TACOMA • SEATTLE

Outfall #4 Hydrologic Report

PREPARED FOR:

Alutiiq International Solutions, LLC
PO Box 750
Fort Lewis, WA 98433
Contact: Jim Thompson

PROJECT:

Stormwater Treatment Facility
Fort Lewis, WA Outfall #4
Contract No. W912DW-07-C-0025
PN 65933

PREPARED BY:

Glenn C. Hume, PE
Project Engineer

REVIEWED BY:

Doreen S. Gavin, PE, LEED® AP
Vice President

April 2009
AHBL Project No. 207246.10

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4/8/09
DOREEN S. GAVIN
STATE OF WASHINGTON
23467
REGISTERED
PROFESSIONAL ENGINEER

I hereby state that this Outfall #4 Hydrologic Report for the Stormwater Treatment Facility Fort Lewis, WA Outfall #4 has been prepared by me or under my supervision, and meets the standard of care and expertise that is usual and customary in this community for professional engineers. I understand that the Army Corps of Engineers does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities prepared by me.

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Acronyms

cfs	cubic feet per second
gpm	gallons per minute
ft	feet
in	inches
ac-ft	acre-feet
ac	acre
WWHM	Western Washington Hydrology Model
HSPF	Hydrological Simulation Program Fortran
yr	year
NRCS	Natural Resource Conservation Service
WSDOE	Washington State Department of Ecology
SMMWW	Stormwater Management Manual for Western Washington, 2005 Edition

1.0 PROJECT OVERVIEW

1.1 Purpose of Study

The purpose of this study was to model and evaluate the hydrologic condition of Outfall #4 after the addition of the proposed stormwater management facilities. The primary objective for the proposed ponds is to provide stormwater quality control for runoff from the Outfall #4 basin, while also reducing flows to the existing channel to the extent feasible. The proposed facilities include a debris interceptor, two open storage ponds, and a new pumping facility to direct a portion of the stormwater runoff for Outfall #4 to the proposed ponds. Scope of project is to provide stormwater treatment for Outfall #4. Quantity control is not within the scope; therefore compliance with established stormwater management quantity control requirements is not a requirement.

1.2 Study Scope

The study includes determination of the boundary and characteristics of the basin area tributary to Outfall #4 based on record documents, topographic surveys, and field reviews; ascertaining the minimum water quality control requirements in accordance with the *Stormwater Management Manual for Western Washington 2005 (SMMWW)*; and, providing the geotechnical engineer with infiltration information in order to determine the impacts to the groundwater elevation at the adjacent existing unlined landfill.

Basin and proposed facility information was entered into the hydrology model to predict proposed pond performance. The model analysis includes determining water quality rates and volumes, pump flow and pond discharge rates, average pond stages, effect of diverting flows on the existing drainage canal, and infiltration rates and volumes.

1.3 Model Methodology

Hydrologic analysis was performed using the Western Washington Hydrology Model, Version 3 (WWHM). WWHM is a continuous simulation model based on Hydrological Simulation Program FORTRAN (HSPF) and was developed by the Washington State Department of Ecology, Aqua Terra Consultants, and Clear Creek Solutions, Inc. The computer program utilizes actual recorded precipitation, measured pan evaporation, and regional HSPF parameters. The model chooses the most appropriate rain gauge data based on the site location and applies appropriate precipitation adjustment factors based on the site's proximity to the available gauge. The Outfall #4 site utilizes the McMillian Gauge with a precipitation correction factor of 1.00. Historic rainfall information for this gauge is available from 1 October 1948, to 29 September 1996. Hourly pond performance data was exported from the model to Excel spreadsheets to further analyze the data including stage, discharge, and infiltration information.

2.0 BASIN DESCRIPTION

2.1 Basin Delineation

The following is an excerpt and basin map from the Fort Lewis Stormwater Pollution Prevention Plan, 29 July 2005, providing a basic description of the Outfall #4 basin.

"**Outfall 4 – Solo Point Road.** Storm drainage is conveyed to Outfall 4 via 24-inch, 54-inch, and 60-inch pipes. The northern portion of North Fort contributes drainage to Outfall 4. The drainage area contributing to Outfall 4 totals approximately 571 acres, of which about 324 acres are impervious. Stormwater treatment is provided at Outfall 4 via a recently constructed oil/water separator with coalescing plates. Following treatment, stormwater discharges to an open canal conveyance system that drains northwesterly to the Puget Sound, near Solo Point."

