WASHINGTON ENGINEERING

Corrected Final Design Report

FORT LEWIS STORMWATER IMPROVEMENTS OUTFALLS 002, 003, AND 007

Contract DACA67-99-R-1000
Work Order 0003

Prepared for:
Fort Lewis
Department of Public Works

May 2001

PREPARED BY:
WASHINGTON ENGINEERING, INC.
4040 Wheaton Way, Suite 202
Bremerton, WA 98310
Phone: 360/405-1420 Fax: 360/377-4153

TABLE OF CONTENTS

REFERENCE LIST

(a) Statement of Work, Contract DACA67-99-D-1000, Work Order no. 3, dated 07/20/00.

(b) Notice of Violation (NOV) – USEPA Letter dated November 2, 1999.

(c) Fort Lewis Response to NOV – Department of the Army Letter dated November 22, 1999.

(d) Federal Facility Compliance Agreement between USEPA and Fort Lewis – dated May 22, 2000.

(e) Washington State Department of Ecology Draft Stormwater Management Manual, August 2000

(f) Fort Lewis Stormwater Manual, dated January 27, 1996

(g) Fort Lewis Design Standards

Reference Drawings:

1. Basin 002 Drawing File No. 222-25-142, 14 June 1978, Wastewater Treatment Facilities, Dupont Outfall

2. Basin 003 Drawing File No. 222-25-104, 22 January 1975, Industrial Waste Treatment Facility

3. Basin 003 Drawing File No. 222-25-152, 7/9/79, Pollution Control Flora Rd. Outfall

4. Basin 003 Drawing File No. 22s/871-90-04, August 1993, Replace Clay Liner in Stormwater Pond (Flora Road)

5. Basin 007 Drawing File No. 4910, 3/9/90, Repair Industrial Wastewater Pre-Treatment Facility, Building 9586, Logistic Center

6. Basin 005 Drawing File No. 22s/871-90-05, March 1996, Stormwater Treatment

1.0 SCOPE OF WORK/PROJECT HISTORY

Washington Engineering, Inc. has been tasked in Delivery Order No. 0003 of Contract No. DACA67-99-D-1000 (Reference (a)) to provide the analysis and design for stormwater quality improvements for the Dupont, Flora Road, and Logistics Center basins, which discharge stormwater via outfalls 002, 003, and 007, at Fort Lewis, Washington.

The Department of the Army holds National Pollutant Discharge Elimination System Permit (NPDES) permit number WA-002195 that allows the discharge of wastewater and stormwater from Fort Lewis to Puget Sound at Solo Point. Each NPDES permit is issued with specific discharge quality, quantity, location, and monitoring requirements to ensure compliance with the Clean Water Act.

The Fort Lewis NPDES permit falls under the jurisdiction of Region 10 of the U.S. Environmental Protection Agency (EPA). On November 2, 1999, Region 10 issued a Notice of Violation (NOV) (Reference (b)) to Fort Lewis for NPDES permit violations at several outfalls during 1998 and 1999. The NOV provided data of specific instances when stormwater effluent quality limits for oil and grease, and pH were exceeded.

The Department of the Army responded to the NOV on by letter on November 22, 1999 (Reference (c)), outlining specific actions to be taken to improve stormwater quality. Subsequently, on May 22, 2000, Fort Lewis and the EPA entered into a Federal Facility Compliance Agreement (Compliance Agreement) (Reference (d)) to formally address the specific violations in the NOV. Appendix A provides copies of the EPA Notice of Violation, the Fort Lewis Response and the Compliance Agreement.

The Compliance Agreement requires that a design contract for improved oil and grease treatment at outfalls 002, 003, and 007 be in place by October 31, 2000 and that construction of these improvements commence by October 31, 2001. In addition to improvements at outfalls 2, 3 and 7, other actions are being taken by Fort Lewis to improve other features of the stormwater collection and discharge system, as required by the compliance agreement.

Washington Engineering submitted the Corrected Final Engineering Report for the projects in October 2000, and the 50% Design in January 2001. In general terms, the design recommendation for each basin is to construct a system consisting of a sedimentation basin, an infiltration/detention pond and a coalescing plate oil/water separator. This submittal forwards the 95% Design drawings, specifications and cost estimates for the project.

Figure 1 outlines the boundaries of each drainage basin at Fort Lewis.

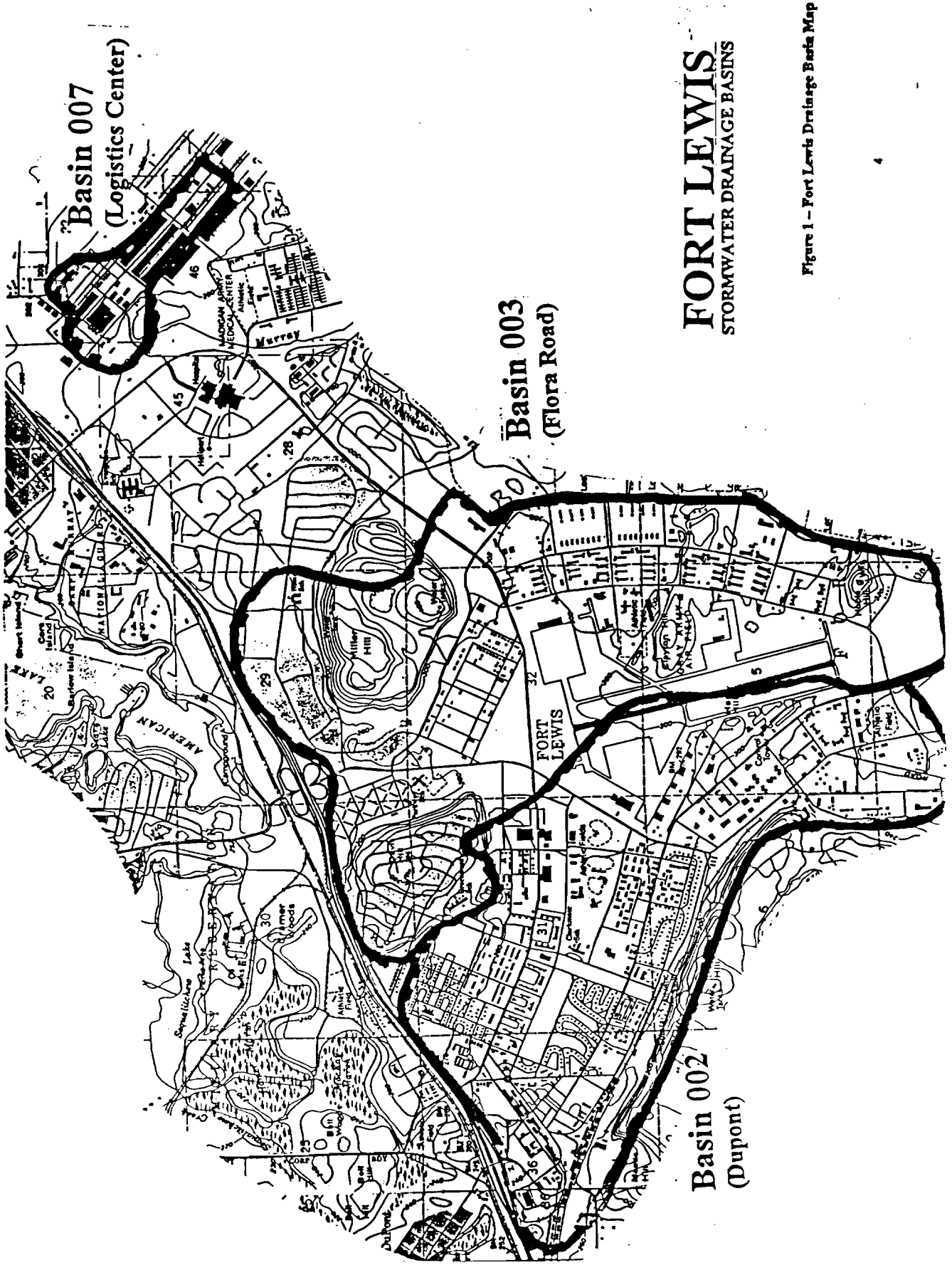


Figure 1 – Fort Lewis Drainage Basin Map

2.0 WATER QUALITY DESIGN CRITERIA

2.1 Stormwater Effluent Standards

Under the Clean Water Act, the NPDES permit program regulates the quality of certain discharges to the environment. Stormwater outfalls 002, 003, and 007 have discharge limitations on oil and grease of 10 mg/l (daily average) and 15 mg/l (daily maximum) and pH limitations between 6.0 standard units (su) and 8.5 su, as specified in the Fort Lewis NPDES permit.

To meet these discharge limitations, a combination of pollution prevention, source control, Best Management Practices (BMPs), and treatment facilities is necessary.

2.2 Design Storms

2.2.1 Water Quality Design Storm

Reference (e) establishes the water quality design storm (WQDS) to be used for the design of treatment facilities as the 6-month, 24-hour, SCS Type 1A rainfall distribution, storm event. This requirement was established as the economical and practical limit based on a cost/benefit analysis in the Stormwater Management Manual in Reference (e). Treatment of the 6-month, 24-hour storm results in treatment of approximately 90% of the total annual stormwater runoff. While isopluvial maps are available for the 2-year, 10-year, 25-year and 100-year, 24-hour storm events, there are no existing isopluvial maps for the 6-month, 24-hour storm. In order to maintain consistency, Reference (e) quantifies the WQDS as 72% of the 2-year, 24-hour storm. Reference (f) provides isopluvial curves for Fort Lewis and established the 2-year, 24-hour storm as 2.0 inches. The 6-month, 24-hour storm in the Fort Lewis area is 1.44 inches. Runoff from larger storm events will be routed to bypass treatment facilities. Higher flows from these storm events act to dilute the concentration of pollutants and the resulting runoff should meet discharge limitations without treatment.

