Tree Top, Inc.

Selah Operations

Yakima County **Washington**

ENGINEERING REPORT

FOR

WASTEWATER FACILITIES IMPROVEMENTS

November 15, 1988

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CONTENTS

Contents, continued....

SECTION 1

INTRODUCTION

1.1 PURPOSE OF REPORT

This report summarizes information concerning alternatives for the treatment and disposal of process wastewater from Tree Top's facilities at Selah. The report has been prepared by Tree Top's engineering staff and consultants, and is intended for use in combination with a report prepared concurrently by the City of Selah.

This report is limited to systems that can be implemented by Tree Top without changes to existing City treatment facilities. The City's report will provide information for the improvements needed for City facilities if Tree Top does not provide pretreatment.

1.2 ALTERNATIVE METHODS OF TREATMENT AND DISPOSAL

1.2.1 ALTERNATIVES CONSIDERED

Table 1.2.1 summarizes the alternatives that are considered in this report for implementation by Tree Top.

TABLE 1.2.1
SUMMARY OF TREE TOP ALTERNATIVES

Alternative	Final Treatment By:
Anaerobic Pretreatment	City (existing facilities)
Separate Discharge to Yakima River	Tree Top
Land Application	Tree Top

1.2.2 ANAEROBIC PRETREATMENT

The anaerobic pretreatment alternative would utilize an anaerobic reactor to reduce BOD to levels within Tree Top's limitation for discharge to the City of Selah (3,125 pounds per day). The City's Industrial Pretreatment Lagoon and Treatment Plant would provide the additional treatment necessary for discharge to the Yakima River. The project would include the following items:

- disconnection of process wastewater discharge piping from the City's Industrial Sewer, Anaerobic pretreatment components, continued....

- construction of new gravity sewers from the Selah Plant and from the Ross Packing Plant, passing under the railroad tracks and to the 20-acre site owned by Tree Top (located immediately east of the Selah and Ross Plants and north of the City of Selah's Industrial Pretreatment Lagoon),

- an anaerobic reactor, consisting of a lined and covered impoundment with influent pumps, recycle pumps, and mixers,

- a gas collection system to allow the gases generated within the anaerobic reactor to be captured without release to the atmosphere, for flaring in a waste gas burner; use of the gas to fire a boiler is presently under consideration, and may be added to the project if cost-effective,

- connection of the anaerobic reactor's effluent piping to the existing City of Selah Industrial Sewer for further treatment by the City.

1.2.3 SEPARATE TREATMENT AND DISCHARGE

The separate treatment and discharge alternative would also utilize anaerobic pretreatment as described above, but the anaerobic reactor would be followed by an aerobic treatment process in order to meet limitations for discharge to the Yakima River. The aerobic system would use a variation of the activated sludge process: either a sequencing batch reactor (SBR) or an oxidation ditch. A final decision will be made between the SBR and oxidation ditch processes before detailed design is undertaken, if this alternative is selected.

This alternative would include the following:

- anaerobic pretreatment facilities as described above,

- a sequencing batch reactor, consisting of a tank, aerators, mixers, effluent drawoff manifold piping, sludge drawoff piping, pumps, and control system; or, an oxidation ditch system consisting of a concrete-lined circular basin, aerators, pumps, clarifier, and controls,

- an outfall to transport final effluent to the Yakima River, terminating with a diffuser in the central 15 percent of the river's cross section.

1.2.4 LAND APPLICATION

The land application alternative would not depend upon discharge to surface waters, but would utilize the water to grow hay at a 200-acre site in the L.T. Murray Wildlife Recreation Area north of Selah. During the growing season screened wastewater would be pumped to the site, aerated, and immediately distributed with sprinklers. The application rate would be limited to crop uptake requirements, to minimize the potential for deep percolation and/or runoff.

The project would include the following items:

- disconnection of process wastewater discharge piping from the City's Industrial Sewer,

- construction of new gravity sewers from the Selah Plant and from the Ross Packing Plant, passing under the railroad tracks and to the 20-acre site owned by Tree Top,

- an equalizing basin to even out flow variations and reduce the peak rate at which wastewater must be pumped; the basin would be mixed with air, in order to keep solids in suspension and to maintain aerobic conditions; pH would be adjusted with the addition of chemicals as required,

- 37,800 feet of 12-inch forcemain, primarily located in Yakima County right-of-way along Wenas Road, with air relief stations at major high points,

- an equalization/aeration basin at the sprayfield site, which would act as a wet well for the spray pumps,

- winter storage lagoons, with earthen embankments, gravel-surfaced roadways, clay or plastic membrane liners, aerators, and fencing,

- spray pumps and a distribution system consisting of buried mains with risers for "big gun" sprinklers,

- sprayfield preparation: grading, construction of runoff containment berms, rock removal, establishment of crop, fencing,

- groundwater monitoring wells above and below the sprayfield area,

- a storage/operations building for electrical gear, maintenance and crop-related equipment, etc..

1.3 RECOMMENDED ACTIONS

This report is not intended to recommend a course of action, since the most cost-effective approach cannot be determined without the information being developed concurrently by the City for other alternatives and methods of financing. An addendum to this report will be developed to summarize cost comparisons, to evaluate acceptability from the standpoint of impact upon the environment, and to recommend an alternative for implementation.

1.4 PROJECT SCHEDULE

The schedule shown in Table 1.4 was developed jointly by Tree Top and the City of Selah, and is incorporated in regulatory orders issued by the Department of Ecology.

TABLE 1.4
PROJECT SCHEDULE

Task	Completion Date
Submit engineering reports to DOE	November 15, 1988
Receive DOE approval of reports	December 15, 1988
Submit plans and specifications to DOE	April 15, 1989
Receive DOE approval of plans and specifications	May 15, 1989
Advertise for bids	June 1, 1989
Open bids	July 1, 1989
Begin construction	July 15, 1989
Construction completion	July 15, 1990
Facilities in operation	August 1, 1990

1.5 PROJECT LOCATIONS

The alternatives considered in this report would require the use of Tree Top's property east of the Selah Plant for pretreatment/treatment facilities or for a pumping station for the land application alternative. Figure 1-1, which follows, shows the general location of the site for Tree Top's projects.

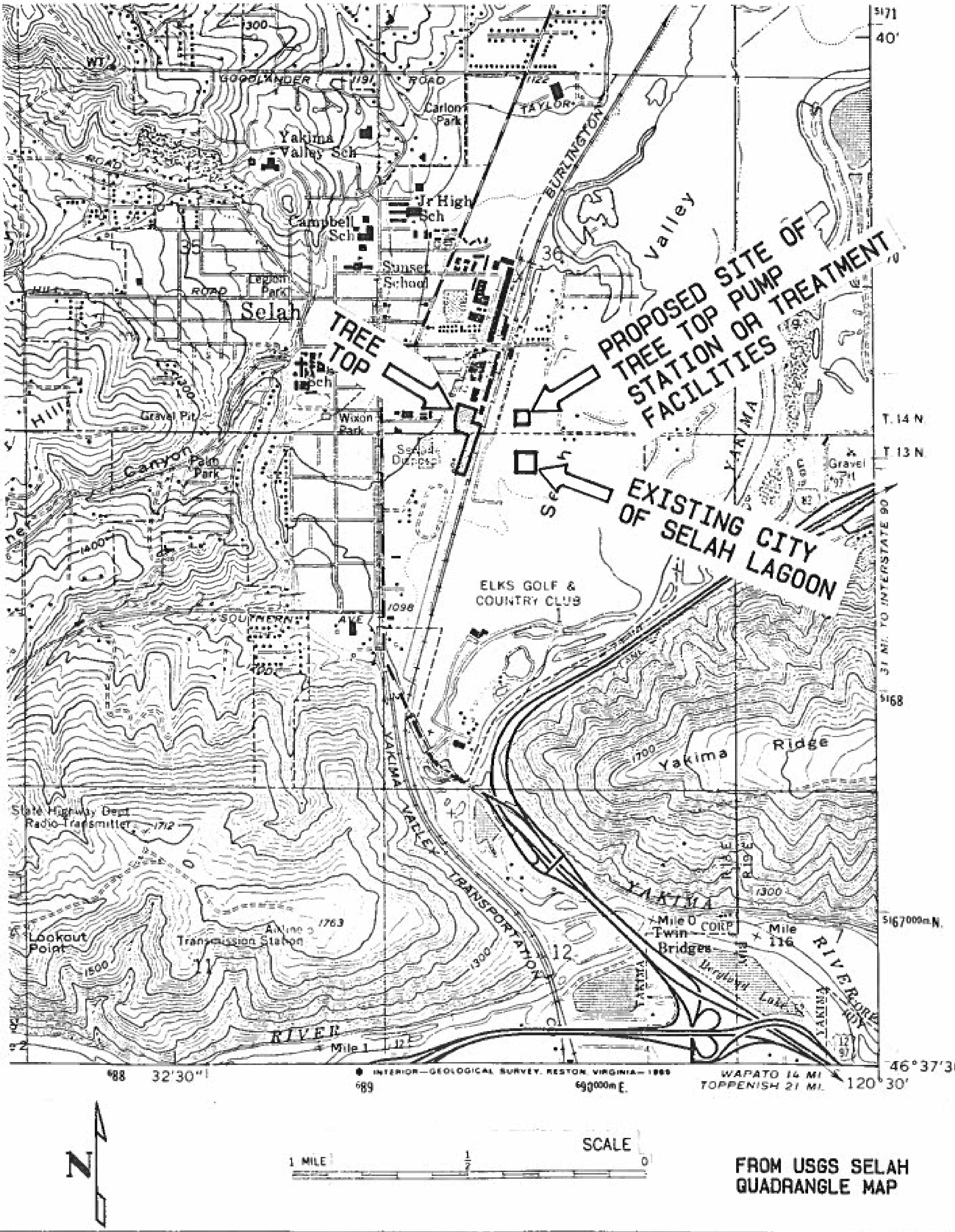

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FIGURE 1-1

LOCATION MAP

SECTION 2

DESIGN LOADINGS AND EFFLUENT LIMITATIONS

2.1 PRODUCTION TRENDS

Tree Top's processing and packaging activities have increased substantially at Selah in recent years, resulting in increases in the wastewater discharged to the City of Selah. However, a rapid growth rate is not expected to continue, for several reasons:

- the area available for plant expansion is restricted by adjacent permanent facilities and the railroad,

- utility costs are relatively high at Selah,

- a developing national market for Tree Top's products will require the construction of packaging facilities at other locations, reducing the pressure on the Selah Plant.

2.2 DESIGN LOADINGS

2.2.1 SOURCES OF WASTEWATER

Several types of wastewater are produced by Tree Top's operations at Selah:

- process wastewater from cleanup activities,

- water from the cooling of equipment and finished product,

- water extracted from juice during the concentration process,

- domestic wastewater from bathrooms.

Process wastewater is currently discharged into the City of Selah's Industrial Sewer. Cooling water is discharged to the storm drain that runs from north to south under the Selah Plant. The water extracted from product (also referred to as "reclaim water" is utilized in the plant for a variety of uses, such as during ion exchange rinsing; the excess reclaim water is discharged to the storm drain. Domestic wastewater is discharged through sanitary sewers to the City's domestic sewer system. This report considers only the treatment and disposal of process wastewater.

2.2.2 BOD AND FLOW

Tree Top developed process wastewater loadings for planning purposes early in 1988, reflecting the expected reduced growth rate for the operations at Selah.

Table 2.2.2 summarizes these design loadings. The values designated in the table as "present" loadings are for the 1988/89 processing season, "future" loadings represent the expected ultimate development of Tree Top's operations at Selah.

TABLE 2.2.2
ANTICIPATED PROCESS WASTEWATER BOD AND FLOW

Parameter/Duration	Present Ross	Present Selah	Present Combined	Future, Combined
Flow, MGD:				
Annual Average	0.02	0.28	0.30	0.34
Peak 31-Day Average	0.04	0.36	0.40	0.44
Peak 7-Day Average	0.05	0.40	0.45	0.50
Peak Day	0.06	0.49	0.55	0.75
BOD, Lb/Day:				
Annual Average	980	2,370	3,350	4,800
Peak 31-Day Average	1,000	5,000	6,000	8,600
Peak 7-Day Average	1,500	5,500	7,000	10,000
Peak Day	2,000	10,000	12,000	15,000

2.2.3 SUSPENDED SOLIDS

All process wastewater leaving the plants passes through 20-mesh equivalent screens. The remaining suspended solids include small particles of fruit and some diatomaceous earth (DE) from filtration activities. It is expected that the amount of DE will decrease in the future as alternative processes such as ultrafiltration are utilized to clarify juice, with a resultant decrease in suspended solids.

The average ratio of BOD to suspended solids during 1987 was 1:0.19. This can be used with the BOD information in the foregoing table to estimate suspended solids quantities, as shown in Table 2.2.3.

TABLE 2.2.3
ANTICIPATED PROCESS WASTEWATER SUSPENDED SOLIDS

Duration	Present Ross + Selah	Future Ross + Selah
Annual, Lb/Day	640	910
Peak 31-Day Average, Lb/Day	1,140	1,630
Peak 7-Day Average, Lb/Day	1,330	1,900
Peak Day, Lb/Day	2,280	2,850

2.2.4 PH

The pH levels of raw wastewaters from different areas within the Selah Plant fluctuate dramatically, due to cleaning solutions and the sulfuric acid used to regenerate ion exchange resins. The regeneration discharges are very acidic, and are neutralized in batches in a 50,000-gallon tank before discharge. Typical pH levels for 24-hour composite samples from both plants combined are in the range from 5 to 9.