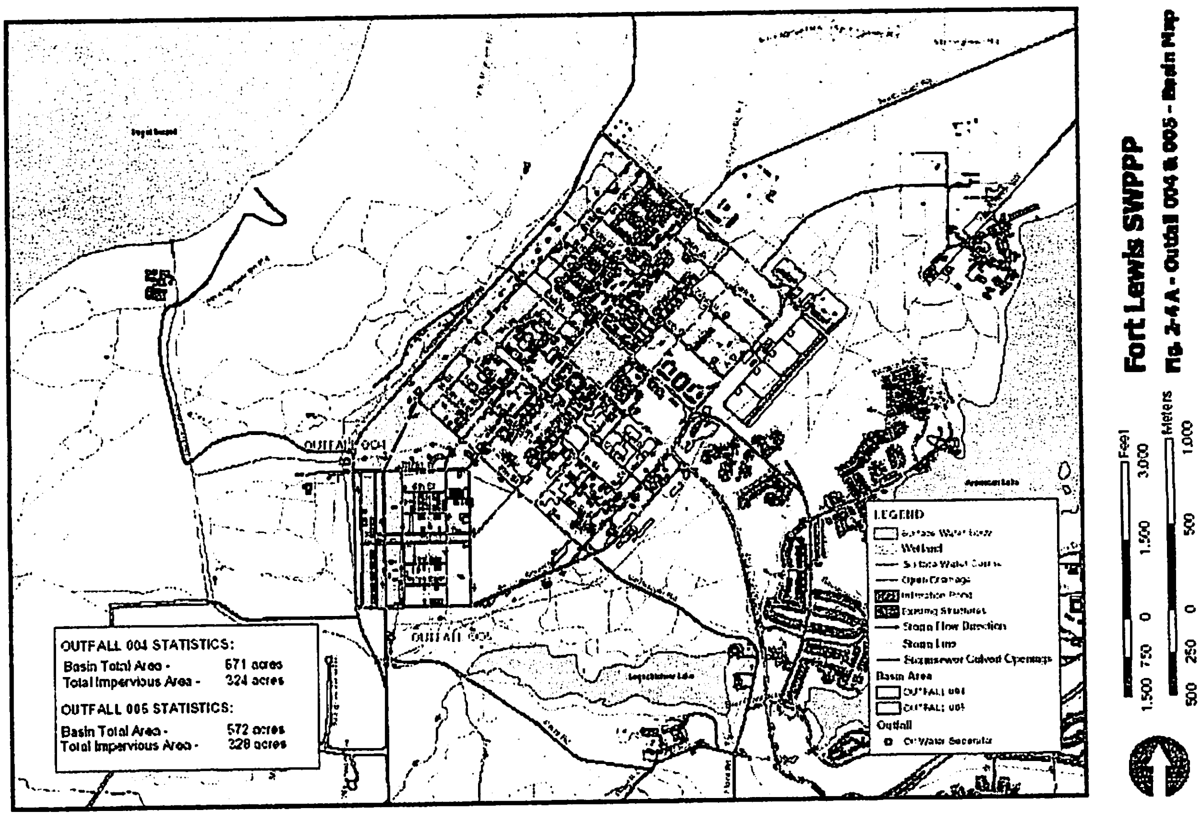


Figure 2.1: Outfall 4 and 5 Basin Map

The basin description defines the total basin area as approximately 571 acres with 324 acres of impervious surfaces. Portions of the basin area are being or will be re-developed. This project has assumed that runoff generated within the re-developed areas will be infiltrated on the individual project site. Therefore, this area has been removed from the basin for the purpose of modeling anticipated future flows to the Outfall #4 discharge. Drainage basin delineation accommodates the future development at "I" Street and 41st Division Drive and was determined by reviewing the "Fort Lewis Stormwater Utility System North Fort GIS" records, dated March 18; 2008, aerial photographs, dated December 2002; a topographic survey; and field visits. Appendix A shows the areas that have been recently redeveloped and removed from the Outfall #4 basin. Prior developed areas are assumed to remain as is in regard to stormwater runoff.

2.2 Land Cover

This analysis includes a total basin area of 654.92 acres and assumes that 325.90 acres of the basin will be infiltrated and are removed from the area tributary to Outfall #4. The remaining basin area is 329.02 acres, of which 56.72 acres are impervious roads, 161.90 acres are other impervious areas including parking and buildings, and 110.40 acres are landscape.

2.3 Topography and Drainage

The basin area is relatively flat. There is an existing network of manholes and underground pipes to collect and convey stormwater runoff to Outfall #4.

2.4 Soils

The Natural Resource Conservation Service (NRCS) classifies the onsite soil as predominately Spanaway gravelly sandy loam (41A). The soil was formed on outwash plains with a parent material of volcanic ash over gravelly outwash. The Spanaway soil is characterized as level (0 to 6% slopes), somewhat excessively drained, with no zone of water saturation within 72 inches of the surface. The soil is classified as Type A for stormwater modeling. A Geotechnical and Hydrogeologic Assessment was created by Associated Earth Sciences in February 2009 and is included in its entirety as Appendix A of this report.

