

AH. K

PRELIMINARY STORM DRAINAGE REPORT

for

AIRPORT HEIGHTS PLAT

November 11, 2009

Encompass Engineering & Surveying, Job No. 08003

Prepared by:

*Encompass Engineering & Surveying
108 East 2nd Street
Cle Elum, WA 98922
Ph. (509) 674-7433*

Prepared for:

*Schuler Deneen Family Ranch, LLC
PO Box 808
Cle Elum, WA 98922*



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I. OVERVIEW

Based on the Preliminary Plat layout, the existing topography, and the intent of the storm drainage analysis, three different drainage basins are proposed for this project:

Detention Basin - consists of the entire Airport Heights Plat project site, including the tributary area to the north located outside of the site boundary, as shown on Exhibit 1 in Appendix A. The portions of Lots 5, 6, 7, 8, 9 and 10 and Tract A south of the proposed bioswale/detention overflow swale and the detention pond are not included in the storm drainage analysis as these areas are not going to be developed. Any development in these areas will require additional and separate storm drainage analysis. Detention Basin is used in preliminary storm drainage analysis of the proposed Airport Heights Plat.

A detention facility is proposed in the central portions of Lots 9 and 10 to detain the post-development run-off associated with the proposed site improvements. The proposed facility is designed to detain the post-development 2-year, 25-year and 100-year storm events. The run-off will be released at 50% of the pre-developed 2-year, pre-developed 25-year and pre-developed 100-year storm events, as required by the Department of Ecology's 2004 Stormwater Management Manual for Eastern Washington (*SWMMEW*), into an existing unnamed seasonal drainage channel located on the west side of the southern portion of Lot 1. As part of the site hydraulic analysis, the proposed detention facility is enlarged to mitigate the 25-year and 100-year storm events from existing Lanigan Meadows Plat (information is shown as part of this report in the following sections). The treatment for the post-development run-off generated from the proposed Danko Road extension, private gravel access road, and Lots 1 thru 4 is provided by a 200-foot long bio-filtration swale.

The precipitation information used for the pre-development and post-development run-off calculations is based on the Isopluvials provided in the 2004 *SWMMEW*:

$$P_{2\text{yr}} = 2.0''$$

$$P_{25\text{yr}} = 3.5''$$

$$P_{100\text{yr}} = 5.0''$$

Based on the knowledge of the local soils and soils percolation information provided by the Kittitas County Public Health Department, it is determined that the Hydrologic Soil Group is "D".

Lanigan Meadows Plat Basin - consists of the entire Lanigan Meadows Plat site located southeast from the project site, as shown on Exhibits 4A and 4B in Appendix A. The assumed 25-year and 100-year pre-development and post-development flows from this basin are mitigated in the storm drainage analysis for Airport Heights Plat in order to facilitate flooding issues downstream of this basin. Taking into consideration the proximity of Lanigan Meadows Plat to Airport Heights Plat project, it is assumed that the precipitation information and Hydrologic Soils Group classification are the same.

Culvert Basin - consists of the tributary area located north and northwest of the Airport Heights Plat project site, as shown on Exhibit 5 in Appendix A. It is used in preliminary hydraulic analysis of the unnamed seasonal drainage channel and culvert design.

A new culvert is proposed at the Danko Road extension crossing of the unnamed seasonal channel. The culvert is designed to handle 100-year storm event with a minimum of 1 ft. of freeboard. The

precipitation information used for the pre-development and post-development run-off calculations is based on the Isopluvials provided in the 2004 *SWMMMEW*:

$$P_{100\text{yr}} = 5.0''$$

Based on the knowledge of the local soils and soils percolation information provided by the Kittitas County Public Health Department, it is determined that the Hydrologic Soil Group is "D".

II. HYDROLOGIC ANALYSIS

Hydrologic analysis for the proposed Airport Heights Plat project is consistent with Title 12 of the Kittitas County Code and the 2004 *SWMMMEW*. Runoff modeling was done using the Santa Barbara Hydrograph method, SCS Type 1A 24-hour storm event. Calculations were performed utilizing King County Hydrograph Program version 4.21B accepted by the Department of Ecology as a proper simulation modeling program.

III. PRE-DEVELOPMENT SITE CONDITIONS

Detention Basin:

The pre-development condition of the entire Detention Basin is determined to be pervious assuming most of the area is considered wooded open space and pasture.

$$A = 37.4 \text{ ac}$$

$$CN = 79 \text{ (Woods - Fair Condition)}$$

$$T_c = 80 \text{ min. (see Appendix B)}$$

Utilizing Santa Barbara Hydrograph (SBUH) method, the following run-off quantities are calculated (See Appendix B):

$$Q_{2\text{yr}} = 1.32 \text{ cfs}$$

$$Q_{25\text{yr}} = 5.57 \text{ cfs}$$

$$Q_{100\text{yr}} = 11.31 \text{ cfs}$$

Lanigan Meadows Plat Basin:

The pre-development condition of the Lanigan Meadows Plat Basin is presumed to be pervious assuming most of the area is considered wooded open space and pasture (similar to Detention Basin).

$$A = 6.2 \text{ ac}$$

$$CN = 84 \text{ (Open space and Pasture - Fair Condition)}$$

$$T_c = 27 \text{ min.}$$

Utilizing SBUH method, the following run-off quantities are calculated (See Appendix B):

$$Q_{25\text{yr}} = 2.16 \text{ cfs}$$

$$Q_{100\text{yr}} = 3.87 \text{ cfs}$$

IV. POST-DEVELOPMENT SITE CONDITIONS

Detention Basin:

IMPERVIOUS AREA – In addition to the proposed paved and gravel roads and approximate proposed surface area of the detention pond, it is assumed that 10,000 sq. ft. is used as impervious area for each lot. Applying the basic dispersion method to the impervious area, it is assumed that 50% of the area is treated as impervious and 50% as grass.

$$A = 2.92 \text{ ac}$$

$$CN = 98 \text{ (Paved road \& driveways, roofs, pond)}$$

PERVIOUS AREA – In addition to the undeveloped tributary area to the north of the project site, it is assumed that 50% of the assumed impervious area per lot after applying the basic dispersion method is treated as grass. It is assumed that the remaining area per each lot is treated as 50% grass and 50% pasture.

$$A = 34.5 \text{ ac}$$

$$CN=79 \text{ (Woods – Fair Condition)}$$

$$CN=84 \text{ (Open space and Pasture – Fair Condition)}$$

$$Tc=84 \text{ min (See Appendix B)}$$

Utilizing SBUH method, the following run-off quantities are calculated (See Appendix B):

$$Q_2=2.02 \text{ cfs}$$

$$Q_{25}=6.86 \text{ cfs}$$

$$Q_{100}=12.83 \text{ cfs}$$

BIOSWALE ANALYSIS – In order to provide the treatment for the proposed Danko Road extension, private gravel access road, and Lots 1 thru 4 post-development run-off, a 200-foot long bio-filtration swale is proposed from Danko Road extension to the proposed detention pond. The bio-filtration swale is designed based on 2004 *SWMM* requirements. The following swale configuration is calculated (See Appendix B):

$$Q_{6\text{-month}} = 0.73 \text{ cfs}$$

$$Q_{25\text{-year}} = 6.86 \text{ cfs}$$

$$\text{Side Slopes} = 3:1$$

$$\text{Swale Longitudinal Slope} = 0.010 \text{ ft/ft}$$

Utilize trapezoidal shape

$$\text{Swale Bottom Width} = 8.5 \text{ ft.}$$

$$\text{Swale Velocity @ Treatment} = 0.96 \text{ ft/sec.}$$

ROADSIDE DITCH – Normal depth analysis is performed on the proposed roadway ditch located along the north edge of the proposed private gravel access road (See Appendix B). Taking into consideration the worst case scenario, the analysis of the triangular ditch shows that the ditch has adequate capacity to handle the 100-year storm event (See Appendix B). The worst case scenario is considered to be a point in the roadside ditch that has the shallowest depth with the flattest slope at the narrowest width, and it is estimated to be at station 10+77.98.

