PRELIMINARY STORMWATER REPORT

EXHIBIT 5

SISUL ENGINEERING

A Division of Sisul Enterprises, Inc.

375 PORTLAND AVENUE, GLADSTONE, OREGON 97027
(503) 657-0188
FAX (503) 657-5779

July 25, 2018

Cascadia Planning + Development Services
PO Box 1920
Silverton, OR 97381

ATTN: Steve Kay

RE: Harmony Park Townhomes

Dear Steve:

With regards to the City of Milwaukie's desire to have some form of infiltration on this site in accordance with Portland's Stormwater manual, we wish to note the following:

- A Water Quality Planter, per Portland's design standards would require a facility of approximately 1,000 SF. Such a facility if placed, in the only available area for such, to the north of the parking area, would create a significant land disturbance in the buffer area of the stream as the planter area would have to be leveled, for a planter to be constructed.
- It may be possible for pervious pavement to be used in some portions of the parking facility, but we would want guidance from the geotechnical engineer about where any such pervious surfacing could be placed, without placing undue hydraulic pressure the retaining wall that will be needed at the north end of the parking area.

As there is not a geotechnical engineer yet involved with the project, but one will be needed for permit drawings, we would ask that City defer the specifics of infiltration system until preparation of the permit drawings. We would be okay with a Condition of Approval that required infiltration of on-site stormwater to the extent feasible per geotechnical engineer recommendations.

Sincerely,

Thomas J. Sisul, P.E.

Harmony Park Apartments

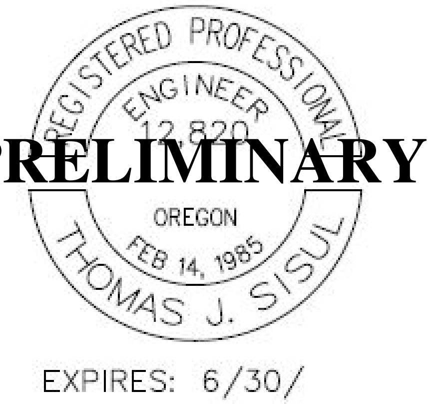
Milwaukie, OR

Developer: Harmony Park Apartments, LLC

J.O. SGL 17-072

March 9th, 2018

PRELIMINARY STORM DRAIN DETENTION CALCULATIONS



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Narrative:

The site is currently undeveloped where the majority of the site is covered with vegetation and trees. Minthorn Creek passes through the middle of the site. The property generally falls from the southwest to the northeast. The slopes vary between 5% and in excess of 50%. The steep slope areas occur near Minthorn Creek. The site is located due north of Harmony Road at 6115 SE Harmony Road in Milwaukie and is zoned R-2 with a Natural Resource Overlay.

The site is proposed to be developed with a 14-unit multi-family apartment as well as associated parking. The building footprint will be approximately 5,918 SF with parking lot and sidewalks approximately 9,727 SF. According to the City of Milwaukie pre-application comments (dated 11/2/17), the runoff from the proposed development is allowed to outfall to Minthorn Creek since there is no Milwaukie storm system to connect to in Harmony Road. Section 2 of the Stormwater Design Standards of the City of Milwaukie Public Works Standards will be followed for design of the stormwater management system. Detention and water quality are required. The City of Milwaukie requirements for detention are as follows.

Detention Requirements:

Developed 2-yr, 24-hour storm event must be released to the pre-developed runoff rate of a 2-yr 24-hour storm event.

Developed 5-yr, 24-hour storm event must be released to the pre-developed runoff rate of a 5-yr 24-hour storm event.

Developed 10-yr, 24-hour storm event must be released to the pre-developed runoff rate of a 10-yr 24-hour storm event.

Developed 25-yr, 24-hour storm event must be released to the pre-developed runoff rate of a 25-yr 24-hour storm event.

Site-Specific Stormwater Management Design Note:

According to Section 2.0044 of the Stormwater Design Standards of the City of Milwaukie Public Works Standards:

Detention volume storage methods, in order of preference, are the following:
1.) Surface storage—pond
2.) Underground storage by tank or vault will be approved by the City Engineer only when a pond is impracticable.

Due to the existing topography of the site and the elevation constraints that must be matched (i.e. existing sidewalks, contours along property lines, etc.), the detention requirements cannot be met via pond or planters. With the site layout and these constraints, there are no adequately sized areas to meet the requirements, therefore, the requirements will be met via detention pipe under the parking lot.

Site Conditions & Design Values - Pre-Development:

Area:

Total Area = 1.33 acres

Pervious Area = 1.33 acres

Impervious Area = 0.00 acres

Existing Use: The site is currently undeveloped where the majority of the site is covered with vegetation and trees.

Soil Type: This site has three (3) soil types as identified by NRCS Web Soil Survey (See Soil Survey Attachments):

Salem silt loam 76B -- Hydrologic Group 'B'
Wapato silty clay 84 – Hydrologic Groups 'C/D'
Woodburn silt loam 91B – Hydrologic Group 'C'

Runoff Curve Numbers:

Open space, good condition - Hydrologic Group 'D' => 80
Paved parking lots, roofs, driveways, etc. - Hydrologic Group 'D' => 98

Rainfall Distribution: (per Oregon Isopluvial Maps)

2-yr, 24-hour duration STD SCS Type 1A Storm => 2.4 inches
5-yr, 24-hour duration STD SCS Type 1A Storm => 2.9 inches
10-yr, 24-hour duration STD SCS Type 1A Storm => 3.4 inches
25-yr, 24-hour duration STD SCS Type 1A Storm => 3.9 inches

Time of Concentration – Pre-Developed: (Design Values per Table 5-4. Normal Range Hydraulic Roughness Coefficient (Manning's n) for Channels, City of Oregon City Stormwater and Grading Design Standards)

Sheet Flow: $$T_{C1} = \frac{0.42\,(n_s L)^{0.8}}{(P_2)^{0.5} * (s_o)^{0.4}}$$

$L = 150$ ft.

$P_2 = 2.4$ in.

$S_o = 0.025$ ft./ft.

$n_s = 0.15$

$$T_{C1} = \frac{0.42\,(0.15*150)^{0.8}}{(2.4)^{0.5} * (0.025)^{0.4}} \rightarrow \underline{T_{C1} = 14.31 \text{ minutes}}$$

Shallow Concentrated Flow: $T_{C2} = \dfrac{L}{(60)*k*\ (s_o)^{0.4}}$

L = 119 ft.
k = 11
S_o = 0.168 ft./ft.