2.5 Runoff Rates

The resulting modeled runoff rates are provided in the following table. This analysis does not account for potential attenuation of runoff due to upstream conveyance restrictions and storage.

Flow Frequency	*Runoff Rate (cfs)*	*Runoff Rate (gpm)*
2-year	63.44	28,474
5-year	85.20	38,240
10-year	100.69	45,193
25-year	121.54	54,551
50-year	138.02	61,948
100-year	155.34	69,721
Treatment*	19.29	8,658

*Treatment rate is based on the flow rate at which 91 percent of the total basin runoff volume is included. The model also calculates a 24-hour water quality volume required to treat stormwater runoff via a wetpool type facility. The calculated 24-hour water quality runoff volume is 24.05 acre-feet.

3.0 FACILITY DESCRIPTIONS

3.1 Oil/Water Separator

There is an existing oil/water separator located at Outfall #4 that receives stormwater flow from both 54-inch storm pipes. The design capacity of the oil/water separator is 8,000 gpm (17.82 cfs). The oil/water separator is located downstream of the proposed debris separator.

3.2 Flow Splitter

A flow splitter exists that directs 8,000 gpm to the existing oil/water separator. All flows exceeding 8,000 gpm bypass the oil/water separator and subsequently combine with the treated flow from the oil/water separator. This combined flow will be intercepted and be pumped to the ponds.

3.3 Stormwater Pump Station

Discharge from the oil/water separator and the bypassed flow are directed to the proposed pump station. The design pump rate for the station is based on directing the full treatment flow rate to the proposed ponds. This rate is 20.05 cfs (9,000 gpm). Flows exceeding the design pump rate will be directed via a bypass system to the existing drainage canal.

3.4 Deep Pond

Stormwater runoff is conveyed from the pump station to the Deep Pond, the first of two ponds, at a rate of 20.05 cfs. The Deep Pond bottom dimensions are approximately 135 feet by 1,126 feet. The side slopes will be 3:1 with a total berm height of 15.5 feet. The maximum design water stage will be 12 feet with overflow occurring above this elevation.

The outlet orifice from the Deep Pond will be set 6 feet above the pond bottom to provide dead storage. The dead storage will provide quality control. The dead storage volume proposed is 24.10 acre-feet, exceeding the required 24-hour treatment volume of 24.05 acre-feet as discussed in Section 4.5.

The total pond volume at the maximum stage of 12 feet is 54.81 acre-feet. Live storage volume is provided from Stage 6 feet to Stage 12 feet, resulting in a total available live storage volume of 30.71 acre-feet.

The discharge rate, 1.0 cfs, for the live storage will be controlled by a 3⅞-inch orifice at Stage 6 feet. Discharge from the orifice, as well as flow through the proposed overflow riser from the Deep Pond, will be directed into the Shallow Pond.

Infiltration from the Deep Pond is based on leakage calculations for the proposed liner design provided by the Geotechnical Engineer. The rate of leakage from the pond varies with pond stage. This variation in rate has been accounted for in the model by varying the effective infiltration rate with stage.

Default precipitation and pan evaporation factors have been applied to the Deep Pond.

The following is a stage/area/storage/discharge/infiltration table for the Deep Pond.

Deep Pond Hydraulic Table

Stage (ft)	Area (acre)	Volume (ac-ft)	Discharge (cfs)	Infiltration (cfs)
0.000	3.487	0.000	0.000	0.000
0.167	3.516	0.584	0.000	0.008
0.333	3.545	1.172	0.000	0.009
0.500	3.574	1.765	0.000	0.010
0.667	3.603	2.363	0.000	0.011
0.833	3.632	2.966	0.000	0.013
1.000	3.661	3.574	0.000	0.014
1.167	3.690	4.186	0.000	0.015
1.333	3.719	4.804	0.000	0.016
1.500	3.749	5.426	0.000	0.018
1.667	3.778	6.053	0.000	0.019
1.833	3.808	6.685	0.000	0.020
2.000	3.837	7.322	0.000	0.021
2.167	3.866	7.964	0.000	0.023
2.333	3.896	8.611	0.000	0.024
2.500	3.926	9.263	0.000	0.025
2.667	3.955	9.920	0.000	0.027
2.833	3.985	10.58	0.000	0.028
3.000	4.015	11.25	0.000	0.029
3.167	4.044	11.92	0.000	0.030
3.333	4.074	12.60	0.000	0.032
3.500	4.104	13.28	0.000	0.033
3.667	4.134	13.96	0.000	0.035
3.833	4.164	14.66	0.000	0.036
4.000	4.194	15.35	0.000	0.037
4.167	4.224	16.05	0.000	0.039
4.333	4.254	16.76	0.000	0.040
4.500	4.284	17.47	0.000	0.042
4.667	4.314	18.19	0.000	0.043
4.833	4.345	18.91	0.000	0.044
5.000	4.375	19.64	0.000	0.046
5.167	4.405	20.37	0.000	0.047
5.333	4.436	21.11	0.000	0.049
5.500	4.466	21.85	0.000	0.050
5.667	4.497	22.59	0.000	0.052
5.833	4.527	23.35	0.000	0.053
6.000	4.558	24.10	0.000	0.055
6.167	4.588	24.87	0.161	0.056
6.333	4.619	25.63	0.228	0.058
6.500	4.650	26.40	0.279	0.059