Lanigan Meadows Plat Basin:

IMPERVIOUS AREA – Based on the site visit of the developed plat and the final plans, the following area is assumed for the impervious condition:

$$A = 1.3 \text{ ac}$$

$$CN = 98 \text{ (Paved road \& driveways, roofs, pond)}$$

PERVIOUS AREA – Based on the site visit of the developed plat and the final plans, the following area is assumed for the pervious condition:

$$A = 4.9 \text{ ac}$$

$$CN=84 \text{ (Open space and Pasture – Fair Condition)}$$

$$T_c=10 \text{ min (Assumed)}$$

Utilizing SBUH method, the following run-off quantities are calculated (See Appendix B):

$$Q_{25}=3.37 \text{ cfs}$$

$$Q_{100}=5.60 \text{ cfs}$$

The difference between Lanigan Meadows Plat basin pre-development and post-development run-off quantities for mitigation purposes is as follows:

$$\Delta Q_{25}= 3.37 - 2.16 = 1.21 \text{ cfs}$$

$$\Delta Q_{100}= 5.60 - 3.87 = 1.73 \text{ cfs}$$

V. CULVERT DESIGN**Culvert Basin:**

The pre-development condition of the entire Culvert Basin is determined to be pervious, assuming most of the area is considered wooded open space and pasture (See Appendix C):

$$A = 319 \text{ ac}$$

$$CN = 73 \text{ (Woods – Fair Condition)}$$

$$T_c = 102 \text{ min. (See Appendix C)}$$

Utilizing SBUH method, the following run-off quantities are calculated (See Appendix C):

$$Q_{100\text{yr}} = 61.90 \text{ cfs}$$

Based on the preliminary analysis of the configuration of the existing unnamed drainage channel and the 100-year run-off quantities, it is determined that the proposed culvert would be regulated by the inlet control. For preliminary calculations purposes, the nomograph of the headwater depth for the corrugated metal pipe with inlet control is used to size the proposed culvert. Based on the nomograph data, the following results are calculated (See Appendix C):

$$Q_{100}=61.90 \text{ cfs}$$

Assume Inlet Control

Headwater depth (HW) = 1.5 times culvert diameter max. for culverts larger than 18-inch

Inlet to be mitered and conform to slope section

Minimum Required Culvert Diameter = 42 in.

Culvert has to be buried 1 foot

Culvert has a 1-foot freeboard
 Provided Culvert Diameter = 72 in.

VI. DETENTION POND DESIGN

Detention Basin:

Allowable discharge rates from the proposed detention pond are based on the 2004 *SWMM* (See Appendix B):

Post-Development $Q_2 = \frac{1}{2}$ Pre-Development $Q_2 = 0.66$ cfs
 Post-Development $Q_{25} =$ Pre-Development $Q_{25} = 5.57$ cfs
 Post-Development $Q_{100} =$ Pre-Development $Q_{100} = 11.31$ cfs

Utilizing SBUH method, the following REQUIRED volumes are modeled (See Appendix B):

$V_{\frac{1}{2} \text{ 2-yr}} = 57,030$ cf
 $V_{25\text{-yr}} = 66,310$ cf
 $V_{100\text{-yr}} = 79,450$ cf

The volumes above do not include mitigated storm run-off from Lanigan Meadows Plat. In order to mitigate the difference between post-development and pre-development flows for 25-year and 100-year storm events for Lanigan Meadows Plat, Detention Basin flows are over-detained by the proposed detention pond. This requires the detention pond to be enlarged such that the increase from the Lanigan Meadows Plat flows and actual outflow for the enlarged proposed detention pond are not larger than the target outflow for Detention Basin, as shown in Appendix B. Based on the analysis, only the 25-year and 100-year storm events for Lanigan Meadows Plat are mitigated. The enlarged REQUIRED volume of the proposed detention pond is (Appendix B):

$V_{\text{Design}} = 66,216$ cf (for a 3 ft stage depth)
 $V_{\frac{1}{2} \text{ 2-yr}} = 59,015$ cf
 $V_{25\text{-yr}} = 76,260$ cf
 $V_{100\text{-yr}} = 89,450$ cf

Based on the design information shown on the plans, the following PROVIDED volumes are calculated (See Appendix B):

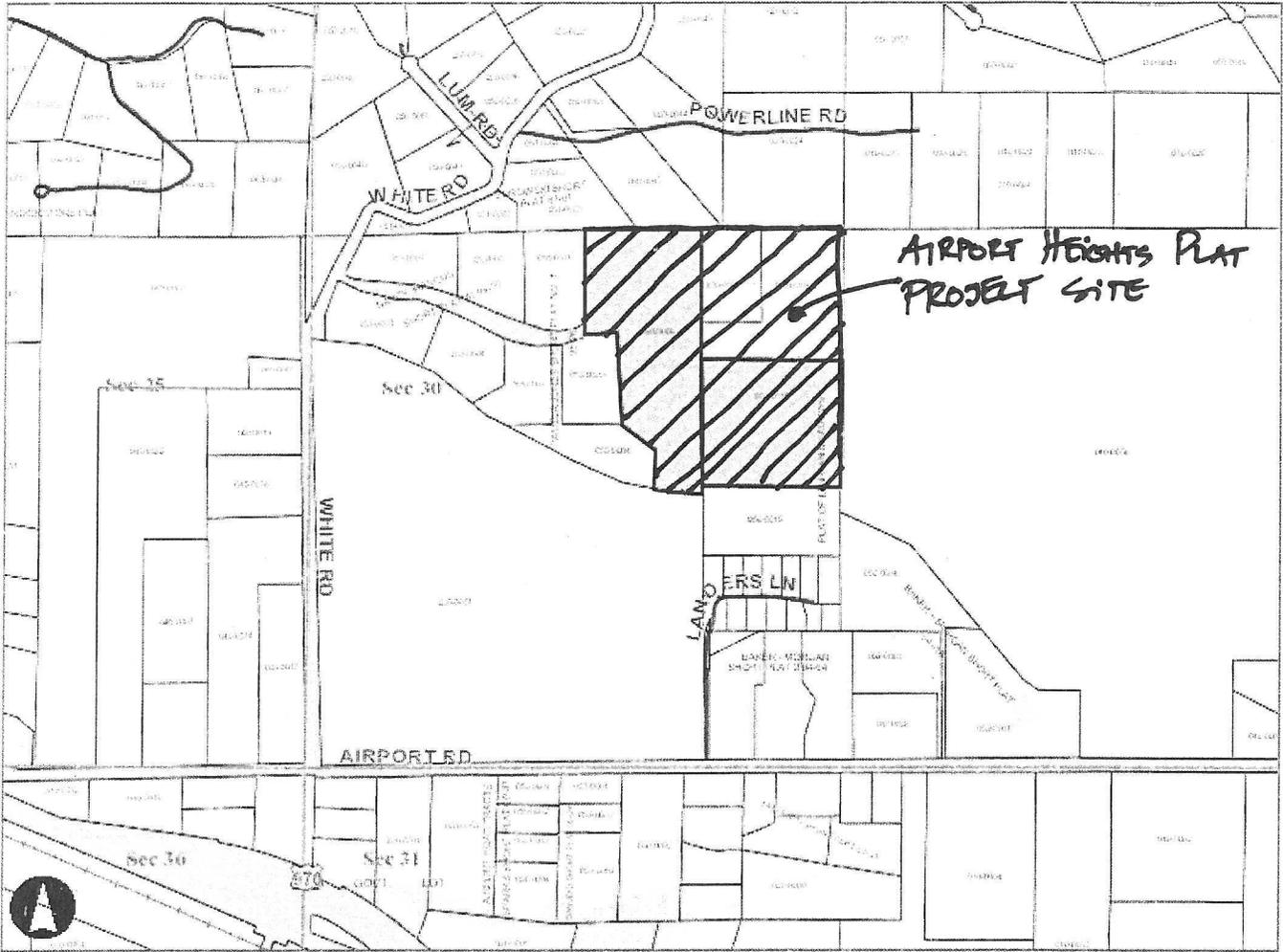
$V_{\text{Design}} = 68,280$ cf (for a 3 ft stage depth)
 $V_{\frac{1}{2} \text{ 2-yr}} = 59,015$ cf
 $V_{25\text{-yr}} = 76,260$ cf
 $V_{100\text{-yr}} = 92,390$ cf

