BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT

R.D. Lewis and Associates Ltd. - Hat Creek Project - Construction Phase Sewage Treatment and Disposal - Conceptual Design Report - November 1980

ENVIRONMENTAL IMPACT STATEMENT REFERENCE NUMBER: 62

LIST OF ABBREVIATIONS

a	year
BOD_5	biochemical oxygen demand (5 day)
cm	centimetre
°C	degree Celsius
d	day
DO	dissolved oxygen
E.T.	Evapo-transpiration
g	gram
h	hour
ha	hectare
kg	kilogram
km	kilometre
kw	kilowatt
l	litre
lpcd	litres per capita per day
m	metre
mg	milligram
mm	millimetre
min	minute
MPN	most probable number
N/A	not available
PCO	Pollution Control Objective
%	percent
s	second
SS	suspended solids
w	watt (Joules per second)
wk	week
WMB	Waste Management Branch (B.C. Ministry of Environment)

SUMMARY

Options ranging from rapid infiltration, through surface water discharge, spray irrigation, to drainage fields were examined for the disposal of sewage from the construction camps in the Hat Creek Project. Of these, combined treatment of sewage from both construction camps, followed by rapid infiltration of the treated effluent, has been recommended. It is the simplest, most reliable and least expensive option, with an equivalent or smaller environmental impact compared to other options.

Sanitary facilities for commissioning personnel as well as sewage disposal from the Mine and Power Plant operation have also been considered. The methods recommended by others for disposal appear acceptable to the regulatory agencies, technically feasible and reliable.

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CONSTRUCTION PHASE SEWAGE TREATMENT AND DISPOSAL

1.0 INTRODUCTION

R. D. Lewis & Associates Ltd. were retained on 1980-10-13 to conduct an investigation and make recommendations in a report for the conceptual design of a sewage treatment and disposal system(s) for the construction phase of the Hat Creek Project.

2.0 TERMS OF REFERENCE

The terms of reference for the report were outlined in a letter dated 1980-10-06 from B. A. Angel, Special Programs Manager, Thermal Generation Projects Division, and consisted of the following principal points.

a) Determination of sewage flows.

b) Investigation of suitable sewage treatment and disposal options.

c) Establishment of size and area requirements.

d) Review of B. C. Pollution Control objectives.

e) Cost factors, and

f) Siting.

In addition, on 1980-10-30, we were requested to provide a conceptual design for sewage treatment and disposal for sewage from the mining operation. On 1980-11-04 we were also requested to address the disposal of sewage from the Power Plant Operation.

3.0 WASTE DISPOSAL REGULATIONS

The B.C. Ministry of Environment, Waste Management Branch, (W.M.B.), is charged with the administration of the Pollution Control Act, 1967, and has set Pollution Control Objectives (P.C.O.) for various categories of discharges.

3.1 MINE, MILLING AND SMELTING INDUSTRIES

The Pollution Control Objectives for The Mine, Mine Milling and Smelting Industries of British Columbia (1973), in Section 4.27, state that domestic sewage may be disposed of in a tailings impoundment where the water is recycled in the process and the volume of domestic waste is less than 1% of the plant discharge to the pond, providing the domestic sewage is collected and treated separately. The minimum treatment required is equivalent to a septic tank treatment. It should be noted that this type of disposal constitutes a non-positive discharge.

The Pollution Control Objectives for The Mining, Smelting and Related Industries of British Columbia (1979), do not address domestic sewage disposal from mining operations explicitly except in Section B where it is stated that fecal coliforms shall not exceed Ministry of Health standards where sanitary discharges are mixed with the effluent.

The above Pollution Control Objectives and current practice in the industries have set the precedent for the disposal of small sewage flows to industrial effluents. Such discharges generally have been trouble free and have not caused concern to the Waste Management Branch to date.

3.2 MUNICIPAL TYPE WASTE DISCHARGES

The Pollution Control Objectives for Municipal Type Waste Discharges in B.C. (1975), Section 5, outlines the objectives for discharge of sewage effluents to surface waters and to the land. These objectives are explicit in stating the minimum quality of effluent. Briefly, the objectives include the following specific items relative to the Hat Creek Project and these items have been taken into account in the assessment and recommendations of the report.

3.2.1 Discharges to Streams

An Environmental Assessment Study would be required where the receiving waters are used for water extraction and the dilution is under 100:1. The Environmental Assessment Study is not defined in the regulations, but the details are subject to approval by the Director of Pollution Control. However, the objectives do state minimum requirements for receiving water quality maintenance and such items as dissolved oxygen, chlorine residual, nutrients, coliforms, toxicity, settleable solids, floatable solids, scum and oil, organisms and heavy metals are set out and these would be necessarily taken into account in such a study. Essentially, these objectives require that no noticeable deterioration of the stream quality should take place below the discharge.