Stage (ft)	Area (acre)	Volume (ac-ft)	Discharge (cfs)	Infiltration (cfs)
6.667	4.680	27.18	0.322	0.061
6.833	4.711	27.96	0.360	0.063
7.000	4.742	28.75	0.394	0.064
7.167	4.773	29.55	0.426	0.066
7.333	4.804	30.34	0.455	0.067
7.500	4.835	31.15	0.483	0.069
7.667	4.866	31.96	0.509	0.071
7.833	4.897	32.77	0.534	0.072
8.000	4.928	33.59	0.558	0.074
8.167	4.959	34.41	0.580	0.076
8.333	4.990	35.24	0.602	0.077
8.500	5.021	36.07	0.624	0.079
8.667	5.053	36.91	0.644	0.081
8.833	5.084	37.76	0.664	0.082
9.000	5.115	38.61	0.683	0.084
9.167	5.147	39.46	0.702	0.086
9.333	5.178	40.32	0.720	0.087
9.500	5.210	41.19	0.738	0.089
9.667	5.241	42.06	0.755	0.091
9.833	5.273	42.94	0.772	0.093
10.00	5.305	43.82	0.789	0.095
10.17	5.336	44.71	0.805	0.096
10.33	5.368	45.60	0.821	0.098
10.50	5.400	46.50	0.837	0.100
10.67	5.432	47.40	0.852	0.102
10.83	5.464	48.31	0.867	0.104
11.00	5.496	49.22	0.882	0.105
11.17	5.528	50.14	0.896	0.107
11.33	5.560	51.06	0.911	0.109
11.50	5.592	51.99	0.925	0.111
11.67	5.624	52.93	0.939	0.113
11.83	5.656	53.87	0.952	0.115
12.00	5.688	54.81	0.966	0.117
12.17	5.720	55.76	2.305	0.119
12.33	5.753	56.72	4.741	0.121
12.50	5.785	57.68	7.892	0.123
12.67	5.818	58.65	11.62	0.124
12.83	5.850	59.62	15.85	0.126
13.00	5.882	60.60	20.52	0.128
13.17	5.915	61.58	25.60	0.130

3.5 Shallow Pond

Discharge from the Deep Pond flows into the proposed Shallow Pond. The Shallow Pond bottom dimensions are approximately 150 feet by 474 feet. The side slopes will be 3:1, with a total berm height of 7.5 feet. The maximum design water stage will be 5 feet, with overflow occurring above this elevation.

The outlet orifice from the Deep Pond will be set 1 foot above the pond bottom.

The total pond volume at the maximum stage of 5 feet is 9.29 acre-feet. Live storage volume is provided from Stage 1 feet to Stage 5 feet, resulting in a total available live storage volume of 7.61 acre-feet.

The discharge rate, 1.0 cfs, for the live storage will be controlled by a 4¼ inch orifice at Stage 1 feet. The design discharge rate at Stage 5 feet is 1.03 cfs. Runoff volumes that exceed the pond capacity will be directed by an overflow riser. Discharge from the orifice, as well as flow through the proposed overflow riser from the Deep Pond, will be directed to the Infiltration Facility.

Infiltration from the Shallow Pond is based on leakage calculations for the proposed liner design provided by the Geotechnical Engineer. The rate of leakage from the pond varies with pond stage. This variation in rate has been accounted for in the model by varying the effective infiltration rate with stage.

Default precipitation and pan evaporation factors have been applied to the Shallow Pond.

The following is a stage/area/storage/discharge/infiltration table for the Shallow Pond.