The following criteria are set for the detention pond calculation and design:

Side Slopes = 3:1
 Riser Stage Depth = 3.0 ft
 Bottom Orifice Diameter = 3.75 in.
 Top Orifice Diameter = 0.50 in.; Top Orifice Height = 2.50 ft
 Emergency Overflow was designed for 100-year storm event

APPENDIX 'A'

Airport Heights Plat Vicinity Map



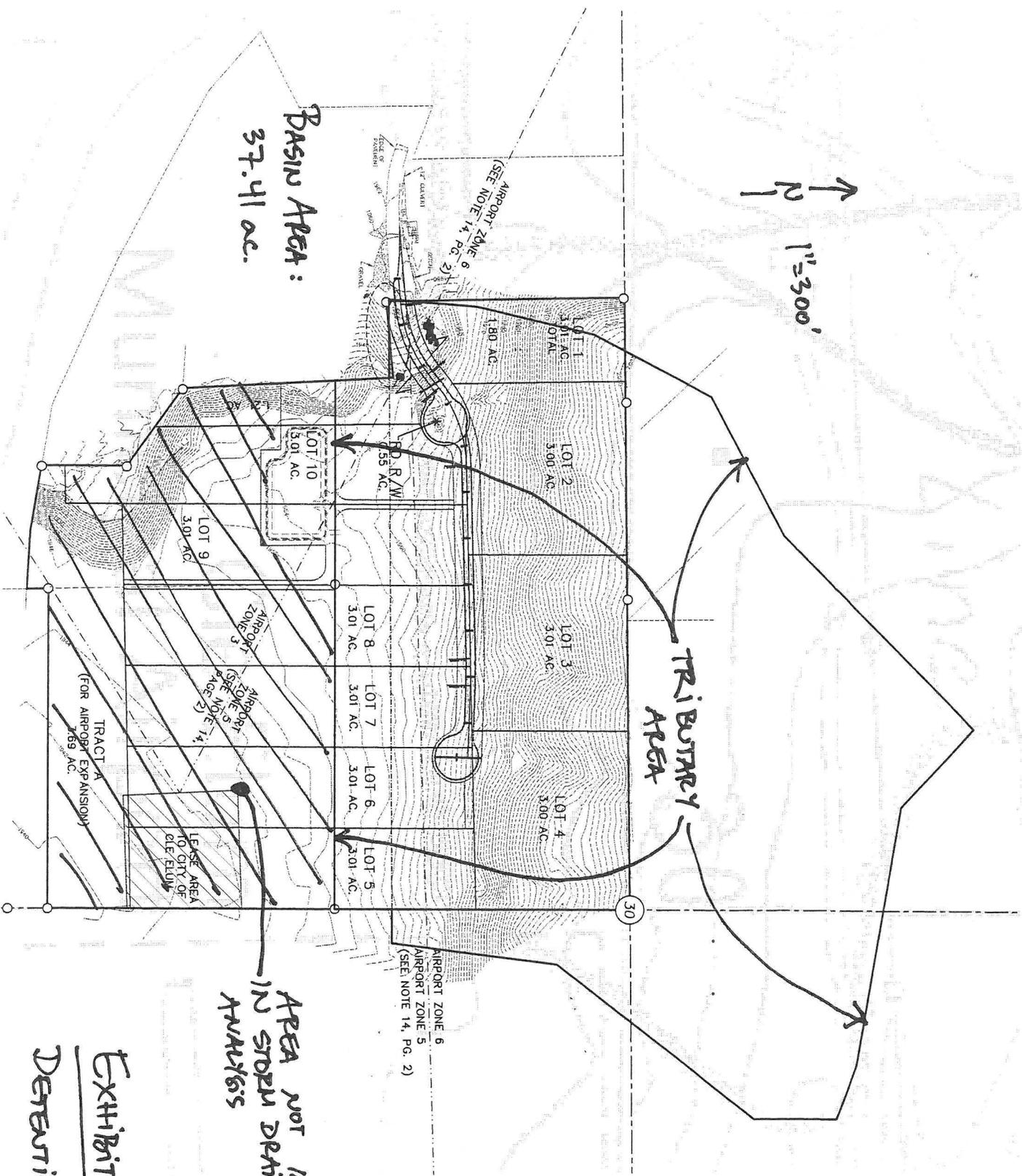
Map Center: Township:20 Range:16 Section:30

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1"=300'
N



BASIN AREA:
37.41 ac.