The monitoring of all effluent would be required. For flows in excess of 45.4 m^3/d, the minimum levels of the discharge are BOD_5 - 30 mg/l, Suspended Solids - 40 mg/l, total Phosphorous - 1.5 mg/l, plus disinfection, and possibly dechlorination would be required.

3.2.2 Discharges to Land Surfaces

Similar to the above, an Environmental Assessment Study may be required where the effluent is to be discharged to land to determine how the discharge will affect ground water quality and in general to reasonably substantiate that: the ground water table will not rise nearer to the ground surface than one meter, the initial water table is not nearer to the ground surface than 1.5 m for spray irrigation systems, the ground water table will not surface under any condition within a distance of 150 m beyond the disposal site perimeter or cause ground instability, and there is no impermeable layer or bedrock within 1 meter of the subsurface diposal system. In addition, nutrient removal could be required where the ground water table does not remain at least 3 meters below the surface and percolation rates are faster than 3.65 m/d (10 minutes per inch).

The quality of effluent for a specific discharge is categorized by the nature of the discharge itself, and is explained for rapid infiltration basins (exfiltration), spray irrigation and subsurface disposal as follows:

For rapid infiltration basins, at least two basins shall be provided and each basin shall be capable of accepting all the effluent under average rainfall conditions. The quality of the effluent required would be BOD_5 - 130 mg/l and suspended solids 130 mg/l with no disinfection.

For spray irrigation disposal on range or forest lands, the quality of effluent required would be BOD_5 - 130 mg/l, suspended solids 130 mg/l with no disinfection. In addition, long term storage lagoons would be required and the exclusion of the public by fencing and posting of the area would also be required. For spray irrigation disposal to forage crops or pastures a

3.2.2 (cont'd)

minimum effluent quality of BOD_5 - 45 mg/l and suspended solids 60 mg/l with disinfection would be required. For both spray irrigation disposal methods the average annual value of the BOD and suspended solids may be acceptable, plus a minimum storage time of one week prior to irrigation is required under most circumstances.

For subsurface disposal of effluent by the use of conventional absorption trenches, the basis for land area is the standard percolation rate (SPR), and the length of tile (trench) required is reduced considerably by treating the effluent to at least secondary treatment levels and beyond. However, no disinfection is required. It should be noted that trench widths of 600 mm (24") at 2 metre (10 ft) spacing are required. Two fields, each capable of accepting the total flow of sewage, would be required, plus an area sufficient for one more field as standby. Many of the above restrictions have been modified or described in 3.4.

3.3 DOMESTIC TYPE WASTE TO INDUSTRIAL SEWER SYSTEMS

The Pollution Control Objectives for Municipal Type Waste Discharges in B.C. in Section 5.11 include provision for domestic waste connection to industrial sewer systems. The restrictions in this category require provision for continuing treatment and disposal of the domestic waste when the industrial system may be inoperative. In enclosed systems on private posted-fenced grounds, such as mine tailings pond, connections for domestic wastes are also permitted provided any relevant objectives of that industry are also met. The fecal coliform level attributable to the domestic waste should not exceed a medium MPN value of 200/100 ml for any five consecutive samples at the location of the water return to the closed system.

3.4 WMB APPLICATION ASSESSMENT GUIDELINES

In addition to the above published PCO's there exists a Guideline for Municipal Effluent Application to Land that is classified by the Waste Management Branch as "to be published" but it is used in the assessment and monitoring of municipal type discharges. The guideline is extensive, very specific, and lays out all the minimum requirements for municipal type discharges, specifically to land and specifically for spray irrigation and ground water recharge type discharges. The requirements of the guideline have been taken into account in making the assessments and recommendations for the report.

4.0 SITE CONSIDERATIONS

The Hat Creek Project is located in the upper Hat Creek Valley and the Valley has been described in detailed reports by others. Briefly, the Valley bottom is at the 1,000 m elevation and the power plant is at the 1,410 m elevation.

The present land use is primarily cattle grazing with about 40% of the area classed as open grass lands. About 2% of the land area is used for crop lands. The remaining land is sparse forests. There are very few sites that would be level enough to consider for any form of cultivation and spray irrigation within a 3 km radius of both construction camps. The land slopes from 10% to over 30% on the valley sides.

The Valley has a relatively dry climate and supports a Douglas Fir/Pine grass biota typical of an Interior Douglas Fir biogeoclimatic zone.
The drainage of the Valley is by Hat Creek, which flows north out of the Valley and into the Bonaparte River and subsequently to the Thompson River. The Hat Creek hydrograph is typical for a dry valley creek producing a spring-early summer freshet flow with the remaining base flow supported by ground water flows.
The land area required by the Project uses the majority of the Valley bottom and a considerable amount of the Valley slopes thereby reducing the number of disposal sites and disposal options. All of the private land in the Valley bottom adjoining the proposed project is owned by B.C. Hydro and the remaining lands are owned by the Crown.