Shallow Pond Hydraulic Table

Stage (ft)	Area (acre)	Volume (ac-ft)	Discharge (cfs)	Infiltration (cfs)
0.000	1.636	0.000	0.000	0.000
0.089	1.643	0.146	0.000	0.004
0.178	1.651	0.292	0.000	0.004
0.267	1.659	0.439	0.000	0.004
0.356	1.666	0.587	0.000	0.005
0.444	1.674	0.735	0.000	0.005
0.533	1.682	0.885	0.000	0.005
0.622	1.690	1.034	0.000	0.006
0.711	1.697	1.185	0.000	0.006
0.800	1.705	1.336	0.000	0.006
0.889	1.713	1.488	0.000	0.007
0.978	1.721	1.641	0.000	0.007
1.067	1.728	1.794	0.122	0.007
1.156	1.736	1.948	0.187	0.008
1.244	1.744	2.103	0.235	0.008
1.333	1.752	2.258	0.274	0.008
1.422	1.760	2.414	0.308	0.009
1.511	1.768	2.571	0.339	0.009
1.600	1.776	2.728	0.367	0.009
1.689	1.783	2.887	0.394	0.010
1.778	1.791	3.045	0.418	0.010
1.867	1.799	3.205	0.442	0.010
1.956	1.807	3.365	0.464	0.011
2.044	1.815	3.526	0.485	0.011
2.133	1.823	3.688	0.505	0.011
2.222	1.831	3.850	0.524	0.012
2.311	1.839	4.014	0.543	0.012
2.400	1.847	4.177	0.561	0.012
2.489	1.855	4.342	0.579	0.013
2.578	1.863	4.507	0.596	0.013
2.667	1.871	4.673	0.612	0.013
2.756	1.879	4.840	0.629	0.014
2.844	1.887	5.007	0.644	0.014
2.933	1.895	5.175	0.660	0.014
3.022	1.903	5.344	0.675	0.015
3.111	1.912	5.514	0.689	0.015
3.200	1.920	5.684	0.704	0.016
3.289	1.928	5.855	0.718	0.016
3.378	1.936	6.027	0.732	0.016
3.467	1.944	6.199	0.745	0.017
3.556	1.952	6.372	0.758	0.017
3.644	1.960	6.546	0.771	0.017
3.733	1.969	6.721	0.784	0.018
3.822	1.977	6.896	0.797	0.018
3.911	1.985	7.072	0.809	0.019
4.000	1.993	7.249	0.822	0.019
4.089	2.001	7.427	0.834	0.019
4.178	2.010	7.605	0.846	0.020
4.267	2.018	7.784	0.857	0.020
4.356	2.026	7.964	0.869	0.021
4.444	2.035	8.144	0.880	0.021
4.533	2.043	8.325	0.892	0.021
4.622	2.051	8.507	0.903	0.022
4.711	2.060	8.690	0.914	0.022
4.800	2.068	8.873	0.925	0.022
4.889	2.076	9.058	0.936	0.023
4.978	2.085	9.243	0.946	0.023
5.067	2.093	9.428	1.292	0.024
5.156	2.101	9.615	2.162	0.024
5.244	2.110	9.802	3.331	0.024
5.333	2.118	9.990	4.736	0.025
5.422	2.127	10.18	6.341	0.025
5.511	2.135	10.37	8.125	0.026
5.600	2.144	10.56	10.07	0.026
5.689	2.152	10.75	12.16	0.027
5.778	2.161	10.94	14.40	0.027
5.867	2.169	11.13	16.76	0.027
5.956	2.178	11.33	19.25	0.028
6.044	2.186	11.52	21.86	0.028
6.133	2.195	11.71	24.58	0.029

3.6 Infiltration Facility

Discharge from the Shallow Pond is directed to the Infiltration Facility. The Infiltration Facility is not an actual pond, but instead is a natural area that will remain undisturbed with the exception of the area that will be utilized as a staging area. The area utilized for staging within 50 feet of the shallow pond outlet will be tilled to a depth of 6 inches after staging is no longer required. Stormwater runoff discharged from the Shallow Pond will be introduced to the Infiltration Facility as sheet flow through a level-spreader type facility. The Infiltration Facility area will not be lined so the infiltration rate is based on native soil conditions and the horizontal movement of the groundwater. Runoff volumes that exceed the Infiltration Facility capacity will flow to existing infiltration ponds that are assumed to have adequate capacity to manage the Infiltration Facility overflow volume.

3.7 Drainage Canal

Three survey sections were measured for the existing drainage canal. The canal, located north of the landfill, is generally trapezoidal in shape with varying bottom width, depth, and side slopes. The three sections show that the bottom width varies from 7.8 feet to 16.8 feet, the depth from 6.93 feet to 12.1 feet, and the side slopes are in the range of 1.32:1 and 1.68:1.

The centerline slope of the canal varies from nearly level to a slope of 0.0016 feet/feet.

The swale bottom is fairly regular, soil surfaced with tall grass on the bottom that is easily laid over by flowing water. The side slopes are covered with vegetation, including light to moderately dense brush.

4.0 HYDROLOGIC RESULTS AND ANALYSIS

4.1 Deep Pond

The model time series starts on 1 October 1948. The historical data based on this start time predicts that the 6 feet of dead storage in the Deep Pond will be full by 30 October 1948. After reaching the 6 foot stage, the minimum stage within the pond through September 1996 is 0.62 feet, with an average stage over the entire time series of 7.88 feet. The maximum stage reached is 13.00 feet. The following table provides the average stage for each month.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Stage (ft)	9.38	9.20	8.90	8.21	7.14	6.75	5.96	5.60	6.32	7.50	9.76	9.94

The total runoff volume entering the Deep Pond from the tributary basin through the entire time series is 26,200 acre-feet. The Deep Pond also receives 754 acre-feet of direct rainfall within the pond footprint for a total runoff volume of 25,235 acre-feet. Evaporation from the pond surface reduces the runoff volume by 431 acre-feet and 2,566 acre-feet is infiltrated. Therefore, 22,238 acre-feet is discharged through the control structure to the Shallow Pond.