$T_{C2} = \dfrac{(119)}{(60) * (11) *(0.168)^{0.5}}$ ➔ T_{C2} = 0.44 minutes

$T_C = T_{C1} + T_{C2}$ ➔ **T_C = 14.75 minutes**

Pre-Development Hydographs:

The pre-developed hydrographs will be generated using the Santa Barbara Urban Hydrograph (SBUH) Method. (KING COUNTY DEPARTMENT OF PUBLIC WORKS Surface Water Management Division, HYDROGRAPH PROGRAMS Version 4.20)

2-year Runoff Rate – Pre-Development

```
----------------------------------------------------------------------
******************** S.C.S. TYPE-1A DISTRIBUTION ********************
*********   2-YEAR  24-HOUR STORM  ****  2.40" TOTAL PRECIP. *********
----------------------------------------------------------------------
ENTER: A(PERV), CN(PERV), A(IMPERV), CN(IMPERV), TC FOR BASIN NO.  1
1.3264,80,0.0000,98,14.75

DATA PRINT-OUT:

  AREA(ACRES)     PERVIOUS     IMPERVIOUS   TC(MINUTES)
                 A     CN      A     CN
      1.3       1.3  80.0      .0  98.0       14.8

  PEAK-Q(CFS)   T-PEAK(HRS)    VOL(CU-FT)
      .19          7.83           3944

ENTER [d:][path]filename[.ext] FOR STORAGE OF COMPUTED HYDROGRAPH:
17072-2.und
```

5-year Runoff Rate – Pre-Development

```
----------------------------------------------------------------------
******************** S.C.S. TYPE-1A DISTRIBUTION ********************
*********   5-YEAR  24-HOUR STORM  ****  2.90" TOTAL PRECIP. *********
----------------------------------------------------------------------
ENTER: A(PERV), CN(PERV), A(IMPERV), CN(IMPERV), TC FOR BASIN NO.  1
1.3264,80,0.0000,98,14.75

DATA PRINT-OUT:
```

```
  AREA(ACRES)     PERVIOUS     IMPERVIOUS   TC(MINUTES)
                  A     CN     A     CN
       1.3        1.3  80.0     .0  98.0       14.8

  PEAK-Q(CFS)   T-PEAK(HRS)    VOL(CU-FT)
       .30          7.83           5645

ENTER [d:][path]filename[.ext] FOR STORAGE OF COMPUTED HYDROGRAPH:
17072-5.und
```

10-year Runoff Rate – Pre-Development

```
----------------------------------------------------------------------
******************* S.C.S. TYPE-1A DISTRIBUTION *******************
*********  10-YEAR  24-HOUR STORM  ****  3.40" TOTAL PRECIP. *********
----------------------------------------------------------------------
ENTER: A(PERV), CN(PERV), A(IMPERV), CN(IMPERV), TC FOR BASIN NO.  1
1.3264,80,0.0000,98,14.75

DATA PRINT-OUT:

  AREA(ACRES)     PERVIOUS     IMPERVIOUS   TC(MINUTES)
                  A     CN     A     CN
       1.3        1.3  80.0     .0  98.0       14.8

  PEAK-Q(CFS)   T-PEAK(HRS)    VOL(CU-FT)
       .43          7.83           7480

ENTER [d:][path]filename[.ext] FOR STORAGE OF COMPUTED HYDROGRAPH:
17072-10.und
```

25-year Runoff Rate – Pre-Development

```
----------------------------------------------------------------------
******************* S.C.S. TYPE-1A DISTRIBUTION *******************
*********  25-YEAR  24-HOUR STORM  ****  3.90" TOTAL PRECIP. *********
----------------------------------------------------------------------
ENTER: A(PERV), CN(PERV), A(IMPERV), CN(IMPERV), TC FOR BASIN NO.  1
1.3264,80,0.0000,98,14.75

DATA PRINT-OUT:

  AREA(ACRES)     PERVIOUS     IMPERVIOUS   TC(MINUTES)
                  A     CN     A     CN
       1.3        1.3  80.0     .0  98.0       14.8

  PEAK-Q(CFS)   T-PEAK(HRS)    VOL(CU-FT)
       .56          7.83           9411

ENTER [d:][path]filename[.ext] FOR STORAGE OF COMPUTED HYDROGRAPH:
17072-25.und
```

Site Conditions & Design Values - Post-Development:

Area: These calculations are for the area of the proposed development that will drain into the detention pipe.

Total Area = 1.33 acres
Pervious Area = 0.9446 acres
Impervious Area = 0.3592 acres

Runoff Curve Numbers:

Open space, good condition - Hydrologic Group 'D' => 80
Paved parking lots, roofs, driveways, etc. - Hydrologic Group 'D' => 98

Rainfall Distribution: (per Oregon Isopluvial Maps)

2-yr, 24-hour duration STD SCS Type 1A Storm => 2.4 inches
5-yr, 24-hour duration STD SCS Type 1A Storm => 2.9 inches
10-yr, 24-hour duration STD SCS Type 1A Storm => 3.4 inches
25-yr, 24-hour duration STD SCS Type 1A Storm => 3.9 inches

Time of Concentration – Post-Development:

Since a large portion of the site is impervious, the minimum time of concentration of **5 minutes** will be used.

T_c = 5 minutes

Post-Developed Hydrographs:

The post developed hydrographs will be generated using the Santa Barbara Urban Hydrograph (SBUH) Method. (KING COUNTY DEPARTMENT OF PUBLIC WORKS Surface Water Management Division, HYDROGRAPH PROGRAMS Version 4.20)

2-year Runoff Rate – Post Development

```
----------------------------------------------------------------------
******************** S.C.S. TYPE-1A DISTRIBUTION ********************
*********   2-YEAR  24-HOUR STORM  ****  2.40" TOTAL PRECIP. *********
----------------------------------------------------------------------
ENTER: A(PERV), CN(PERV), A(IMPERV), CN(IMPERV), TC FOR BASIN NO.  1
0.9446,80,0.3592,98,5

DATA PRINT-OUT:

  AREA(ACRES)    PERVIOUS     IMPERVIOUS   TC(MINUTES)
                 A     CN      A     CN
      1.3         .9   80.0     .4   98.0        5.0

  PEAK-Q(CFS)   T-PEAK(HRS)    VOL(CU-FT)
      .37          7.67           5644

ENTER [d:][path]filename[.ext] FOR STORAGE OF COMPUTED HYDROGRAPH:
17072-2.dev
```