The undersigned visited the site on 1980-10-09 accompanied by M. Jordan and P. Imada of B.C. Hydro. Numerous potential disposal sites were viewed and are discussed and assessed below.

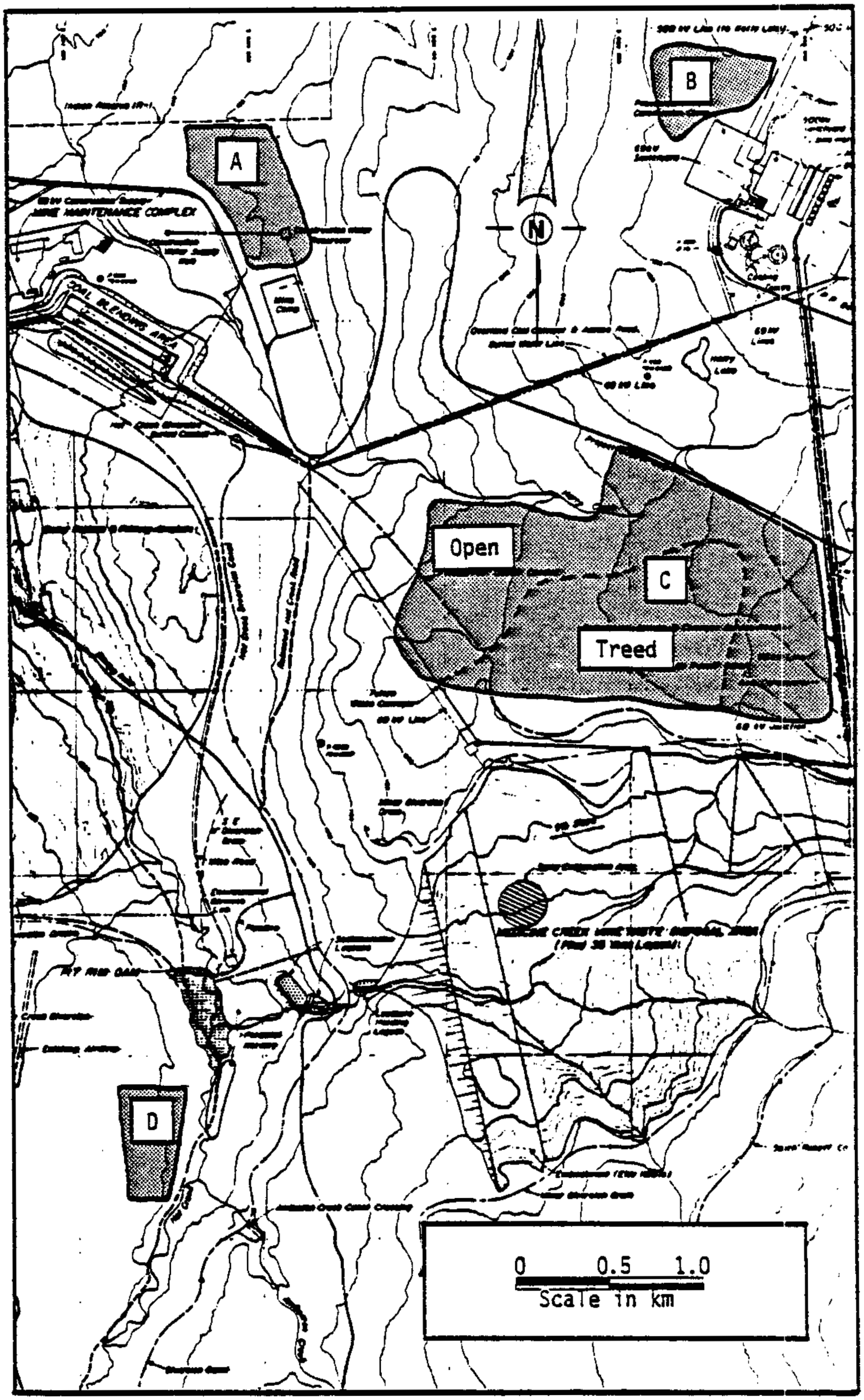


FIG. 4.1 - DISPOSAL SITES FOR SEWAGE EFFLUENT

4.0 (cont'd)

SITE A

Site A is adjacent to the proposed Mine Camp as shown on Figure 4.1. The topography of the bench is gently undulating and is sparsely treed. The underlying geology of the area, as determined from a preliminary geology map and from drilling and soils reports, consists of a gravelly post glacial till deposit extending to depthsof over 145 m. This area has a potential for either spray irrigation or rapid infiltration disposal. The useable area is about 30 ha. The potential capacity of the area for spray irrigation disposal, based on potential evapo-transpiration (1) and soils (2) data, is 99,000 m^3/a or a 270 m^3/d sewage flow. The potential capacity of the area for rapid infiltration disposal, based on soils reports and estimates of probable permeability and infiltration rates, is 0.64 m/d per unit area or some 190,000 m^3/d. This site is also well set back from any major streams. B.C. Hydro sources (8) have indicated that the water supply well shown on Figure 4.1 and other figures had poor quality water and insufficient flow and consequently the water supply well will be located elsewhere.