4.2 Shallow Pond

The Shallow Pond receives runoff volume from the Deep Pond, as well as direct precipitation into the pond. The Shallow Pond is designed to discharge at a maximum rate of 1.00 cfs to the Infiltration Facility under normal circumstances.

The average discharge rate for the Shallow Pond over the entire time series is 0.58 cfs, with a peak discharge rate of 1.03 cfs. The pump station is designed to shut off when the Shallow Pond stage exceeds Stage 5.00 so that the discharge rate to the Infiltration Facility does not exceed 1.03 cfs. The pumps will shut down due to overflow conditions approximately 5.4 percent of the time.

The average stage over the entire time series is 2.34 feet, with a minimum stage of 0 and a maximum stage of 5.00 feet. The following table provides the average stage for each month.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Stage (ft)	3.51	3.34	3.16	2.58	1.84	1.53	1.02	0.71	1.12	1.91	3.50	3.88

The Shallow Pond receives 22,238 acre-feet of discharge from the Deep Pond and 293 acre-feet of direct precipitation for a total volume of 22,531 acre-feet. Evaporation accounts for 169 acre-feet and approximately 425 acre-feet is infiltrated, resulting in a total volume discharged to the infiltration facility of 21,937 acre-feet.

4.3 Infiltration Facility

The Infiltration Facility receives the discharge runoff from the Shallow Pond. Detailed level pool information has not been developed for the Infiltration Facility because the design approach is to introduce flows to the area via a level-spreader device at 1.00 cfs with the ability to manually allow the flow to increase up to 6.00 cfs under conditions of low to moderate general water levels.

4.4 Drainage Canal

Stormwater runoff rates entering the pump station that exceed the design pump rate of 9,000 gpm are bypassed directly into the existing drainage canal. The diversion of the pumped runoff to the proposed ponds reduces the flow within the canal. The following table summarizes the design flows with and without the ponds.

Flow Frequency	*Runoff Rate without Ponds (cfs)*	*Runoff Rate with Ponds (cfs)*
2-year	63.44	49.59
5-year	85.20	71.43
10-year	100.69	86.78
25-year	121.54	107.14
50-year	138.02	122.98
100-year	155.34	139.38

Reduction of the discharge rate to the canal will reduce the flow depth. For instance, during the 2-year flow event, the flow depth in the canal is reduced from 15.05 inches to 13.03 inches. The flow in the canal is potentially hydraulically connected to the groundwater. Therefore, reducing the flow depth in the canal may reduce the adjacent groundwater elevation.

The following table summarizes the channel calculations with and without the ponds.