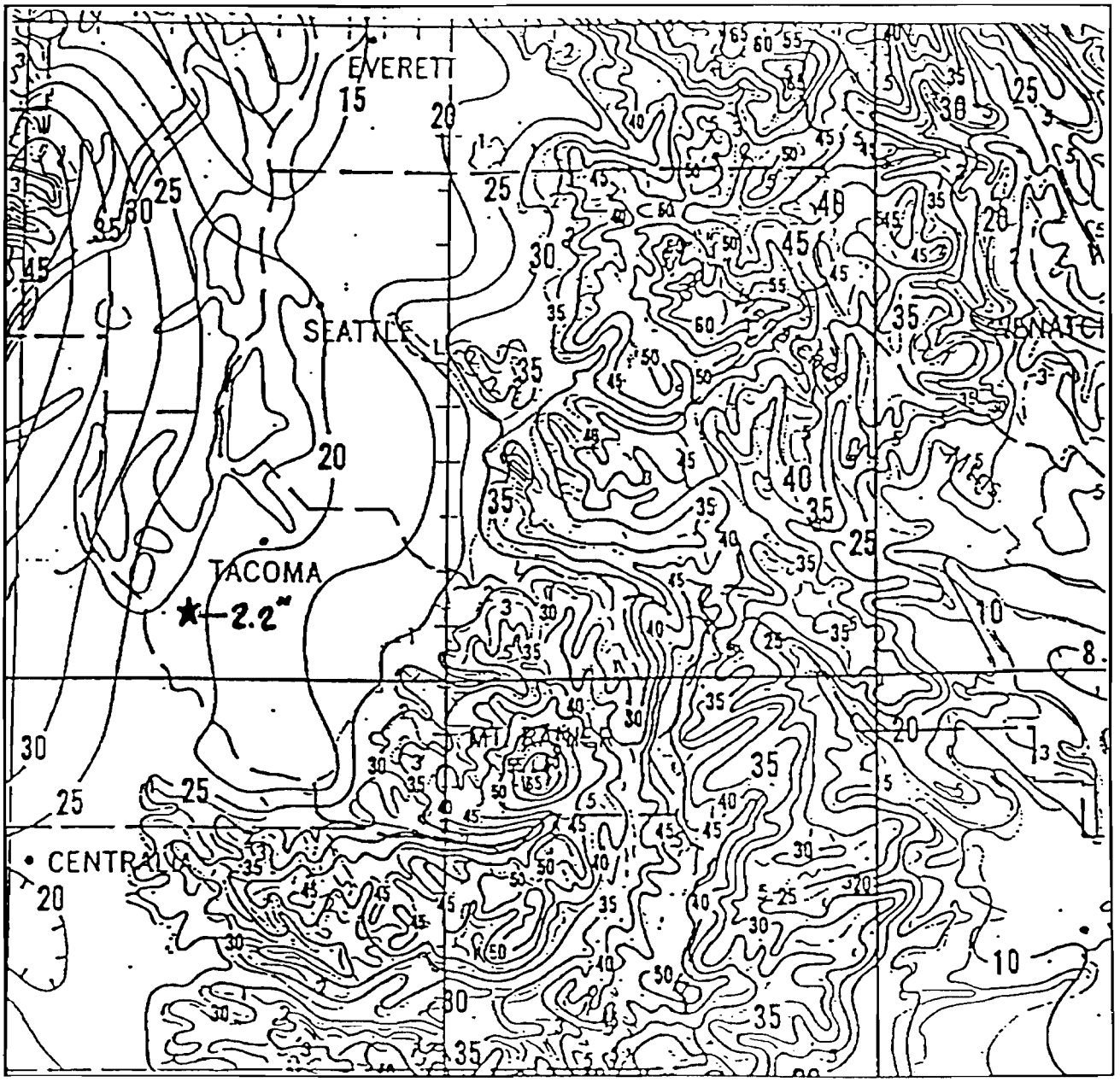
With proper source control, strict adherence to established BMPs and adequate treatment facility sizing and maintenance, the NPDES discharge limitations can be met by treating only the 6-month, 24-hour storm events.

3.2.2 Facility Sizing

The design event for conveyance systems (piping) is the 25-year, 24-hour storm event. Additionally, the basin overflow facilities must be sized to pass the 100-year, 24-hour storm event. The rainfall intensity curves for the 2-year, 25-year and 100 year 24 hour storms are shown in Figures 2, 3 and 4.

Stormwater runoff quantities and flow rates for each basin were estimated using SCS coverage factors and the Santa Barbara Unit Hydrograph method for this engineering evaluation. Calculations for the inflow hydrographs based on the WQDS are included in Appendix B for Outfall 002, Appendix C for Outfall 003 and Appendix D for Outfall 007.

Isopluvials of 2-Year, 24-Hour Precipitation in Tenths of an Inch



NOTE: WATER QUALITY DESIGN STORM EQUALS 64% OF 2 YEAR, 24 HOUR EVENT. FOR FORT LEWIS, THE WQDS = 1.44"