5-year Runoff Rate – Post-Development

```
-----------------------------------------------------------------------
******************* S.C.S. TYPE-1A DISTRIBUTION *******************
*********   5-YEAR  24-HOUR STORM  ****  2.90" TOTAL PRECIP. *********
-----------------------------------------------------------------------
ENTER: A(PERV), CN(PERV), A(IMPERV), CN(IMPERV), TC FOR BASIN NO.  1
0.9446,80,0.3592,98,5

DATA PRINT-OUT:

  AREA(ACRES)    PERVIOUS    IMPERVIOUS   TC(MINUTES)
                 A     CN     A     CN
       1.3        .9  80.0     .4  98.0        5.0

  PEAK-Q(CFS)   T-PEAK(HRS)    VOL(CU-FT)
       .52          7.67          7510

ENTER [d:][path]filename[.ext] FOR STORAGE OF COMPUTED HYDROGRAPH:
17072-5.dev
```

10-year Runoff Rate – Post-Development

```
-----------------------------------------------------------------------
******************* S.C.S. TYPE-1A DISTRIBUTION *******************
*********  10-YEAR  24-HOUR STORM  ****  3.40" TOTAL PRECIP. *********
-----------------------------------------------------------------------
ENTER: A(PERV), CN(PERV), A(IMPERV), CN(IMPERV), TC FOR BASIN NO.  1
0.9446,80,0.3592,98,5

DATA PRINT-OUT:

  AREA(ACRES)    PERVIOUS    IMPERVIOUS   TC(MINUTES)
                 A     CN     A     CN
       1.3        .9  80.0     .4  98.0        5.0

  PEAK-Q(CFS)   T-PEAK(HRS)    VOL(CU-FT)
       .67          7.67          9469

ENTER [d:][path]filename[.ext] FOR STORAGE OF COMPUTED HYDROGRAPH:
17072-10.dev
```

25-year Runoff Rate – Post-Development

```
-----------------------------------------------------------------------
******************* S.C.S. TYPE-1A DISTRIBUTION *******************
*********  25-YEAR  24-HOUR STORM  ****  3.90" TOTAL PRECIP. *********
-----------------------------------------------------------------------
ENTER: A(PERV), CN(PERV), A(IMPERV), CN(IMPERV), TC FOR BASIN NO.  1
0.9446,80,0.3592,98,5

DATA PRINT-OUT:

  AREA(ACRES)    PERVIOUS    IMPERVIOUS   TC(MINUTES)
                 A     CN     A     CN
       1.3        .9  80.0     .4  98.0        5.0

  PEAK-Q(CFS)   T-PEAK(HRS)    VOL(CU-FT)
       .83          7.67         11497
```

```
ENTER [d:][path]filename[.ext] FOR STORAGE OF COMPUTED HYDROGRAPH:
17072-25.dev
```

Detention Pipe Routing:

The detention pipe will be 42" in diameter and 140 feet in length. The flow control structure for the detention pipe will have two orifices and an overflow riser. The attached spreadsheet shows the detention area routing data.

The routing will be performed using the Santa Barbara Urban Hydrograph (SBUH) Method. (KING COUNTY DEPARTMENT OF PUBLIC WORKS Surface Water Management Division, HYDROGRAPH PROGRAMS Version 4.20)

```
RESERVOIR ROUTING INFLOW/OUTFLOW ROUTINE

SPECIFY [d:][path]filename[.ext] OF ROUTING DATA
17072.txt
 DISPLAY ROUTING DATA (Y or N)?
y

ROUTING DATA:
```

STAGE(FT)	DISCHARGE(CFS)	STORAGE(CU-FT)	PERM-AREA(SQ-FT)
.00	.00	.0	.0
.25	.08	45.8	.0
.50	.12	124.3	.0
.75	.15	221.1	.0
1.00	.17	330.1	.0
1.25	.21	449.4	.0
1.50	.27	570.6	.0
1.75	.30	696.2	.0
2.00	.34	821.5	.0
2.25	.37	944.3	.0
2.50	.39	1061.8	.0
2.75	.42	1170.9	.0
3.00	.44	1267.7	.0
3.25	1.51	1346.3	.0
3.50	3.46	1390.9	.0

```
AVERAGE PERM-RATE:    .0 MINUTES/INCH
```

2-year Detention Routing:

```
ENTER [d:][path]filename[.ext] OF COMPUTED HYDROGRAPH:
17072-2.dev

INFLOW/OUTFLOW ANALYSIS:
```

PEAK-INFLOW(CFS)	PEAK-OUTFLOW(CFS)	OUTFLOW-VOL(CU-FT)
.37	**.19**	5706

INITIAL-STAGE(FT)	TIME-OF-PEAK(HRS)	PEAK-STAGE-ELEV(FT)
.00	8.00	**1.15**

```
PEAK STORAGE:      390 CU-FT
```

```
ENTER [d:][path]filename[.ext] FOR STORAGE OF COMPUTED HYDROGRAPH:
17072-2.pip
```

5-year Detention Routing:

```
ENTER [d:][path]filename[.ext] OF COMPUTED HYDROGRAPH:
17072-5.dev

INFLOW/OUTFLOW ANALYSIS:

  PEAK-INFLOW(CFS)   PEAK-OUTFLOW(CFS)   OUTFLOW-VOL(CU-FT)
         .52                .28                 7505

  INITIAL-STAGE(FT)  TIME-OF-PEAK(HRS)   PEAK-STAGE-ELEV(FT)
         .00               8.00                 1.57

  PEAK STORAGE:      600 CU-FT

ENTER [d:][path]filename[.ext] FOR STORAGE OF COMPUTED HYDROGRAPH:
17072-5.pip
```

10-year Detention Routing:

```
ENTER [d:][path]filename[.ext] OF COMPUTED HYDROGRAPH:
17072-10.dev

INFLOW/OUTFLOW ANALYSIS:

  PEAK-INFLOW(CFS)   PEAK-OUTFLOW(CFS)   OUTFLOW-VOL(CU-FT)
         .67                .35                 9545

  INITIAL-STAGE(FT)  TIME-OF-PEAK(HRS)   PEAK-STAGE-ELEV(FT)
         .00               8.00                 2.05

  PEAK STORAGE:      840 CU-FT

ENTER [d:][path]filename[.ext] FOR STORAGE OF COMPUTED HYDROGRAPH:
17072-10.pip
```

25-year Detention Routing:

```
ENTER [d:][path]filename[.ext] OF COMPUTED HYDROGRAPH:
17072-25.dev

INFLOW/OUTFLOW ANALYSIS:

  PEAK-INFLOW(CFS)   PEAK-OUTFLOW(CFS)   OUTFLOW-VOL(CU-FT)
         .83                .40                11490

  INITIAL-STAGE(FT)  TIME-OF-PEAK(HRS)   PEAK-STAGE-ELEV(FT)
         .00               8.00                 2.62

  PEAK STORAGE:     1110 CU-FT

ENTER [d:][path]filename[.ext] FOR STORAGE OF COMPUTED HYDROGRAPH:
17072-25.pip
```

Detention Summary:

The detention requirements are to as follows:

Developed 2-yr, 24-hour storm event must be released to the pre-developed runoff rate of a 2-yr 24-hour storm event.