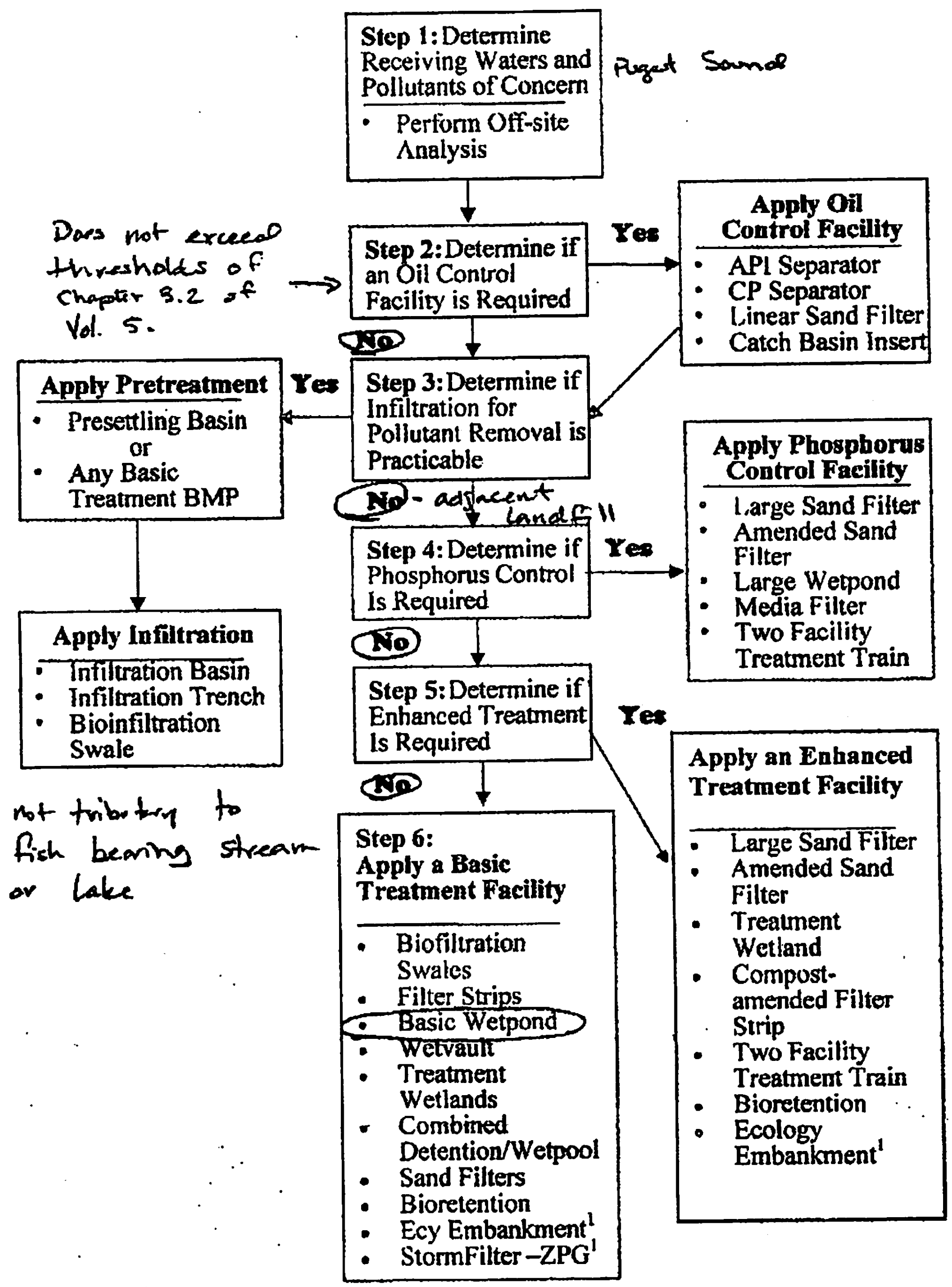
Channel Calculator without Ponds		Channel Calculator with Ponds	
Given Input Data:		Given Input Data:	
Shape	Trapezoidal	Shape	Trapezoidal
Solving for	Depth of Flow	Solving for	Depth of Flow
Flowrate	63.4400 cfs	Flowrate	49.4300 cfs
Slope	0.0016 ft/ft	Slope	0.0016 ft/ft
Manning's n	0.0175	Manning's n	0.0175
Height	83.1600 in	Height	83.1600 in
Bottom width	148.80 in	Bottom width	148.80 in
Left slope	0.69 ft/ft (V/H)	Left slope	0.69 ft/ft (V/H)
Right slope	0.595 ft/ft (V/H)	Right slope	0.595 ft/ft (V/H)
Computed Results:		Computed Results:	
Depth	15.0501 in	Depth	13.0289 in
Velocity	3.5218 fps	Velocity	3.2395 fps
Full Flowrate	1429.2838 cfs	Full Flowrate	1429.2838cfs
Flow area	18.0134 ft2	Flow area	15.3081 ft2
Flow perimeter	204.7333 in	Flow perimeter	197.2212 in
Hydraulic radius	12.6698 in	Hydraulic radius	11.1771 in
Top width	195.9061 in	Top width	189.5799 in
Area	161.0897 ft2	Area	161.0897 ft2
Perimeter	457.8615 in	Perimeter	457.8615 in
Percent full	18.0978 %	Percent full	15.6673 %

In addition to a reduction in peak flow rate, the proposed storm facilities also significantly reduce the flow volumes to the canal. The design pump rate of 9,000 gpm represents approximately 93 percent of the existing basin runoff to the canal. Therefore, diverting the pump design rate to the proposed ponds reduces the flow volume to the canal by that amount.

4.5 Water Quality

The Project Scope of Work states that the proposed ponds shall be designed to meet the treatment requirements of the *SMMWW*.

Figure 2.1 – Treatment Facility Selection Flow Chart from the *SMMWW* was used to determine the required type of treatment facility. The flow chart and thresholds as described in Chapter 3 of Volume 5 of the *SMMWW* show that a basic wetpond can be used to treat the runoff from Outfall #4. (See Figure 4.1 in this document.)