Figure 2 – 2 Year, 24 Hour Storm Data

Isopluvials for 25 Year, 24-Hour Precipitation in Tenths of an Inch

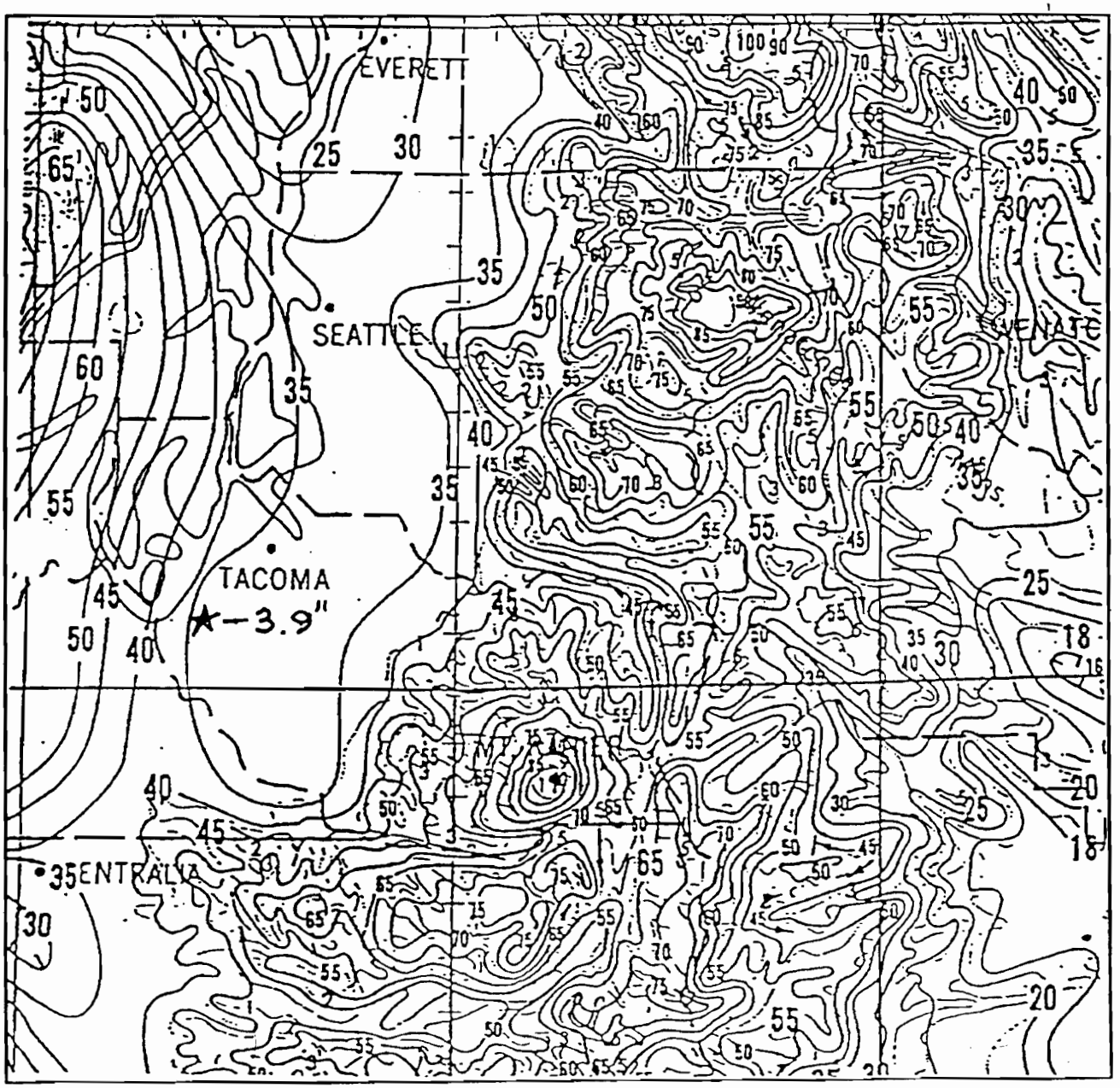


Figure 3 – 25 Year, 24 Hour Storm Data

Isopluvials of 100 Year, 24-Hour precipitation in Tenths of an Inch

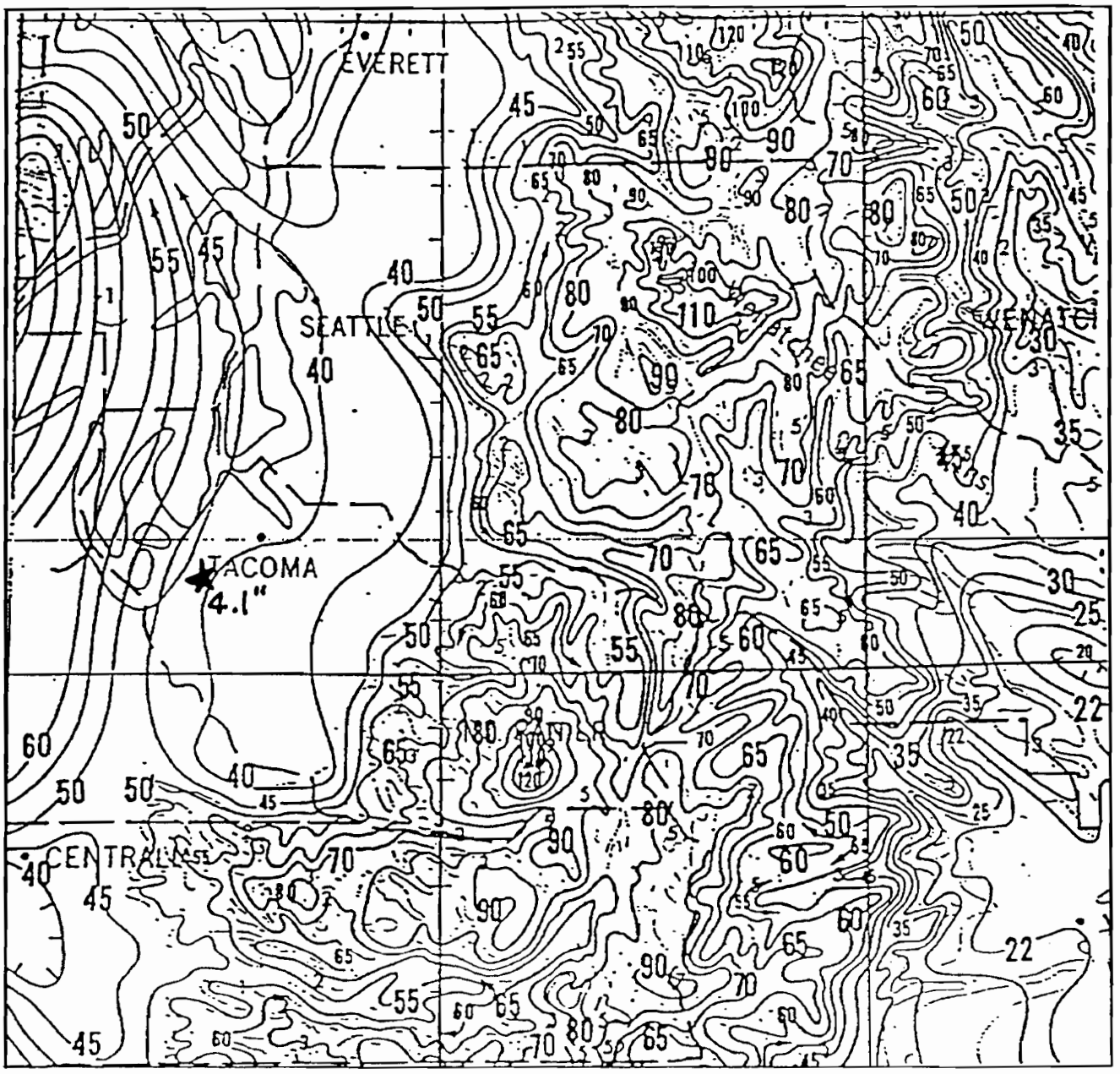


Figure 4 – 100-year, 24-hour Storm

3.3 Design Assumptions

It is assumed that each basin is fully developed and that development density will remain. The design team recognizes that some demolition and new construction will occur but these activities are assumed to be modest compared to the overall level of development. Roof drainage and runoff from large new, impervious surfaces should be infiltrated and/or routed through detention facilities to minimize the impact of peak flows at the treatment facilities. Therefore, no future growth has been factored into the treatment facilities being proposed.

3.4 Treatment Selection Process

Best Management Practices (BMPs) fall into two general categories: (1) Non-structural BMPs and (2) Structural BMPs. Non-structural BMPs generally include maintenance and low-cost practices such as pollution prevention measures, process improvements, employee training and customer education, stormwater catch basin maintenance, and low-technology stormwater treatment methods. Structural BMPs normally involve capital construction of treatment facilities including such items as: wetpools, biofiltration, oil/water separators, pretreatment facilities, infiltration basins and filtration facilities. The following treatment methods were evaluated for outfalls 002, 003 and 007:

- Wetpools
- Biofiltration
- Oil/Water Separators (OWS)
- Pretreatment by Sediment Removal
- Infiltration
- Sand Filtration
- Repair of existing system

The table on the following page provides a summary of treatment technologies that were evaluated and recommendations for outfalls 002, 003 and 007.

TABLE 1 – COMPARISON OF TREATMENT ALTERNATIVES			
Feature	**Basin 002 (Dupont Outfall)**	**Basin 003 (Flora Road Outfall)**	**Basin 007 (Logistics Center)**
Existing Stormwater Treatment Facility	An existing 5000 gpm Flotation Thickener, Diversion Structure and pumping system exists at the site. The Floatation Thickener is inoperable.	An existing 5000 gpm Flotation Thickener, Sedimentation Basin, Diversion Structure and pumping system exists at the site. The Flotation Thickener is inoperable.	A diversion structure which discharges untreated water to Murray Creek and an API type oil/water separator which discharges to a blind ditch exist at the site.
Water Quality Design Storm [WQDS] (6-month, 24-hour event)	Peak Flow: 65.21 cfs Volume: 2,830,351 cf	Peak Flow: 60.66 cfs Volume: 2,466,436 cf	Peak Flow: 14.75 cfs Volume: 425,432 cf
Treatment Option 1 – Repair and Upgrade Existing Facilities	The existing Floatation Thickener (FT) system has been cannibalized and is inoperable at this time. The system flowrate is not high enough to support the WQDS. Repair of the existing system is not recommended.	The existing Floatation Thickener (FT) system has been cannibalized and is inoperable at this time. The system flowrate is not high enough to support the WQDS. Repair of the existing system is not recommended.	The existing API separator and diversion structure are undersized for the WQDS. The existing concrete settling basins are in good shape and could be used in a coalescing plate OWS design.
Treatment Option 2 – Infiltration Pond	An infiltration pond designed to treat the WQDS within 24 hours will need to infiltrate 49,700 cf/hr at an infiltration rate of 1 in/hr. The land area required for an infiltration pond is about 13.7 acres. There is insufficient land available to accommodate this option.	An infiltration pond designed to treat the WQDS within 24 hours will need to infiltrate 43265 cf/hr at an infiltration rate of 1 in/hr. The land area required for an infiltration pond is about 11.91 acres. There is insufficient land available to accommodate this option.	An infiltration pond designed to treat the WQDS within 24 hours will need to infiltrate 7675 cf/hr at an infiltration rate of 1 in/hr. The land area required for an infiltration pond is about 2.11 acres. There is sufficient land available to accommodate this option, pending verification of the soil for infiltration..
Treatment Option 3 – Sand Filtration System	Construction of a sand filter system capable of discharging at the rate of 2 in/hr would require a land area of 6.75 acres. There is insufficient land area available at the site to accommodate this option.	Construction of a sand filter system capable of discharging at the rate of 2 in/hr would require a land area of 6.75 acres. There is insufficient land area available at the site to accommodate this option.	Construction of a sand filter system capable of discharging at the rate of 2 in/hr would require a land area of 1.10 acres. There is sufficient land area available at the site to accommodate this option.
Treatment Option 4 – Coalescing Plate (CP) Oil/Water Separator (OWS) System	Coalescing Plate OWS systems can be used to effectively treat the flowrate for this outfall. Due to the size of this basin and the long duration of the peak flows, it appears to be most feasible to use a CP OWS in conjunction with an infiltration pond to treat this stormwater.	Coalescing Plate OWS systems can be used to effectively treat the flowrate for this outfall. Due to the size of this basin and the long duration of the peak flows, it appears to be most feasible to use a CP OWS in conjunction with an infiltration pond to treat this stormwater.	The flowrate at this site is low enough to provide treatment using the coalescing plate OWS. The existing API separator basins could be retrofitted for use with the CP OWS, or a separate pre-manufactured OWS vault could be provided.
Treatment Option 5 – Leaf Compost Filter System	The flowrate at this site is too great to be cost effectively treated by a leaf compost filter system.	The flowrate at this site is too great to be cost effectively treated by a leaf compost filter system.	The flowrate at this site is low enough that a new leaf compost filter system could be installed with a design flowrate of 6 cfs, in conjunction with a detention/infiltration pond.
Recommended Treatment	Due to restrictions on the amount of land available adjacent to the outfall, it is our recommendation to utilize a coalescing plate oil/water separator as the primary treatment, in conjunction with an on-site infiltration pond and sedimentation basin. The infiltration pond will reduce the total amount of water to be processed through the oil/water separator. A lift station is required to pump stormwater at this outfall.	Due to restrictions on the amount of land available adjacent to the outfall, it is our recommendation to utilize a coalescing plate oil/water separator as the primary treatment, in conjunction with an enlarged on-site infiltration pond and sedimentation basin. The infiltration pond will reduce the total amount of water to be processed through the oil/water separator.	This site has the most viable options available. The recommended solution to treat the WQDS is to construct new sedimentation and detention ponds and install a pre-manufactured OWS vault.

4 DESIGN FOR OUTFALL 002 (DUPONT)

The Dupont Stormwater Outfall (Outfall No. 002) discharges storm water from the main cantonment area. The drainage area of Outfall No. 002 covers 1,928 acres. An inoperable storm water runoff treatment system (oil/water separation) exists at the site. The system consists of dissolved air flotation and oil skimming. Oil captured by the system is collected periodically by pump truck for disposal or recycling. Drainage from Outfall No, 002 enters Bell Marsh and is then conveyed northwestward into Puget Sound via an open ditch network. Discussions with Fort Lewis Public Works maintenance personnel indicate that the Floatation Thickener (FT) is not operational, and that various components have been removed. Usage of the FT was discontinued about nine years ago due to high maintenance and utility costs. An oil skimmer is installed but has insufficient capacity to treat the design storm. In effect, stormwater is discharged from Outfall 002 without treatment to remove oils/grease or sediment. When the Floatation Thickener was installed in the late-1970's, Fort Lewis had not yet implemented upstream source control practices and the amount of oil in the stormwater was several times greater than current levels of oil/grease. While the Floatation Thickener was suitable for the high removal rate required in the 1970's, it is not effective for treatment down to the current discharge standards; consequently, repair of the Floatation Thickener is not a viable option at this time.