Developed 5-yr, 24-hour storm event must be released to the pre-developed runoff rate of a 5-yr 24-hour storm event.

Developed 10-yr, 24-hour storm event must be released to the pre-developed runoff rate of a 10-yr 24-hour storm event.

Developed 25-yr, 24-hour storm event must be released to the pre-developed runoff rate of a 25-yr 24-hour storm event.

The detention pipe will be 42" in diameter and 140 feet in length. The flow control structure will have two orifices and an overflow riser. The bottom orifice will be 2-1/2 inches in diameter at an elevation of 0.00 feet above the bottom of the pipe, and the top orifice will be 2 inches in diameter at an elevation of 1.15 feet above the bottom of the pipe. The 12-inch overflow riser will be at an elevation of 3.00 feet above the bottom of the pipe.

The following tables show that the detention requirements have been met.

Minimum Peak Rate Stormwater Runoff Control Requirements.

Developed 2-yr, 24-hour storm event must be released to the pre-developed runoff rate of a 2-yr 24-hour storm event.

2-year allowable release rate	2-year post-development release rate
0.19 cfs	0.19 cfs

Developed 5-yr, 24-hour storm event must be released to the pre-developed runoff rate of a 5-yr 24-hour storm event.

5-year allowable release rate	5-year post-development release rate
0.30 cfs	0.28 cfs

Developed 10-yr, 24-hour storm event must be released to the pre-developed runoff rate of a 10-yr 24-hour storm event.

10-year allowable release rate	**10-year post-development release rate**
0.43 cfs	**0.35 cfs**

Developed 25-yr, 24-hour storm event must be released to the pre-developed runoff rate of a 25-yr 24-hour storm event.

25-year allowable release rate	**25-year post-development release rate**
0.56 cfs	**0.40 cfs**

Detention Pipe Routing Data

Harmony Park Apartments

J.O. SGL17-072

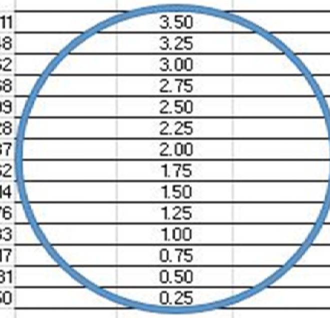
Pipe Diameter =	42	inches	Orifice 1 Diameter (in):	2.500	Overflow Length (in):	37.7
Pipe Length =	140	feet	Orifice 1 Elevation (ft):	0.00	Overflow Elevation (ft):	3.00
*Pipe Slope =	0.0000	ft/ft	Orifice 2 Diameter (in):	2.000		
Inv. Elevation =	0.00	ft	Orifice 2 Elevation (ft):	1.15		

Head (ft)	Stage Elevation (ft)	Downstream Average Area (sq.ft.)	Upstream Average Area (sq.ft.)	Pipe Storage (cu.ft.)	Manhole Storage (cu.ft.)	Total Storage (cu.ft.)	Elevation (ft)	Orifice 1 Discharge (cfs)	Orifice 2 Discharge (cfs)	Overflow Discharge (cfs)	Actual Discharge (cfs)
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000
0.25	0.25	0.31	0.31	42.70	3.14	45.84	0.25	0.085	0.000	0.000	0.085
0.50	0.50	0.84	0.84	118.03	6.28	124.31	0.50	0.120	0.000	0.000	0.120
0.75	0.75	1.51	1.51	211.64	9.42	221.06	0.75	0.147	0.000	0.000	0.147
1.00	1.00	2.27	2.27	317.56	12.56	330.12	1.00	0.170	0.000	0.000	0.170
1.25	1.25	3.08	3.08	433.66	15.70	449.36	1.25	0.190	0.034	0.000	0.224
1.50	1.50	3.94	3.94	551.80	18.84	570.64	1.50	0.208	0.064	0.000	0.272
1.75	1.75	4.81	4.81	674.27	21.98	696.25	1.75	0.224	0.084	0.000	0.308
2.00	2.00	5.68	5.68	796.42	25.12	821.54	2.00	0.240	0.100	0.000	0.340
2.25	2.25	6.54	6.54	915.99	28.26	944.25	2.25	0.254	0.114	0.000	0.368
2.50	2.50	7.35	7.35	1030.39	31.40	1061.79	2.50	0.268	0.126	0.000	0.394
2.75	2.75	8.11	8.11	1136.35	34.54	1170.89	2.75	0.281	0.137	0.000	0.419
3.00	3.00	8.78	8.78	1230.07	37.68	1267.75	3.00	0.294	0.148	0.000	0.441
3.25	3.25	9.32	9.32	1305.47	40.82	1346.29	3.25	0.306	0.157	1.052	1.516
3.50	3.50	9.62	9.62	1346.95	43.96	1390.91	3.50	0.317	0.166	2.977	3.461

*If pipe is given a slope of greater than 0.0000, then change equation in cells for pipe storage to account for upstream and downstream areas.

A	Head
B	Water Surface Elevation
C	Downstream Water Surface Area @ Given Elevation
D	Upstream Water Surface Area @ Given Elevation
E	Pipe Storage Volume = [(Average Area) x (d Elevation)] + Previous Volume
F	Manhole Storage Volume = (Head) + [(3.14 x (Manhole Radius)^2) x (Stage Interval)]
G	Total Storage = Pipe Storage Volume + Manhole Storage Volume
ORIFICE	Q = 0.62 x (Area) x (2 x g x h)^(0.5)
I	Q = Orifice Equation
J	Q = Orifice Equation
K	Overflow Riser as a Weir: Q = 2.68 x L x H^(3/2)
	L = 2 x π x r^2
L	Actual Discharge = I + J + K

42" Pipe Cross-Section Stage Areas:



Area	Stage
9.6211	3.50
9.3248	3.25
8.7862	3.00
8.1168	2.75
7.3599	2.50
6.5428	2.25
5.6887	2.00
4.8162	1.75
3.9414	1.50
3.0976	1.25
2.2683	1.00
1.5117	0.75
0.8431	0.50
0.3050	0.25