SITE B

Site B, located immediately northwest of the Power Plant site is a 20 ha area of land located at a 1,350 m elevation. The soil cover is sparse and the underlying bedrock is very near the surface. This site has a very limited disposal potential and would be suitable for open lagoon type treatment facilities and/or possibly deep well injection.

4.0 (cont'd)

SITE C

Site C is the open grass land upper plateau area south of Harry Lake. The total area is some 316 ha of which 134 ha is treed. The soils are up to 1 m deep. There is evidence of rock outcropping. The slopes are moderate, up to 20% with some minor steeper areas. The soils are silt-loam (2) and the area has a potential capacity for spray irrigation disposal of 330 mm/a per unit area (1) or 1,042,800 m^3/a or the equivalent of 2,800 m^3/d sewage flow.

SITE D

Site D is the cultivated agricultural area of the ranch in the north half of Sec. 31, R. 26 near the existing airstrip. There is presently about 18 ha in cultivation now and the adjacent area has a potential for expansion to about double the area. The potential capacity for spray irrigation disposal of the site is 60,000 m^3/a or 162 m^3/d.

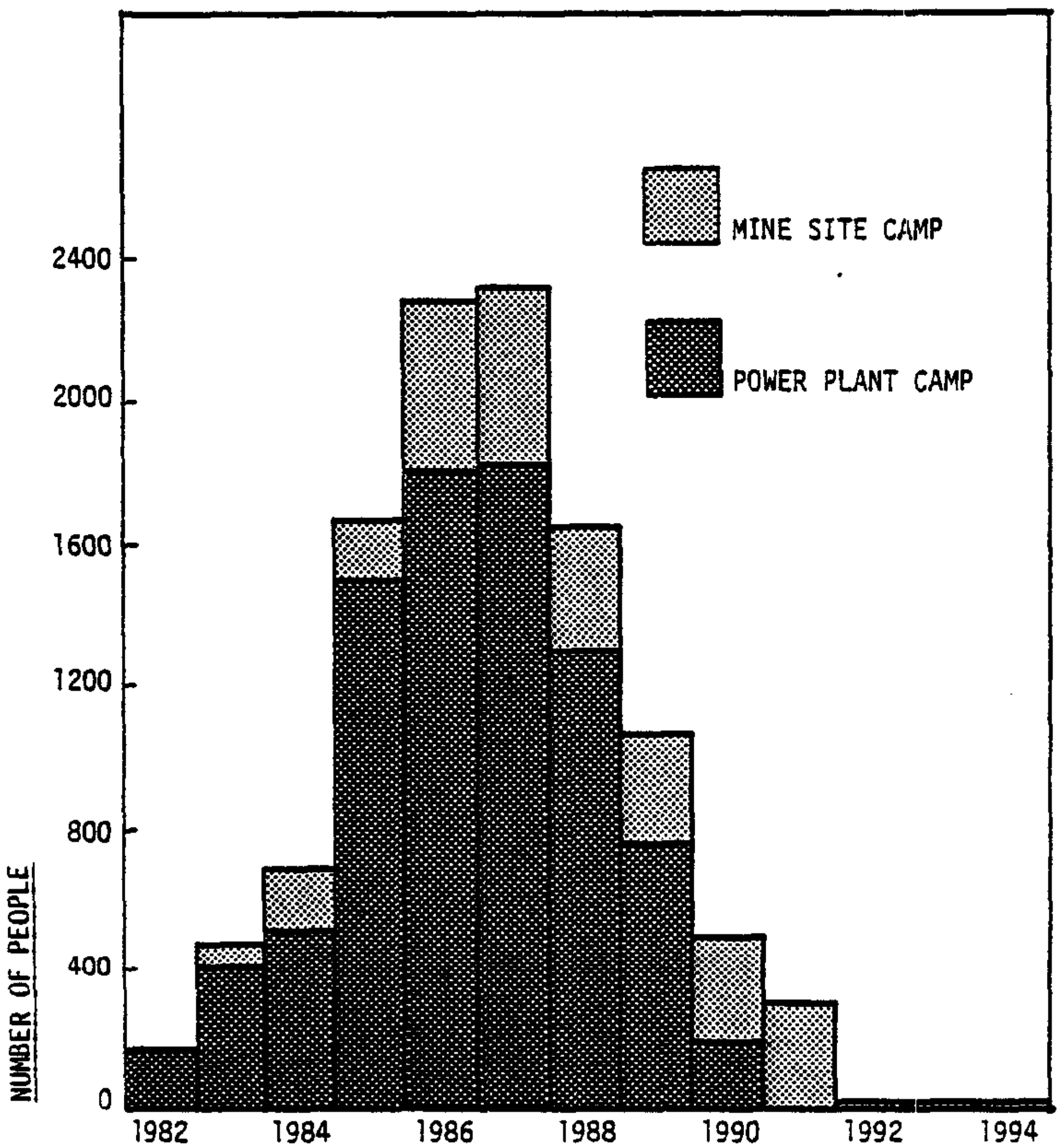
5.0 SEWAGE FLOW PROJECTIONS

The sewage flow projections for the project are based on the construction camp populations projected by H. A. Simons (International) Ltd., 1980-05 and as shown in Figure 5.1. These population figures and their distribution between the two camps can be expected to change slightly as the Project progresses.

The sewage flows are based on 230 litres per capita per day (lpcd), the same figure used by Simons in sizing the water supply for the construction camps (3). This per capita allowance is typical for well maintained camp facilities (4)(5). This figure could be reduced through water conservation measures such as water-miser toilet flush valves, low flow shower heads, etc. The sewage flows are summarized in Table 5.1 and shown in Figure 5.2.

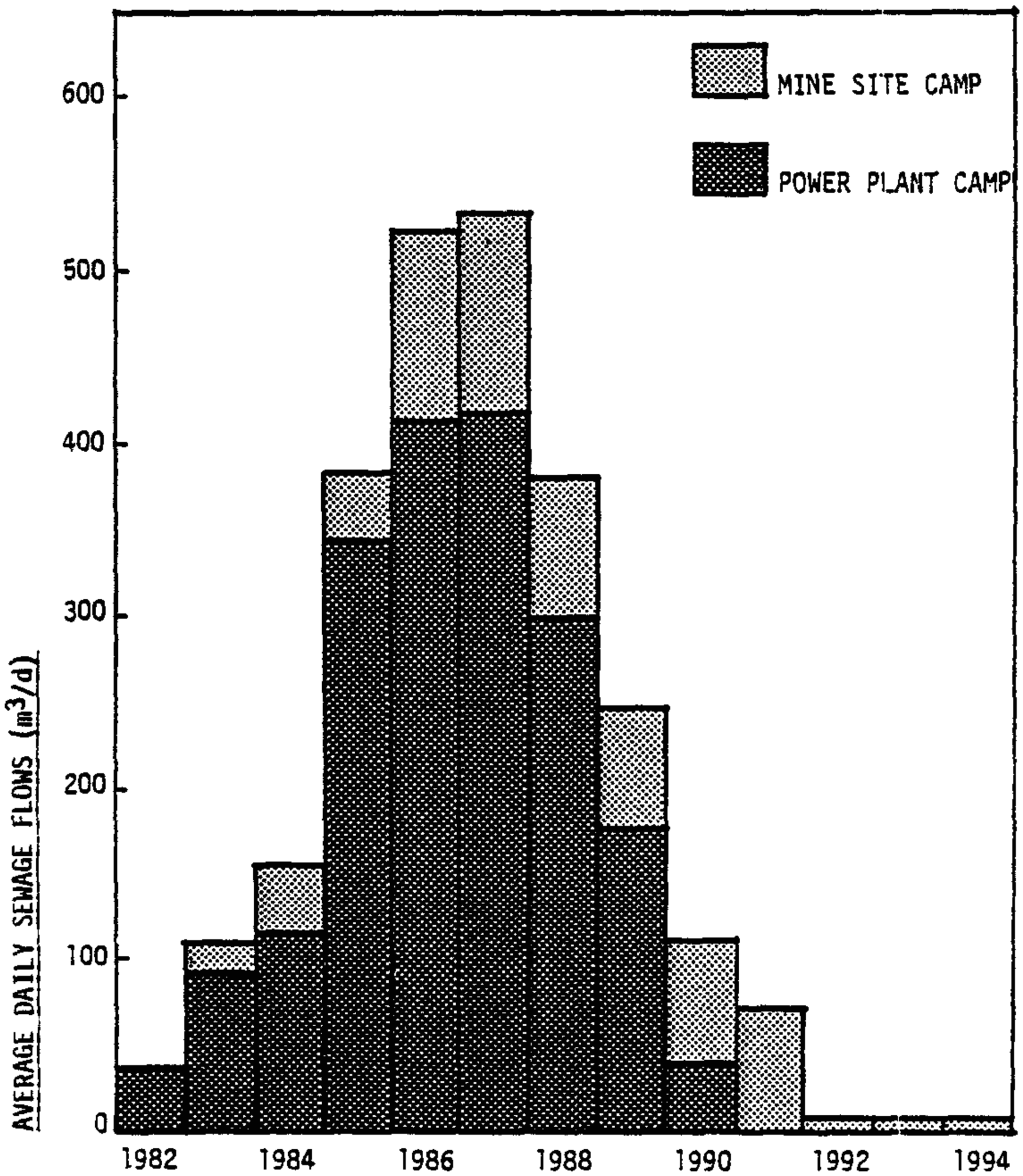
Based on these flows, all systems must be designed to accommodate the peak camp populations: 420 m^3/d of sewage from the Power Plant Camp and 115 m^3/d of sewage from the Mine Site Camp. However, these systems must also be able to operate under the low flow conditions at the beginning and the end of the construction period.

