LACAMAS SHORES

MODIFICATION TO LACAMAS SHORES STORMWATER DISPOSAL SYSTEM

DRAINAGE CALCULATION

INCLUDED:

1. *SUMMARY*
2. *HEC FLOW CALCULATIONS*
3. *LEVEL SPREADER DESIGN*
4. *SPLITTER MANHOLE DESIGN*
5. *FILTER STRIP DESIGN*
6. *BOIFILTRATION SWALE DESIGN*
7. *WET POND CALCULATIONS*
8. *POND OUTLET STRUCTURE DESIGN*

7/9/96

EXPIRES: DEC. 26,1996

JOB NO: 10990X

02-19-92 BY: T.Z.
REV. 1 08-13-93 BY: T.Z.
REV. 2 11-13-95 BY: T.Z.
REV. 3 05-22-96 BY: T.Z.

Douglas Quinn, P.E.
City of Camas
616 N.E. 4th Ave.
Camas, WA 98607

RE: PROPOSED CHANGES TO THE LACAMAS SHORES STORMWATER MODIFICATION PLAN

Dear Doug:

This is revision to the proposed water quality facility near the boat launch area. The proposed changes will not only enhance the storm water quality for the stormwater disposal system, but will also increase useability of the open space area, presently used as a community soccer field.
The previous water quality system, approved by the Department of Ecology consists of a biofiltration swale for a first flush runoff, a level spreader outfall for runoff from larger storms and a small wet pond for final treatment of all runoff. The system requires monitoring for five years.
The proposed revision will not change any of the previous criteria and principals of this water quality system. The biofiltration swale is moved northeasterly closer to the proposed gravel path along the lake. This will increase the length of biofiltration, and decrease its slope, which creates better condition for water quality treatment. The residence time (for the same amount of flow as in the previous design [Q= 4.0 cfs] and the same maximum depth of flow = 0.41') is increased approximately 83 percent.
By moving the biofiltration swale into new location, we free more space needed for a soccer field, that will also act as a water quality filter strip for larger storms. The average enhancement of the residence time for the filter strip, comparing to the previous design, is about 54 percent.
The wet pond configuration was also improved. The wet pond surface area was increased about 29 percent in comparison to previous design.

All proposed changes to the modification plan of the stormwater disposal system are designed to improve the conditions for water quality treatment. The system will still require monitoring for five year as per previously approved plans by Department of Ecology.

If you have any questions or comments regarding this proposed changes, please feel free to to call Donald J. Moe, or myself.

Sincerely,

Tadeusz "T.Z." Zbigniew

Revised Water Quality Facility Summary

A. Wet Pond

1. Bottom area @ Elev. 187.1 = 2,747 ☐
2. Water surface area @ Elev. 189.1 = 4114 ☐
3. Wet pond storage = [(2747 + 4114) ½][2 Ft.] = 6,860 ☐ > 5300 C.F. previous
29% increase

B. Biofiltration Swale

	Original Design	Revised Design	
Length	200'	285'	
Width	6'	8'	
Slope	0.017 Ft/Ft	0.01 Ft/Ft	
Depth	0.41'	0.41'	
Velocity	1.36 fps	1.06 fps	
Residence Time	147 sec.	269 sec	83% increase

C. Filter Strip

	Original Design	Revised Design	
Length	95'	155'	
Width	155'	120'	
Slope	0.055 Ft/Ft	0.047 Ft/Ft	
6 mo. Depth	0.05'	0.07'	
6 mo. Velocity	0.71 fps	0.75 fps	
6 mo. Residence Time	134 sec.	207 sec.	54% increase
2 yr. Depth	0.10'	0.13'	
2 yr. Velocity	1.11 fps	1.17 fps	
2 yr. Res. Time	86 sec.	132 sec.	53% increase
100 yr. Depth	0.20'	0.25'	
100 yr. Velocity	1.70 fps	1.80 fps	
100 yr. Res. Time	56 sec.	86 sec.	54% increase

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ENGINEERS SURVEYORS PLANNERS
1703 MAIN STREET
VANCOUVER, WA. 98660
(360) 695-3411 (503) 289-6726
FAX (360) 695-0833

DATE: 11-16-95
DRAWN: D.J.M
CHECKED: D.J.M

Lacamas Shores
Storm Water Quality
Facility Modifications

JOB NO.: 10,990-X
SHEET: 2 of

Path: F:\TZHEC
File: 109900I .OUT 11,645 .a.. 2-26-93 11:07:30 am Page 1

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*****************************************
*                                       *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1)    *
*           FEBRUARY 1981               *
*         REVISED 05 DEC 88             *
*                                       *
*  RUN DATE  02/26/1993  TIME  11:06:43 *
*                                       *
*****************************************
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*****************************************
*                                       *
*    U.S. ARMY CORPS OF ENGINEERS       *
*  THE HYDROLOGIC ENGINEERING CENTER    *
*         609 SECOND STREET             *
*        DAVIS, CALIFORNIA 95616        *
*           (916) 551-1748              *
*                                       *
*****************************************
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X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X       XXXXX  X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX  XXXXX          XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1