0.00	0.00	0.0	0.00
0.25	0.08	45.8	0.00
0.50	0.12	124.3	0.00
0.75	0.15	221.1	0.00
1.00	0.17	330.1	0.00
1.25	0.22	449.4	0.00
1.50	0.27	570.6	0.00
1.75	0.31	696.2	0.00
2.00	0.34	821.5	0.00
2.25	0.37	944.3	0.00
2.50	0.39	1061.8	0.00
2.75	0.42	1170.9	0.00
3.00	0.44	1267.7	0.00
3.25	1.52	1346.3	0.00
3.50	3.46	1390.9	0.00

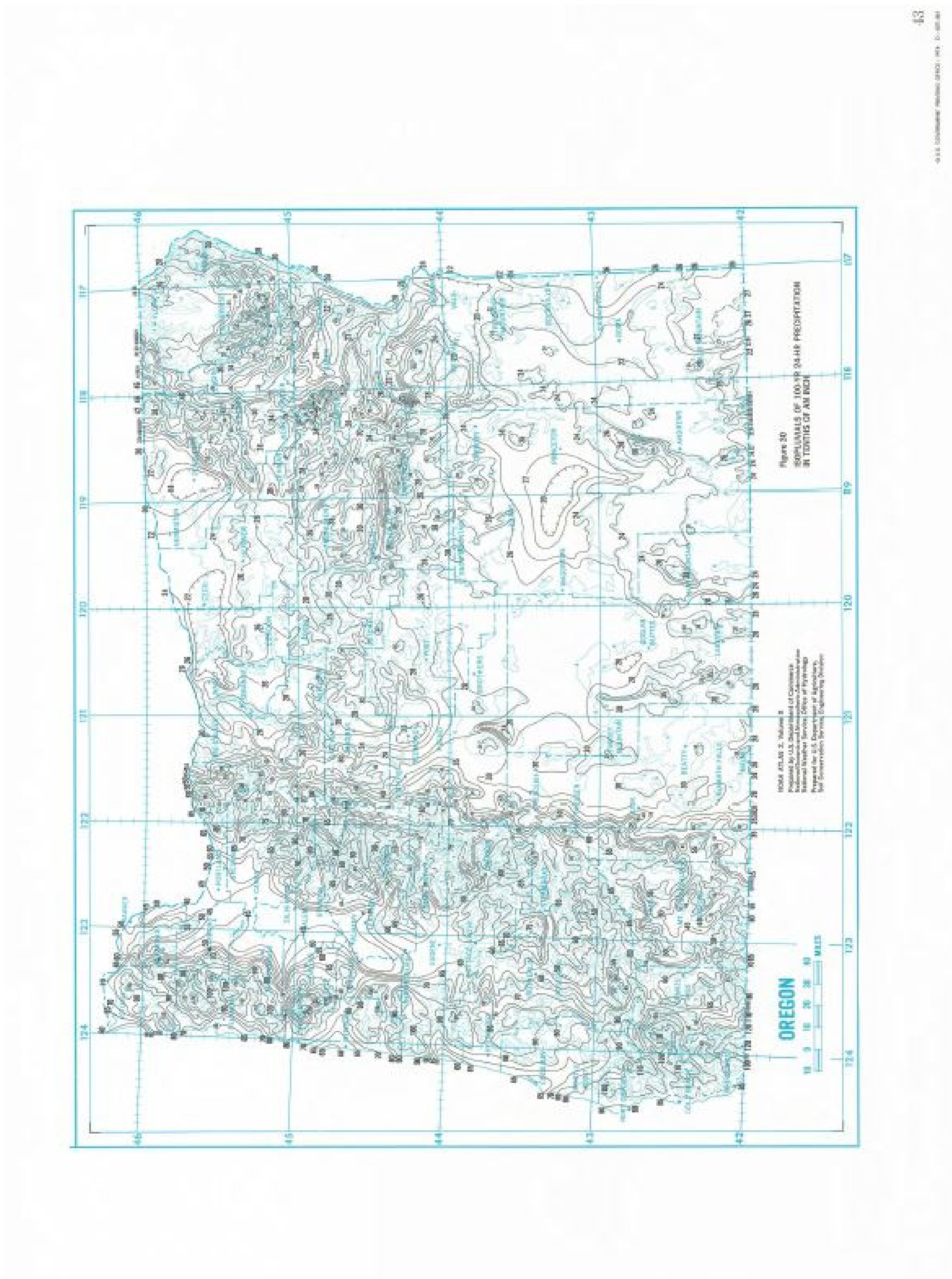
Emergency Overflow:

The 100-year, 24-hour storm was routed through the detention pipe to verify that it can overflow safely. The routing data is shown below:

100-year Runoff Rate – Post-Development

```
----------------------------------------------------------------------
******************** S.C.S. TYPE-1A DISTRIBUTION ********************
********* 100-YEAR  24-HOUR STORM  ****  5.00" TOTAL PRECIP. *********
----------------------------------------------------------------------
ENTER: A(PERV), CN(PERV), A(IMPERV), CN(IMPERV), TC FOR BASIN NO.  1
0.9446,80,0.3592,98,5

DATA PRINT-OUT:

  AREA(ACRES)     PERVIOUS     IMPERVIOUS   TC(MINUTES)
                 A     CN     A     CN
      1.3         .9   80.0     .4   98.0        5.0

  PEAK-Q(CFS)    T-PEAK(HRS)    VOL(CU-FT)
      1.20          7.67          16129

ENTER [d:][path]filename[.ext] FOR STORAGE OF COMPUTED HYDROGRAPH:
17072-100.dev
```

* NOTE: The 5.00” of precipitation was obtained from the 100-year, 24-hour isopluvial map of Oregon (See following page).


OREGON

100-Year Detention Routing:

```
ENTER [d:][path]filename[.ext] OF COMPUTED HYDROGRAPH:
17072-100.dev
INFLOW/OUTFLOW ANALYSIS:

  PEAK-INFLOW(CFS)   PEAK-OUTFLOW(CFS)   OUTFLOW-VOL(CU-FT)
       1.20                1.20                16062

  INITIAL-STAGE(FT)  TIME-OF-PEAK(HRS)   PEAK-STAGE-ELEV(FT)
        .00                7.83                 3.19

  PEAK STORAGE:     1320 CU-FT

ENTER [d:][path]filename[.ext] FOR STORAGE OF COMPUTED HYDROGRAPH:
17072-100.pip
```

Summary:

The peak stage elevation from the routed 100-year, 24-hour storm is 3.19 feet above the bottom of the pipe which is approximately 0.19' above the top of the overflow riser. Therefore, there is still 0.31 feet of freeboard within the 42" detention pipe. Thus, the structure can adequately convey the 100-year storm event.