The Fort Lewis Storm Water Pollution Prevention Plan states that Basin 002 includes almost 1,900 acres of land of which 52% is impervious. In our field investigation, we determined that the percentage of impervious area was in the 30-35% range rather than the 52%; we have utilized 32% in our runoff calculations. Basin 002 has had 4 violations of effluent oil and grease concentrations in the past 5 years. The measured effluent oils and grease has averaged 50 mg/l with a peak measurement of 77 mg/l. Effluent concentrations this high indicates that either the treatment facilities are undersized and /or that high concentrations of pollutants are present in the influent.

The treatment facilities consist of a *84*" influent line which passes through a small open grit chamber and trash rack prior to entering the diversion structure. Within the diversion structure lower flows (up to 5000 gpm) are diverted to a pump chamber. In the pump chamber a polymer is added and the flow is pumped to a flotation thickener. The flotation thickener promotes flotation of lighter constituents in the wastewater, including oils and greases. Treated water is discharged to the effluent channel. The oils and greases are conveyed to a separator (similar to an API oil water separator without the skimmers). Collected oil is stored in a storage tank, the bottom effluent is discharged back to the stormwater influent pipe. Operation of the treatment facility is automatic, controlled by water level sensors. Figure 5 shows the existing Floatation Thickener at Outfall 002.

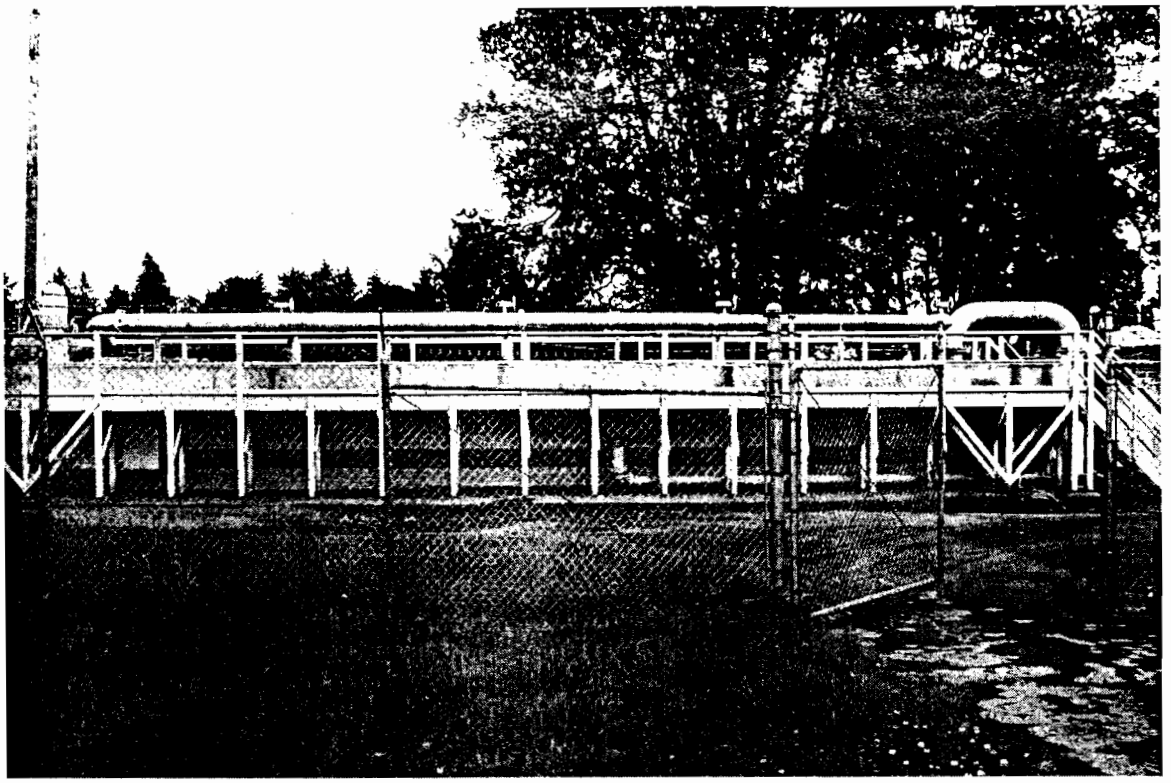


Figure 5 – Existing Floatation Thickener at Outfall 002

The existing Floatation Thickener at Basin 002 is not operational; usage was discontinued due to high maintenance and utility costs. Additionally, the existing FT unit does not have the capacity to treat the water quality design storm. This basin does not have any upstream sedimentation or detention capacity.

The capacity of the flotation thickener is about 5000 gpm. FT's were typically used in industrial applications where there is a high concentration of oil/grease. FT's are an ineffective treatment method for the low oil/grease concentrations in stormwater. It is not a common practice to use flotation thickeners for oil and grease removal for stormwater applications now. Due to the age of the treatment unit and the availability of more efficient treatment, it is recommended that the existing flotation thickener be removed from service and replaced.

In preparation for this design, a complete site topographical survey was performed and geotechnical site analysis, consisting of 3 borings and percolation testing was performed. Appendix F, prepared by URS, provides a copy of the final geotechnical report. Outfall 2 presents significant design challenges due to the volume of water to be treated in the design storm, the depth of the existing stormwater lines and the elevation of groundwater in the area. The installation of an oil/water separator and/or any other wet pond treatment at Outfall 2 will require installation of a pumping system capable of peak flows up to 66 cfs for treatment of the stormwater.

All hydrographs were generated using the Santa Barbara Urban Hydrograph method with a SCS type 1A rainfall distribution. King County Department Of Public Works Surface Water Management Division Hydrograph Program Version 4.21B was used in generating the inflow and outflow hydrographs for outfall 002. Figure 6 has a peak inflow of 66 cfs and a peak outflow of 38cfs. A proposed infiltration/detention pond of ~2.0 acres will provide sufficient storage capacity through infiltration and by pumping the outflow to the OWS to treat the 6-month design storm. By using an appropriately designed infiltration/detention pond, the flow to the OWS is reduced decreasing the size and cost of the OWS. Approximately 4-7% of the total runoff will be infiltrated at this site; the infiltration is not expected to have an impact on water levels in Bell Marsh.

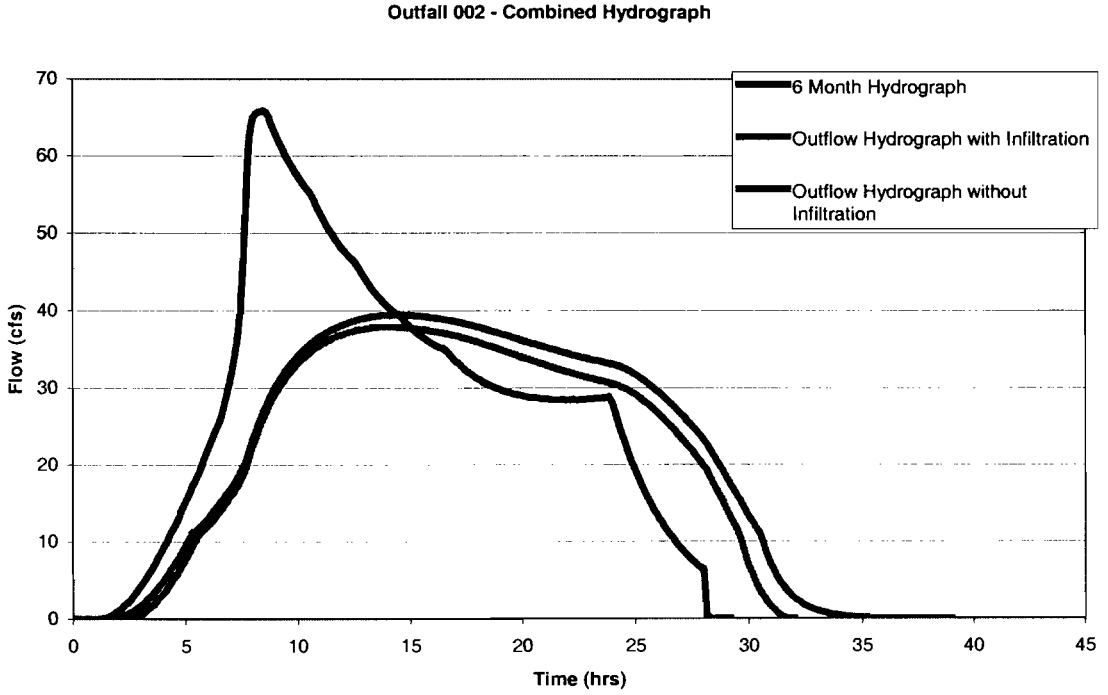


Figure 6 – Combined Hydrograph for Outfall 002

As noted in Table I, several options to treat the WQDS were evaluated for Outfall 002. The recommended solution at Outfall 002 is to provide a coalescing plate oil/water separator system, similar in capacity to Outfall 5, with infiltration/detention pond and an upstream sedimentation chamber. A lift station for pumping stormwater is required at Outfall 002.