2.2.5 NITROGEN AND PHOSPHOROUS

The nutrient content of wastewater from fruit processing activities is typically low, well below the generally-accepted minimum levels for microbial growth of BOD:N:P of 100:5:1 for aerobic systems and 500:5:1 for anaerobic systems. Nitrogen and phosphorous will have to be added to the raw wastewater for either anaerobic or aerobic treatment. It is expected that average BOD, nitrogen, and phosphorous ratios in the raw wastewater will be BOD:N:P = 100:0.23:0.1

2.2.6 TEMPERATURE

The temperature for the Selah Plant process wastewater was checked frequently during March of 1988, and averaged 77 degrees F. Average temperature data is not available for the Ross Plant, so an average temperature for the combined wastewaters of 77 degrees F will be used for preliminary design purposes.

2.3 EFFLUENT LIMITATIONS FOR DISCHARGE TO THE CITY OF SELAH

Aerobic conditions and pH levels in the range of 6.5 to 8.5 will be required for discharges into the City's domestic sewer system.

Tree Top has an agreement with the City of Selah that was developed in 1973 that establishes limitations for discharges to the City's treatment plant as follows (the combined loadings of the Selah Plant and the Ross Packing Plant are shown):

BOD: 3,125 pounds of BOD per day,

Flow: 740,000 gallons per day.

Since the original City/Tree Top contract was signed the City Council required by resolution that all major industrial dischargers use the Pretreatment Lagoon for process wastewater. The Department of Ecology subsequently issued NPDES Waste Discharge Permits to Tree Top and Hi-Country Foods that were based on the total capacity of the lagoon and the portion of that capacity requested by Hi-Country. Tree Top is allowed by permit to discharge the following loadings to the lagoon:

BOD: 5,000 pounds per day, monthly average,
7,500 pounds per day, maximum day,

Flow: 470,000 gallons per day, monthly average,
740,000 gallons per day, maximum day.

2.4 EFFLUENT LIMITATIONS FOR DIRECT DISCHARGE TO YAKIMA RIVER

2.4.1 BOD, SUSPENDED SOLIDS, AND PH LIMITATIONS

The Department of Ecology has indicated that limitations for the biochemical oxygen demand (BOD), total suspended solids (TSS), and pH that can be discharged into the Yakima River at Selah will be based on DOE's definition of municipal Secondary Treatment, as shown in Table 2.4.1.

TABLE 2.4.1
BOD, TSS, AND PH LIMITATIONS FOR RIVER DISCHARGE

Time Period	BOD	TSS	pH
7-Day Average	45 Mg/L	45 Mg/L	6.5 to 8.5
Monthly Average	30 Mg/L	30 Mg/L	6.5 to 8.5

These secondary treatment limits are currently applied to Tree Top's discharge through the City of Selah's treatment plant. DOE has indicated that it has the authority to allow the use of the less-stringent Effluent Limitations Guidelines established by EPA for fruit processing, but only if water quality would not be adversely affected. In order to allow the use of these limits, a study of the impact upon water quality in the river would be required. Such a study would require at least a full year of river monitoring data, and cannot be considered within the time that is available for completion of the project.

Disinfection would not be required, since only process wastewater would be treated.

2.4.2 AMMONIA LIMITATIONS

Limitations would also be applied to the amount of ammonia that could be discharged to the river, since ammonia in the un-ionized form is highly toxic to fish. The fraction of ammonia that is present in the un-ionized form is a function of pH and temperature, with pH having the predominant effect. A discussion of the derivation of ammonia limits is included in Appendix B.

Briefly, two different exposures must be considered: chronic toxicity and acute toxicity. Chronic toxicity is the long-term effect of low dosages of ammonia on resident fish; acute toxicity reflects the short-term effects of high dosages on both migratory and resident fish. EPA has developed criteria for both conditions, as outlined below.

> Chronic toxicity criteria are based on 4-day averages of the un-ionized ammonia concentration at the downstream edge of the dilution zone, including any upstream background ammonia. The dilution zone can include no more than 15 percent of the river flow. The pH and temperature that must be used in calculation of the un-ionized fraction are the upstream values in the river.
>
> Acute toxicity criteria are based on 1-hour values of the un-ionized ammonia in the effluent. No dilution is allowed and the effluent must meet the criteria as it leaves the diffuser ports. The temperature and pH that must be used in calculation of the un-ionized fraction are the values in the effluent.

The most stringent of these two limitations will control the amount of ammonia allowed in the discharge. The following factors must be used to calculate allowable ammonia levels for each condition:

- chronic toxicity (4-day): river temperature, pH, flow, and upstream ammonia concentration; effluent temperature and pH,

- acute toxicity (1-hour): effluent temperature and pH.

The ammonia that can be discharged is much greater at lower pH levels. Since the effluent pH can be easily controlled by the addition of small quantities of acid, acute toxicity criteria will not control the design. Table 2.4.2 summarizes the concentrations of total ammonia that could be discharged within the chronic toxicity criteria, under average river conditions and with the anticipated future 7-day effluent flow rate of 0.50 MGD (see Appendix B).

TABLE 2.4.2
4-DAY AVERAGE AMMONIA LIMITS

Month	Maximum Total Ammonia, as N Lb/Day	Mg/L
January	277	66
February	278	67
March	478	115
April	647	155
May	467	112
June	1,240	297

Table 2.4.2, continued....

Month	Maximum Total Ammonia, as N Lb/Day	Mg/L
July	1,540	369
August	1,065	255
September	409	98
October	374	90
November	542	130
December	295	71

2.5 EFFLUENT LIMITATIONS FOR LAND APPLICATION

The Department of Social and Health Services (DSHS) and DOE jointly developed guidelines for land application of domestic wastewater, establishing minimum treatment levels from the standpoint of protection of public health. The primary concerns of the guidelines are to prevent nuisance conditions (odors, insects), runoff to surface streams, contamination of groundwater, and the introduction of pathogens, pesticides, or heavy metals into food.

Tree Top's process wastewater does not contain significant quantities of human pathogens, pesticides, or heavy metals, and no specific treatment levels are applicable to the protection of food chain crops. However, the remaining portions of the DSHS/DOE guidelines are applicable, and must be taken into account in the design of a land application system. Treatment must include screening to remove large solids and adequate aeration to ensure that the wastewater is applied under aerobic conditions. Application rates will be limited to avoid runoff or groundwater contamination, as a function of soil, crop, and weather conditions.

2.6 EFFLUENT LIMITATIONS FOR DISCHARGE TO THE STORM SEWER

DOE established biomonitoring criteria for discharges to surface waters in 1988 that require the use of bioassay testing to demonstrate that discharges are not toxic to sensitive organisms that may be present in the receiving water. The organisms frequently used in bioassays are Rainbow Trout and daphnia species.

DOE is presently in the process of implementing this new regulation, and will eventually specify biomonitoring protocols for all permitted discharges. Tree Top's direct discharge to the storm sewer of untreated flows that are generally referred to as "non-contaminated" must meet the biomonitoring requirements prior to dilution in the river. These flows include storm water runoff, cooling water, and water extracted from juice during concentration.

SECTION 3

ANAEROBIC PRETREATMENT/CITY TREATMENT

3.1 DESCRIPTION

This alternative would include pretreatment by Tree Top to reduce organic loadings below the level established in the current City/Tree Top agreement (including the loadings allocated to Ross Packing). Anaerobic pretreatment facilities would be utilized, as described in detail in Appendix A.

ADI International, Inc. provided consulting engineering services to Tree Top for the evaluation of anaerobic facilities. ADI was responsible for the development of the information in Appendix A.

Figure 3-1, which appears on the following page, is a schematic diagram showing the arrangement of major components of this alternative. The discharge from the anaerobic reactor would flow by gravity to the existing Industrial Sewer, for polishing in the City's Industrial Pretreatment Lagoon and Treatment Plant. This report does not consider the modifications that may be necessary at the City's facilities to meet effluent limitations at the loadings allocated to industrial users by existing contracts. The City's engineers will evaluate the need for such modifications in a separate report.

3.2 ESTIMATED COSTS

Two different approaches to anaerobic pretreatment were evaluated:

- Conversion of the City's existing Industrial Pretreatment Lagoon into an anaerobic reactor for the treatment of all process wastewaters from both Tree Top and Hi-Country Foods,

- construction of a new anaerobic reactor treating only Tree Top's process wastewater.

Table 3.2 summarizes estimated construction, operation, and maintenance costs.

TABLE 3.2
ANAEROBIC PRETREATMENT COST ESTIMATE SUMMARY

Item	Conversion of Lagoon	New Pretreatment System
Capital Costs	$1,860,000	$1,790,000
Operation and Maintenance	$91,100/year	$86,100/year

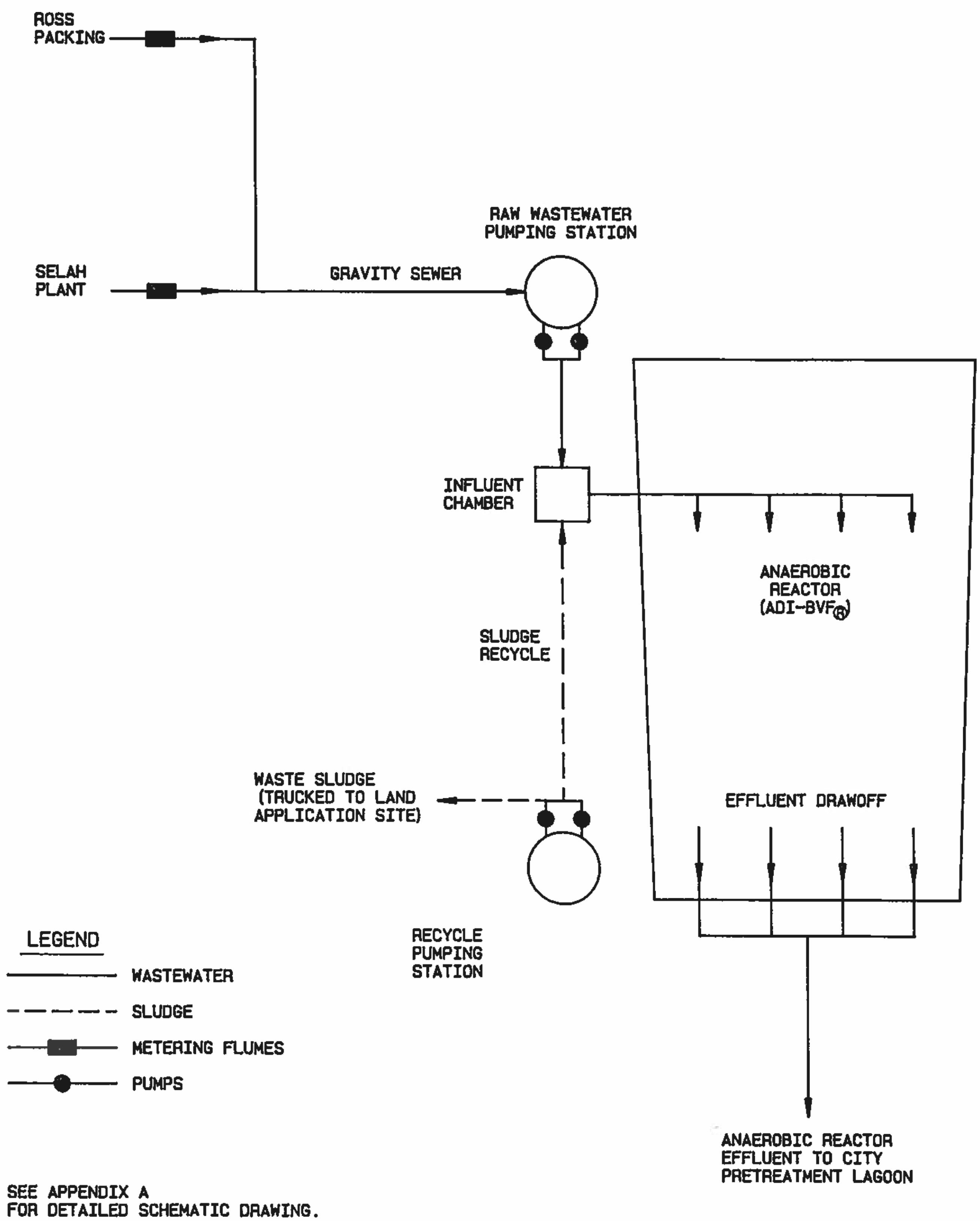

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FIGURE 3-1

ANAEROBIC PRETREATMENT FLOW SCHEMATIC

SECTION 4

SEPARATE TREATMENT AND DISCHARGE

4.1 DESCRIPTION

This alternative would include anaerobic pretreatment as described in Section 3 followed by aerobic treatment to bring the effluent into conformance with limitations for discharge to the Yakima River. Details of both anaerobic and aerobic facilities are described in Appendix A. Tree Top would discontinue discharge of process wastewater to the City of Selah's wastewater facilities.