HEC-1 INPUT PAGE 1

```
LINE      ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
          *DIAGRAM
    1     ID   PRELIMINARY STORM DRAINAGE ANALYSIS TO DETERMINE RUNOFF TO BE CARRIED
    2     ID   BY BUBBLER OUTFALL RELIEF LINE IN N.W. LACAMAS DRIVE
    3     ID   BASINS INCLUDED IN THIS CALCULATION - "A" THRU "H"
    4     ID   2, 10, 25, & 100 YEAR FLOWS TO DETERMINE FLOW PER ACRE FOR PRELIMINARY
    5     ID   PIPE SIZING.  A 6 MONTH FLOW   FOR WATER QUALITY SYSTEM SIZING.
    6     ID   OWNER - TOM SHIPLER
    7     ID   INPUT FILE=109900.DAT    OUTPUT FILE=109900.OUT
    8     ID   RAINFALL RATIOS(JR)= 1.000(1.792",6 MONTH -  WATER QUALITY),
    9     ID   1.563(2YR.,2.8"), 2.176(10YR.,3.9"), 2.400(25YR.,4.3"), 3.013(100YR.,5.4")
   10     ID   DATE 2/26/93
   11     IT      5  1JAN91       0     300
   12     IO      5       0
   13     JR    PREC   1.000   1.563   2.176   2.400   3.013
```

Path: F:\TZHEC
File: 1099001 .OUT 11,645 .a.. 2-26-93 11:07:30 am Page 2

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14          KK   SBTOT
15          KM   TOTAL 45.0 AC. TRIBUTARY TO NEW OUTFALL
16          BA   .0702
17          PB   1.792
18          IN     10  1JAN91      0
19          PC   .004    .008    .012    .016    .020    .024    .028    .032    .036    .040
20          PC   .045    .050    .055    .060    .065    .070    .076    .082    .088    .094
21          PC   .100    .106    .113    .120    .127    .134    .141    .148   .1562   .1644
22          PC  .1726   .1808   .1890   .1972   .2067   .2162   .2257   .2352   .2447   .2542
23          PC  .2676   .2810   .2944   .3124   .3304   .3644   .4184   .4454   .4634   .4768
24          PC  .4902   .5036   .5124   .5212   .5300   .5388   .5476   .5564   .5652   .5740
25          PC  .5828   .5916   .6004   .6092   .6164   .6236   .6308   .6380   .6452   .6524
26          PC  .6596   .6668   .6740   .6812   .6884   .6956   .7013   .7070   .7127   .7184
27          PC  .7241   .7298   .7355   .7412   .7469   .7526   .7583   .7640   .7690   .7740
28          PC  .7790   .8040   .8090   .8140   .8190   .8240   .8280   .8320   .8360   .8400
29          PC  .8440   .8480   .8520   .8560   .8600   .8640   .8680   .8720   .8760   .8800
30          PC  .8840   .8880   .8920   .8960   .9000   .9040   .9080   .9120   .9160   .9200
31          PC  .9240   .9280   .9320   .9360   .9400   .9440   .9480   .9520   .9560   .9600
32          PC  .9640   .9680   .9720   .9760   .9800   .9840   .9880   .9920   .9960  1.000
33          LS     0     92
34          UK   150    .03     .24     100
35          RK  3830    .01     .013            CIRC    2.5
36          ZZ
```

SCHEMATIC DIAGRAM OF STREAM NETWORK

INPUT LINE (V) ROUTING (---)) DIVERSION OR PUMP FLOW

NO. (.) CONNECTOR ((---) RETURN OF DIVERTED OR PUMPED FLOW

14 SBTOT

(###) RUNOFF ALSO COMPUTED AT THIS LOCATION