For good measure, the full flow capacity of the outlet pipe from the flow control manhole was examined to ensure that it will be capable of conveying the flows from the 100-year, 24-hour storm. If the peak flow resulting from the routing of the 100-year storm is less than the full flow discharge, than the pipe size is adequate. It is assumed that the pipe will be an 8" diameter. FlowMaster was used to obtain these results.

```
Circular Channel: Manning's Equation

Comment: 8" OUT FROM FLOW CONTROL MANHOLE

 Solve For......Full Flow Capacity

 Diameter.......     0.67 ft          Velocity......      4.91 fps
 Slope..........     0.0200 ft/ft     Flow Area.....      0.35 sf
 Manning's n....     0.013            Critical Slope      0.0176 ft/ft
 Discharge......     1.73 cfs         Critical Depth      0.60 ft
 Depth..........     0.67 ft          Percent Full..      100.00 %
                                      Froude Number.      FULL
                                      Full Capacity.      1.73 cfs
                                      QMAX @.94D....      1.86 cfs
```

Since the full flow discharge at a 2% slope is determined to be 1.73 CFS and the peak discharge from the routed 100-year storm is 1.20 CFS, it is concluded that the pipe size is adequate to convey the runoff from the 100-year storm.

NOTE: Due to the terrain and proposed grading on site, the slope of this pipe is likely to be steeper, and therefore, would be even more capable of conveying the discharge (minimum slope of 8" pipe = 0.0096 or 0.96%).

Water Quality Calculations:

According to City of Milwaukie's pre-application comments (dated 11/2/17), the City has adopted the City of Portland 2016 Stormwater Management Manual for the design of water quality facilities. As previously mentioned, due to topography and grading constraints for the site, a typical water quality facility is not feasible. Therefore, according to the City of Portland 2016 Stormwater Management Manual:

"Manufactured stormwater treatment technologies may also be considered where site constraints limit or prevent facility sizing for the water quality storm (0.83 inches in 24 hours). In those instances, approved manufactured stormwater treatment technologies may be proposed for pollution reduction."

Water Quality Calculations:

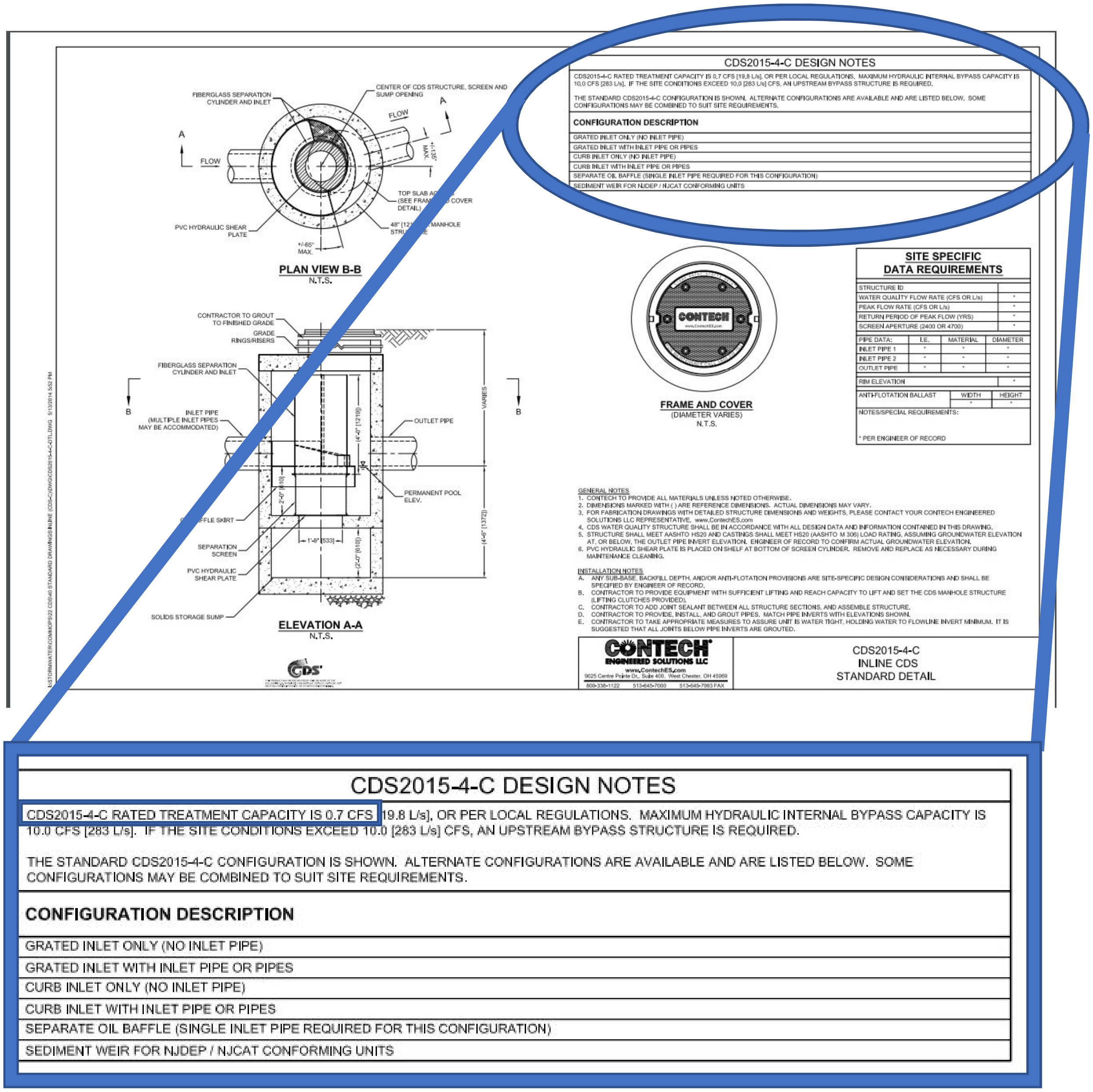
The water quality requirement is to collect and treat 0.83 inches of runoff in 24 hours.