TRIBUTARY
AREA

AREA NOT INCLUDED
IN STORM DRAINAGE
ANALYSIS

EXHIBIT 1
DETENTION BASIN

Area NOT
included
in storm
drainage
analysis

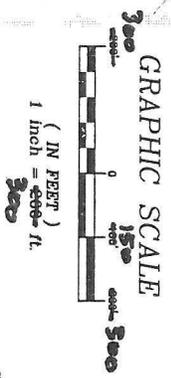
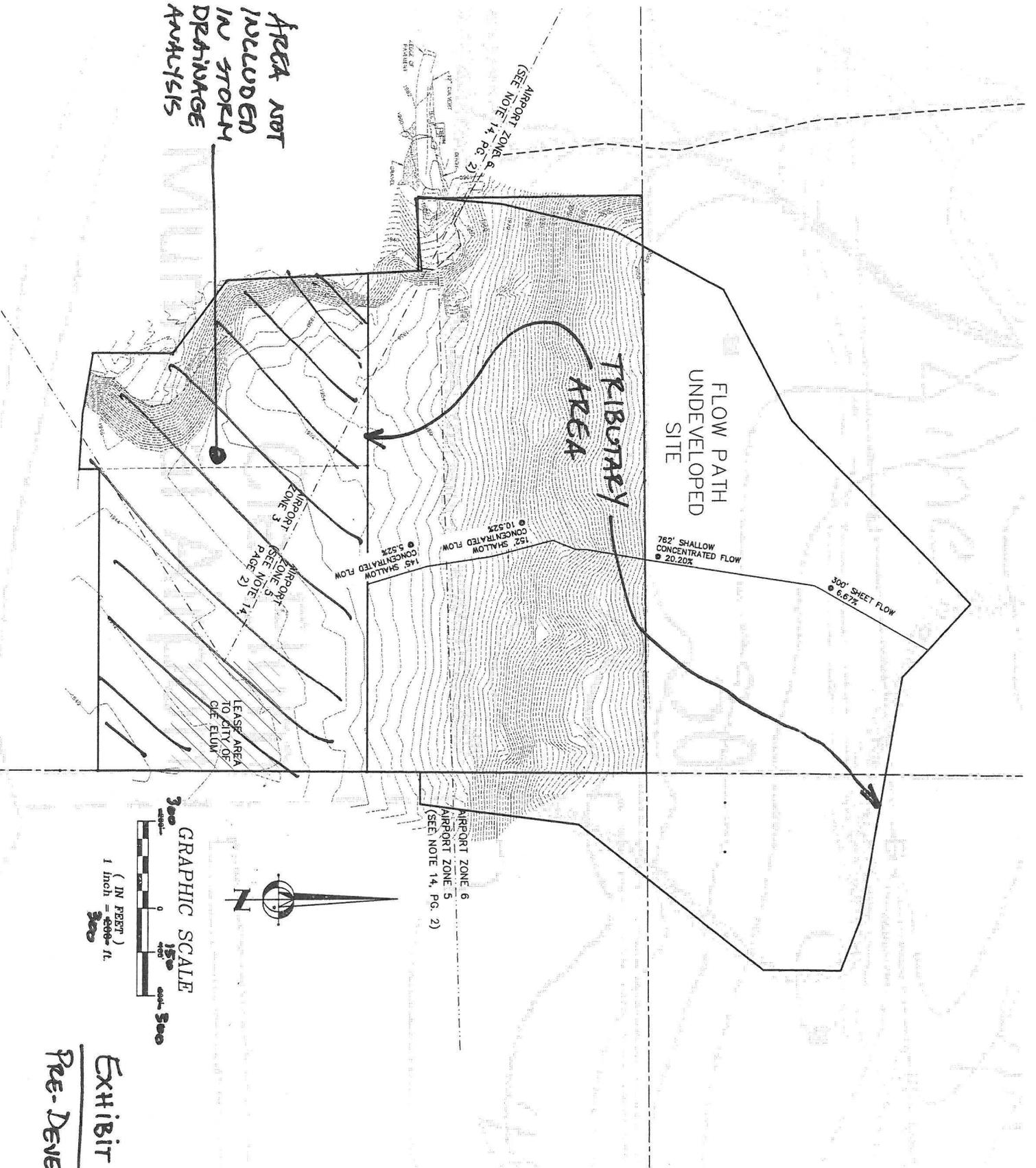


Exhibit 2
Pre-Development

AREA NOT
INCLUDED IN
STORM DRAINAGE
ANALYSIS

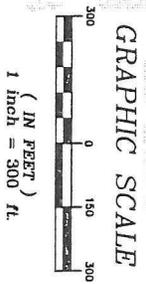
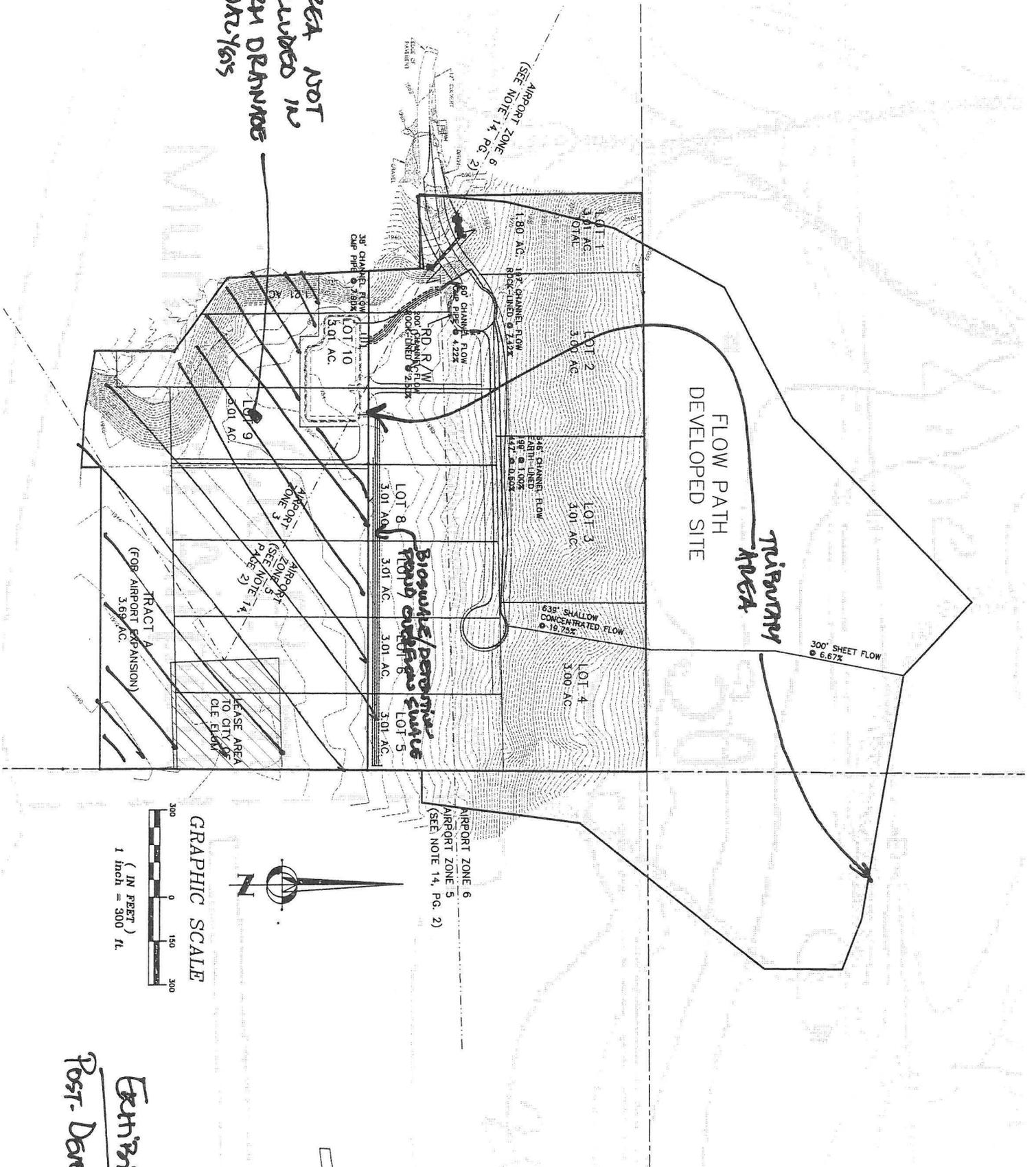