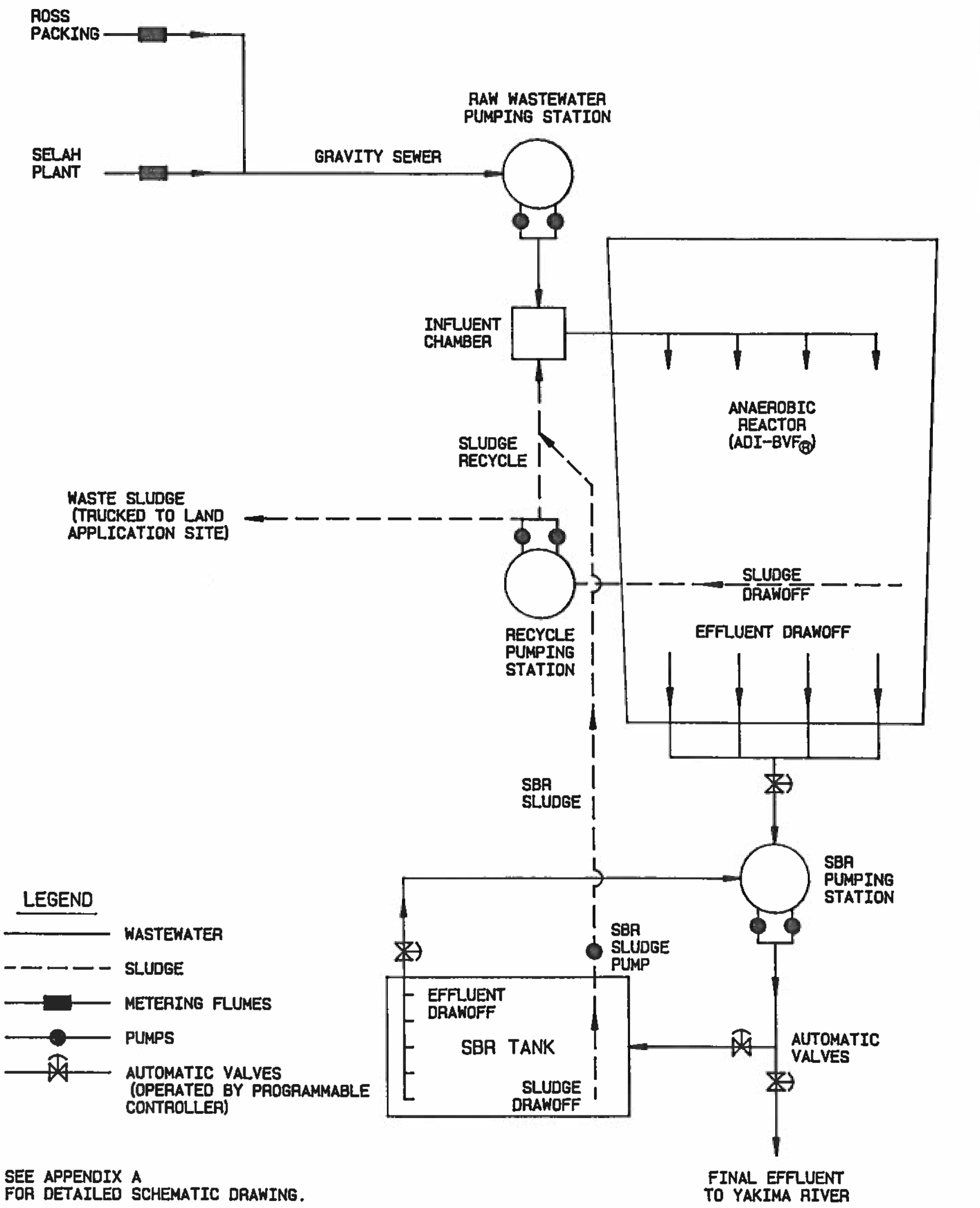
Two different methods of aerobic treatment were considered in detail: the oxidation ditch variant of the activated sludge process and the sequencing batch reactor process. Figure 4-1, which appears on the following page, is a schematic diagram showing the arrangement of major components of this alternative, with the SBR polishing process.

4.2 ESTIMATED COSTS

Table 4.2 summarizes estimated construction, operation, and maintenance costs.

TABLE 4.2
ANAEROBIC PRETREATMENT COST ESTIMATE SUMMARY

Item	Oxidation Ditch	SBR
Capital Costs	$1,102,000	$1,102,000
Operation and Maintenance	$85,000/year	$85,000/year



SEE APPENDIX A FOR DETAILED SCHEMATIC DRAWING.

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FIGURE 4-1

SEPARATE TREATMENT & DISCHARGE FLOW SCHEMATIC

SECTION 5

LAND APPLICATION

5.1 BACKGROUND

The application of industrial wastewater to land as a method of both treatment and disposal offers significant advantages over the more traditional approach of treatment followed by discharge to surface waters. The semi-arid climate of Eastern Washington is particularly suitable for land application, since the water is needed for crop growth and since problems with runoff are minimized.

Land application has the following advantages in comparison to treatment and discharge to the Yakima River:

- sludge disposal is not required,
- crops can be harvested, removing nutrients and generating revenue,
- treatment requirements are much less stringent,
- operation and maintenance costs are lower,
- the system is simple to operate and performance is reliable.

The principal drawbacks to land application are that large areas with suitable soils and slopes are required, winter storage is needed, and transportation (pipeline) costs are high for remote sites.

Land application sites are not available in the immediate vicinity of Selah. Most of the area is suburban, and is not suitable for wastewater disposal. The only nearby large undeveloped area is located immediately to the northeast of Tree Top, but is situated largely in the Yakima River floodplain. The best available sites within a reasonable pumping distance of Selah are the Yakima Firing Center and the L.T. Murray Wildlife Recreation Area.

The Firing Center's administrative staff was contacted by Tree Top early in 1988. The Army was interested in obtaining water for irrigation of grass-covered troop and equipment staging areas and a sagebrush nursery, but after evaluation of the project with its large permanent winter storage facilities it was determined that such a major private development could not be located on the Firing Center.

The Department of Wildlife was also asked to review potential uses of water. The Department presently operates several farming operations in the Yakima Valley, primarily to raise hay for elk. The southern portion of the L.T. Murray area is part of the winter range for the Yakima herd, and elk have recently caused problems on private lands adjacent to unfenced portions in the

Wenas Valley. Hay at this location could be used to entice the elk to remain off private land and also to augment the feeding programs at other locations in Yakima County.

5.2 DESIGN CRITERIA

During the growing season screened wastewater would be pumped to the site, aerated, and immediately distributed with sprinklers over approximately 200 acres of hay. The application rate would be limited to minimal crop uptake requirements, to reduce the potential for deep percolation and/or runoff.

The project would include the following major components:

- disconnection of process wastewater piping from the City's Industrial Sewer,

- construction of new gravity sewers from the Selah Plant and from the Ross Packing Plant, passing under the railroad tracks and to the 20-acre site owned by Tree Top (see Figure 1-1 in Section 1),

- an equalizing basin to even out flow variations and to reduce the peak rate at which wastewater must be pumped; the basin would be mixed with air, in order to keep solids in suspension and to maintain aerobic conditions; pH would be adjusted with the addition of chemicals as required,

- 37,800 feet of 12-inch forcemain, primarily located in Yakima County road right-of-way along Wenas Road, with air relief stations at high points,

- an equalization/aeration basin at the sprayfield site, which would act as a wet well for the spray pumps and which would ensure that the wastewater is aerobic as it is distributed by the sprinklers,

- winter storage lagoons with earthen embankments, gravel-surfaced roadways, PVC membrane liners, aerators, and chain-link fencing,

- spray pumps and a distribution system consisting of buried mains with risers for portable pipe and "big gun" sprinklers,

- sprayfield preparation: grading, construction of runoff containment berms, rock removal, establishment of crop,

- groundwater monitoring wells above and below the sprayfield area,

- a storage/operations building for electrical gear, maintenance and crop-related equipment, etc..

Figure 5-1, which follows, shows a schematic flow diagram for the proposed land application alternative.

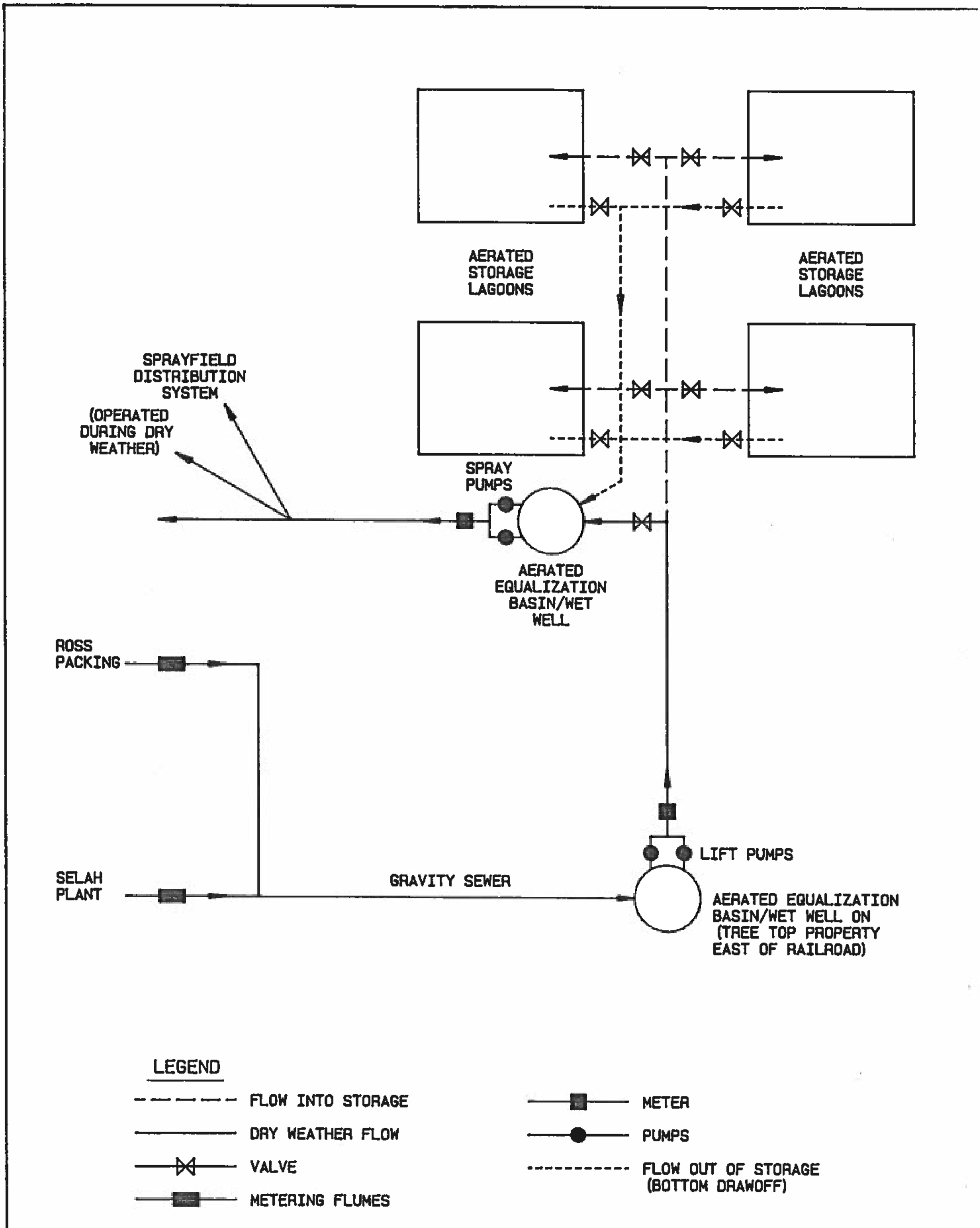

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FIGURE 5-1

LAND APPLICATION FLOW SCHEMATIC

The land application system will be designed in accordance with the applicable portions of the DSHS/DOE land application guidelines, as discussed in Section 2 of this report. Treatment prior to application during the growing season will be limited to screening and aeration. The wastewater will be retained in aerated storage lagoons during winter months, and will receive treatment incidental to this storage. Table 5.2 summarizes major design criteria.

TABLE 5.2
LAND APPLICATION DESIGN CRITERIA

Parameter	Design Value (1)
Winter Storage:	
Duration	120 days
Period	November -> March
Maximum stored volume	40,800,000 gallons
Sprayfield:	
Irrigated area	150 acres
Annual application rate	30.5 inches
Annual average application rate	0.083 inches/day
Peak month application rate	0.11 inches/day
Peak week application rate	0.12 inches/day
Annual organic loading	11,680 pounds/acre
Annual average organic loading	32 Lb/acre/day
Peak month organic loading	57 Lb/acre/day
Peak week organic loading	67 Lb/acre/day

Notes:

(1) Loadings represent the application of wastewater after short-term equalization and aeration; the effects of the application of water from long-term (Winter) storage in the Spring are not included. Future average flows of 0.43 MGD annual average are used to calculate loadings.

(2) Hydraulic application rates do not include precipitation.

(3) Organic loading rates do not reflect the BOD reduction that will occur during winter storage in the aerated lagoons.

5.3 PROPOSED PIPELINE ROUTE AND APPLICATION SITE

5.3.1 SITE LOCATION

The L.T. Murray area will be used as the basis for land application facilities evaluated in this report. The following information is based on preliminary discussions with District personnel, and is not meant to represent Department of Wildlife policy. If this alternative is selected it will be necessary to develop a long-term agreement between the Department of Wildlife and Tree Top to define the responsibilities and rights of both parties.

The closest portion of the L.T. Murray area with suitable slopes is located north of Wenas Road and east of Sheep Company Road, as shown on Figure 5-2, which follows. The proposed site is located on Sections 35 and 36, Township 15 North, Range 18 EWM. Cottonwood Creek, an intermittent stream, bisects the site. An un-named intermittent stream is located west of Cottonwood Creek on Section 35, and will form the western boundary of the sprayfield. The southern boundary of the site are the south lines of Sections 35 and 36, which are also the boundaries of the L.T. Murray Area. The area is covered with grass; there are no trees or brush on the site.

5.3.2 SOIL CONDITIONS

Detailed site-specific soil and groundwater information will be obtained if this alternative is selected. The Soil Conservation Service **Soil Survey** indicates that a variety of silt-loams underlie the site, primarily of the Willis and Lickspittle Series. These soils are relatively thin, and are underlain by hardpan in places. Permeability is moderate above the hardpan and very slow through it. Water capacity is moderately high.