```
**********************************************
*                                            *
*  FLOOD HYDROGRAPH PACKAGE (HEC-1)          *
*            FEBRUARY 1981                   *
*          REVISED 05 DEC 88                 *
*                                            *
*  RUN DATE 02/26/1993  TIME 11:06:43        *
*                                            *
**********************************************
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*                                            *
*  U.S. ARMY CORPS OF ENGINEERS              *
*  THE HYDROLOGIC ENGINEERING CENTER         *
*        609 SECOND STREET                   *
*      DAVIS, CALIFORNIA 95616               *
*          (916) 551-1748                    *
*                                            *
**********************************************
```

PRELIMINARY STORM DRAINAGE ANALYSIS TO DETERMINE RUNOFF TO BE CARRIED
BY BUBBLER OUTFALL RELIEF LINE IN N.W. LACAMAS DRIVE
BASINS INCLUDED IN THIS CALCULATION - "A" THRU "H"
2, 10, 25, & 100 YEAR FLOWS TO DETERMINE FLOW PER ACRE FOR PRELIMINARY

Path: F:\TZHEC
File: 109390Q1 .OUT 11,645 .a.. 2-26-93 11:07:30 am Page 3

PIPE SIZING. A 6 MONTH FLOW FOR WATER QUALITY SYSTEM SIZING.
OWNER - TOM SHIPLER
INPUT FILE=109390.DAT OUTPUT FILE=109390.OUT
RAINFALL RATIOS(JR)= 1.000(1.732".6 MONTH - WATER QUALITY),
1.563(2YR.,2.8"), 2.176(10YR.,3.9"), 2.400(25YR.,4.3"), 3.013(100YR.,5.4")
DATE 2/26/93

12 IO OUTPUT CONTROL VARIABLES

IPRNT	5	PRINT CONTROL
IPLOT	0	PLOT CONTROL
QSCAL	0.	HYDROGRAPH PLOT SCALE

IT HYDROGRAPH TIME DATA

NMIN	5	MINUTES IN COMPUTATION INTERVAL
IDATE	1JAN91	STARTING DATE
ITIME	0000	STARTING TIME
NQ	300	NUMBER OF HYDROGRAPH ORDINATES
NDDATE	2JAN91	ENDING DATE
NDTIME	0055	ENDING TIME
ICENT	19	CENTURY MARK

COMPUTATION INTERVAL .08 HOURS
TOTAL TIME BASE 24.92 HOURS

ENGLISH UNITS

DRAINAGE AREA	SQUARE MILES
PRECIPITATION DEPTH	INCHES