Exhibit 3
Post-Developed Te

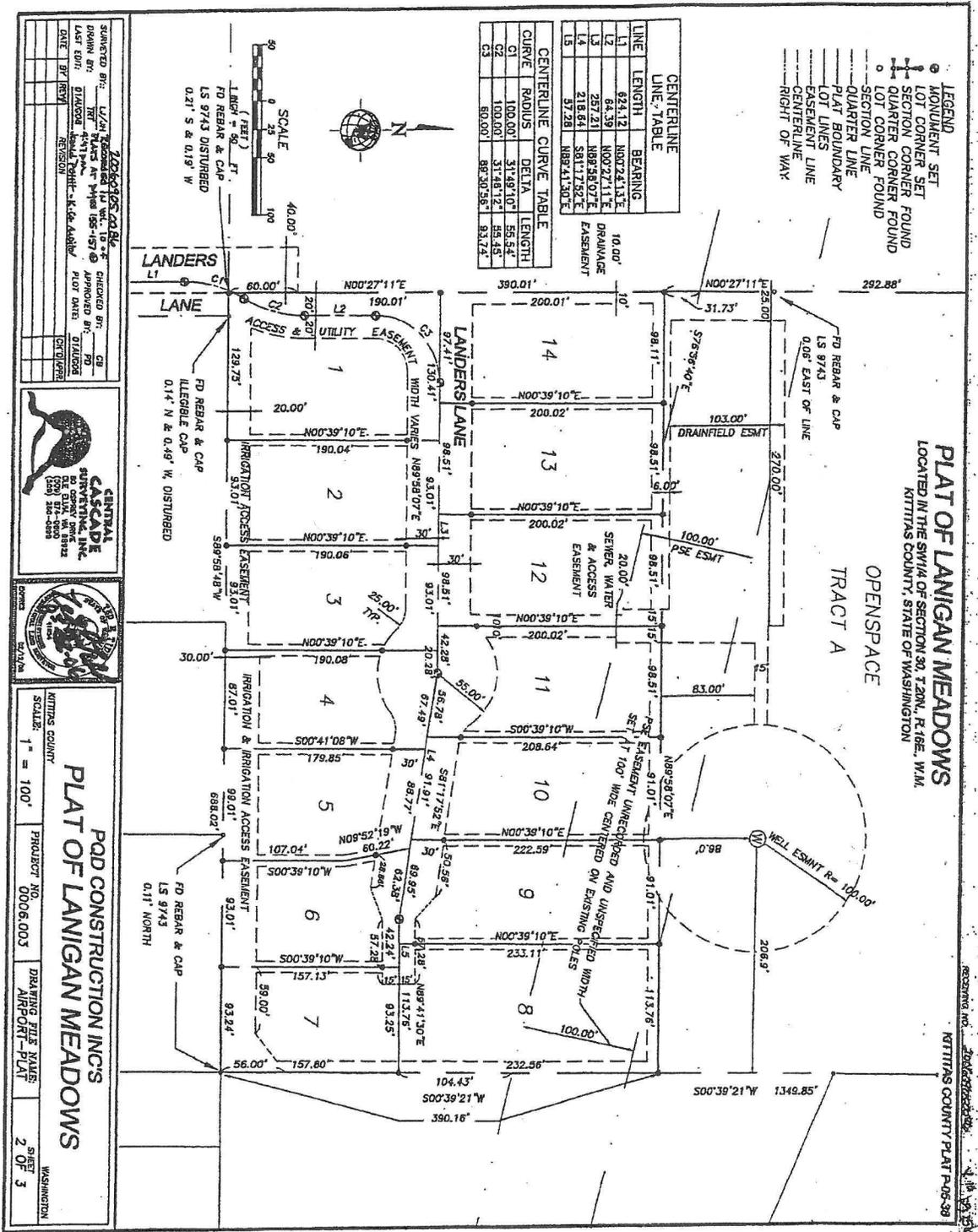
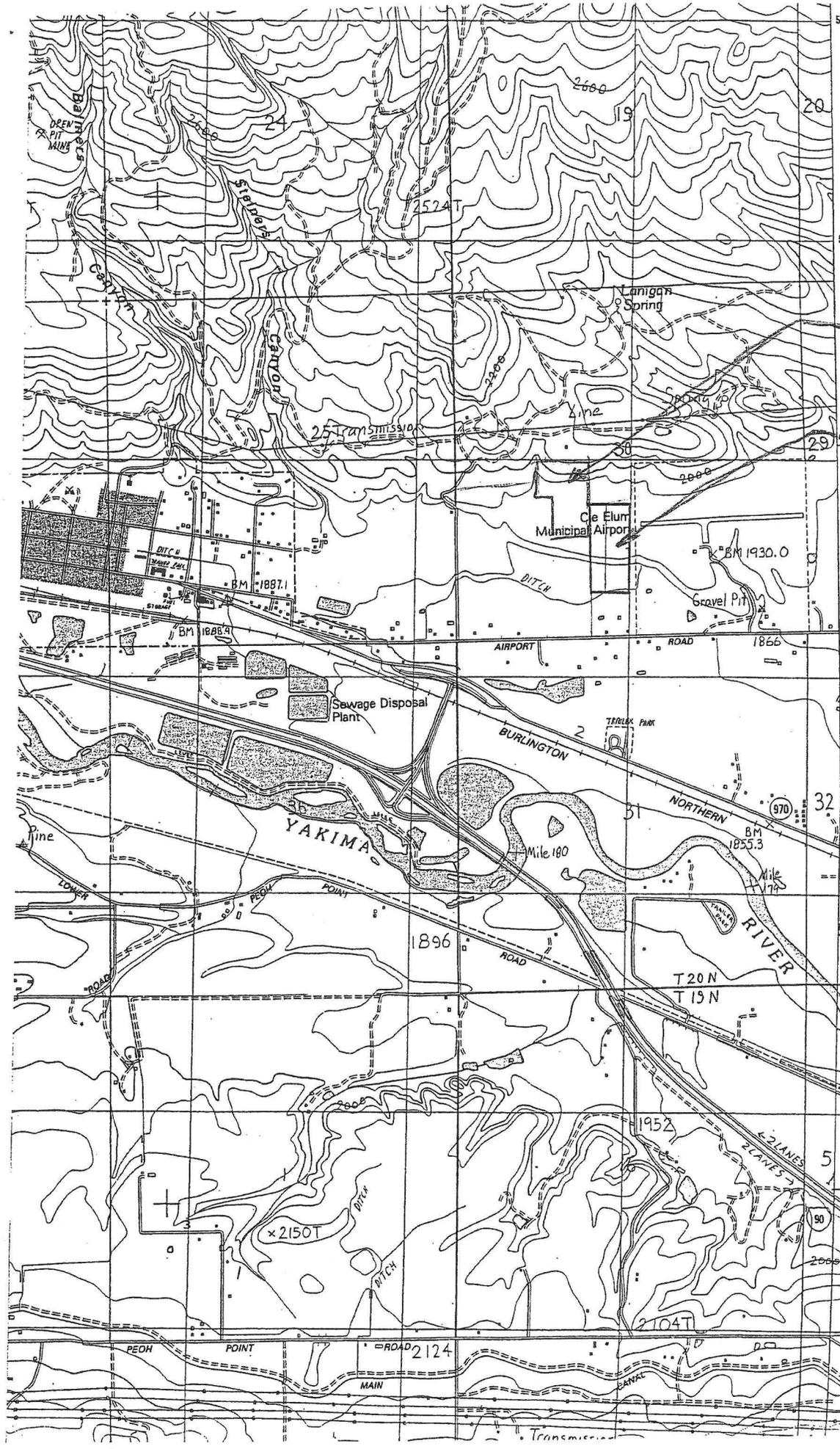