The functional layout of the proposed system is shown in Figure 7:

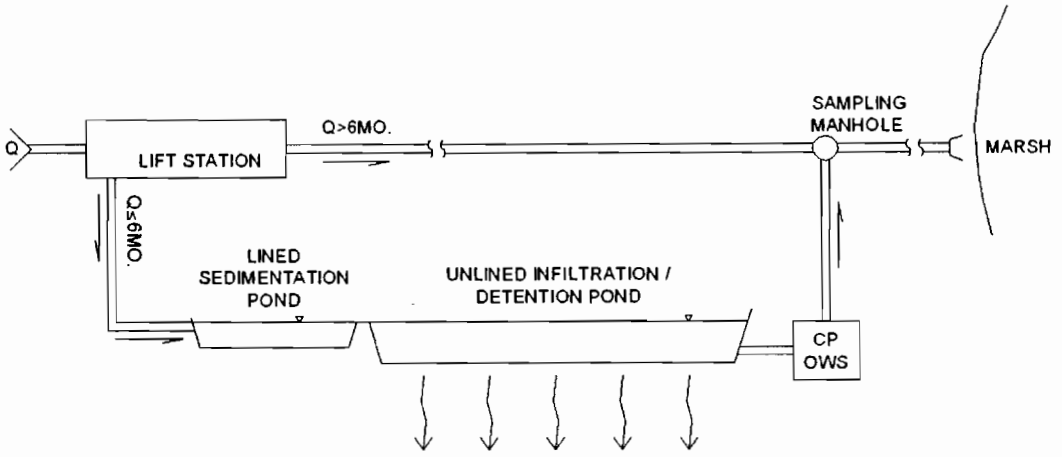


Figure 7 – Schematic for Outfall 002

RECOMMENDED CP OWS CONFIGURATION (Applicable To Outfalls 002 And 003)

The recommended configuration for the coalescing plate oil/water separator for Outfall 002 is described below. This configuration is also adaptable to Outfall 003 with only Jminor changes. The principal items to be installed for this project at each of the sites are:

a. One cast-in-place concrete structure with two coalescing plate oil separator compartments.
b. One stormwater inlet chamber.
c. One oil pump (outfall 007 only).
d. Security fence.
e. Gravel access road.
f. 2" PVC water line and backflow preventer assembly.
g. At Outfall 002 only, a lift station will be constructed.

The separator is sized to remove oil droplets. The droplet size selected is a function of the removal efficiency needed to achieve the effluent standard. The sizing of a separator requires the following information: water temperature, influent concentration, and the distributions of specific gravities and droplet sizes of the oil. Data is not available on the

distributions of specific gravity and droplet size for oil in stormwater from urban land with the exception of petroleum products storage terminals. This data indicates that by volume, about 80 percent of the droplets are greater than 90 micron. Less than 30 percent are greater than 150 micron. DOE requires the oil/water separator be sized to remove 80% of 90 micron or larger droplets. At a temperature of 10 degrees C and oil specific gravity of 0.9, (the specific gravity of motor oil) the rise rate of oil is 0.066 ft/min., based on Stokke's law.

The oil/water separators have been designed for a rise rate of 0.066 ft/min., and the removal of 80% of oil droplets greater than 90 microns. The grab sample taken on May 6, 1991, had an oil concentration of 35 mg/l. According to the above parameters and assuming 80% removal, an effluent concentration of 7 mg/1 would be achieved. This is below than the NPDES standard of 10 mg/l. The design objectives of this project are to provide an effective method of oil/grease removal to meet the requirements of the NPDES standards.

At outfall 002, the stormwater will be pumped from the lift station to a sedimentation pond; it will them flow by gravity into the infiltration/detention pond and from the infiltration/detention pond to the oil separators.

Two compartments, each designed for one half of the capacity, will be installed in a single basin at outfalls 002 and 003, instead of one separator designed at full capacity. Installation of a two-compartment unit will allow one separator to be shut off for maintenance during the dry weather flow season. If one full design capacity separator is installed, shut down of the separator will bypass 100% of the influent and might cause effluent standard violations.

A weir type overflow/diversion chamber will be installed within the oil separator to divert the design storm flow from the existing inlet line. The overflow chamber will include a weir that will divert flows up to the design storm into the effluent channel and bypass flows greater than the design storm to the storm sewer line. For flows up to the design flow, the weir will capture floating oil and grease. The overflow weirs are adjustable.

Strormwater is conveyed by means of an inlet pipe from the infiltration pond to a manhole structure equipped with a restrictor plate to the oil separators. At outfalls 002 and 003, the inflow will be divided equally into the two separators at an inlet chamber. Slide gates can isolate each separator. A 36" (W) x 48" (H) slide gate is located at the upstream end and a 24" (W) x 36" (H) slide gate at the downstream end. Influent flow velocity is 1.66 ft/sec.

The oil separators will be placed within a cast-in-place concrete structure. Each oil separator will be 15.5' (W) x 40.5' (L) x 9.0' (W.D.). Each compartment contains an influent distribution channel, coalescing plates, an effluent collection channel, and an oil

skimmer. The storm inflow is distributed evenly to the coalescing plates by a multi-orifice concrete channel, and the effluent is collected also by a concrete channel. Each compartment flow is combined in a treated water channel and discharged through an effluent channel.

The design rise rate is 0.066 ft/min or 0.5 gpm/sf. The coalescing plates are mounted 55 degrees from the horizontal and spaced 1/2" apart. The plates will be made of fiberglass or polypropylene and supported by galvanized steel angles or manufacturer supplied materials. A concrete baffle wall constructed between the coalescing plates and the effluent channel will eliminate oil carryover to the effluent.

The separators are designed for a combined maximum flow capacity of 18,000 gpm. The flow will vary due to the variation of rainfall intensity. An effluent weir will maintain a minimum water surface level of ~8.5 feet, in the separators during low flow periods.

An effluent concrete pipe discharges the treated stormwater to the storm sewer line or outfall. A manhole connects the effluent concrete pipe to the storm sewer line or outfall.

Each separator will be equipped with an oil skimmer. Each oil skimmer will be equipped with a decanter that will permit minute droplets of water removed by the skimming system to be returned to the area being skimmed.

The oil/scum pit shall act as a holding area for the waste oil. The volume of the oil/scum pit is approximately 16,000 gallons, therefore, cleaning of pit will be on an annual basis or when the high oil level alarm is sounded. A vacuum truck will perform cleaning of the oil/scum pit. This kind of design will provide a flexible and effective waste oil disposal operation

The oil skimmer is Model 6V as manufactured by Oil Skimmers. Inc., or equal. The oil skimmer is driven by a l/2HP , 208V, 3 Phase motor. It is designed to remove floating oil from the water. The oil skimming tube will float on the oil-laden surface and collects the oil as it slowly snakes back and forth across the surface. The tube is periodically raised out of the water and drawn through scrapers to remove the collected oil. The cleaned tube is returned to the water surface to gather more oil. A timer will control the motor.

This coalescing plate oil/water separator is similar to the unit already installed at Outfall 5. The major difference between this separator and the outfall 5 separator is the pre-treatment that will be provided by the lift station, sedimentation pond and the infiltration pond prior to stormwater entering the separator.

A service walkway is located between the oil separator units. The walkway is at 1.5 feet above the water surface of the oil separator units. A 2-inch PVC pipe will bring potable water to the site for tank cleaning and will provide adequate flow and pressure for wash down.

LIFT STATION (Outfall 002 Only)

Ground Elevation differences at outfall 002 require the addition of a lift station. The lift station is placed in-line with the existing 84" storm sewer line and is 80'(L)x 22'(W)x 26'(H). The unit contains a settling chamber and a pumping chamber. Stormwater enters through the grit chamber and flows into the pumping chamber. The pumps are designed to pump the 6 month, 24-hour design storm to the settlement/energy dissipation pond. Stormwater in excess of the 6 month, 24-hour design storm is bypassed by an overflow weir into the existing 84" storm line.

The grit chamber in the lift station has a sloped bottom and length of 54'. Under flow conditions, the grit chamber will allow removal of solids that can damage the pumps. The grit will settle on the horizontal portion of the chamber floor and will be removed by means of a vacuum truck. The grit chamber is equipped with a trash bar grate to intercept floating debris. A baffle near the pump chamber prevents floatable material from entering the pump chamber.

A 6'-8" weir separates the grit chamber from the pump chamber. The pump chamber contains (5) five vertical mounted axial flow pumps. The separation weir provides the minimum submergence of 76" for the pumps. Flows in excess of the 6 month, 24 hour storm are bypassed by an overflow weir at the end of the pump chamber.

The pumps are designed to pump a flow rate of 5900 gpm (13cfs) under a dynamic head of 26'. The pump are Prime Pump axial mixed flow pumps model 18M14–13 or equal. The pump motors are a 50HP, 3 phase, 60 cycle, 460V vertical hollow shaft motor running at 1180 rpm. The staging consists of (3) three main pumps and (2) two reserve pumps. The main pumps are rotated in sequence and the reserve pumps are set aside for high flow conditions. The sequencing of the main and reserve pumps are controlled by a programmable logic controller (PLC).

ELECTRICAL

The load consists of two 1/2-hp oil skimmers each with 300 watt heaters, lights, outlets, etc. Because the loads are small the operating voltage was selected to be 480/208/120V, three phase, four wire system. Thus no additional transformers will be required to supply the lighting and other small loads.

A large NEMA 3R enclosure will be provided which will house the panelboard, motor starters, and pump control panels, as well as other miscellaneous electrical equipment, indicating lights, switches, timers, etc. Outdoor, pole-mounted light fixtures will be provided for illumination of the sedimentation basins, infiltration ponds and the oil/water separators.

ACCESS ROAD

A 14' wide access road will be installed at each site. The road will be designed for a large single unit truck. In addition, a 6' high chain link fence will be installed around the site.

To preserve the site's existing natural drainage, a 1% slope has been incorporated into the access road section to allow surface water to run across the roadway section. A drainage ditch has also been built into the section to direct any surface water trapped on the north side of the access road to the east away from the storm water overflow structure. The Contractor shall furthermore provide finished grades that prevent surface water ponding around the stormwater overflow structure.