LENGTH, ELEVATION	FEET
FLOW	CUBIC FEET PER SECOND
STORAGE VOLUME	ACRE-FEET
SURFACE AREA	ACRES
TEMPERATURE	DEGREES FAHRENHEIT

JP MULTI-PLAN OPTION
NPLAN 1 NUMBER OF PLANS

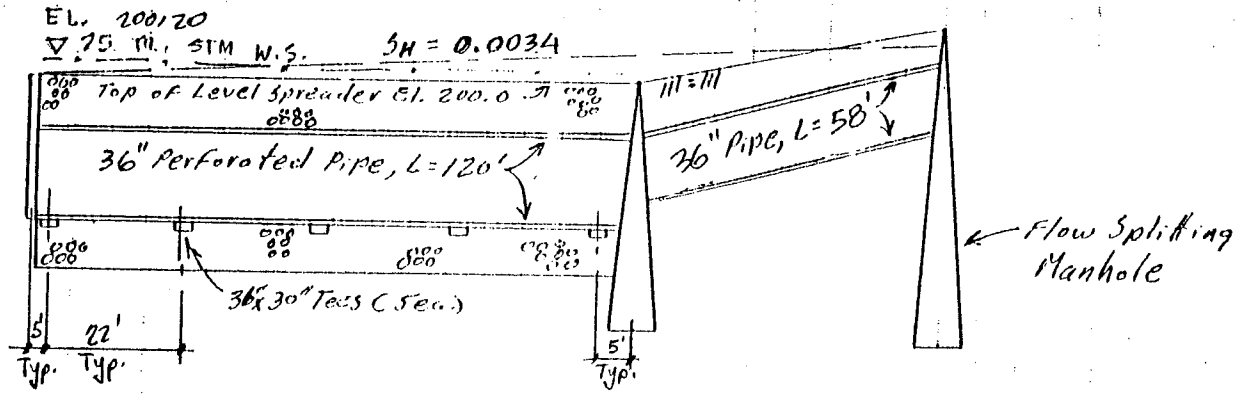
JR MULTI-RATIO OPTION
RATIOS OF PRECIPITATION
1.00 1.56 2.18 2.40 3.01

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5
					1.00	1.56	2.18	2.40	3.01
					6 Month	2Yr.	10Yr.	25Yr.	100Yr.
HYDROGRAPH AT									
	SBTOT	.07	1	FLOW	10.	22.	37.	43.	57.
				TIME	7.92	7.75	7.75	7.75	7.75

3. LEVEL SPREADER DESIGN

A) Hydraulic slope necessary to carry 25 year peak discharge, (43cfs - 4cfs to swale) = 39 cfs is 0.0034 (see Sheet 7)



B) Water surface elevation in flow splitting manhole during 25 year storm

= 200.20 + (178')(0.0034) = 200.81

C) Flow through 36"x30" tees to bottom of trench

a) Surface area of 30" tee = $\pi(1.25')^2$ = 4.91 ft²
b) Effective surface area assuming 70% of tee opening is blocked by drain rock = 0.3(4.91 ft²) = 1.47 ft²
c) Capacity of each tee = $CA(2gh)^{1/2}$ = 0.63(1.47)[64.4(201.62 - 200.0)]$^{1/2}$ = 9.46 cfs
d) Number of tees required for 25 yr. storm = 39 cfs / 9.46 cfs = 4.12 tees
Use 5 tees, one every 22 feet along perforated pipe,
capacity = 5(9.46 cfs) = 47.3 cfs > 39 cfs

MacKay & Sposito Inc. M&S ENGINEERS SURVEYORS PLANNERS 1703 MAIN STREET VANCOUVER, WA. 98660 (360) 695-3411 (503) 289-6726 FAX (360) 695-0833	DATE: 01-17-96 DRAWN: T.Z. CHECKED: D.J.M.	LEVEL SPREADER DESIGN MODIFICATIONS TO LAGAMAS SHORES STM. DISPOSAL SYSTEM	JOB NO.: 10,990X SHEET: 6 of

Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: LACAMAS SHORES

Comment: Hydraulic Slope Required for 25 Yr. Storm

Solve For Full Flow Slope

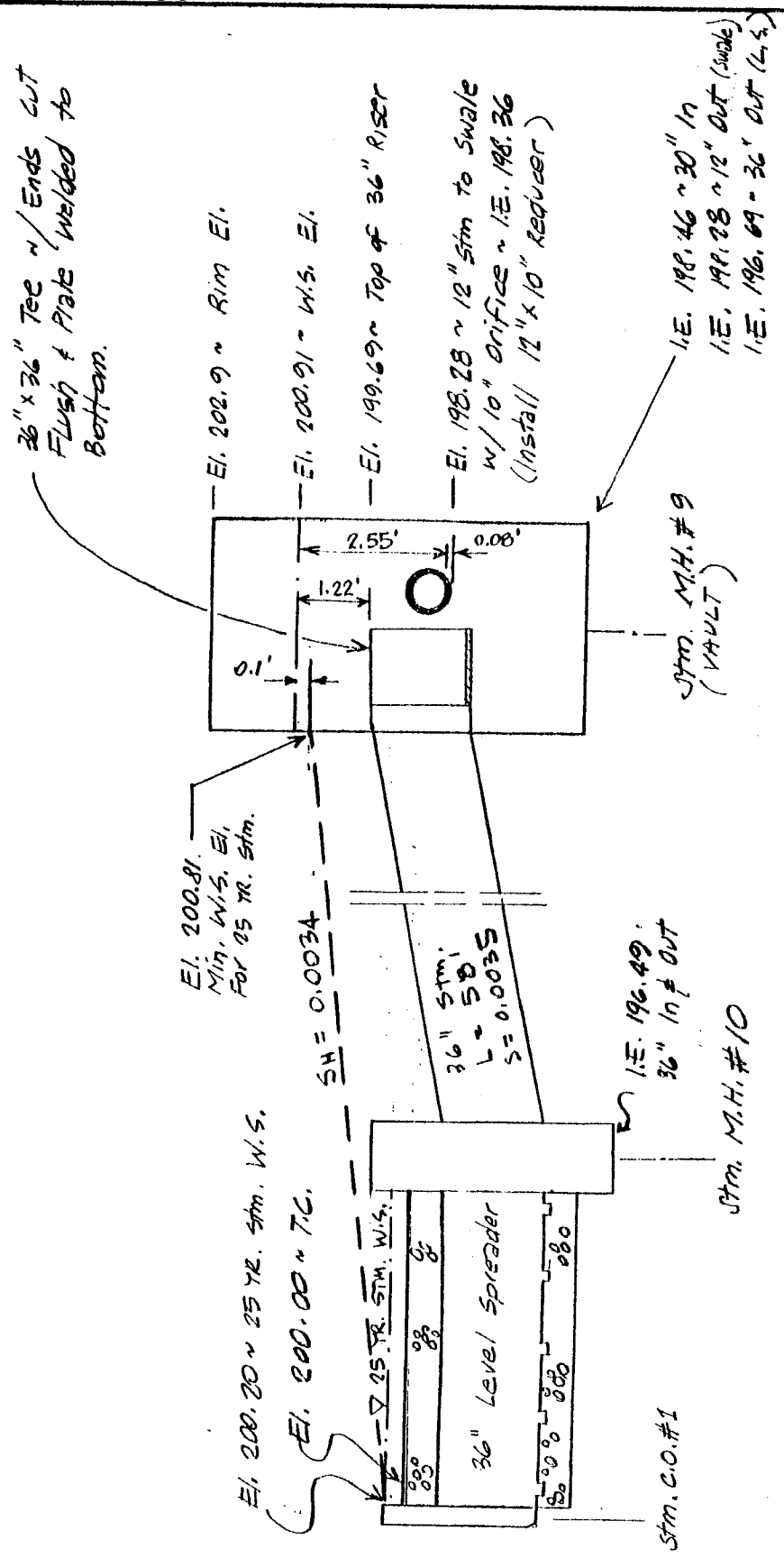
Given Input Data:

Diameter.....	3.00 ft
Manning's n.....	0.013
Discharge.....	39.00 cfs

Computed Results:

Full Flow Channel Slope	0.0034 ft/ft — H. SLOPE
Full Flow Depth.....	3.00 ft
Velocity.....	5.52 fps