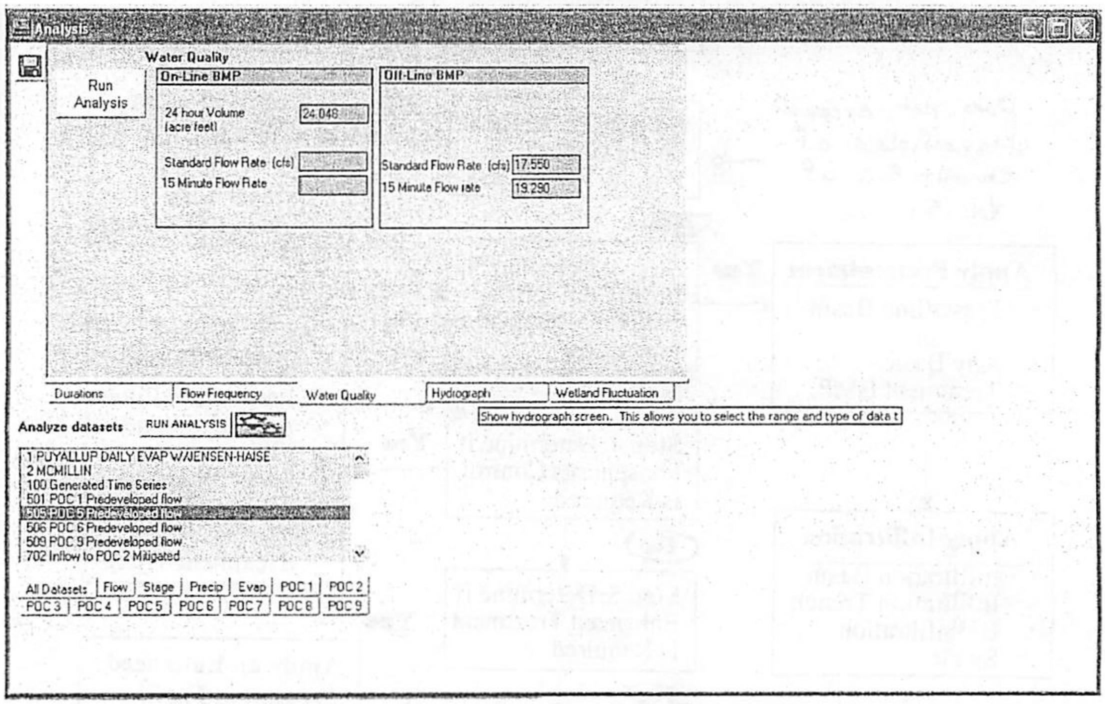


[1] See Section 3.5, Chapter 3 of Volume V for more information

Figure 2.1 – Treatment Facility Selection Flow Chart

Figure 4.1 – Treatment Facility Selection Flow Chart

The Outfall #4 tributary basin area characteristics were input into the WWHM, Version 3, to determine the treatment design rate and volume. The treatment requirements are provided in the following exhibit.



The proposed system will utilize a wetpond to provide the treatment as required by the *SMMWW*. The proposed pumps will direct runoff to the ponds at a rate of 9,000 gpm (20.05 cfs), exceeding the water quality flow rate of 19.29 cfs.

The required minimum wetpond storage volume is 24.05 acre-feet. The outlet orifice from the Deep Pond will be set 6 feet above the pond bottom to provide the required dead storage. The proposed dead storage volume in the Deep Pond is 24.10 acre-feet, exceeding the minimum required 24-hour treatment volume.

In addition to the wetpond, treatment is enhanced by the existing oil/water separator. The existing oil/water separator located at Outfall #4 has a design capacity of 8,000 gpm (17.82 cfs). This capacity is slightly less than the modeled 15-minute treatment flow rate of 19.29 cfs. However, the treatment provided by the oil/water separator is above and beyond the minimum treatment requirements as provided by the wetpond.

5.0 GEOTECHNICAL AND HYDROGEOLOGIC ASSESSMENT

The hydrologic analysis was performed to assist in the design of the proposed pump station and to provide information to the geotechnical engineer in order to determine the project's potential impacts to the groundwater elevations in the adjacent landfill area. See Appendix A for the analysis in its entirety.

Preliminary groundwater mounding analysis (see Appendix A) shows that during periods of high groundwater, the discharge rate to the infiltration facility should be limited to 1 cfs in order to prevent an excessive increase in the groundwater elevation. The hydrologic model shows that the Shallow Pond enters overflow conditions resulting in higher rates of runoff to the infiltration facility. The project includes a pump off relay to discontinue pumping when the Shallow Pond reaches 3 inches below the overflow stage. This will prevent larger runoff rates to the infiltration facility, reducing the potential for increased groundwater mounding in the vicinity.

6.0 SUMMARY AND RECOMMENDATIONS

This hydrologic analysis has been performed to determine water quality requirements, assist in the design of the proposed pump station, and to provide information to the geotechnical engineer in order to determine the project's potential impacts to the groundwater elevations in the adjacent landfill area.

This analysis is based on data and records either supplied to or obtained by AHBL, Inc. These documents are referenced within the text of the analysis. The analysis has been prepared utilizing procedures and practices within the standard accepted practices of the industry.

AHBL, Inc.

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GCH/lah

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