The water quality analysis will be performed using the Santa Barbara Urban Hydrograph (SBUH) Method. (KING COUNTY DEPARTMENT OF PUBLIC WORKS Surface Water Management Division, HYDROGRAPH PROGRAMS Version 4.20)

```
----------------------------------------------------------------------
******************* S.C.S. TYPE-1A DISTRIBUTION *******************
*********   1-YEAR  24-HOUR STORM  ****   .83" TOTAL PRECIP. *********
----------------------------------------------------------------------
ENTER: A(PERV), CN(PERV), A(IMPERV), CN(IMPERV), TC FOR BASIN NO.  1
0.9446,80,0.3592,98,5

DATA PRINT-OUT:

  AREA(ACRES)     PERVIOUS     IMPERVIOUS   TC(MINUTES)
                 A      CN      A     CN
      1.3         .9   80.0     .4   98.0        5.0

  PEAK-Q(CFS)    T-PEAK(HRS)     VOL(CU-FT)
      .06           7.67            949

ENTER [d:][path]filename[.ext] FOR STORAGE OF COMPUTED HYDROGRAPH:
17072-1.wq
```

Water Quality Summary:

A Contech CDS2015-4-C water quality manhole will be sufficient enough to treat runoff from the proposed development. See the following detail for further information.


CDS2015-4-C DESIGN NOTES
CDS2015-4-C RATED TREATMENT CAPACITY IS 0.7 CFS [19.8 L/s], OR PER LOCAL REGULATIONS. MAXIMUM HYDRAULIC INTERNAL BYPASS CAPACITY IS 10.0 CFS [283 L/s]. IF THE SITE CONDITIONS EXCEED 10.0 [283 L/s] CFS, AN UPSTREAM BYPASS STRUCTURE IS REQUIRED.
THE STANDARD CDS2015-4-C CONFIGURATION IS SHOWN. ALTERNATE CONFIGURATIONS ARE AVAILABLE AND ARE LISTED BELOW. SOME CONFIGURATIONS MAY BE COMBINED TO SUIT SITE REQUIREMENTS.
CONFIGURATION DESCRIPTION
GRATED INLET ONLY (NO INLET PIPE)
GRATED INLET WITH INLET PIPE OR PIPES
CURB INLET ONLY (NO INLET PIPE)
CURB INLET WITH INLET PIPE OR PIPES
SEPARATE OIL BAFFLE (SINGLE INLET PIPE REQUIRED FOR THIS CONFIGURATION)
SEDIMENT WEIR FOR NJDEP / NJCAT CONFORMING UNITS
PLAN VIEW B-B
ELEVATION A-A
FRAME AND COVER
SITE SPECIFIC DATA REQUIREMENTS
CONTECH ENGINEERED SOLUTIONS LLC
CDS2015-4-C
INLINE CDS
STANDARD DETAIL

Erosion Prevention and Sediment Control:

During construction, sediment fence will be placed surrounding the perimeter of the site improvements to prevent any movement of soil or debris from on-site to neighboring properties. Sediment fence will remain on-site for the entire duration of construction. In the catch basins on-site, silt sack inserts will be used to catch sediment that is transferred by storm runoff. Bio bags will be used on the proposed curb inlet to the north as well as the next downstream catch basins from the site. Straw wattles will be placed along the contours on the steep slopes.

SUPPORTING PAGES

Engineering Properties

This table gives the engineering classifications and the range of engineering properties for the layers of each soil in the survey area.

Hydrologic soil group is a group of soils having similar runoff potential under similar storm and cover conditions. The criteria for determining Hydrologic soil group is found in the National Engineering Handbook, Chapter 7 issued May 2007(http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17757.wba). Listing HSGs by soil map unit component and not by soil series is a new concept for the engineers. Past engineering references contained lists of HSGs by soil series. Soil series are continually being defined and redefined, and the list of soil series names changes so frequently as to make the task of maintaining a single national list virtually impossible. Therefore, the criteria is now used to calculate the HSG using the component soil properties and no such national series lists will be maintained. All such references are obsolete and their use should be discontinued. Soil properties that influence runoff potential are those that influence the minimum rate of infiltration for a bare soil after prolonged wetting and when not frozen. These properties are depth to a seasonal high water table, saturated hydraulic conductivity after prolonged wetting, and depth to a layer with a very slow water transmission rate. Changes in soil properties caused by land management or climate changes also cause the hydrologic soil group to change. The influence of ground cover is treated independently. There are four hydrologic soil groups, A, B, C, and D, and three dual groups, A/D, B/D, and C/D. In the dual groups, the first letter is for drained areas and the second letter is for undrained areas.

The four hydrologic soil groups are described in the following paragraphs:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Depth to the upper and lower boundaries of each layer is indicated.

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is 15 percent or more, an appropriate modifier is added, for example, "gravelly."

Classification of the soils is determined according to the Unified soil classification system (ASTM, 2005) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO, 2004).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to particle-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of particle-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Percentage of rock fragments larger than 10 inches in diameter and 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

References:

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Report—Engineering Properties

Absence of an entry indicates that the data were not estimated. The asterisk '*' denotes the representative texture; other possible textures follow the dash. The criteria for determining the hydrologic soil group for individual soil components is found in the National Engineering Handbook, Chapter 7 issued May 2007(http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17757.wba). Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Engineering Properties–Clackamas County Area, Oregon

Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				L-R-H	L-R-H	L-R-H	L-R-H	L-R-H	L-R-H	L-R-H	L-R-H
76B—Salem silt loam, 0 to 7 percent slopes														
Salem	85	B	0-8	Silt loam	CL-ML, ML, CL	A-4	0- 0- 0	0- 0- 0	95-98-100	75-80-85	65-70-75	60-65-70	25-30-35	5-8 -10
			8-24	Gravelly clay loam, gravelly silty clay loam, gravelly silt loam, gravelly loam	CL, GM, ML, SM, GC	A-2, A-6, A-7	0- 0- 0	0- 3- 5	55-68-80	50-63-75	40-55-70	20-43-65	35-40-45	10-15-20
			24-60	Extremely gravelly loamy sand, very gravelly loamy sand, extremely gravelly sand	GP, GP-GM, SP, SP-SM	A-1	0- 0- 0	0- 8- 15	25-40-55	15-33-50	10-23-35	0- 5- 10	0-5 -10	NP
84—Wapato silty clay loam														
Wapato	85	C/D	0-18	Silty clay loam	ML	A-6	0- 0- 0	0- 0- 0	100-100-100	100-100-100	95-98-100	85-90-95	35-38-40	10-13-15
			18-45	Silty clay loam	ML	A-4, A-6	0- 0- 0	0- 0- 0	100-100-100	100-100-100	95-98-100	80-88-95	30-35-40	5-10-15
			45-60	Silty clay, silty clay loam	MH	A-7	0- 0- 0	0- 0- 0	100-100-100	100-100-100	95-98-100	90-93-95	50-55-60	10-15-20

Engineering Properties–Clackamas County Area, Oregon

Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				L-R-H	L-R-H	L-R-H	L-R-H	L-R-H	L-R-H	L-R-H	L-R-H
91B—Woodburn silt loam, 3 to 8 percent slopes														
Woodburn	90	C	0-16	Silt loam	ML	A-4	0- 0- 0	0- 0- 0	100-100-100	95-98-100	85-90-95	70-78-85	25-28-30	NP-3 -5
			16-38	Silty clay loam, silt loam	CL	A-6	0- 0- 0	0- 0- 0	100-100-100	100-100-100	95-98-100	85-90-95	30-35-40	10-15-20
			38-60	Silt loam, silty clay loam	CL-ML, ML, CL	A-4	0- 0- 0	0- 0- 0	100-100-100	100-100-100	95-98-100	80-85-90	25-30-35	5-8 -10

Data Source Information

Soil Survey Area: Clackamas County Area, Oregon
Survey Area Data: Version 12, Sep 19, 2017

Physical Soil Properties

This table shows estimates of some physical characteristics and features that affect soil behavior. These estimates are given for the layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Depth to the upper and lower boundaries of each layer is indicated.