Flow Area.....	7.07 sf
Critical Depth....	2.03 ft
Critical Slope....	0.0053 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	39.00 cfs
QMAX @.94D.....	41.95 cfs
Froude Number.....	FULL

Open Channel Flow Module, Version 3.12 (c) 1990
Haestad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708



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ENGINEERS SURVEYORS PLANNERS
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VANCOUVER, WA. 98660
(206) 695-3411 (503) 289-6726
FAX (206) 695-0833

DATE: 01-11-96
DRAWN: T.Z
CHECKED: D.J.M.

SPLITTER MANHOLE DESIGN
MODIFICATIONS TO LACAMAS SHORES STM. DISPOSAL SYSTEM

JOB NO.: 10990X
SHEET: 8 of

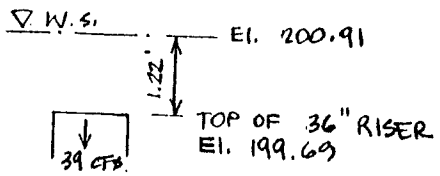
SPLITTER MANHOLE DESIGN CONT..

PIPE RISER WEIR FLOWS

PROJECT: LACAMAS SHORES
MODIFICATION TO STORMWATER DISPOSAL SYSTEM
DATE: 11-16-95
DESIGNED BY: T.Z.

RISER DIA. (inches)	36
"H" (feet)	FLOW (cfs)
0.00	0.00
1.22	39.37

1.22 =INCREMENTAL DEPTH CHANGE (ft.)

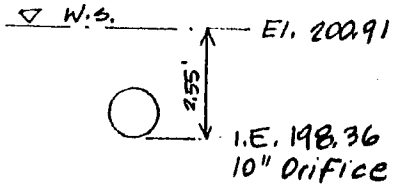


10" ORIFICE

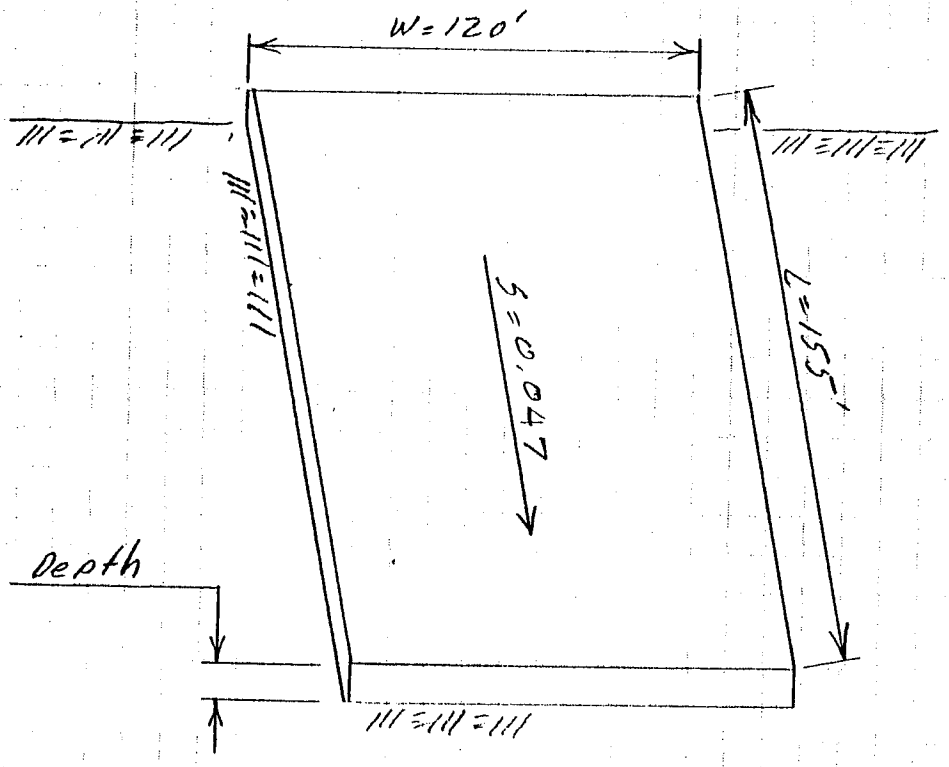
ORIFICE SIZE (in.)	10
AREA (sq. in.)	78.540
INVERT TO SURFACE (ft.)	FLOW (cfs)
0.00	
2.55	4.03

DATE: 01-09-96
DESIGNED BY: T.Z.

0.63 =ENTRANCE COEFFICIENT (Cd)
2.55 =INCREMENTAL DEPTH CHANGE (ft.)



5a. FILTER STRIP DESIGN



FLOW SUMMARY

Storm Event	Discharge	Depth	Velocity	Residence Time
6 mo.	6 cfs	0.07'	0.75 fps	207 sec.
2 yr.	18 cfs	0.13'	1.17 fps	132 sec.
10 yr.	33 cfs	0.18'	1.49 fps	104 sec.
25 yr.	39 cfs	0.20'	1.59 fps	98 sec.
100 yr.	53 cfs	0.25'	1.80 fps	86 sec.

Note: Permissible velocity for grass mixture = 4 fps

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(360) 695-3411 (503) 289-6726
FAX (360) 695-0833

DATE: 01-17-96
DRAWN: F.Z.
CHECKED: D.J.M.

FILTER STRIP DESIGN

MODIFICATION TO CAMAS STORES STM. DISPOSAL SYSTEM

JOB NO.: 10,990X
SHEET: 10 of -

FILTER STRIP DESIGN CONT...