5. DESIGN FOR OUTFALL 003 (FLORA ROAD)

The Flora Road Stormwater Outfall (Outfall No. 003) discharges storm water from the main cantonment area. The drainage area of Outfall No. 003 covers 1,675 acres with approximately 530 acres of impervious surface. Storm water runoff receives treatment for oil removal. The treatment system consists of dissolved air flotation and oil skimming. Oil captured by the system is collected periodically by pump truck for disposal or recycling. A large pond upstream of the treatment system that acts to buffer flow surges enhances efficiency of this system. The pond is also equipped with oil booms that provide additional oil removal. Drainage from Outfall No. 003 enters Hamer Marsh, with final discharge to Puget Sound. Discussions with Fort Lewis Public Works maintenance personnel indicate that the Floatation Thickener (FT) is not operational, and that various components have been removed. Usage of the FT was discontinued about nine years ago due to high maintenance and utility costs. An oil skimmer is installed but has insufficient capacity to treat the design storm. In effect, stormwater is discharged from Outfall 003 without treatment to remove oils/grease or sediment.

Basin 003 includes 1,675 acres of land of which 32% is impervious. Basin 003 has had 9 violations of effluent oil and grease concentrations in the past 5 years. The measured effluent oils and grease averaged 18 mg/l with a peak measurement of 23.7 mg/l. Basin 003 has a Floatation Thickener similar to Basin 002. The primary difference between Basins 002 and 003 is the existence of a large sedimentation/detention pond upstream of the Outfall 003 treatment facilities. This sedimentation basin is lined to prevent infiltration and considerable sediment collected in the pond prior to cleaning and liner repair in July 2000. Figure 8 shows the condition of the pond prior to cleaning:

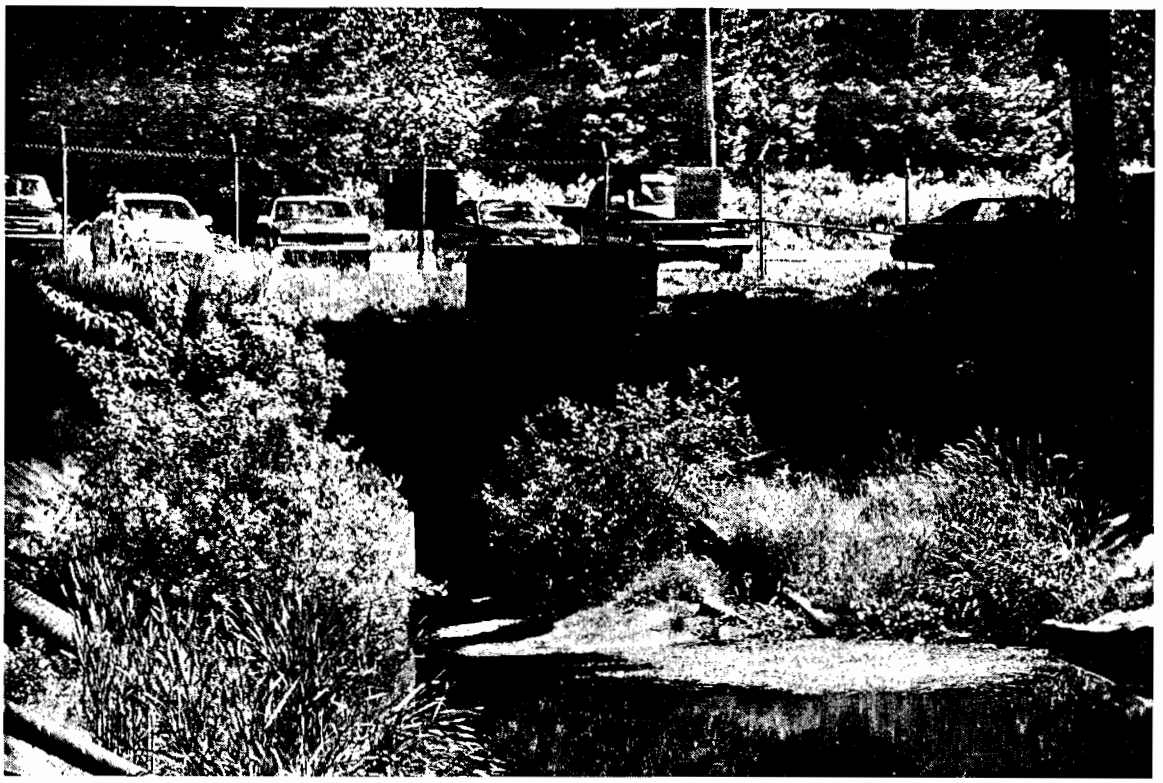


Figure 8 – Outfall 003 Sedimentation Basin prior to Cleaning (June 2000)

The treatment facilities consist of a 33" and a 72" influent line discharge into a large basin that collects grit and stills the flow before passing through a trash rack prior to entering the diversion structure. Within the diversion structure lower flows (design capacity unknown) are diverted to a pump chamber. In the pump chamber a polymer is added and the flow is pumped to a flotation thickener. The flotation thickener promotes flotation of lighter constituents in the wastewater, including oils and greases. Treated water is discharged to the effluent channel. The oils and greases are conveyed to a separator (similar to an API oil water separator without the skimmers). Collected oil is stored in a storage tank, and the bottom effluent is discharged back to the stormwater influent channel. Operation of the treatment facility is automatic, controlled by water level sensors.

It is assumed that the influent low flow diversion weirs are set appropriately for the 6 month design storm and that the pumps are of sufficient capacity to pump this flow to the treatment unit (flotation thickener).

In general, flotation thickeners were used for industrial applications where high concentrations of oils are found. It is not a common practice to use flotation thickeners for oil and grease removal for stormwater applications now. Due to the age of the treatment unit and the availability of more efficient treatment, it is recommended that the existing flotation thickener be removed from service. The flowrate for the water quality design storm is similar to Basin 002 and similar treatment facilities are proposed. In basin

003, we recommend that the existing basin be modified to provide a sedimentation basin, infiltration pond, and coalescing plate oil/water separator in series.

All hydrographs were generated using the Santa Barbara Urban Hydrograph method with a SCS type 1A rainfall distribution. King County Department Of Public Works Surface Water Management Division Hydrograph Program Version 4.21B was used in generating the inflow and outflow hydrographs for outfall 003. Figure 9 has a peak inflow of 60.66 cfs and a peak outflow of 27cfs. A sedimentation pond followed by an infiltration pond of 1.88 acres will provide sufficient storage capacity through infiltration and outflow to the OWS to treat the 6-month design storm.

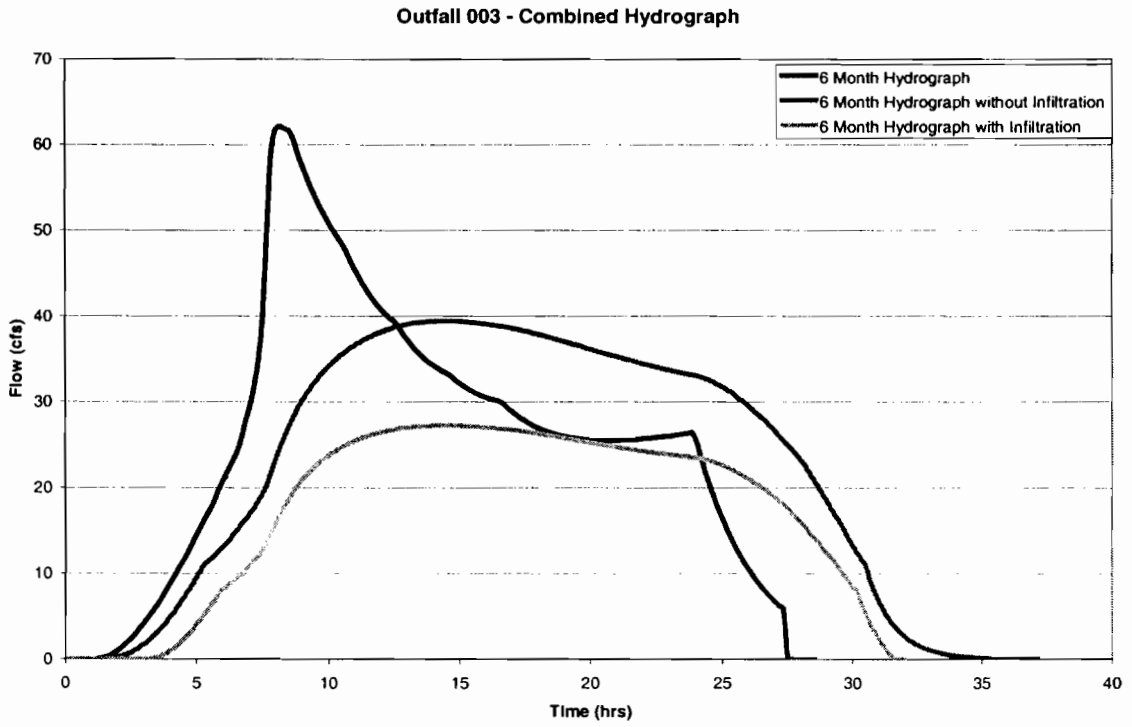


Figure 9 – Combined Hydrograph for Outfall 003

Appendix I provides detailed cost estimates for outfall 003.