EXHIBIT 4A
LANIGAN MEADOWS PLAT BASIN

71
1" = 2000'

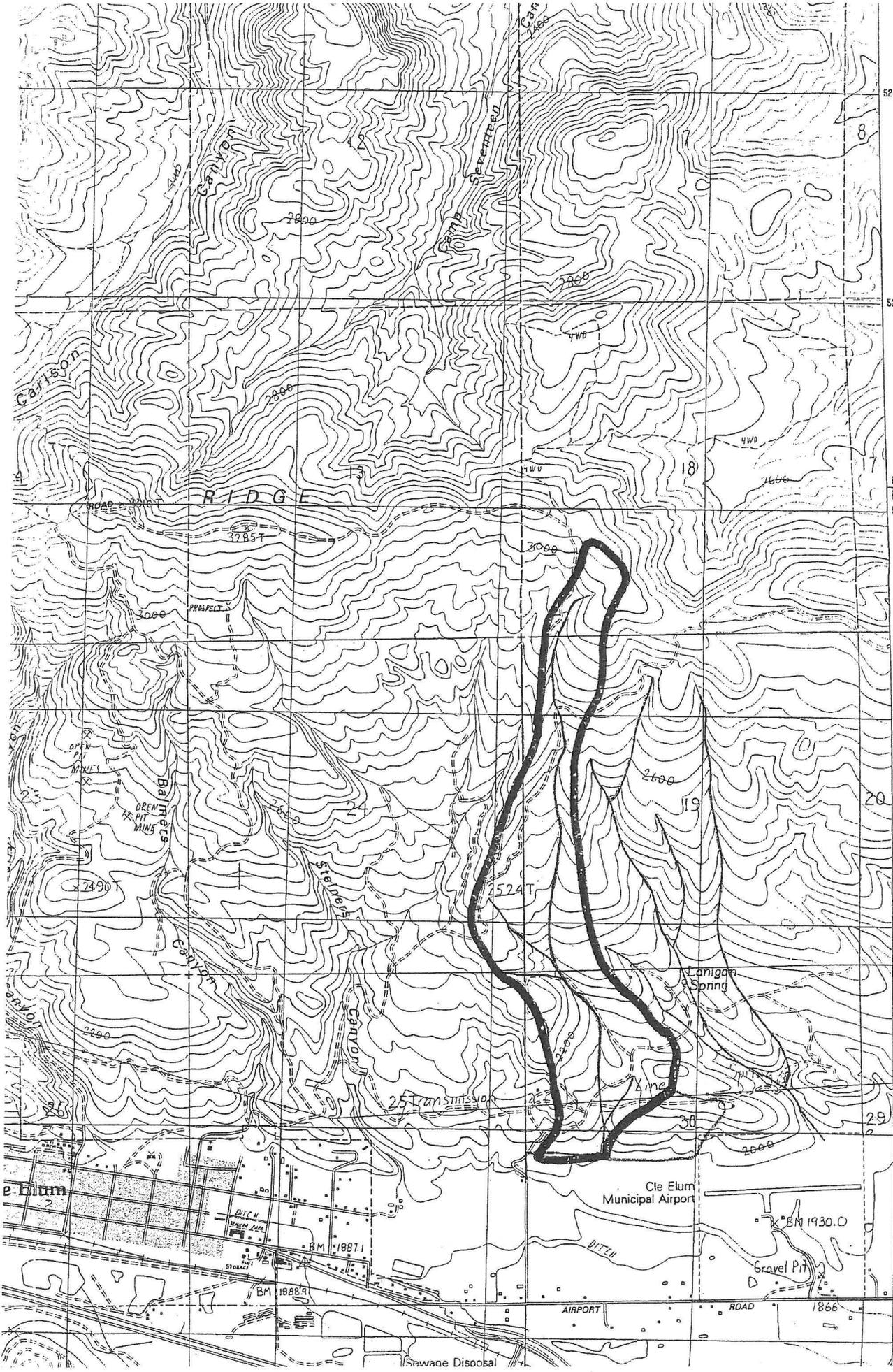


Airport Heights
PLAT
PLAT OF
LANIGAN
MEADOWS



Exhibit 4B
Lanigan Meadows Plat Basin

08003



VS VOLKE SALDY
CLAY LOAM
CF Cle Elum
FINE SALDY LOAM

690 000
FEET
5232

EXHIBIT 5

CULVERT
BASIN

12' 30"



5228

APPENDIX 'B'

TIME OF CONCENTRATION

Under the existing conditions the runoff will begin flowing as sheet flow from the northeastern end of On-Site Basis and then to concentrated shallow flow through the rest of the On-Site Basin towards the southerly portion of the Airport Heights Plat.

The Soil Survey of Kittitas County Area, Washington identifies the soil in this area as a Type "D" soil.

CALCULATION:

Total area =	1,629,580 S.F.	37.41 acres	
Pervious area =	1,629,580 S.F.	37.41 acres	79 CN
Impervious area =	0 S.F.	0.00 acres	0 CN

Calculate Time of Concentration Pre-Development Tc=Tsh+

n _s =	0.8	L ₁ =	300
P ₂ 24 _{hr} =	2	L ₂ =	762
S ₀₁ =	0.0667	L ₃ =	152
S ₀₂ =	0.202	L ₄ =	145
S ₀₃ =	0.1052	V ₂ =	2.25
S ₀₄ =	0.0552	V ₃ =	1.62
k =	5	V ₄ =	1.17

$$T_t = \frac{0.42 (n_s L)^{0.8}}{(P_2 24_{hr})^{0.5} (S_o)^{0.4}}$$

$$T_t = \frac{L}{60V} \quad V = k\sqrt{S_o}$$

T ₁ =	70	T ₂ =	5.65	T ₃ =	1.56	T ₄ =	2.06
Tc =	79.62 min	⇒	assume 80 min				

Calculate Time of Concentration Post-Development Tc=Tsh+

n _s =	0.8		
P ₂ 24 _{hr} =	2		
S ₀₁ =	0.0667	L ₁ =	300
S ₀₂ =	0.1975	L ₂ =	629
S ₀₃ =	0.01	L ₃ =	199
S ₀₄ =	0.005	L ₄ =	447
S ₀₅ =	0.0742	L ₅ =	197
S ₀₆ =	0.0422	L ₆ =	60
S ₀₇ =	0.025	L ₇ =	200
S ₀₈ =	0.079	L ₈ =	38
k =	5	k =	20
k =	15	k =	21

T ₁ =	70
T ₂ =	4.72
T ₃ =	1.66
T ₄ =	5.27
T ₅ =	0.57
T ₆ =	0.23
T ₇ =	1.41
T ₈ =	0.11

Tc =	84.31 min	⇒	assume 84 min
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DETENTION BASIN - PRE-DEVELOPMENT CONDITION:

 ***** S.C.S. TYPE-1A DISTRIBUTION *****
 ***** 2-YEAR 24-HOUR STORM **** 2.00" TOTAL PRECIP. *****

AREA (ACRES)	PERVIOUS		IMPERVIOUS		TC (MINUTES)
	A	CN	A	CN	
37.4	37.4	79.0	.0	98.0	80.0
PEAK-Q (CFS)	T-PEAK (HRS)		VOL (CU-FT)		
1.32	12.50		70359		

 ***** S.C.S. TYPE-1A DISTRIBUTION *****
 ***** 25-YEAR 24-HOUR STORM **** 3.50" TOTAL PRECIP. *****

AREA (ACRES)	PERVIOUS		IMPERVIOUS		TC (MINUTES)
	A	CN	A	CN	
37.4	37.4	79.0	.0	98.0	80.0
PEAK-Q (CFS)	T-PEAK (HRS)		VOL (CU-FT)		
5.57	8.17		210361		

 ***** S.C.S. TYPE-1A DISTRIBUTION *****
 ***** 100-YEAR 24-HOUR STORM **** 5.00" TOTAL PRECIP. *****

AREA (ACRES)	PERVIOUS		IMPERVIOUS		TC (MINUTES)
	A	CN	A	CN	
37.4	37.4	79.0	.0	98.0	80.0
PEAK-Q (CFS)	T-PEAK (HRS)		VOL (CU-FT)		
11.31	8.17		375769		

LANIGAN MEADOWS PLAT BASIN - PRE-DEVELOPMENT CONDITION:

 ***** S.C.S. TYPE-1A DISTRIBUTION *****
 ***** 2-YEAR 24-HOUR STORM ***** 2.00" TOTAL PRECIP. *****

 AREA (ACRES) PERVIOUS IMPERVIOUS TC (MINUTES)
 A CN A CN
 6.2 84.0 .0 98.0 27.0

 PEAK-Q (CFS) T-PEAK (HRS) VOL (CU-FT)
 .66 7.83 16611

 ***** S.C.S. TYPE-1A DISTRIBUTION *****
 ***** 25-YEAR 24-HOUR STORM ***** 3.50" TOTAL PRECIP. *****

 AREA (ACRES) PERVIOUS IMPERVIOUS TC (MINUTES)
 A CN A CN
 6.2 84.0 .0 98.0 27.0

 PEAK-Q (CFS) T-PEAK (HRS) VOL (CU-FT)
 2.16 7.83 43206

 ***** S.C.S. TYPE-1A DISTRIBUTION *****
 ***** 100-YEAR 24-HOUR STORM ***** 5.00" TOTAL PRECIP. *****

 AREA (ACRES) PERVIOUS IMPERVIOUS TC (MINUTES)
 A CN A CN
 6.2 84.0 .0 98.0 27.0

 PEAK-Q (CFS) T-PEAK (HRS) VOL (CU-FT)
 3.87 7.83 73007

CULVERT BASIN - PRE-DEVELOPMENT CONDITION:

***** S.C.S. TYPE-1A DISTRIBUTION *****
***** 100-YEAR 24-HOUR STORM **** 5.00" TOTAL PRECIP. *****

AREA (ACRES)	PERVIOUS		IMPERVIOUS		TC (MINUTES)
	A	CN	A	CN	
319.0	319.0	73.0	.0	98.0	102.0
PEAK-Q (CFS)	T-PEAK (HRS)		VOL (CU-FT)		
61.90	8.50		2606160		

DETENTION BASIN - POST-DEVELOPMENT CONDITION:

 ***** S.C.S. TYPE-1A DISTRIBUTION *****
 ***** 2-YEAR 24-HOUR STORM **** 2.00" TOTAL PRECIP. *****

AREA (ACRES)	PERVIOUS		IMPERVIOUS		TC (MINUTES)
	A	CN	A	CN	
37.4	34.5	81.0	2.9	97.0	84.0
PEAK-Q (CFS)	T-PEAK (HRS)		VOL (CU-FT)		
2.02	8.50		92505		

 ***** S.C.S. TYPE-1A DISTRIBUTION *****
 ***** 25-YEAR 24-HOUR STORM **** 3.50" TOTAL PRECIP. *****

AREA (ACRES)	PERVIOUS		IMPERVIOUS		TC (MINUTES)
	A	CN	A	CN	
37.4	34.5	81.0	2.9	97.0	84.0
PEAK-Q (CFS)	T-PEAK (HRS)		VOL (CU-FT)		
6.86	8.17		244197		

 ***** S.C.S. TYPE-1A DISTRIBUTION *****
 ***** 100-YEAR 24-HOUR STORM **** 5.00" TOTAL PRECIP. *****

AREA (ACRES)	PERVIOUS		IMPERVIOUS		TC (MINUTES)
	A	CN	A	CN	
37.4	34.5	81.0	2.9	97.0	84.0
PEAK-Q (CFS)	T-PEAK (HRS)		VOL (CU-FT)		
12.83	8.00		417524		

LANIGAN MEADOWS PLAT BASIN - POST-DEVELOPMENT CONDITION:

 ***** S.C.S. TYPE-1A DISTRIBUTION *****
 ***** 2-YEAR 24-HOUR STORM ***** 2.00" TOTAL PRECIP. *****

 AREA (ACRES) PERVIOUS IMPERVIOUS TC (MINUTES)
 A CN A CN
 6.2 4.9 84.0 1.3 98.0 10.0

 PEAK-Q (CFS) T-PEAK (HRS) VOL (CU-FT)
 1.33 7.83 21610

 ***** S.C.S. TYPE-1A DISTRIBUTION *****
 ***** 25-YEAR 24-HOUR STORM ***** 3.50" TOTAL PRECIP. *****

 AREA (ACRES) PERVIOUS IMPERVIOUS TC (MINUTES)
 A CN A CN
 6.2 4.9 84.0 1.3 98.0 10.0

 PEAK-Q (CFS) T-PEAK (HRS) VOL (CU-FT)
 3.37 7.83 49783

 ***** S.C.S. TYPE-1A DISTRIBUTION *****
 ***** 100-YEAR 24-HOUR STORM ***** 5.00" TOTAL PRECIP. *****

 AREA (ACRES) PERVIOUS IMPERVIOUS TC (MINUTES)
 A CN A CN
 6.2 4.9 84.0 1.3 98.0 10.0

 PEAK-Q (CFS) T-PEAK (HRS) VOL (CU-FT)
 5.60 7.83 80472

DETENTION BASIN - DETENTION DESIGN:

PERFORMANCE:	INFLOW	TARGET-OUTFLOW	ACTUAL-OUTFLOW	PK-STAGE	STORAGE
DESIGN HYD:	2.02	.66	.66	3.00	57030
TEST HYD 1:	6.86	5.57	4.67	3.42	66310
TEST HYD 2:	12.83	11.31	9.23	3.99	79450

ENLARGEMENT OPTION: ALLOWS FOR INCREASING STORAGE AT A SPECIFIED STAGE HEIGHT, TO PROVIDE A FACTOR OF SAFETY.