Rectangular Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: LACAMAS SHORES

Comment: FILTER STRIP DESIGN ~100 YEAR FLOW

Solve For Depth

Given Input Data:

Bottom Width.....	120.00 ft
Manning's n.....	0.070
Channel Slope....	0.0470 ft/ft
Discharge.....	53.00 cfs

Computed Results:

Depth.....	0.25 ft
Velocity.....	1.80 fps
Flow Area.....	29.46 sf
Flow Top Width...	120.00 ft
Wetted Perimeter.	120.49 ft
Critical Depth...	0.18 ft
Critical Slope...	0.1265 ft/ft
Froude Number....	0.64 (flow is Subcritical)

Open Channel Flow Module, Version 3.12 (c) 1990
Haestad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708

Rectangular Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: LACAMAS SHORES

Comment: FILTER STRIP DESIGN ~ 25 YEAR FLOW

Solve For Depth

Given Input Data:

Bottom Width.....	120.00 ft
Manning's n.....	0.070
Channel Slope....	0.0470 ft/ft
Discharge.....	39.00 cfs

Computed Results:

Depth.....	0.20 ft
Velocity.....	1.59 fps
Flow Area.....	24.50 sf
Flow Top Width...	120.00 ft
Wetted Perimeter.	120.41 ft
Critical Depth...	0.15 ft
Critical Slope...	0.1353 ft/ft
Froude Number....	0.62 (flow is Subcritical)

Open Channel Flow Module, Version 3.12 (c) 1990
Haestad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708

Rectangular Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: LACAMAS SHORES

Comment: FILTER STRIP DESIGN ~ 10 YEAR FLOW

Solve For Depth

Given Input Data:

Bottom Width.....	120.00 ft
Manning's n.....	0.070
Channel Slope....	0.0470 ft/ft
Discharge.....	33.00 cfs

Computed Results:

Depth.....	0.18 ft
Velocity.....	1.49 fps
Flow Area.....	22.16 sf
Flow Top Width...	120.00 ft
Wetted Perimeter.	120.37 ft
Critical Depth...	0.13 ft
Critical Slope...	0.1404 ft/ft
Froude Number....	0.61 (flow is Subcritical)

Open Channel Flow Module, Version 3.12 (c) 1990
Haestad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708

FILTER STRIP DESIGN CONT...

Rectangular Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: LACAMAS SHORES