These soils are used for irrigated field and orchard crops in Yakima County. The main limitation for irrigated crops is the depth to hardpan. Relatively uniform application of water with sprinkler systems will be required in order to reduce runoff and the potential for erosion. The presence of the hardpan layers will minimize the possibility for deep percolation and groundwater contamination, but will require that application rates be limited to avoid saturation of soils above the hardpan and resultant lateral movement of water towards Cottonwood Creek. Interceptor drains along the lower edges of the sprayfield areas may be needed to avoid this problem, and/or the use of wide buffer strips near the creek.

5.3.3 SURFACE WATER PROTECTION ON SITE

A canal and two intermittent streams cross the proposed sprayfield, and it will be necessary to provide buffer areas. Buffer areas will also be provided adjacent to the private properties along the south boundary of the site.

5.3.4 PIPELINE ROUTE

The proposed pipeline route would cross property owned by Tree Top, Washington Central Railroad Company, Yakima County, and the Department of Wildlife. Figure 5-2, which follows, shows the preliminary proposed location of the pipeline. Most of the route would be within Yakima County road right-of-way, and it will be necessary to obtain a franchise from the County. The pipeline will cross several minor drainages, Wenas Creek, and Cottonwood Creek. Air relief valves will be provided at high points, and wye fittings will be buried at intervals for use in locating obstructions and cleaning.

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FIGURE 5-2

LAND APPLICATION SITE & FORCEMAIN ROUTE

5.4 ESTIMATED COSTS

A detailed cost estimate for land application is included in Appendix C. The total estimated capital requirement for the project is $3,680,000, including an allowance of 20 percent of the construction costs to cover engineering, contingencies, legal and administrative expenses.

Table 5.4 summarizes estimated costs of operation and maintenance, based on 1988 cost levels. It is proposed that the Department of Wildlife will be responsible for sprayfield operation, including sprinklers, spray pumps, crop planting/replanting, fertilization, and harvest. The Department of Wildlife is considering this proposal at the time that this report is prepared.

Tree Top would provide the facilities and deliver the water to the sprayfield. Maintenance of all equipment, including the sprinklers, would be Tree Top's responsibility. A full-time operator would be provided by Tree Top for the lagoon and pumping facilities. The operator would check aerators and pumps at least once each weekday, perform maintenance activities as required, collect samples, carry out laboratory testing work, and prepare monitoring reports for submission to DOE.

TABLE 5.4
TREE TOP OPERATION AND MAINTENANCE COSTS
(Department of Wildlife O&M costs not included)

Item	Annual Cost
Labor, including benefits:	
Operator, 0.90 FTE (full-time equivalent)	$24,300
Maintenance, 0.05 FTE	$1,600
Supervisory, 0.025 FTE	$400
Clerical, 0.025 FTE	$1,200
Outside services: meter calibration, special repairs, etc.	2,000
Miscellaneous supplies	2,000
Electrical energy, @ $0.043/KWH overall average rate	85,600
Travel to/from sprayfield site, @ 1¼ trips/day average	1,400
Equipment maintenance and repair, @ 3% of major equipment costs	8,500
Misc. expenses: insurance, phone, continuing education, etc.	5,000
Crop-related operations by Department of Wildlife	0
TOTAL ANNUAL COST:	$132,000

APPENDIX A

ANAEROBIC SYSTEM INVESTIGATIONS

CONTENTS

APPENDIX A

ANAEROBIC SYSTEM INVESTIGATIONS

1.0 CONCLUSIONS

The following conclusions have been drawn from the investigations of anaerobic pretreatment systems both with and without aerobic polishing.

1. Wastewater from Tree Top's fruit processing activities is an excellent candidate for anaerobic pretreatment.

2. An on-site pilot study is recommended to verify design criteria and to establish operating conditions (e.g., chemical requirements).

3. Construction of a new ADI-BVF is recommended, rather than conversion of the existing aerated lagoon to an anaerobic system.

4. The estimated 1988 capital costs for ADI-BVF systems for Alternatives A, B, and C are as follows:

Alternative	Estimated Capital
Alternative A	$1,860,000
Alternatives B and C	$1,790,000

5. The SBR and oxidation ditch systems were judged equally appropriate for aerobic polishing of anaerobic effluent (alternative C).

6. The 1988 capital costs for the SBR and oxidation ditch systems were both estimated to be $1,102,000 (in addition to the ADI-BVF costs), including costs of transporting wastewater to the site and discharging effluent to the Yakima River.

7. Annual operating costs for anaerobic pretreatment and aerobic treatment were estimated to be as follows:

Item	Alternative A	Alternative B or C
Anaerobic Pretreatment:		
Labor	$50,100	$50,100
Electrical energy	$3,000	$3,000
Sludge disposal	$10,000	$7,000
Chemicals	$8,000	$7,000
Maintenance	$20,000	$19,000

Annual operating costs, continued...

Item	Alternative A		Alternative B or C
Aerobic Treatment:			
Labor	$22,700		$22,700
Electrical energy	$26,000		$28,000
Sludge disposal	$14,300		$14,300
Chemicals	$10,000		$10,000
Maintenance	$10,000		$10,000
Total:	$174,100	per year	$171,100

2.0 INTRODUCTION

This appendix was prepared by ADI International, Inc., of Fredericton, New Brunswick. The purpose of ADI's work was to examine anaerobic pretreatment and aerobic polishing options for three different pretreatment and treatment alternatives: A, B and C, defined as follows.

Alternative A:

Anaerobic pretreatment of the combined wastewaters generated by Tree Top and Hi-Country Foods, with a system constructed by modifying the City's existing 6.0 million gallon (MG) aerated lagoon.

Aerobic polishing of the anaerobic effluent would be accomplished at the City's wastewater treatment plant.

Alternative B:

Anaerobic pretreatment of process wastewater from Tree Top in a new ADI-BVF system to be constructed to the north of the City's aerated lagoon on Tree Top property.

Aerobic polishing of the anaerobic effluent would be accomplished at the City's wastewater treatment plant.

Alternative C:

Anaerobic pretreatment of Tree Top's wastewater in a new ADI-BVF system to be constructed to the north of the City's aerated lagoon on Tree Top property.

Aerobic polishing in a new Tree Top wastewater treatment facility with direct discharge to the Yakima River.

3.0 OBJECTIVES

Major objectives of ADI's investigations included the following.

1. Evaluation of the use of anaerobic pretreatment systems, including both new facilities and conversion of the existing City Pretreatment lagoon.

2. Evaluation of aerobic polishing alternatives for direct discharge to the Yakima River (Alternative C).

3. Preparation of preliminary capital and annual cost estimates for the pretreatment and treatment alternatives.

4.0 ANAEROBIC PRETREATMENT

4.1 ADVANTAGES OF ANAEROBIC PRETREATMENT

Anaerobic pretreatment for industrial wastewater holds several advantages over conventional aerobic treatment, including:

- no aeration required (energy savings),
- generates biogas which may be used as fuel in a boiler or generator,
- produces much less waste sludge,
- requires less nutrients,
- is capable of digesting waste solids such as pomace as well as waste aerobic sludge from polishing facilities.

Warm, high-strength wastes, such as fruit processing wastewater, are normally considered as excellent candidates for anaerobic treatment.

4.2 THE ADI-BVF* SYSTEM

The ADI-BVF system is an adaptation of the anaerobic lagoon and is termed a "low-rate" system, reflecting its low loading rates of 0.5 to 3 kilograms of COD per cubic meter per day. The system is considered as "proven technology" by Environment Canada (Canada's equivalent of EPA). There are presently 14 full-scale ADI-BVF systems in place or under construction in the United States and Canada. ADI-BVF systems presently operating in the Northwest include those owned by Twin City Foods and J.R. Simplot and treating potato processing wastewater.

*Registered trademark of ADI International, Inc., with U.S. patent.

While the ADI-BVF technology utilizes low-cost earthen-basin construction, it is much more than a glorified anaerobic lagoon because it incorporates many design improvements.

Major physical and process improvements in first-generation reactors included:

- utilization of a durable, floating membrane cover for biogas collection, temperature control, and positive odor control,
- capabilities for utilizing biogas in a boiler system, electrical generator set, or other use,
- effluent recycle to enhance performance,
- on-stream sludge removal capability,
- special inlet and outlet arrangements,
- provision for alkalinity and pH control,
- use of seed sludge for start-up,
- employment of anaerobic specialist on site for start-up,
- a monitoring system, and
- follow-up by ADI during the first year of operation.

The first-generation, low-rate ADI-BVF technology was the result of several years of research at ADI and an affiliated research program at the University of New Brunswick.

In addition to the above improvements, ADI has added low-power, slow-speed mixers to all of its second-generation BVF designs. These mixers are normally operated on an intermittent basis only. Mixers were added to the design after in-house laboratory testing revealed that the reactor can operate at higher loadings with low intensity, intermittent mixing without sacrificing system performance. In addition, mixers add significantly to the system's ability to cope with shock loadings and other stress situations.

In addition to slow-speed mixers, the second-generation systems included the following design improvements:

- introduction of the wastewater feed through a specially designed header on the bottom of the reactor,
- mixing of feed with recycled sludge from the effluent end of the BVF,
- variable-level effluent drawoff/variable active volume (optional).

The ADI-BVF reactor can be characterized as a low-rate anaerobic contact process, which basically derives its mixing action through gassing activity but supplemented by intermittent, low-intensity mixing, and with a built-in clarification zone. ADI has also developed "in-basin" clarification devices to further enhance removal of suspended solids as part of the third-generation improvements. Another innovation is the addition of a sludge retention baffle at the inlet reaction zone.

Low-rate technology has many potential benefits and advantages over high-rate systems. These benefits can include:

- less expensive basin construction methods and cover system,

- lower manpower requirements and lower operating and maintenance costs (system is very simple to operate and maintain),

- satisfactory performance over a much wider range of temperature conditions (this improves the energy balance and extends anaerobic applicability),

- elimination of the need for any primary treatment and primary sludge dewatering, handling and disposal; primary sludge can be added directly to the system, where it is digested to produce biogas,

- ability to treat raw wastewaters having high concentrations of fat, such as potato and cheese processing wastes,

- reduced sludge handling as this system produces very little waste sludge on its own, and, further, it provides an excellent place for disposal of waste biological sludge from any aerobic polishing step which follows; this results in savings in sludge dewatering, handling, and disposal costs, and has a secondary benefit of producing additional biogas and recycling nutrients and alkalinity to further reduce operating costs,

- ability to waste sludge on-line from the reactor on a continuous basis or intermittently; at a solids concentration in the range of 3 to 7 percent, this sludge is very stable, does not have an offensive odor, and has good fertilizer value,

- inherent stability, as the large physical size of the BVF and volume of biomass maintained in it work together to provide the reactor with an "inherent" stability against shock loadings (organic, pH, temperature, solids, etc.), toxic chemicals, and intermittent and variable loading schedules; this stability normally precludes the need for equalization, further simplifying the system,

- minimal explosion hazard because the cover is a flexible membrane rather than a concrete or steel roof, and because very little gas is ever in storage,

- biogas is produced more evenly and can be removed and used continuously at its rate of production,

- a large volume with a floating cover permits equalization of the rate of discharge to the City sewer or to downstream processes.

The membrane cover consists of a combination of chemically-bonded polyester reinforcement and a blended, polymeric membrane. These membranes are chosen for their chemical resistance to the wastewater being treated and for long life under rigorous weather conditions. The membrane cover system is designed to complement the system operation. Some of its features include:

- collection and removal of biogas,

- positive odor control (any gas leakage is inward rather than outward) and temperature control with insulation,

- access hatches and sampling ports, to allow easy access for inspection and monitoring while the system is in operation,

- folds which allow the cover to adjust to rising or falling liquid level; thus the reactor may act as an equalization basin, thereby protecting downstream aerobic processes,

- rainwater collection in the folds; (this permits rain and snowmelt to be collected in controlled locations and subsequently drained by gravity pipes or by pumping; biogas collection continues as usual during precipitation events since the membrane collector system is virtually unchanged; the biogas pressure in the collector system is also unaffected as its pressure is always kept slightly negative by a blower as a means of assisting gas extraction,

- easy field repair, without taking the basin out of service,

- ability to be installed in-the-dry or with basin full,

- good access (a person can readily walk on the cover), and

- extended warranty (10 years).

4.3 ANAEROBIC SYSTEM DESIGN CRITERIA

The design criteria summarized in Table 1 for Alternatives A, B and C were established by Tree Top personnel on the basis of past monitoring data and on anticipated future processing levels. Plant production is normally 24 hours per day, 7 days per week, for 220 to 250 days per year with a summer shutdown of as long as 6 to 8 weeks. In recent years summer shutdowns have been decreasing in length, and can be as short as 1 to 2 weeks.

