.0460	0.8120	0.6036	SuperCrit flow, Inlet end controls
3-2	0.9022	0.9022	2.00	1.5221	0.6063	0.4085	SuperCrit flow, Inlet end controls
4-3	0.2497	0.2497	0.22	1.2071	0.1905	0.1251	SuperCrit flow, Inlet end controls
2A-2	1.5320	1.5320	0.42	1.5221	0.2676	0.1923	Outlet Control
5-Gallery	0.2920	0.2920	0.32	0.6724	0.2327	0.1156	SuperCrit flow, Inlet end controls
1-Gallery	1.0437	1.0437	2.46	0.6724	0.6724	0.5220	SuperCrit flow, Inlet end controls
2-1	1.3685	1.3685	3.62	1.0460	0.8120	0.6036	SuperCrit flow, Inlet end controls
3-2	0.9022	0.9022	2.00	1.5221	0.6063	0.4085	SuperCrit flow, Inlet end controls
4-3	0.2497	0.2497	0.22	1.2071	0.1905	0.1251	SuperCrit flow, Inlet end controls
2A-2	1.5320	1.5320	0.42	1.5221	0.2676	0.1923	Outlet Control

Node and Reach invert report

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Node and Reach invert report

SECTION 6: OPERATIONS AND MAINTENANCE MANUAL

The proposed storm drainage system consists of buried pipes, sump catch basins, and infiltration facilities. These facilities will require periodic maintenance and inspection. Inspection and maintenance procedures are contained on the following pages. This information was taken from the 2014 DOE.

Maintenance Criteria for Infiltration Trenches

Make provisions for regular and perpetual maintenance of the infiltration basin/trench, including replacement and/or reconstruction of the any media relied upon for treatment purposes. Conduct maintenance when water remains in the basin or trench for more than 24 hours after the end of runoff, or when overflows occur more frequently than planned. For example, off-line infiltration facilities should not have any overflows. Infiltration facilities designed to completely infiltrate all flows to meet flow control standards should not overflow. An Operation and Maintenance Plan, approved by the local jurisdiction, should ensure maintaining the desired infiltration rate.

Include adequate access for operation and maintenance in the design of infiltration basins and trenches.

Conduct removal of accumulated debris/sediment in the basin/trench every 6 months or as needed to prevent clogging. Indications that the facility is not infiltrating adequately include:

- The Water Quality Design Storm Volume does not infiltrate within 48 hours.
- Water remains in the pond for greater than 24 hours after the end of most moderate rainfall events

Maintenance Criteria for BMP T7.20 Inifiltration Trench

- Monitor sediment buildup in the top foot of stone aggregate or the surface inlet on the same schedule as the observation well.

Table V-4.5.2(5) Maintenance Standards - 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%. 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. Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height. Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No Trash or debris located immediately in front of catch basin or on grate opening. No trash or debris in the catch basin. Inlet and outlet pipes free of trash or debris. 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

Table V-4.5.2(5) Maintenance Standards - Catch Basins

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
	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). 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	Top slab is free of holes and cracks. 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. 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.	Basin replaced or repaired to design standards. 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. Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation blocking opening to basin. No vegetation or root growth present.
	Contamination and Pollution	See "Detention Ponds" (No. 1).	No pollution present.

Table V-4.5.2(5) Maintenance Standards - 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

Table V-4.5.2(18) Maintenance Standards - Catch Basin Inserts

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Sediment Accumulation	When sediment forms a cap over the insert media of the insert and/or unit.	No sediment cap on the insert media and its unit.
	Trash and Debris Accumulation	Trash and debris accumulates on insert unit creating a blockage/restriction.	Trash and debris removed from insert unit. Runoff freely flows into catch basin.
	Media Insert Not Removing Oil	Effluent water from media insert has a visible sheen.	Effluent water from media insert is free of oils and has no visible sheen.
	Media Insert Water Saturated	Catch basin insert is saturated with water and no longer has the capacity to absorb.	Remove and replace media insert
	Media Insert-Oil Saturated	Media oil saturated due to petroleum spill that drains into catch basin.	Remove and replace media insert.
	Media Insert Use Beyond Product Life	Media has been used beyond the typical average life of media insert product.	Remove and replace media at regular intervals, depending on insert product.

SECTION 7: SPECIAL REPORTS AND STUDIES

The following studies were conducted in preparation of this Report:

- Geotechnical and Infiltration Feasibility Evaluation, Geotest, Dated August 26, 2016