PERFORMANCE:	INFLOW	TARGET-OUTFLOW	ACTUAL-OUTFLOW	PK-STAGE	STORAGE
DESIGN HYD:	2.02	.66	.63	2.71	59015
TEST HYD 1:	6.86	5.57	4.36	3.40	76260
TEST HYD 2:	12.83	11.31	8.83	3.90	89450

STRUCTURE DATA: R/D-POND (3.0:1 SIDE SLOPES)

RISER-HEAD	POND-BOTTOM-AREA	TOP-AREA(@1'F.B.)	STOR-DEPTH	STORAGE-VOLUME
3.00 FT	19311.1 SQ-FT	26962.0 SQ-FT	3.00 FT	66216 CU-FT

DOUBLE ORIFICE RESTRICTOR:	DIA (INCHES)	HT (FEET)	Q-MAX (CFS)
BOTTOM ORIFICE:	3.75	.00	.660
TOP ORIFICE:	.50	2.50	.005

STAGE (FT)	DISCHARGE (CFS)	STORAGE (CU-FT)	PERM-AREA (SQ-FT)
.00	.00	.0	.0
.30	.21	5873.2	.0
.60	.30	11907.6	.0
.90	.36	18105.1	.0
1.20	.42	24467.5	.0
1.50	.47	30996.9	.0
1.80	.51	37695.3	.0
2.10	.55	44564.5	.0
2.40	.59	51606.4	.0
2.50	.60	53992.5	.0
2.70	.63	58823.1	.0
3.00	.66	66216.5	.0
3.10	1.14	68720.6	.0
3.20	1.99	71244.6	.0
3.30	3.10	73788.5	.0
3.40	4.40	76352.6	.0
3.50	5.88	78936.8	.0
3.60	7.32	81541.1	.0
3.70	7.86	84165.8	.0
3.80	8.36	86810.8	.0
3.90	8.83	89476.2	.0

AVERAGE VERTICAL PERMEABILITY: .0 MINUTES/INCH

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BIOFILTRATION SWINE DESIGN:

(1) PEAK FLOW RATE FOR 6-MONTH, 24-HOUR:

$$P_{6\text{month, 24hr}} = C_{avg} (P_{24\text{hr}})$$

$$C_{avg} = \frac{0.7 + 0.66}{2} = 0.68$$

$$P_{6\text{month, 24hr}} = 0.68(2) = \underline{\underline{1.36}}$$

$$\rightarrow Q_{6\text{month, 24hr}} = \underline{\underline{0.73}}$$

(2) SWINE $S = 1.0\%$ MIN.

(3) USE TRAPEZOIDAL SHAPE



ASSUME $d = 0.33 \text{ FT}$

$$A = 2 \times \left(\frac{1}{2} \times 0.33 \times 1 \right) + 0.33B = 0.33 + 0.33B = 0.33(1+B)$$

$$P = 2.1 + B$$

$$R = \frac{0.33(1+B)}{2.1+B}$$

(4) CALCULATE FOR B:

$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$$

$$\rightarrow Q = 0.73 \text{ cfs (6-month)}$$

$$0.73 = \frac{1.486}{0.03} (0.33 + 0.33B) \left(\frac{0.33(1+B)}{2.1+B} \right)^{2/3} (0.01)^{0.5}$$

$$n = 0.03$$

$$d = 0.33 \text{ FT}$$

$$S = 0.010 \text{ FT/FT}$$

$$Q = 6.86 \text{ cfs (75-yr)}$$

$$B = 8.5'$$

$$\text{SWINE DEPTH} = d + 1 = 1.33 \text{ FT}$$

BIOFILTRATION SWIMS

6 month, 24-hr

S= 0.0100 ft/ft channel slope *OK ✓*
n= 0.0300 manning's roughness coefficient *OK ✓*
H= 0.0875 ft depth of flow ✓
B= 8.5 ft bottom of channel width
Z_R= 3 slope of right ditch side wall as in Z:1
Z_L= 3 slope of left ditch side wall as in Z:1

A= 0.77 ft² area of the trapezoidal section
P= 9.05 ft wetted perimeter
R= 0.08 ft Hydraulic Radius

Q= 0.73 cfs ✓

V= 0.96 ft/sec

Velocity



< 1 fps OK

ROOF FILTRATION SWALE

25-YR, 24-h

S= 0.0100 ft/ft channel slope
n= 0.0300 manning's roughness coefficient
H= 0.33 ft depth of flow
B= 8.5 ft bottom of channel width
Z_R= 3 slope of right ditch side wall as in Z:1
Z_L= 3 slope of left ditch side wall as in Z:1

A= 3.13 ft² area of the trapezoidal section
P= 10.59 ft wetted perimeter
R= 0.30 ft Hydraulic Radius
Q= 6.89 cfs
V= 2.20 ft/sec Velocity

OK!

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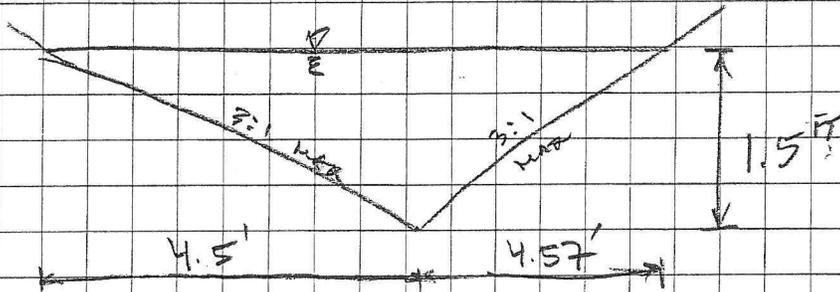
SHEET NO. _____ OF _____

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Roadside Ditch Capacity Analysis:



$$A = \frac{1}{2}(4.5)(1.5) + \frac{1}{2}(4.57)(1.5) = 6.8 \text{ FT}^2$$

$$P = 4.74 + 4.81 = 9.55 \text{ FT}$$

$$R = \frac{A}{P} = \frac{6.8}{9.55} = 0.71 \text{ FT}$$

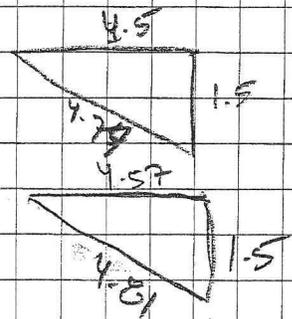
$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$$

$$\rightarrow \begin{aligned} n &= 0.033 \\ S &= 0.5\% \end{aligned}$$

$$Q = \frac{1.486}{0.033} (6.8)(0.71)^{2/3} (0.005)^{1/2}$$

$$Q = 7.23 \text{ cfs}$$

OK



APPENDIX 'C'

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JOB 08003 DENFEN

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CALCULATED BY TREVIN ROLETTO DATE 02/03/2009

CHECKED BY _____ DATE _____

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**OFF-SITE
BASIN**

319 ACRES

SOIL GROUP = C

CN = 73 (WOODS - FAIR)

FLOW LENGTH = 9,990 FT

$n_s = 0.4$ WOODS OR FOREST, POOR COVER

SLOPE = 0.1061

$R_c = 5$ FORESTED SWALE w/ HEAVY GROUND LITTER
($n = 0.10$)

$$V = K_c \sqrt{S_0} = (5)(\sqrt{0.1061})$$

$$V = 1.63 \text{ ft/s}$$

$$T_c = 102 \text{ min.}$$

$$T = \frac{L}{V} = \frac{9990}{(60)(1.63)} = 102 \text{ min.}$$

FIGURE 4.3.1.C HEADWATER DEPTH FOR CORRUGATED PIPE CULVERTS WITH INLET CONTROL