The proposed functional layout for Outfall 003 is shown in Figure 10:

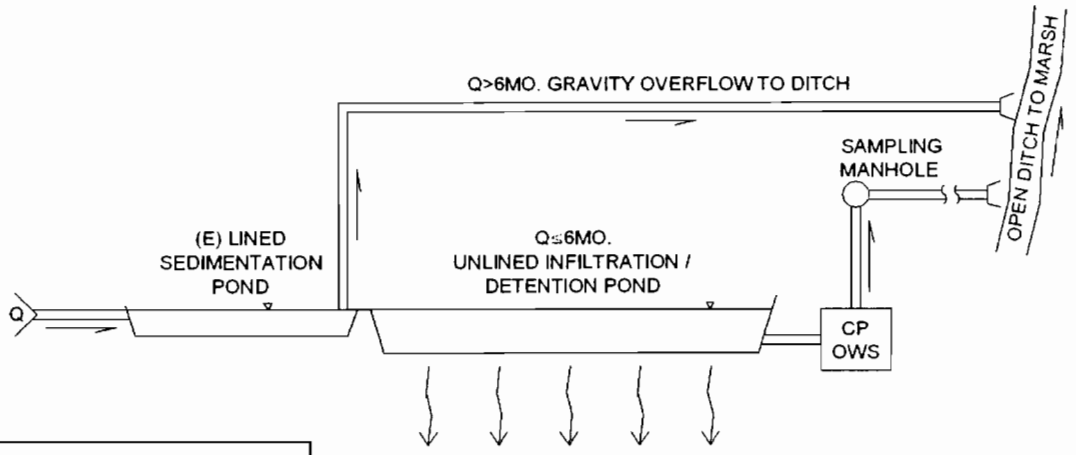


Figure 10 – Schematic for Outfall 003

6.0 DESIGN FOR OUTFALL 007 (LOGISTICS CENTER)

The drainage area of Outfall No. 007 covers 131 acres with approximately 95 acres of impervious area. Stormwater from the **Logistics Center** basin **(Outfall No. 007)** is routed to a diversion structure with a proportional weir which discharges up to 6 cfs to an API type oil/water separator and remaining flow is directly discharged to Murray Creek. The outflow from the oil/water separator is discharged into a blind ditch that parallels Murray Creek. The ditch is intended to provide infiltration of the treated effluent. Calculations show that overflows at this stormwater treatment facility actually occur during the 6-month, 24-hour water quality design storm. The outfall 007 facility also includes a process water treatment facility; the treated process water is discharged to the sanitary sewer. Basin 007 has had 1 violation of effluent oil and grease concentrations in the past 5 years; the measured effluent oils and grease was 28 mg/l.

The existing treatment facilities in Basin 007 are generally described above. The treatment facility consists of 2-24" influent lines discharging into a bypass structure. Low flows (up to 6 cfs) are diverted to an API type oil water separator. Flows in excess of this are discharged directly to Murray Creek. Treated water is discharged to a blind ditch that is separated from Murray Creek by a berm. Operation of the treatment facility is automatic, controlled by water level sensors. Figure 11 shows the existing API-type oil/water separator basins at Outfall 007.

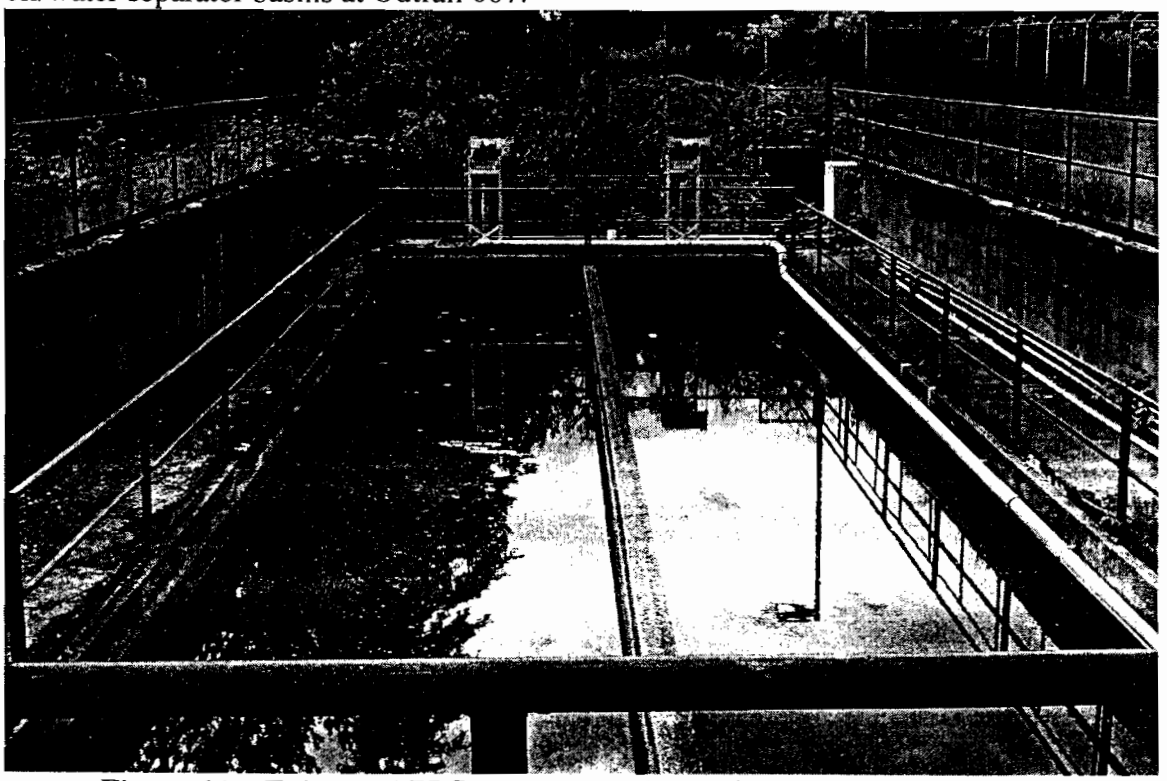


Figure 11 – Existing API Separator Basins at Outfall 007

The flow calculations for runoff from the 6 month storm indicated that the design flow is 13 cfs. The bypass structure is set for 6 cfs. This indicates that something less than the six month storm is being treated in the oil water separator. Adding to or replacing the system will be necessary to treat the design storm.

Outfall 007 has a relatively large amount of land adjacent to the outfall. Improvements at Outfall 007 are proposed to abandon the API type separators and install a precast concrete coalescing plate vault, together with construction of an upstream sedimentation basin and a moderate capacity infiltration/detention pond to control discharge quantities through the OWS. The effluent from the oil water separator will discharge through a new outfall structure to the blind ditch. The collected oil will be pumped to a storage tank, equipped with a high-level float switch. The tank float switch and oil pump switch will be interlocked. This will allow the oil pump to de-energize when the tank is full.

Infiltration rates at outfall 007 exceed allowable long-term design rates as established by the Dept. of Ecology of 2.4 in/hour. Outfall 007 will require over excavation of the pond bottom and excavated material from one or both of the other outfalls to be placed and compacted achieving acceptable infiltration rates.

All hydrographs were generated using the Santa Barbara Urban Hydrograph method with a SCS type 1A rainfall distribution. King County Department Of Public Works Surface Water Management Division Hydrograph Program Version 4.21B was used in generating the inflow and outflow hydrographs for outfall 007. Figure 12 has a peak inflow of 14.75 cfs and a peak outflow of 3.7 cfs. A proposed sedimentation pond followed by an infiltration/detention pond of 0.55 acres will provide sufficient storage capacity through infiltration and gravity outflow to the OWS to treat the 6-month design storm. By using an appropriately designed infiltration/detention pond, the flow to the OWS is reduced decreasing the size and cost of the OWS.

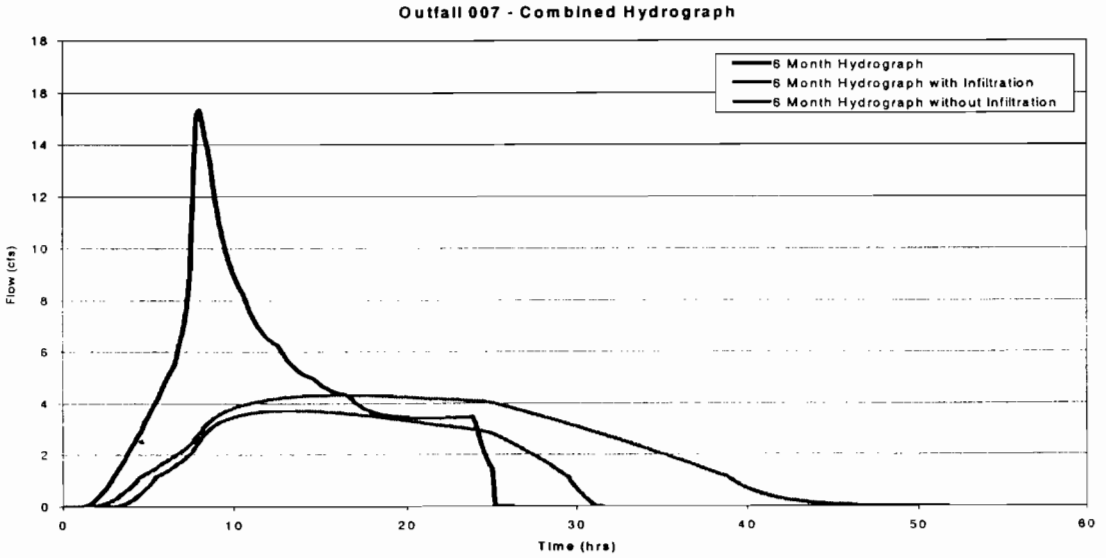


Figure 12 – Combined Hydrograph for Outfall 007

Appendix I provides detailed cost estimates for outfall 007.