Comment: FILTER STRIP DESIGN ~ 2 YEAR FLOW

Solve For Depth

Given Input Data:

Bottom Width.....	120.00 ft
Manning's n.....	0.070
Channel Slope....	0.0470 ft/ft
Discharge.....	18.00 cfs

Computed Results:

Depth.....	0.13 ft
Velocity.....	1.17 fps
Flow Area.....	15.40 sf
Flow Top Width...	120.00 ft
Wetted Perimeter.	120.26 ft
Critical Depth...	0.09 ft
Critical Slope...	0.1605 ft/ft
Froude Number....	0.58 (flow is Subcritical)

Open Channel Flow Module, Version 3.12 (c) 1990
Haestad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: LACAMAS SHORES

Comment: BIOFILTRATION SWALE

Solve For Depth

Given Input Data:

Bottom Width.....	8.00 ft
Left Side Slope..	3.00:1 (H:V)
Right Side Slope.	3.00:1 (H:V)
Manning's n.....	0.070
Channel Slope....	0.0100 ft/ft
Discharge.....	4.00 cfs

Computed Results:

Depth.....	0.41 ft
Velocity.....	1.06 fps
Flow Area.....	3.76 sf
Flow Top Width...	10.44 ft
Wetted Perimeter.	10.58 ft
Critical Depth...	0.19 ft
Critical Slope...	0.1275 ft/ft
Froude Number....	0.31 (flow is Subcritical)

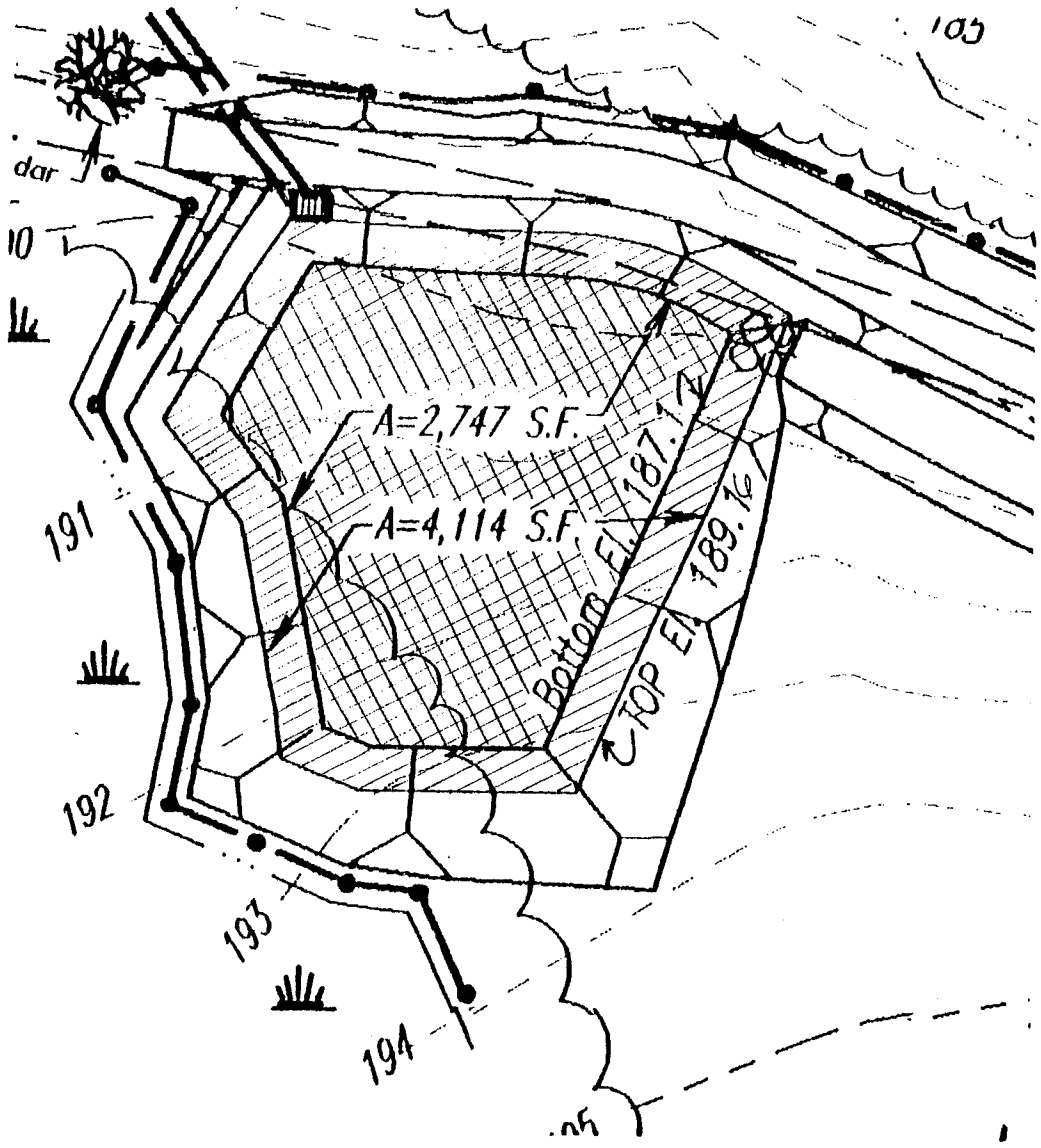
L = 285'

RESIDENCE TIME

$T = \frac{L}{V}$ = 285 Ft / 1.06 Ft/sec = 269 sec. > 147 sec. ORIGINAL DESIGN.

Open Channel Flow Module, Version 3.12 (c) 1990
Haestad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708

WET POND DESIGN



WET POND VOLUME = $\frac{2,747\phi + 4,114\phi}{2} \times 2.0' = 6,861$ C.F.

POND OUTLET STRUCTURE DESIGN

RECTANGULAR SHARP CRESTED

WEIR

PROJECT: LACAMAS SHORES

MODIFICATION TO STORMWATER DISPOSAL SYSTEM

DATE: 01-16-96

DESIGNED BY: T.Z.

	WEIR LENGTH (FT.)		10.854	
ELEV.	HEAD OVER WEIR (FT.)	COEFFI-CIENT "C"	FLOW (CFS)	STORM
189.45	0.350	4.47	10.05	6 Mo.
189.75	0.645	3.92	22.05	2 YR.
190.05	0.945	3.71	37.04	10 YR.
190.16	1.055	3.67	43.14	25 YR.
190.39	1.288	3.60	57.06	100 YR.

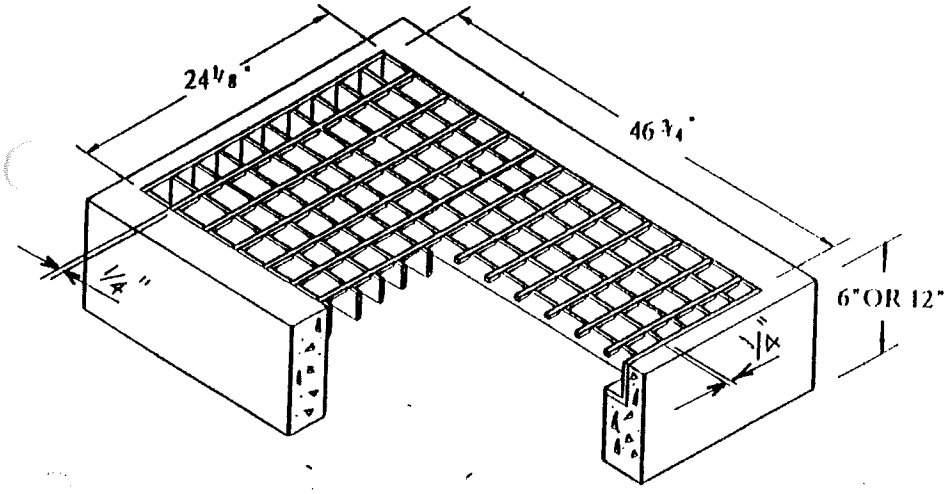
1.05 =HEIGHT OF WEIR (h)