TABLE 1
ANAEROBIC SYSTEM DESIGN CRITERIA

Parameter	Alternative A	Alternatives B and C
Flow (MGD):		
Annual average (365 days)	0.40	0.34
Peak 31-day average	0.52	0.44
Peak 7-day average	0.59	0.50
Peak day	0.95	0.75
BOD (Lb/Day):		
Annual average (365 days)	6,800 (2,040 Mg/L)	4,800 (1,690 Mg/L)
Peak 31-day average	12,200 (2,810 Mg/L)	8,600 (2,340 Mg/L)
Peak 7-day average	15,000 (3,050 Mg/L)	10,000 (2,400 Mg/L)
Peak day	21,300 (2,690 Mg/L)	15,000 (2,400 Mg/L)
COD (Lb/Day):		
Annual average (365 days)	11,200 (3,370 Mg/L)	7,920 (2,790 Mg/L)
Peak 31-day average	20,100 (4,640 Mg/L)	14,200 (3,860 Mg/L)
Peak 7-day average	24,800 (5,030 Mg/L)	16,500 (3,960 Mg/L)
Peak day	35,100 (4,440 Mg/L)	24,800 (3,960 Mg/L)
TSS (Lb/Day):		
Annual average (365 days)	1,290 (390 Mg/L)	910 (320 Mg/L)
Peak 31-day average	2,310 (530 Mg/L)	1,630 (440 Mg/L)
Peak 7-day average	2,840 (580 Mg/L)	1,890 (450 Mg/L)
Peak day	4,030 (510 Mg/L)	2,840 (450 Mg/L)

The design loadings were originally derived for BOD. The COD data in Table 1 is based on a COD:BOD ratio of 1.65:1, and the TSS data is based on a BOD:TSS ratio of 5.29:1. The average temperature of wastewater from Tree Top's Selah Plant, (from measurements made during February and March, 1988) is approximately 77 F. Based on typical apple processing wastewater nutrient content, the BOD/N/P ratio is expected to average approximately 760/2.1/1. This presents a nutrient deficiency, since the minimum recommended ratio for anaerobic pretreatment is 500/5/1.

5.0 ANAEROBIC FACILITIES

5.1 ALTERNATIVE A: CONVERSION OF EXISTING CITY PRETREATMENT LAGOON

The required anaerobic reactor volume for Alternative A is 4.1 million gallons (MG). The existing aerated lagoon could be converted to an ADI-BVF system, with an operating volume of 6.0 MG. The aerated lagoon is a square, gunite-lined pond with water surface dimensions of 295 feet by 295 feet and a normal operating depth range of 12 to 13 feet.

In order to convert the aerated lagoon the following items would be required:

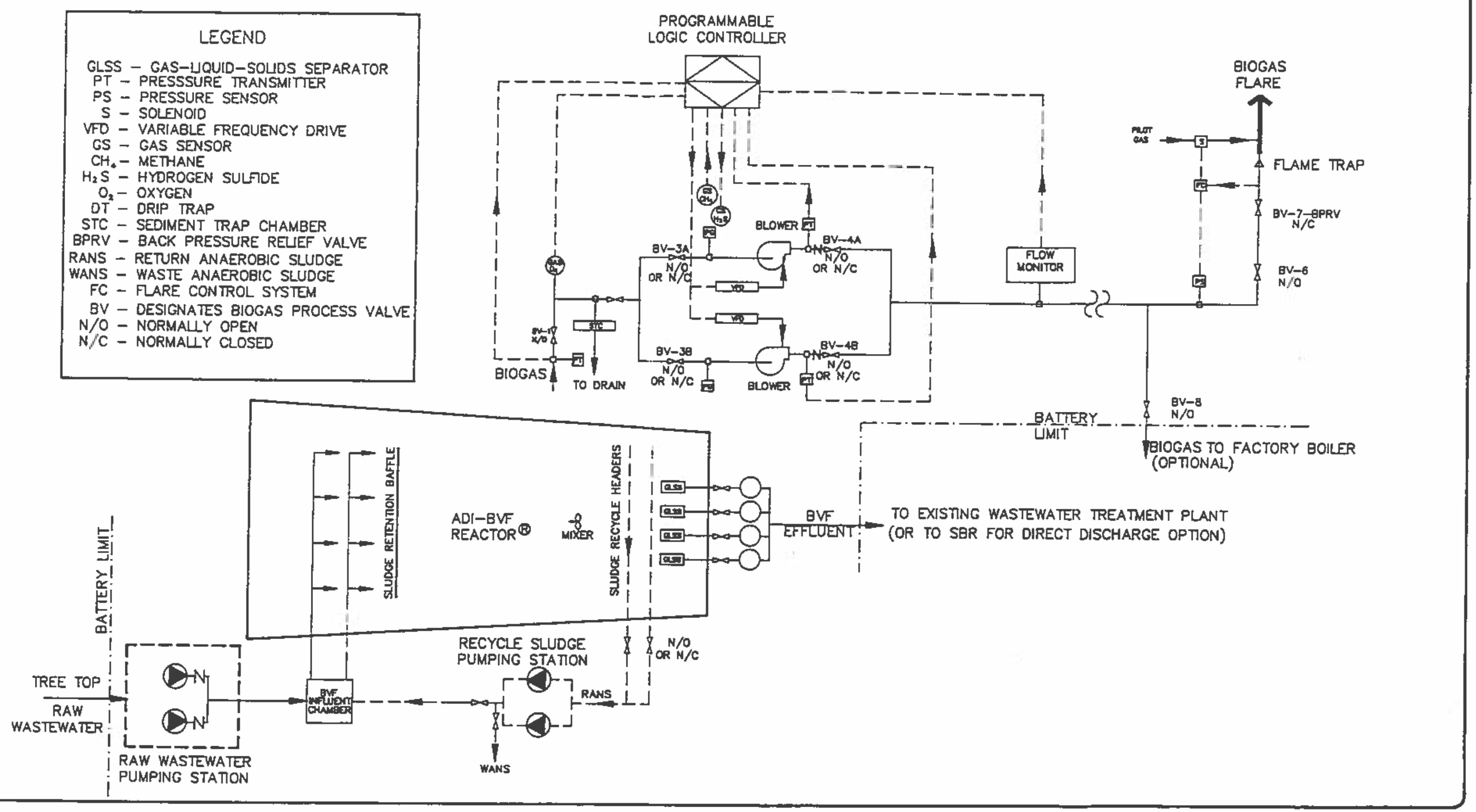
- floating, insulated membrane cover for biogas collection (extra insulation required due to large surface area),
- influent header system, with sludge retention baffle,
- three sludge recycle headers with sludge recycle pumping system,
- two, slow-speed mixers,
- effluent header system,
- removal/modification of existing influent/effluent works, aerators, etc.,
- complete biogas handling/combustion system and all controls.

The converted system would use the existing industrial sewer and pump station to deliver the combined Tree Top and Hi-Country wastewaters to the BVF inlet. Effluent from the BVF would flow to the City's treatment plant through the existing lagoon discharge piping. For details regarding BVF operation and performance, refer to Section 5.2. In general, construction of a new BVF is preferable to conversion of the existing lagoon, because it does not conform to normal standards for length, width, depth, etc.. Conversions of existing facilities also frequently lead to construction delays and cost overruns, and would require a period of complete shutdown of the discharging industries during portions of the construction work.

5.2 ALTERNATIVES B AND C: NEW ANAEROBIC FACILITIES

The operating volume of the proposed ADI-BVF system for Alternatives B and C is 3.5 MG. In terms of performance, it is estimated that the BVF would achieve 85 percent BOD removal, but an on-site, pilot-scale study is recommended to verify BVF design criteria and performance. Such a study is presently underway at Tree Top's Cashmere Plant, and may provide adequate information for use in connection with facilities at Selah. Figure 5.1, which follows, is a preliminary process and instrumentation diagram (P&ID) and schematic of the proposed BVF system. Figure 5.1 also defines the system battery limits.

The BVF basin will be earthen construction with 12-ft vertical concrete side walls, and will be totally membrane-lined to ensure watertightness. The reactor may be either rectangular or trapezoidal in shape (plan view). The outside berms of the reactor will be approximately 7 feet wide at the top. The inside wall is concrete and vertical for a height of approximately one-half depth, with the remainder being earth and sloped as appropriate. Both the outside and inside slopes will be 2.0 to 1. The trapezoidal BVF would be 220 feet long, 150 feet wide at the influent end, and 75 feet wide at the effluent end.



ADI INTERNATIONAL INC.
Anaerobic Systems
® US PATENT 4672691

No.	Revision	Date

Drawn By	K.J.G.
Dwg. Chd. By	G.J.B.
Calcs. By	
Calcs. Chd. By	
Date Drawn	MAY/88
Date Issued	

Project Title
ANAEROBIC PRETREATMENT FACILITY FOR TREE TOP SELAH, WASH

Drawing Title
PRELIMINARY SCHEMATIC AND P & ID

Project No.	2727-1
Drawing No.	FIG. 5-1
Rev. No.	

Const. North

No additional equalization or pretreatment facilities are required with the ADI-BVF reactor. Raw wastewater from Tree Top will flow by gravity to the BVF influent pumping station. At the inlet chamber the wastewater mixes with recycled anaerobic sludge (and waste activated sludge (WAS) if aerobic polishing is used), and this mixture enters the reactor through a special dual header system. A sludge retention baffle is used to retain anaerobic sludge in the influent zone. The trapezoidal BVF shape allows a greater volume of sludge to be retained behind the baffle. Also, the reactor floor is sloped downward towards the influent zone to further encourage sludge retention.

Sludge recycle to the influent structure is accomplished through an in-line pumping station and a special system of two suction headers located in the reactor. It is this same system which is used to waste sludge as the need arises. Experience has shown that this sludge can be wasted with solids concentrations in the range of 3 to 7 percent. The sludge will be highly stabilized and should be excellent for land disposal without the creation of an odor nuisance. Because of the very large sludge storage capacity in the reactor, sludge wasting can be done periodically and only when it best suits the operator's/owner's schedule, etc.

The reactor is equipped with a slow-speed, low-power mixer which normally operates a maximum of two to three hours daily. The mixer is placed and operated in such a manner as not to adversely affect the reactor effluent suspended solids concentration. Typically, effluent SS concentrations in such applications are of the order of 300 milligrams per liter (Mg/L), with 500 Mg/L being the usual maximum.

The effluent must pass through gas-liquid-solids separators (GLSS) before leaving the BVF. The GLSS devices act as internal clarifiers to further minimize effluent solids loss. BVF effluent then flows, by gravity, to the City's treatment plant. Alternatively, the SBR pumping system (Section 6.2) will deliver BVF effluent (in a timed sequence) to the SBR for aerobic polishing before direct discharge.

5.3 BIOGAS PRODUCTION

The bacteria in anaerobic reactors produce a mixture of gases as they utilize wastewater for energy and carbon. These gases are mostly methane and carbon dioxide, with a small amount of hydrogen sulfide. The mixture is commonly referred to as "biogas".

The reactor will be covered with an insulated, floating membrane cover. The cover will permit biogas collection (under slight vacuum) while providing temperature and odor control. The biogas system is designed to flare but biogas could be used in the plant boiler (to offset conventional fuel) for the extra cost of a pipeline and burner modification. A decision regarding the use of biogas in the plant boilers will be made during the design phase of the project.

The anticipated biogas composition will be approximately 65 percent methane (CH_4), 35 percent carbon dioxide (CO_2), with traces of hydrogen sulfide (H_2S)

and other gases. The gas quality will vary from time to time, with methane excursions down to 50 percent and up to 75 percent on occasion. It has been ADI's experience that these excursions in gas quality should not cause any difficulties in biogas utilization. (Pilot plant operation is a valuable aid to verify estimated biogas quantity and composition.)

The biogas is collected continuously from beneath the BVF cover system as it is produced, under a slight vacuum and via a peripheral collection header. The vacuum is created and controlled by a duplex system of variable-speed, positive-displacement blowers. A discharge pressure of approximately 5.0 psig has been assumed, which is more than adequate for flaring and should be suitable for utilization in the process boilers.

As part of the biogas system, a waste gas flare, complete with suitable back-pressure relief valve, flame trap and flare controls, has been provided. There is also an automatic emergency biogas venting system to relieve biogas in the event of prolonged power failure and a take-off will be included for future interconnection to the plant boiler.

The proposed blowers are of cast iron construction with gastight seals. In other similar applications, cast iron construction has worked very well. Biogas piping, valving, etc., will all be of corrosion-resistant materials so as to provide good service life (e.g., biogas piping will be FRP and/or stainless steel).

The design and all components of the biogas system will meet the requirements of the National Standard of Canada, Installation Code for Digester Gas Systems. (There are no equivalent U.S. standards or codes.) All sensitive electrical/electronic equipment will receive special protection to help reduce corrosion problems from any fugitive H_2S in the ambient air.

The biogas will be continuously monitored for O_2 infiltration to ensure biogas system integrity at all times. The biogas control system will initiate a warning alarm at a biogas O_2 content of 2.5 percent and total system shutdown at 5 percent. (Biogas will become flammable near 15 percent O_2, and thus there is a wide margin of safety provided in the design of the biogas control system.) Room air in the building housing the biogas handling system (blowers) will be continuously monitored for methane and hydrogen sulfide, with appropriate alarms.

The estimated average daily and annual biogas production for present and future conditions are presented in Table 2. The estimates in Table 2 are based upon the following assumptions:

- average COD removal: 80 percent,

- methane recovered: 5.0 cubic feet per pound of COD removed,

- biogas composition: 65 percent methane; 35 percent carbon dioxide.

TABLE 2
ESTIMATED BIOGAS PRODUCTION

Production	Alternative A		Alternatives B and C
Annual average (365 days)	150,000	cubic feet per day	100,000
Annual total volume	25.1	million cubic feet per year	17.8
Annual total heat value	16,300	million BTU per year	11,500

5.4 OPERATIONAL REQUIREMENTS

From experience at other ADI-BVF installations, it is suggested that only one operator/technician is needed to run the proposed facility. The primary duties of the BVF operator/technician will be routine system surveillance and operation, minor maintenance, sample collection and some analytical testing. Reactor pH, alkalinity, volatile acids, and temperature will be monitored manually, on a daily basis, as the operator does his rounds. All major maintenance requirements or tasks requiring additional help can be met from outside forces.