Project operations personnel will increase the combined resident and non-resident Project population to about 3,000 people around 1987. However, non-resident personnel are expected to contribute proportionately much less sewage than the resident personnel and hence this extra sewage (from portable toilets, use of cafeteria, etc.) is not accounted for in Table 5.1, nor has it been taken into consideration in this report. The assumption is that this contribution will not increase the camp sewage flows enough to affect the recommendations contained herein. They will only affect the size of the facilities to a small extent. This can be firmed up when project staging and manpower plans become more precise.



CONSTRUCTION CAMP POPULATION PROJECTION

FIGURE 5.1



CONSTRUCTION CAMP SEWAGE FLOW PROJECTIONS

FIGURE 5.2

5.0 (cont'd)

TABLE 5.1 - CONSTRUCTION CAMP SEWAGE FLOW PROJECTIONS

Data Source: H. A. Simons (International) Ltd. Report based on 230 lpcd.

PROJECT YEAR	POWER PLANT CAMP Men	POWER PLANT CAMP m^3/d	MINE CAMP Men	MINE CAMP m^3/d	TOTAL m^3/d
1982	165	38	---	---	38
1983	405	93	60	14	107
1984	505	116	170	39	155
1985	1,494	344	170	39	383
1986	1,810	416	480	110	526
1987*	1,820	419*	500	115*	534*
1988	1,305	300	345	79	379
1989	765	176	305	70	246
1990	180	41	305	70	111
1991	---	---	300	69	69
1992	---	---	30	7	7
1993	---	---	30	7	7
1994	---	---	30	7	7

* Design Flows

6.0 TREATMENT AND DISPOSAL OPTIONS

This section covers a number of sewage disposal options presented in the order of their apparent attractiveness. Although not all possible combinations pretend to be covered, the options do represent the major approaches to sewage disposal for the site, and narrow down the choice of alternatives.

In general terms, the primary problem is one of effluent disposal. Actual treatment of sewage is secondary, provided it is compatible with the method of disposal and complies with technical and regulatory requirements.

In addition, the overall sewage disposal system of choice should be:

a) Totally reliable: it must accept all the sewage at all times.
b) Simple: the fewer and simpler the sub-systems, the lower the probability of serious problems or vulnerability from human error.
c) Ecologically attractive: camp sewage treatment and disposal will be temporary, and the environmental impact must be minimal.

6.1 RAPID INFILTRATION BASINS

In this option, the treated sewage from both camps is fed into basins built on porous soil, and is allowed to percolate into the soil matrix below. The area near the Mine Site Camp is an ideal location for this method of disposal because of its deep permeable sandy subsoils and the very low water table (183 m)(6).

6.1.1 Proposed Combination System

The sewage from the Mine and Power Plant construction sites would be combined for treatment and disposal. Sewage from the Power Plant Camp would be piped down to the Mine Site Camp sewage lagoon and the combined effluent from this lagoon would overflow into one of four basins, as shown in Figures 6.1.1 and 6.1.2.

To prevent freezing in the winter, the sewage drop line from the Power Plant Camp would be 75 mm plastic pipe with a 200 - 300 mm ground cover. In addition, it would be dosed from a holding tank with a siphon discharge to ensure that it is either full of fast flowing sewage or empty, but not carrying just a trickle of sewage. Under these conditions, the temperature drop through the line is not expected to exceed 2°C under winter conditions.

Sewage flowing by gravity to the dosing tank at the top of the sewage drop line would be screened for rags or material which could clog the drop line. Screenings would be drained and disposed of in a landfill site. As a further precaution against clogging, the inlet to the drop line would be reduced to slightly less diameter than the pipe itself.