0.35 =INCREMENTAL HEAD CHANGE (FT.)

WEIR COEFFICIENT C= 3.27 +0.40 h/H

WEIR FORMULA: $Q = LC(H)^{1.50}$

TYPE 2 GRATE INLET



Galvanized Steel Grates Type A and Type B meet WSDOT Standard Plan B-4b.

GRATE OPEN SPACES PARAMETER:

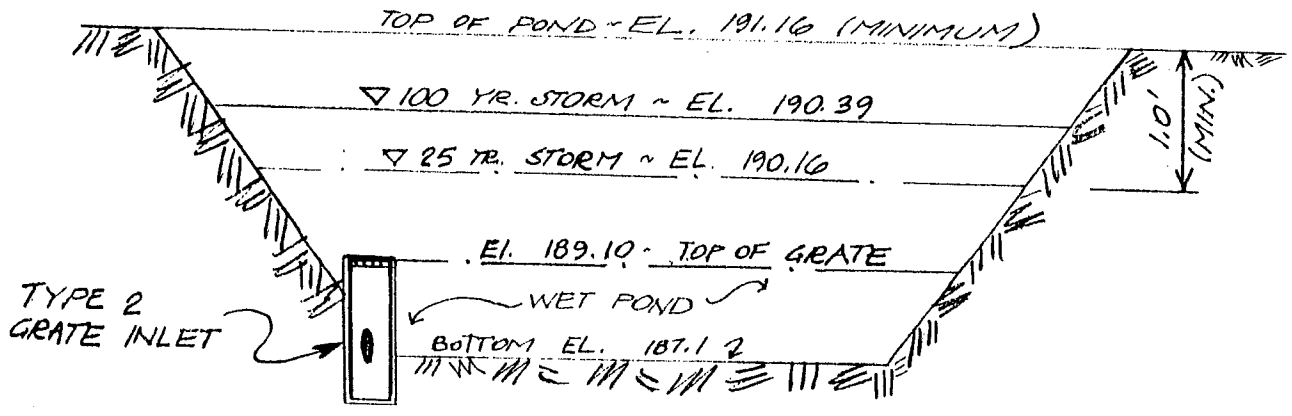
$L_{(o)} = 46\frac{3}{4}" - (12 \times \frac{1}{4}") = 43\frac{3}{4}"$

$L_{(o)} = 3.646'$

$W_{(o)} = 24\frac{1}{8}" - (11 \times \frac{1}{4}") = 21\frac{3}{8}"$

$W_{(o)} = 1.781'$

$P_{(o)} = 2L_{(o)} + 2W_{(o)} = 10.854'$



Circular Channel Analysis & Design
Solved with Manning's Equation

Open Channel - Uniform flow

Worksheet Name: LACAMAS SHORES

Comment: STORM OUTLET TO LACAMAS LAKE

Solve For Full Flow Slope

Given Input Data:

Diameter.....	2.00 ft
Manning's n.....	0.013
Discharge.....	21.50 cfs

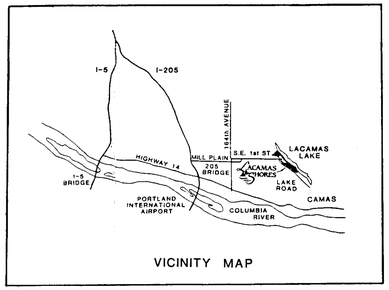
Computed Results:

Full Flow Channel Slope	0.0090 ft/ft
Full Flow Depth.....	2.00 ft
Velocity.....	6.84 fps
Flow Area.....	3.14 sf
Critical Depth....	1.66 ft
Critical Slope....	0.0088 ft/ft
Percent Full.....	100.00 %
Full Capacity.....	21.50 cfs
QMAX @.94D.....	23.13 cfs
Froude Number.....	FULL

25 YR. STORM = 43 cfs.
USE 2 - 24" DIA. STM. @ MIN. SLOPE = 0.009

Open Channel Flow Module, Version 3.12 (c) 1990
Haestad Methods, Inc. * 37 Brookside Rd * Waterbury, Ct 06708

DRAINAGE BASIN	AREA
A	1.2 Ac.
B	1.2 Ac.
C	5.8 Ac.
D	3.8 Ac.
E	9.3 Ac.
F	6.7 Ac.
G	9.8 Ac.
H	7.0 Ac.
I	10.2 Ac.
J	21.8 Ac.
APPROVED NOT CONSTRUCTED K	4.4 Ac.
APPROVED NOT CONSTRUCTED L	8.4 Ac.
APPROVED NOT CONSTRUCTED M	1.7 Ac.
APPROVED NOT CONSTRUCTED N	8.5 Ac.



VICINITY MAP

LEGEND

BIO-FILTER "A"

DRAINAGE BASIN TRIBUTARY TO BIO-FILTER "A"

SHIPLER PROPERTY
BIO-FILTER BASINS MAP

CITY OF CAMAS WASHINGTON

PREPARED BY: MacKay & Sposito
ENGINEERS SURVEYORS PLANNERS
110 E 17TH ST. VANCOUVER, WA

JOB # 11,990 10-2-91 BY: T.Z.

RICHARD SPOSITO STATE OF WASHINGTON 13935 REGISTERED PROFESSIONAL ENGINEER
10-2-91
EXPIRES 12/29/91