Based on the available design data, it will be necessary to add nitrogen to the raw wastewater to support biological growth (although certainly less than would be required for conventional aerobic treatment). Estimated additional nitrogen quantities are as follows:

- anaerobic pretreatment only: 12 tons per year, as N,

- anaerobic pretreatment with aerobic treatment: 24 tons per year, as N.

6.0 AEROBIC TREATMENT

6.1 AEROBIC SYSTEM DESIGN CRITERIA (ALTERNATIVE C)

Alternative C requires the use of aerobic treatment to polish the anaerobic pretreatment system's effluent for discharge to the Yakima River. Design loadings for aerobic polishing facilities are summarized in Table 3, and are based upon the information that was presented in Table 1 and the following assumptions:

- average BOD removal in ADI-BVF anaerobic pretreatment: 85 percent,

- no flow attenuation through the anaerobic reactor.

TABLE 3
AEROBIC SYSTEM DESIGN CRITERIA

Parameter	Average	Peak Day
Flow, MGD	0.50	0.75
BOD, pounds/day	1,500	2,250
BOD, milligrams/liter	360	360
TSS, pounds/day	2,090	--
TSS, milligrams/liter	500	--

Table 4 summarizes effluent limitations for BOD, suspended solids, and pH for discharge to the Yakima River. These limitations are based on domestic secondary treatment levels, which are the basis for Tree Top's current discharge through the City of Selah's wastewater treatment facilities. The Department of Ecology has indicated that these limitations will be applied to a direct discharge by Tree Top unless information from a receiving water study indicates that less stringent limits can be applied without problems. The greatest extent that limits could be reduced would be defined by the effluent limitations guidelines established by EPA for fruit processing.

TABLE 4
FINAL EFFLUENT REQUIREMENTS

Parameter	7-Day Average		31-Day (Monthly) Average
BOD	45	milligrams per liter	30
Total Suspended Solids (TSS)	45	milligrams per liter	30
pH	within the range: 6.5 -> 8.5 at all times		

In addition, the final effluent for direct discharge must not exceed acute toxicity limits for ammonia, as outlined in Table 5. A more complete discussion of the derivation of ammonia limitations is included in Appendix B. For acute toxicity, the maximum allowable concentration of ammonia is primarily a function of pH. Table 5 illustrates the relationship between pH and allowable ammonia levels over the range of allowable discharge pH levels at a temperature of 20 degrees C. This temperature represents an upper limit for the anticipated range of aerobic system discharge temperatures.

TABLE 5
EFFLUENT LIMITATIONS FOR AMMONIA

pH	Max. Total NH3, Mg/L as N	pH	Max. Total NH3, Mg/L as N
6.50	23.8	7.75	8.5
6.75	21.9	8.00	5.6
7.00	19.2	8.25	3.2
7.25	15.8	8.50	1.9
7.50	12.0		

The pH of the final effluent would be adjusted with the addition of acid, when necessary to allow acute ammonia toxicity limits to be met.

6.2 ALTERNATIVES FOR AEROBIC TREATMENT

6.2.1 ALTERNATIVES CONSIDERED IN DETAIL

Aerobic treatment alternatives were screened based on ability to reliably meet effluent limits, simplicity of operation, and cost. Preliminary designs for three alternatives were prepared:

- three aerated lagoons (in series) with a polishing pond,
- an oxidation ditch/clarifier system,
- a sequencing batch reactor (SBR).

6.2.2 AERATED LAGOONS

The preliminary design for the aerated lagoon system consists of three, 3.2 MG cells, operated in series, followed by a 2.0 MG polishing pond. The lagoons would use a total of approximately 250 horsepower in floating aerators. Although such a system would be simple to operate, it would have difficulty meeting the 30 Mg/L TSS limit. DOE typically allows higher effluent solids concentration from aerated lagoons, but can be expected to require a detailed study of the impacts on water quality before allowing less stringent limits.

6.2.3 OXIDATION DITCH

The preliminary design of the oxidation ditch was based on an Envirex Orbal system. The oxidation ditch would consist of three concentric ovals (aeration channels) with a total operating volume of 0.5 MG (overall: 109 feet long by 94 feet wide). Aeration would be supplied by two rotating disc systems (40 horsepower each).

BVF effluent would flow by gravity to the first aeration channel, which typically operates at low dissolved oxygen levels to inhibit filamentous organisms. Wastewater is then further treated in the following two aeration channels, before overflowing to a rectangular clarifier with 1,500 square feet of surface area. The clarifier will employ a travelling sludge removal mechanism. Return sludge would be recycled to the first two aeration channels, while waste sludge would be pumped to the BVF for digestion. The operation of the oxidation ditch would allow nitrification to take place for ammonia control.

6.2.4 SEQUENCING BATCH REACTOR (SBR)

The SBR process is basically an activated sludge plant in which the aeration and clarification processes are carried out in the same tank. SBRs can be used to treat any wastewater where an activated sludge system might otherwise be utilized. The SBR process can readily be used to remove BOD, nitrogen, (by nitrification and denitrification) and phosphorus (by changing operational procedures).

In its simplest form, the batch reactor consists of a single vessel in which timed processes take place sequentially. A typical SBR cycle uses four phases: *FILL*, *REACT*, *SETTLE*, and *DECANT*, as follows:

- *FILL*: during *FILL*, the reactor is filled with the wastewater to be treated (i.e., BVF effluent); the reactor is mixed continuously but is not always aerated; the wastewater is mixed with the mixed liquor in the reactor for solids/liquid contact and for uptake of soluble BOD,

- *REACT*: during the *REACT* phase, the aerators are operated for waste stabilization (i.e., BOD removal and nitrification); mixing of reactor contents continues; however, aeration can be cycled on and off to allow nitrification and denitrification,

- *SETTLE*: mixing and aeration are terminated, and the biological solids are allowed to settle,

- *DECANT*: clarified effluent is decanted and waste activated sludge is removed (i.e., pumped to BVF for digestion), as required.

The primary applications of SBRs are in small communities requiring treatment facilities which have low capital and operating costs, and in industries and municipalities that have unique applications, such as the removal of nitrogen or phosphorus. The single-tank system is applicable for noncontinuous-flow situations, such as those that occur in the food processing industry. Minimal operator input is required.

SBRs have some advantages over a conventional aerobic system:

- a single tank is used for both aeration and settling, SBR advantages, continued....

- anoxic periods can be added to cause denitrification for enhanced nitrogen removal, to control growth of filamentous organisms, and to reduce power consumption,

- due to the high substrate concentrations that are experienced during part of the *FILL* cycle, floc-forming organisms are favored over filamentous organisms, thereby reducing the likelihood of settling problems due to filamentous bulking,

- the surface area for liquid/solids separation in SBRs is generally five to ten times that of conventionally-designed secondary clarifiers; also, liquid-solids separation takes place during near-ideal, quiescent conditions (i.e., no inflow or outflow),

- the cost is reduced due to the elimination of secondary clarifiers and sludge pumping stations.

A complete SBR system includes the following major components:

- SBR basin,

- SBR pumping system,

- waste sludge (WAS) pumping system,

- floating aerators,

- mixers,

- decant mechanism,

- controls, including a programmable local control system (PLC).

The SBR basin is a square, 20-feet deep concrete tank (86 feet by 86 feet) with an operating volume of 1.0 MG. The SBR pumping system (refer to Figure 6.1) is a duplex pumping system providing 100 percent backup, complete with automatic valves. During the *FILL* phase of the SBR cycle, a pump will deliver BVF effluent to the SBR. During the *DECANT* phase, the pump will discharge clarified SBR effluent. The SBR pumps and automatic valves will be controlled by a PLC, which will control the timing of all SBR operating phases.

It is necessary to waste solids from the SBR (usually daily). The WAS pumping system will deliver WAS directly to the BVF for anaerobic digestion.

Slow-speed mixers are included to allow mixing of SBR contents and BVF effluent during the *FILL* phase without aerator operation. Such anoxic mixing is often used in SBR operations to discourage growth of filamentous organisms.

It will also reduce aeration energy requirements because the oxygen derived from nitrates and nitrites during anoxic conditions offsets free dissolved oxygen which would otherwise have to be supplied by aeration.

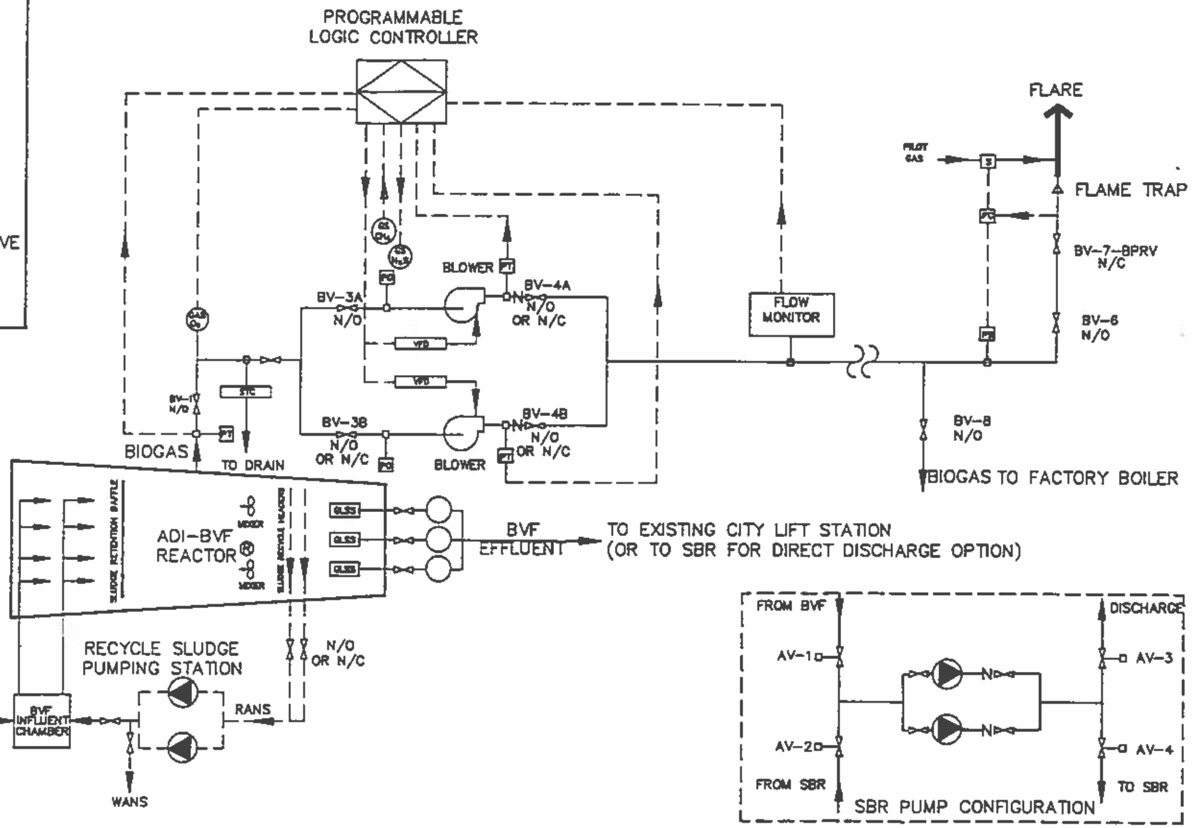
The basin will be equipped with four, 50-horsepower floating aerators, to provide sufficient capacity to handle the anticipated peak loads. The use of four aerators will allow flexibility at times when oxygen demand is lower, by turning aerators on or off in response to dissolved oxygen concentrations. To encourage nitrification, basin heat loss may be minimized by using floating aerators with subsurface discharge. Since denitrification is not required, an anoxic reaction phase following aeration will not be necessary. Operation of the slow-speed mixers and aerators would be controlled by the PLC.

A floating, subsurface decant mechanism will be employed to remove clarified effluent during the *DECANT* phase. The mechanism will allow effluent to be pumped from a large area above the settled sludge blanket (not from just a point source).

The PLC is an important part of SBR operation since it times the reactor's operating phases, it receives information from liquid level sensors (in the BVF and SBR) and a dissolved oxygen probe, and it operates the pumps, valves, aerators, and mixers.

LEGEND

GLSS – GAS-LIQUID-SOLIDS SEPARATOR
PT – PRESSSURE TRANSMITTER
PS – PRESSURE SENSOR
S – SOLENOID
VFD – VARIABLE FREQUENCY DRIVE
GS – GAS SENSOR
CH_4 – METHANE
H_2S – HYDROGEN SULFIDE
O_2 – OXYGEN
DT – DRIP TRAP
STC – SEDIMENT TRAP CHAMBER
BPRV – BACK PRESSURE RELIEF VALVE
RANS – RETURN ANAEROBIC SLUDGE
WANS – WASTE ANAEROBIC SLUDGE
FC – FLARE CONTROL SYSTEM
BV – DESIGNATES BIOGAS PROCESS VALVE
N/O – NORMALLY OPEN
N/C – NORMALLY CLOSED
AV – DESIGNATES AUTOMATIC VALVE



ADI INTERNATIONAL INC.
Anaerobic Systems
US PATENT 4672691

No	Revision	Date

Drawn By	K.J.G.
Dwg. Ckd. By	G.J.B
Calcs By	
Calcs Ckd By	
Date Drawn	MAR/88
Date Issued	

Project Title: ANAEROBIC PRETREATMENT FACILITY FOR TREE TOP CASHMERE, WASH.

Drawing Title: PRELIMINARY SCHEMATIC AND P & ID

Project No. 2727-2
Drawing No. FIG. 6-1
Rev No

Const. North

6.3 COMPARISON OF AEROBIC ALTERNATIVES

Conventional activated sludge and fixed-film processes (e.g., biotower) were not considered as appropriate choices for aerobic polishing in this application. Activated sludge would be more costly (both to build and to operate) and could have some difficulty meeting the effluent ammonia limit. A fixed-film process is not generally used for aerobic polishing of anaerobic effluent, due to potential odor nuisance and sensitivity to low temperatures.