Particle size is the effective diameter of a soil particle as measured by sedimentation, sieving, or micrometric methods. Particle sizes are expressed as classes with specific effective diameter class limits. The broad classes are sand, silt, and clay, ranging from the larger to the smaller.

Sand as a soil separate consists of mineral soil particles that are 0.05 millimeter to 2 millimeters in diameter. In this table, the estimated sand content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

Silt as a soil separate consists of mineral soil particles that are 0.002 to 0.05 millimeter in diameter. In this table, the estimated silt content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of sand, silt, and clay affects the physical behavior of a soil. Particle size is important for engineering and agronomic interpretations, for determination of soil hydrologic qualities, and for soil classification.

The amount and kind of clay affect the fertility and physical condition of the soil and the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, saturated hydraulic conductivity (Ksat), plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3- or 1/10-bar (33kPa or 10kPa) moisture tension. Weight is determined after the soil is dried at 105 degrees C. In the table, the estimated moist bulk density of each soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute linear extensibility, shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. Depending on soil texture, a bulk density of more than 1.4 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

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

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each soil layer. The capacity varies, depending on soil properties that affect retention of water. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

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

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

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In this table, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter. The content of organic matter in a soil can be maintained by returning crop residue to the soil.

Organic matter has a positive effect on available water capacity, water infiltration, soil organism activity, and tilth. It is a source of nitrogen and other nutrients for crops and soil organisms.

Erosion factors are shown in the table as the K factor (Kw and Kf) and the T factor. Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and Ksat. Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor Kw indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments.

Erosion factor Kf indicates the erodibility of the fine-earth fraction, or the material less than 2 millimeters in size.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind and/or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their susceptibility to wind erosion in cultivated areas. The soils assigned to group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible. The groups are described in the "National Soil Survey Handbook."

Wind erodibility index is a numerical value indicating the susceptibility of soil to wind erosion, or the tons per acre per year that can be expected to be lost to wind erosion. There is a close correlation between wind erosion and the texture of the surface layer, the size and durability of surface clods, rock fragments, organic matter, and a calcareous reaction. Soil moisture and frozen soil layers also influence wind erosion.

Reference:
United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. (http://soils.usda.gov)

Report—Physical Soil Properties

Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Physical Soil Properties–Clackamas County Area, Oregon														
Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Saturated hydraulic conductivity	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In	Pct	Pct	Pct	g/cc	micro m/sec	In/In	Pct	Pct					
76B—Salem silt loam, 0 to 7 percent slopes														
Salem	0-8	-29-	-53-	15-18- 20	1.20-1.35 -1.50	4.00-9.00-14.00	0.11-0.14-0. 17	0.0- 1.5- 2.9	2.0- 4.0- 6.0	.37	.37	3	5	56
	8-24	-34-	-37-	25-30- 35	1.20-1.35 -1.50	4.00-9.00-14.00	0.09-0.13-0. 17	3.0- 4.5- 5.9	1.0- 2.0- 3.0	.15	.28			
	24-60	-84-	- 9-	0- 8- 15	1.30-1.45 -1.60	141.00-300.00- 705.00	0.03-0.04-0. 05	0.0- 1.5- 2.9	0.1- 0.6- 1.0	.02	.05			
84—Wapato silty clay loam														
Wapato	0-18	- 7-	-62-	27-31- 35	1.20-1.30 -1.40	1.40-8.00-14.00	0.19-0.20-0. 21	3.0- 4.5- 5.9	4.0- 6.0- 8.0	.32	.32	5	6	48
	18-45	- 7-	-62-	27-31- 35	1.20-1.30 -1.40	1.40-3.00-4.00	0.15-0.16-0. 17	3.0- 4.5- 5.9	0.5- 2.8- 5.0	.37	.37			
	45-60	- 8-	-49-	35-43- 50	1.20-1.30 -1.40	1.40-3.00-4.00	0.15-0.16-0. 17	3.0- 4.5- 5.9	0.2- 1.1- 2.0	.32	.32			

Physical Soil Properties–Clackamas County Area, Oregon														
Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Saturated hydraulic conductivity	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In	Pct	Pct	Pct	g/cc	micro m/sec	In/In	Pct	Pct					
91B—Woodburn silt loam, 3 to 8 percent slopes														
Woodburn	0-16	-14-	-71-	10-15- 20	1.20-1.30 -1.40	4.00-9.00-14.00	0.19-0.20-0. 21	0.0- 1.5- 2.9	3.0- 4.0- 5.0	.37	.37	5	5	56
	16-38	- 7-	-65-	20-28- 35	1.20-1.30 -1.40	4.00-9.00-14.00	0.19-0.20-0. 21	3.0- 4.5- 5.9	0.5- 1.8- 3.0	.43	.43			
	38-60	-10-	-68-	15-23- 30	1.30-1.40 -1.50	0.42-0.91-1.40	0.19-0.20-0. 21	0.0- 1.5- 2.9	0.0- 0.3- 0.5	.55	.55			

Data Source Information

Soil Survey Area: Clackamas County Area, Oregon
Survey Area Data: Version 12, Sep 19, 2017

Soil Map—Clackamas County Area, Oregon

Map Scale: 1:758 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 10 20 40 60

Feet: 0 35 70 140 210

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 1:20,000.

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: Clackamas County Area, Oregon
Survey Area Data: Version 12, Sep 19, 2017

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

Date(s) aerial images were photographed: Jul 26, 2014—Sep 5, 2014

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
76B	Salem silt loam, 0 to 7 percent slopes	0.0	2.9%
84	Wapato silty clay loam	1.3	88.1%
91B	Woodburn silt loam, 3 to 8 percent slopes	0.1	9.0%
Totals for Area of Interest		**1.4**	**100.0%**