Figure 13 shows the schematic for installing the flow bypass manhole, constructing sedimentation and infiltration ponds and installing a vault-type OWS at outfall 7:

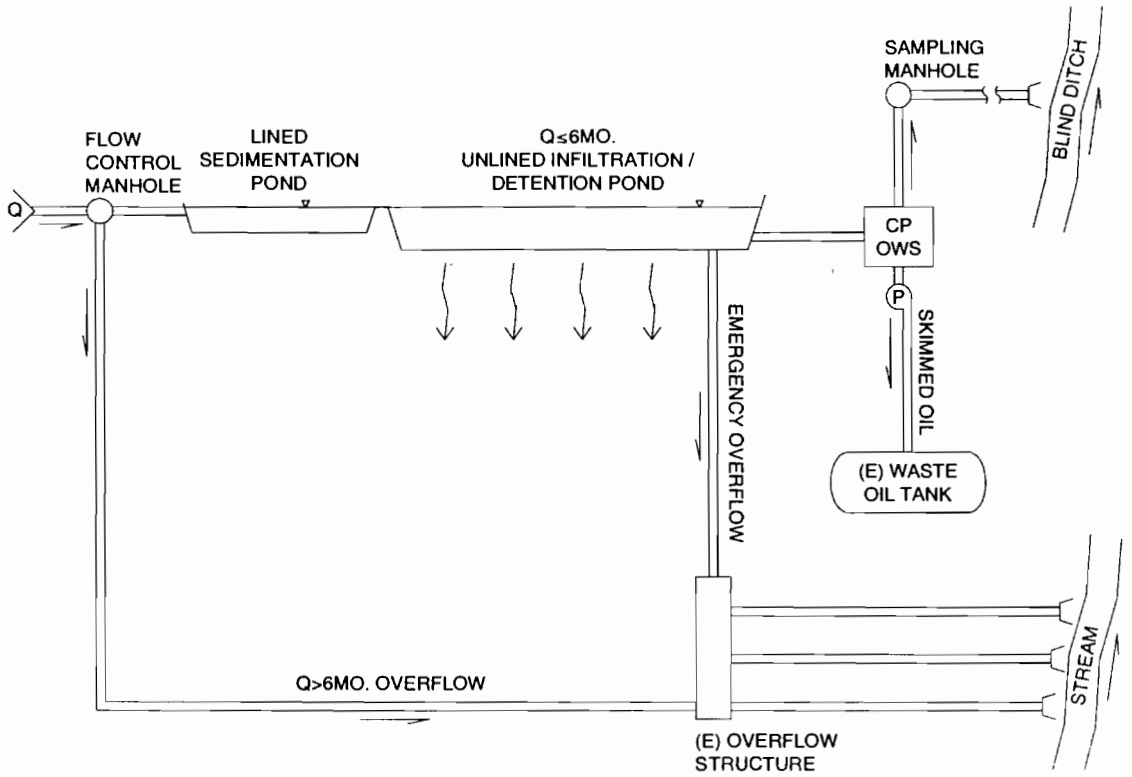


Figure 13 – Schematic Concept for Retrofitting Basins as Outfall 007

7.0 PROJECT SUMMARY AND RECOMMENDATIONS

7.1 Basin Comparisons – Table 2 provides a comparison of basins 002, 003 and 007.

TABLE 2 - DRAINAGE BASIN COMPARISONS			
Basin Parameter	**002** See App A	**003** See App B	**007** See App C
Total Acreage	1928	1675	131
Pervious Acreage	1311	1145	36
Impervious Acreage	617	530	95
% Impervious Area	32%	32%	72%
Main Influent Pipe Diameter	72"	84"	2-24"
Peak Discharge 6Mo24Hr Storm	56.66 cfs	52.69 cfs	12.83 cfs
Peak Discharge 25Yr24Hr Storm	225.14 cfs	209.62 cfs	40.69 cfs
Peak Discharge 100Yr24Hr Storm	372.42 cfs	271.54 cfs	49.06 cfs
Existing Detention Facility	No	Yes	No
Existing Sedimentation Facility	No	Yes	No
Existing Oil/Water Treatment	FT	FT	API-OWS
Existing Treatment in Operation	No	No	Partially
Estimated Construction Cost	NA	NA	NA

8.0 MAINTENANCE OF STORMWATER OUTFALLS

A scheduled maintenance plan is vital for the proper functioning of any stormwater treatment system. Proper maintenance will extend the useful life and reduce costly replacement of the system and/or system components.

The suggested maintenance program for Outfalls 002, 003 and 007 are provided on the following pages.

OUTFALL 002 - MAINTENANCE PROGRAM			
Maintenance requirements for settlement and infiltration ponds should be performed as follows:	Quarterly	Semi-Annual	Annual
(1) Remove trash and debris from and around sedimentation and infiltration pond. Remove any vegetation which may impede the movement of water in and out of ponds. Inspect for erosion damage of sideslopes; stabilize slopes by using appropriate erosion control measure(s); e.g. rock reinforcement, planting of grass, compaction, etc.		X	
(2) Inspect spillways to ensure appropriate amount of rock is covering the native soils. Replace rock to design standards as required.		X	
(3) Verify pond liners are free from damage. Repair or replace according to manufacturers specifications.		X	
(4) Remove accumulations of sediments in sedimentation pond on an annual basis or when sediment exceeds 7.0".			X
(5) inspect overflow structures and remove any obstructions.		X	
Maintenance requirements for manhole and control structures should be performed as follows:			
(1) Verify structure is free of cracks and damage. Verify inlet and outlet pipes are securely attached and no cracking or spalling of concrete is present. Remove built-up debris at bottom of structure.		X	
(2) Inspect orifice plate to ensure the control device is not missing, obstructed, bent or rusted.			X
Maintenance requirements for grit chamber/ pump station should be performed as follows:			
(1) Verify structure is free of cracks and damage. Verify inlet and outlet piping is securely attached and no cracking or spalling of concrete is present.			X
(2) Remove all trash and debris from bar screen on a quarterly basis or when debris are plugging more than 20% of bar screen area. Ensure bars are not missing or bent out of shape more than 3".	X		
(3) Remove accumulated grit and sediment from grit chamber. Inspect pump chamber and remove debris and sediment as required.			X
(4) During low storm water flow conditions, drain pump chamber and inspect basket strainer to ensure strainer is not missing and is free of damage and rust. Verify bowl assembly and impellers are free of damage. Replace as required.			X
(5) Keep pump oil reservoir full with ISO VG 32 oil. Check motor oil levels.	X		
(6) Check pump vibration levels and ammeter readings.		X	
(7) Replace pump motor oil.			X
Maintenance requirements for oil/water separators should be performed as follows:			
(1) Inspect coalescing plates and insure no debris or vegetation is blocking flow through plates. Inspect coalescing plates for cracking and damage.		X	
(2) Inspect flow control weirs to ensure weirs are not missing, obstructed, bent or rusted.			X
(3) Verify oil skimming devices are working properly. Verify tube scrapers, tube guide, drive wheel , and drive wheel fingers are free of damage . Check oil level on motor and refill as required.			X
(4) Inspect tubing for cracks, ultra violet and fungal degradation. Replace as required.	X		
(5) Verify sludge levels and remove sludge with mobile vacuum system as required.			
(6) Inspect and drain oil/scum pit. Ensure float switches are functioning properly.			X

OUTFALL 003 - MAINTENANCE PROGRAM			
Maintenance requirements for settlement and infiltration ponds should be performed as follows:	Quarterly	Semi-Annual	Annual
(1) Remove trash and debris from and around sedimentation and infiltration pond. Remove any vegetation which may impede the movement of water in and out of ponds. Inspect for erosion damage of sideslopes; stabilize slopes by using appropriate erosion control measure(s); e.g. rock reinforcement, planting of grass, compaction, etc.		X	
(2) Inspect spillways to ensure appropriate amount of rock is covering the native soils. Replace rock to design standards as required.		X	
(3) Verify pond liners are free from damage. Repair or replace according to manufacturers specifications.		X	
(4) Remove accumulations of sediments in sedimentation pond on an annual basis or when sediment exceeds 7.0".			X
(5) inspect overflow structures and remove any obstructions.		X	
Maintenance requirements for manhole and control structures should be performed as follows:			
(1) Verify structure is free of cracks and damage. Verify inlet and outlet pipes are securely attached and no cracking or spalling of concrete is present. Remove built-up debris at bottom of structure.		X	
(2) Inspect orifice plate to ensure the control device is not missing, obstructed, bent or rusted.			X
Maintenance requirements for oil/water separators should be performed as follows:			
(1) Inspect coalescing plates and insure no debris or vegetation is blocking flow through plates. Inspect coalescing plates for cracking and damage.		X	
(2) Inspect flow control weirs to ensure weirs are not missing, obstructed, bent or rusted.			X
(3) Verify oil skimming devices are working properly. Verify tube scrapers, tube guide, drive wheel , and drive wheel fingers are free of damage . Check oil level on motor and refill as required.			X
(4) Inspect tubing for cracks, ultra violet and fungal degradation. Replace as required.	X		
(5) Verify sludge levels and remove sludge with mobile vacuum system as required.			
(6) Inspect and drain oil/scum pit. Ensure float switches are functioning properly.			X

OUTFALL 007 - MAINTENANCE PROGRAM			
Maintenance requirements for settlement and infiltration ponds should be performed as follows:	Quarterly	Semi-Annual	Annual
(1) Remove trash and debris from and around sedimentation and infiltration pond. Remove any vegetation which may impede the movement of water in and out of ponds. Inspect for erosion damage of sideslopes; stabilize slopes by using appropriate erosion control measure(s); e.g. rock reinforcement, planting of grass, compaction, etc.		X	
(2) Inspect spillways to ensure appropriate amount of rock is covering the native soils. Replace rock to design standards as required.		X	
(3) Verify pond liners are free from damage. Repair or replace according to manufacturers specifications.		X	
(4) Remove accumulations of sediments in sedimentation pond on an annual basis or when sediment exceeds 7.0".			X
(5) inspect overflow structures and remove any obstructions.		X	
Maintenance requirements for manhole and control structures should be performed as follows:			
(1) Verify structure is free of cracks and damage. Verify inlet and outlet pipes are securely attached and no cracking or spalling of concrete is present. Remove built-up debris at bottom of structure.		X	
(2) Inspect orifice plate to ensure the control device is not missing, obstructed, bent or rusted.			X
Maintenance requirements for oil/water separators should be performed as follows:			
(1) Inspect coalescing plates and insure no debris or vegetation is blocking flow through plates. Inspect coalescing plates for cracking and damage.		X	
(3) Verify oil skimming devices are working properly. Verify tube scrapers, tube guide, drive wheel , and drive wheel fingers are free of damage . Check oil level on motor and refill as required.			X
(4) Inspect tubing for cracks, ultra violet and fungal degradation. Replace as required.	X		
(5) Remove sludge with mobile vacuum system as required.			X
(6) Inspect and drain oil/scum structure. Ensure pump and float switches are functioning properly.			X
(7) Inspect waste oil collection tank for damage and leaks. Verify all piping connections are secure to prevent leakage. Drain oil tank.			X