Although an aerated lagoon system would certainly be simple to operate, it would have to rely upon relaxed solids discharge limits, and it cannot be determined within the time available for this study if such limits will be allowed. The electrical energy costs for aerated lagoons would also be higher than for other systems.

The SBR and oxidation ditch both have technical advantages over other systems, including:

- relative ease of operation,

- can be designed to utilize oxic/anoxic zones to foster nitrification and denitrification,

- can readily be designed to incorporate "selector mechanisms" to enhance sludge settleability.

Either treatment system should be capable of consistently meeting effluent limits, and there is no significant difference between them in estimated capital or annual cost (Sections 7.1 and 7.2). Therefore, in this preliminary analysis, the SBR and oxidation ditch systems are judged to be equally appropriate for Alternative C.

7.0 CAPITAL AND ANNUAL COSTS

7.1 CAPITAL COST ESTIMATES

7.1.1 ANAEROBIC SYSTEM CAPITAL COST ESTIMATES

The estimated 1988 capital costs for complete ADI-BVF pretreatment systems for Alternatives A, B and C are summarized below in Table 6. The estimated costs include a 15 percent allowance for contingencies, start-up/training services, and engineering.

Engineering includes mobilization, geotechnical investigations, topographic survey, development of a project design manual, client liaison, detailed design work, preparation of specifications, review of bids, negotiations with contractors, construction inspection and administration, development of a process operating manual, shop drawing review, record drawings, and follow-up.

Anaerobic system cost estimates provide for complete operating facilities including:

- gravity sewers from the Selah Plant and Ross Packing to the BVF wet well,
- membrane-lined earthen BVF basin, with concrete vertical walls for Alternatives B and C; modification of the existing shotcrete-lined lagoon for Alternative A,
- floating membrane cover system with sample ports, access hatches, perimeter tie, and biogas piping,
- reactor inlet and outlet headers and piping,
- sludge retention baffle and GLSS system for Alternatives B and C; no GLSS for Alternative A,
- sludge recycle and waste system,
- slow-speed mixers,
- complete biogas handling system with blowers, biogas main to flare, piping, valves, flare, emergency vent and safety equipment,
- yard lighting and fencing,
- connection of effluent piping to the existing City of Selah Industrial Sewer (note: no post-aeration facilities will be provided; the effluent will be anaerobic),
- engineering and contingencies.

The estimates also include a PLC control system with a graphics display terminal in a free-standing cabinet. This provides complete local control, real-time data display and annunciation. Remote control, data logging, remote displays, etc., are not included.

The estimated 1988 capital costs for the ADI-BVF systems for Alternatives A, B, and C are as shown in Table 6.

TABLE 6
ESTIMATED ANAEROBIC SYSTEM CAPITAL COSTS

Pretreatment	Estimated Capital
Alternative A	$1,860,000
Alternatives B and C	$1,790,000

7.1.2 AEROBIC SYSTEM CAPITAL COST ESTIMATES

The estimated 1988 capital costs for the aerobic treatment facilities (the SBR and oxidation ditch of Alternative C) are presented in Table 7. The estimates for aerobic systems include start-up/training, complete engineering services, and a 15 percent allowance for contingencies

The SBR cost estimate includes the following items:

- concrete SBR tank,
- SBR pumping system, with automatic valves,
- waste sludge pumping station,
- four floating aerators,
- two slow-speed mixers,
- effluent decant mechanism,
- PLC and controls,
- forcemain to Yakima River, with an outfall and diffuser located upstream of the confluence of Golf Course Creek with the river,
- engineering and contingencies.

Cost estimates for the oxidation ditch alternative include:

- concrete oxidation ditch, with three aeration channels and disc aeration systems,
- rectangular concrete clarifier, with sludge removal equipment and overflow weirs,
- sludge recycle and wasting systems,
- forcemain to Yakima River, with an outfall and diffuser located upstream of the confluence of Golf Course Creek with the river,
- engineering and contingencies.

The SBR and oxidation ditch costs include a preliminary estimate for extension of the discharge force main to the Yakima River and an outfall in the river. Table 7 summarizes estimated costs for aerobic systems.

TABLE 7
ESTIMATED AEROBIC SYSTEM CAPITAL COSTS

Treatment System	Estimated Capital
Sequencing Batch Reactor	$1,102,000
Oxidation Ditch	$1,102,000

7.2 ESTIMATED ANNUAL COSTS

The estimated annual operating costs for labor, electrical energy, chemicals, sludge disposal, and maintenance are summarized in Table 8. In terms of manpower, there will be one operator with primary responsibility for the wastewater facilities, 8 hours per day, 7 days per week. The duties of the operator will be routine system surveillance, sample collection and minor maintenance such as calibrating and lubricating.

TABLE 8
ESTIMATED ANNUAL OPERATION COSTS
(Anaerobic and Aerobic Systems)

Item	Estimated Annual Costs Alternative A	Alternative B or C
Anaerobic Pretreatment		
Labor, including benefits:		
Operator: 1.40 FTE	$37,900	$37,900
Maintenance: 0.20 FTE	$6,500	$6,500
Supervisory: 0.10 FTE	$4,900	$4,900
Clerical: 0.05 FTE	$800	$800
Electrical energy	$3,000	$3,000
Sludge disposal	$10,000	$7,000
Chemicals	$8,000	$7,000
Maintenance	$20,000	$19,000
Aerobic Treatment - Additional Costs		
Labor, including benefits:		
Operator: 0.60 FTE	$16,200	$16,200
Maintenance: 0.20 FTE	$6,500	$6,500
Electrical energy	$26,000	$28,000
Sludge disposal	$14,300	$14,300
Chemicals	$10,000	$10,000
Maintenance	$10,000	$10,000
Total:	$174,100 per year	$171,100

The electrical energy costs for the anaerobic systems are based upon typical operating experience with biogas blowers, recycle sludge pumps, and slow-speed mixers, with a unit cost of $0.043/KWH. It is projected that BVF sludge disposal will not be required for the first four or five years of operation. Eventually, however, some anaerobic sludge must be removed. Typically, the sludge is applied to land. The estimated costs are based upon application to land in liquid form at a unit cost of $0.05/gallon.

Based on the available data, it is estimated that the raw wastewater requires supplemental nitrogen. The estimated costs are based upon the use of urea to provide 20 Mg/L of nitrogen at a unit cost of $220/ton. Also included is an allowance for addition of 11/52 fertilizer (52 percent phosphorous) to supplement phosphorus. No allowances for pH or alkalinity control chemicals are included (operation of a pilot system would further clarify chemical requirements). Annual maintenance cost estimates are based on an allowance of 1.5 percent of construction costs.

The electrical energy costs for the aerobic systems are based upon projected aeration requirements and operation of pumps and mixers. Costs for sludge disposal are due to the extra anaerobic solids resulting from WAS digestion in the BVF.

The estimated chemical costs for aerobic systems were based upon the addition of nitrogen and phosphorus to supply sufficient nutrient for aerobic operation. The nitrogen addition should be carefully controlled so that the final effluent can easily meet ammonia discharge requirements with minimal nitrification.

APPENDIX B

EFFLUENT LIMITATIONS FOR AMMONIA

1. BASIS FOR AMMONIA LIMITATIONS

The Department of Ecology utilizes the limits for ammonia established by the Environmental Protection Agency for the protection of fish in EPA publication 440/5-86-001: **Quality Criteria for Water 1986**. These limits are a function of temperature, pH, and type of fish. The limitations are expressed in terms of un-ionized ammonia, since that form has been demonstrated to be the principal toxic form of ammonia for aquatic organisms. Two different time periods were used by EPA to establish maximum allowable in-stream concentrations: 4 days and 1 hour. The 4-day average requirement reflects chronic toxicity levels, while the 1-hour maximum level reflects acute toxicity.

The ammonia limitations discussed in this appendix are based upon the presence of salmonids and/or other sensitive coldwater species (the most restrictive category).

2. EFFECT OF DISCHARGE LOCATION

The effluent will be discharged into the drainage ditch located immediately to the east of the Tree Top plant, more than a mile above its confluence with the Yakima River near the Selah Elks Lodge. It can be anticipated that the un-ionized ammonia levels in the discharge will be reduced by dilution, uptake by plants, and volatilization in the drainage ditch, which has a year-round flow. These decreases cannot readily be quantified and are not taken into account in this appendix, but can be considered as an additional factor of safety.

3. CHRONIC AMMONIA TOXICITY: 4-DAY AVERAGE LIMITATIONS

3.1 UPSTREAM RIVER CONDITIONS

Only limited data is available for conditions in the Yakima River upstream of Selah. Table 1, which follows, summarizes information available from the Bureau of Reclamation for temperature, ammonia, and pH. The values in Table 1 are averages of all available data for each month, based on samples taken at the Harrison Road bridge from March 21, 1974 through September 16, 1981.

The flow rates shown in Table 1 are the lowest 4-day averages occurring during each month, based on the 1-year period from March 1, 1987 through February 29, 1988. This period of time represents a dry period with very low flows in the Yakima River above its confluence with the Naches River. Flows are low throughout the year since storage in the upper Yakima basin reservoirs was being replenished during periods of high precipitation.

The average river flow are based on measurements made below Roza Dam, with the Selah-Moxee Canal withdrawals subtracted. All flow measurements were made by the Bureau of Reclamation. The flow that that Wenas Creek adds to the river above Selah is not included, since data was not available.

TABLE 1
AVERAGE CONDITIONS IN YAKIMA RIVER UPSTREAM OF SELAH

Month	Temp, C	pH	Total NH3, Mg/L	Un-ion. NH3, Mg/L	River Flow, CFS	Flow for Dilution, CFS
January	2.7	7.54	0.049	0.00017	171	25.7
February	3.9	7.53	0.050	0.00019	174	26.1
March	6.8	7.76	0.016	0.00013	338	50.7
April	9.3	7.35	0.019	0.00007	431	64.7
May	11.2	7.44	0.021	0.00012	316	47.4
June	14.6	7.56	0.013	0.00013	858	128.7
July	17.2	7.34	0.012	0.00008	1,261	189.2
August	16.0	7.50	0.022	0.00020	794	119.1
September	13.5	7.57	0.007	0.00006	281	42.2
October	8.8	7.75	0.010	0.00009	267	40.1
November	4.6	7.76	0.030	0.00021	374	56.1
December	2.0	7.70	0.020	0.00010	180	27.0

3.2 MAXIMUM ALLOWABLE 4-DAY AVERAGE AMMONIA QUANTITIES

Table 2 summarizes the maximum quantities of ammonia (maximum 4-day average) for each month of the year, based on the upstream conditions given in Table 1. The diluting effect of the effluent flow are not considered. Quantities shown in Table 2 are based on 15 percent of the river flow.

TABLE 2
4-DAY AVERAGE AMMONIA LIMITATIONS

						MAXIMUMS @ EDGE OF DILUTION ZONE				
Month	Temp, C	FT	pH	FPH	EPA "Ratio"	Un-Ion NH3 Mg/L as NH3	Un-Ion NH3 Mg/L as N	Total NH3 Mg/L as N	River Flow, CFS	Eff. Limits Total NH3, Lb/day, as N
January	2.7	3.310	7.54	1.376	20.04	0.00877	0.00721	2.01	171	277
February	3.9	3.051	7.53	1.400	20.52	0.00913	0.00750	1.97	174	278
March	6.8	2.482	7.76	1.152	16.00	0.01750	0.01438	1.75	338	478
April	9.3	2.101	7.35	1.698	25.32	0.00886	0.00728	1.86	431	647
May	11.2	1.840	7.44	1.534	22.91	0.01237	0.01017	1.83	316	467
June	14.6	1.454	7.56	1.357	19.66	0.02063	0.01696	1.79	858	1,240

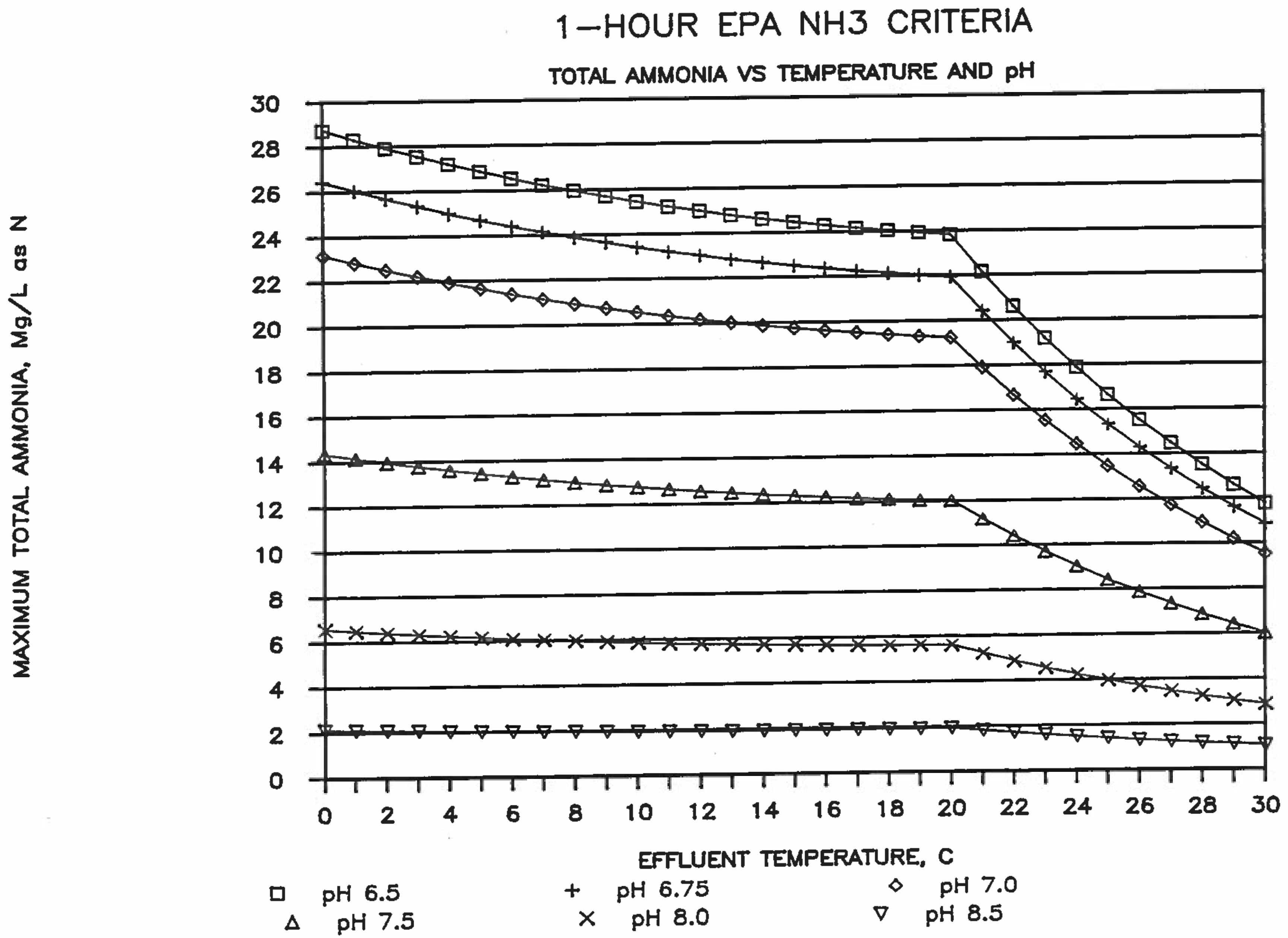
Table 2, continued...

Month	Temp, C	FT	pH	FPH	EPA "Ratio"	Maximums @ Edge of Dilution Zone Un-Ion NH3, Mg/L as NH3	Un-Ion NH3, Mg/L as N	Total NH3 Mg/L as N	River Flow, CFS	Effluent Limitations: Total NH3, Lb/day, as N
July	17.2	1.413	7.34	1.712	25.52	0.01296	0.01065	1.51	1,261	1,540
August	16.0	1.413	7.50	1.435	21.20	0.01861	0.01530	1.66	794	1,065
September	13.5	1.569	7.57	1.345	19.40	0.01954	0.01606	1.80	281	409
October	8.8	2.165	7.75	1.157	16.00	0.01996	0.01641	1.73	267	374
November	4.6	2.897	7.76	1.152	16.00	0.01499	0.01232	1.79	374	542
December	2.0	3.467	7.70	1.201	16.00	0.01201	0.00987	2.02	180	295

4. ACUTE AMMONIA TOXICITY: 1-HOUR CONCENTRATION LIMITS

Current DOE policy requires that the EPA 1-hour maximum concentrations be applied as "end-of-pipe" limits. In other words, no dilution zone is allowed for acute toxicity. The figure which follows at the end of this appendix summarizes allowable ammonia concentrations as a function of effluent temperature and pH.

The ammonia limitations established by acute toxicity requirements are more stringent than the 4-day limits, and will control the quantity of ammonia that can be discharged during all anticipated combinations of effluent pH and temperature and river flow rates.


1—HOUR EPA NH3 CRITERIA
TOTAL AMMONIA VS TEMPERATURE AND pH
MAXIMUM TOTAL AMMONIA, Mg/L as N
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
EFFLUENT TEMPERATURE, C
pH 6.5
pH 6.75
pH 7.0
pH 7.5
pH 8.0
pH 8.5

APPENDIX C

CONSTRUCTION COST ESTIMATE

LAND APPLICATION AT L.T. MURRAY WILDLIFE RECREATION AREA

The following cost estimates are based on competitively-bid work, managed by Tree Top and completed during 1989. Construction would take place under 3 separate schedules, as follows:

- *Schedule 1: Work at Plant* - pump station, equalization tank, sewer from Ross Packing, and associated work at the plant,
- *Schedule 2: Forcemain* - forcemain to the storage lagoon,
- *Schedule 3: Disposal Area* - lagoon/sprayfield development.

Item	Units	Quantity	Price	Amount
Schedule 1: Work at Plant				
Mobilization/demobilization	LS	1	$10,000	$10,000
Gravity sewer from Ross Plant to connection with Selah Plant piping to pump station (utilize existing metering and screening equipment at both plants)	LF	600	$25	$15,000
Gravity sewer from Selah Plant to pump station	LS	150	$25	$3,750
Railroad crossing for gravity sewer (after Ross and Selah Plant flows are combined)	LS	1	$5,000	$5,000
40,000-gallon, below-grade concrete tank for equalization basin (circular tank without cover):				
site preparation	LS	1	$500	$500
excavation and backfill	CY	500	$5	$2,500
concrete	CY	85	$300	$25,500
roadway gravel	CY	15	$15	$225
grass restoration	Acres	0.25	$500	$125
inlet/outlet piping	LS	1	$3,000	$3,000
railing	LF	82	$20	$1,640
Blower, air piping, diffusers (relocate Tree Top's blower from City lagoon)	LS	1	$4,000	$4,000

Item	Units	Quantity	Price	Amount
Miscellaneous piping, fittings, etc.	LS	1	$7,500	$7,500
Dry well for pumps (forms basement of pump station building):				
excavation & backfill	CY	385	$5	$1,925
bedding gravel	CY	15	$15	$225
concrete	CY	100	$300	$30,000
sump & pump	LS	1	$800	$800
spiral stairway	LS	1	$2,500	$2,500
hatch in floor above, lifting beam and rails, etc.	LS	1	$2,000	$2,000
Pump station building for blower, controls, pump motor, propane tank, etc..	SF	400	$40	$16,000
Chain-link fencing, 100' square, w/signs and gate	LF	400	$15	$6,000
New electrical service (Tree Top costs for CT can, conduit, entrance cable, etc.)	LS	1	$5,000	$5,000
Electrical: MCC, alarms, lights/heat	LS	1	$25,000	$25,000
Split case pumps: 1,000 GPM, 150-HP	EA	2	$20,000	$40,000
Check valves, gate valves, pipe and fittings in pump room	LS	1	$5,000	$5,000
Engine-drive emergency power for 1 pump	LS	1	$20,000	$20,000
Potable water extension to pump station (in same railroad crossing carrier pipe)	LS	1	$3,000	$3,000
Backflow preventer, clean water piping, hose bibbs, hose racks, etc.	LS	1	$1,500	$1,500
SUB-TOTAL FOR SCHEDULE 1 - WORK AT PLANT				$237,690
Schedule 2: Forcemain				
Mobilization/demobilization	LS	1	$10,000	$10,000
Clearing, grubbing, grass restoration, etc. along railroad right-of-way	LF	4,500	$4.00	$18,000
Foundation gravel in wet areas adjacent to railroad right-of-way	CY	400	$12	$4,800

Item	Units	Quantity	Price	Amount
Gravel roadway crossing	LS	1	$1,500	$1,500
Railroad crossing	LS	1	$2,500	$2,500
Pipe: 12" cement-lined Class 50 D.I.	LF	13,000	$17	$221,000
Pipe: 12" AWWA C-900 PVC, 150 psi	LF	24,800	$12	$297,600
Miscellaneous C.I. fittings	LS	1	$15,000	$15,000
Excavation and backfill for all portions of route - except County project (Harrison Rd. to Nagler Rd.) - based on an average cut of 5′ and a trench pay width of 32"	CY	15,450	$4.50	$69,525
Excavation and backfill for roadway in County project area	CY	3,620	$7.50	$27,150
Bedding gravel: 32" trench width at bottom; 4" below and 6" above pipe	CY	4,550	$15	$68,250
Wenas Road pavement repair: N. Park Drive (Price Chopper store) to Harrison Road; patch of damaged area only - no overlay.	LF	3,600	$7.70	$27,720
Wenas Road pavement repair: temporary pavement patching, Harrison Rd. to Nagler Rd.; 3′ wide x 2" thick hot-mix ACP.	LF	6,520	$4.20	$27,380
Wenas Road pavement repair: full overlay where adjacent to high-pressure natural gas pipeline, Nagler Rd. to Ames Rd.	LF	1,400	$15.40	$21,560
Wenas Road pavement repair: half-width tapered overlay, Ames Rd. to Shaw Rd.	LF	11,850	$7.20	$85,320
Shaw Rd. gravel roadway repair: from Wenas Road to Gibson Road	LF	1,400	$3.50	$4,900
New gravel roadway: Gibson Road to L.T. Murray area (note: none of the existing unpaved roadway along this line now meets County gravel surfacing standards; upgrading of this roadway will serve as payment to adjacent landowners for easements along west line of Section 1, R18E, T14N)	LF	5,280	$16.15	$85,270
Air relief stations (manual)	EA	5	$500	$2,500

Item	Units	Quantity	Price	Amount
Wye assemblies with markers, at approximately 3,000′ spacing	EA	11	$500	$5,500
Isolation valves: 12-inch butterfly valves with cast-iron valve boxes	EA	5	$700	$3,500
Wenas Creek crossing, on County bridge	LS	1	$4,000	$4,000
Traffic control	LS	1	$10,000	$10,000
Franchise from County: advertisement, inspection, misc.	LS	1	$5,000	$5,000
SUB-TOTAL FOR SCHEDULE 2: FORCEMAIN				$1,017,975
Schedule 3: Disposal Area				
Storage Lagoons				
Mobilization/demobilization	LS	1	$10,000	$10,000
Lagoon site preparation	Acres	21.1	$500	$10,550
6′ chain-link fencing	LF	3,900	$12.50	$48,750
Chain link gates	EA	2	$400	$800
Signs (@ 100′ o.c.)	EA	40	$15	$600
Earthwork for lagoon embankments	CY	97,000	$3.00	$291,000
Liner: 20-mil PVC with 6" cover and geotextile underlayment	SY	70,000	$4.00	$280,000
Rock riprap, 8" thick with geotextile underlayment	CY	6,500	$20	$130,000
Gravel roadway	CY	800	$15	$12,000
Grass restoration	Acres	5.4	$300	$1,620
Transfer structures (including 4 emergency overflow structures)	EA	6	$2,500	$15,000
Piping between lagoon cells	LS	1	$25,000	$25,000
Buried 12" plug valves, w/valve boxes, etc.	EA	10	$850	$8,500

Item	Units	Quantity	Price	Amount
Concrete splash pads at inlets	EA	10	$150	$1,500
15,000-gallon, below-grade concrete tank for equalization ahead of spray pumps (circular tank w/o lid):	LS	1	$21,770	$21,770
Blower, air piping, diffusers	LS	1	$12,500	$12,500
Misc. piping	LS	1	$7,500	$7,500
Dry well for pumps (forms basement of sprayfield operations building):	LS	1	$37,450	$37,450
Operations building for blower, controls, MCC, etc..	SF	400	$40	$16,000
Check valves, gate valves, pipe and fittings in pump room	LS	1	$5,000	$5,000
Magnetic flow meter with totalizing, indicating, and recording panel	LS	1	$5,000	$5,000
New electrical service to site	LS	1	$30,000	$30,000
Electrical: MCC, controls, lights/heat, relocate from Selah Pretreatment Lagoon	LS	1	$15,000	$15,000
Split case pumps: 1,000 GPM, 150-HP	EA	2	$20,000	$40,000
Remote alarm: phone dialer type with battery backup; senses power, pump, high water, and aerator failure conditions	LS	1	$3,000	$3,000
Relocate existing aerators from City of Selah Pretreatment Lagoon	EA	8	$3,500	$28,000
Wiring to aerators	EA	8	$1,500	$12,000
Shallow groundwater monitoring wells	EA	8	$2,500	$20,000
SUB-TOTAL FOR LAGOON PORTION OF SCHEDULE 3				$1,088,540
Sprayfield				
Distribution piping: trunk	LF	3,500	$10	$35,000
Distribution piping: laterals	LF	45,000	$8	$360,000

Item	Units	Quantity	Price	Amount
Distribution piping: risers w/valves	EA	240	$300	$72,000
Distribution piping: isolation valves	EA	30	$400	$12,000
Distribution piping: fitting/thrust block assemblies	LS	1	$10,000	$10,000
Big-gun type sprinkler heads	EA	20	$250	$5,000
Excavation and backfill: 2.5′ trench width x 3.5′ average cut depth	CY	15,720	$3.50	$55,020
Bedding gravel: 2.5′ width x 8" average thickness	CY	3,000	$15	$45,000
Sprayfield preparation: leveling, rock removal, plowing, fertilization, seeding.	Acres	200	$500	$100,000
Access roadway grading	LS	1	$3,500	$3,500
Roadway gravel	CY	1,780	$15	$26,700
Signs around border of sprayfield	EA	120	$15	$1,800

SUB-TOTAL FOR SPRAYFIELD PORTION OF SCHEDULE 3 $726,020

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SUB-TOTAL ALL ITEMS $3,070,225
+20% FOR ENGINEERING, CONTINGENCIES, ADMINISTRATIVE, LEGAL $609,775

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TOTAL ESTIMATED CONSTRUCTION COST (w/o State Sales Tax): $3,680,000