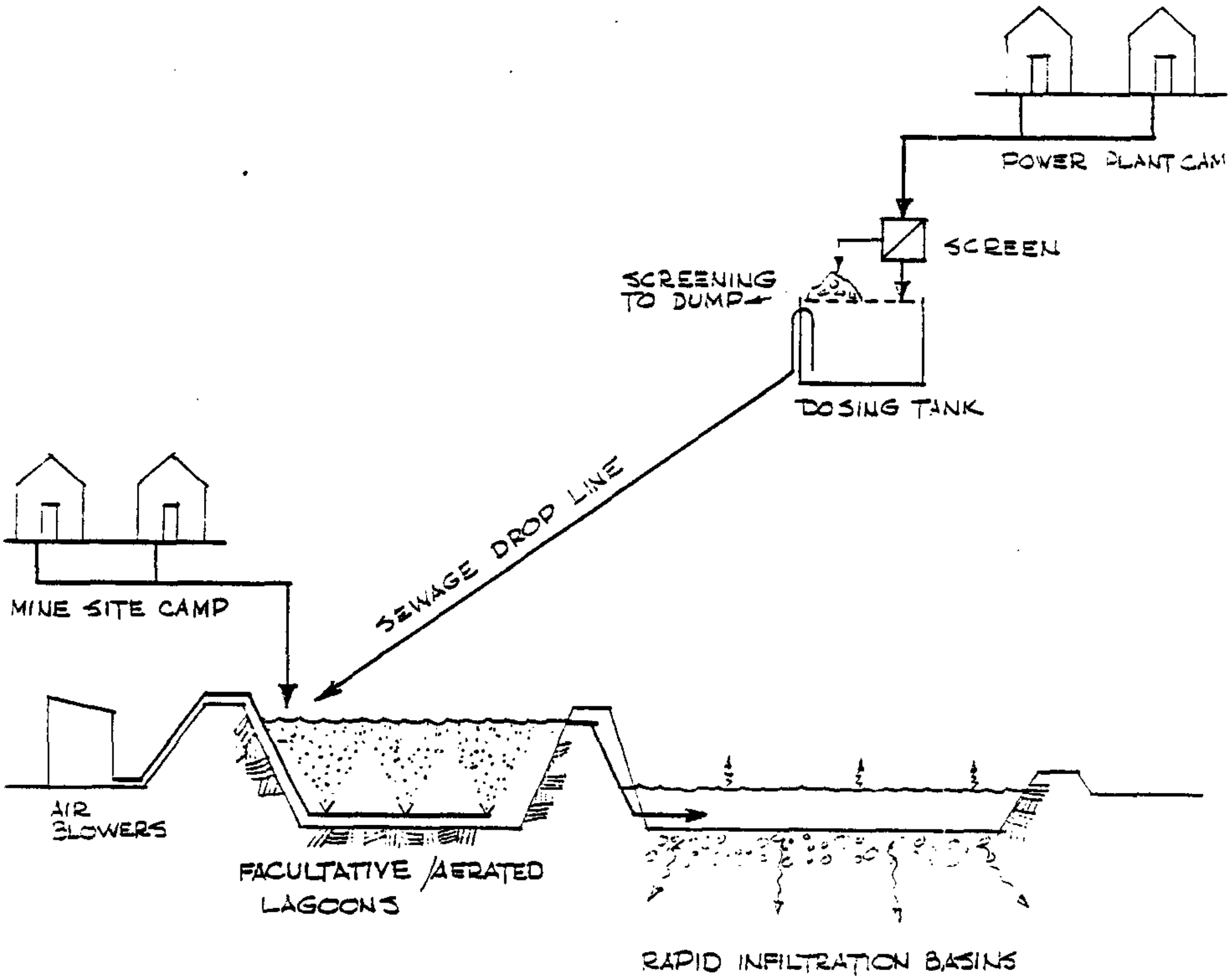


FIG. 6.1.1 SEWAGE DISPOSAL BY RAPID INFILTRATION - SCHEMATIC

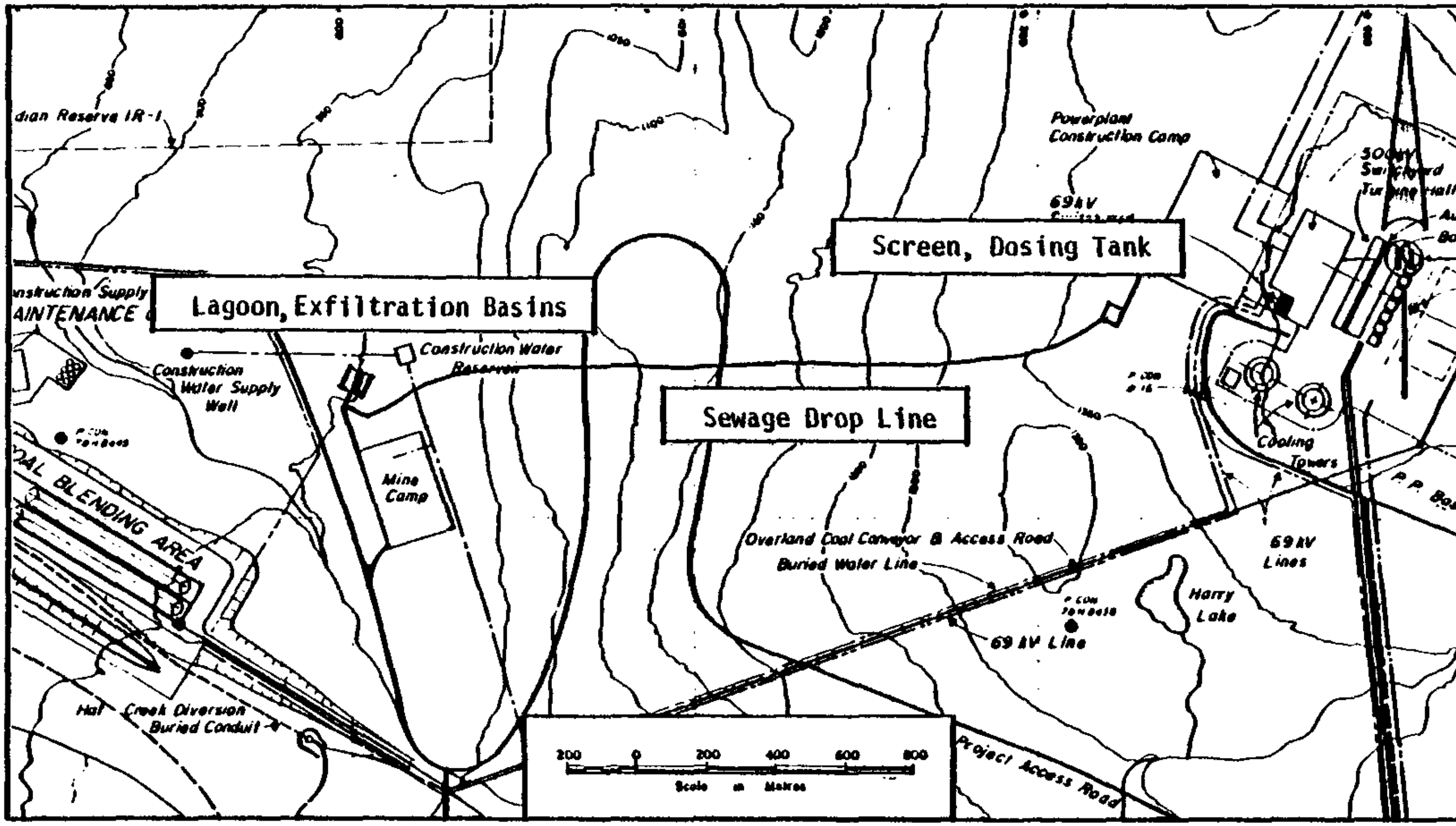


FIGURE 6.1.2 - SEWAGE DISPOSAL BY RAPID INFILTRATION - SITING

6.1.1 (cont'd)

The sewage drop line would not have valves in line. In the event of an emergency, it could be stoppered at the dosing tank and the dosing tank could be allowed to overflow temporarily to a small emergency dyked area nearby. This area would be drained back to the dosing tank with a portable pump, once the emergency is over. In actual fact, it may never be used.

Sewage from the Mine Site Camp would flow by gravity to a deep sewage treatment lagoon where it would join the sewage dropped from the Power Plant Camp, for treatment and removal of the bulk of the solids.

The sewage treatment lagoon would be designed for the peak camp populations (535 m^3/d) with a 7 day retention and a liquid depth of 6 m to minimize heat loss and summer algae problems. Initially it would be operated as a facultative lagoon and, as the loading is increased, aeration would be added to prevent odours and ensure an effluent with less than the 130 mg/l BOD and 130 mg/l S.S. Once construction tapers off, aeration could be discontinued, returning to a facultative lagoon operation.

Sewage aeration would be by means of submerged air lines with perforations, supplied by two 8 H.P. blowers complete with intake filters and silencers and housed in a small prefabricated insulated frame shed. Alternately, subsurface static aerators are also feasible.

6.1.1 (cont'd)

Treated effluent would overflow on an intermittent basis into one of four 1,250 m^2 infiltration basins excavated below the till, to the sandy-gravel soil below. Each basin would be flooded with about 0.5 - 0.8 m of effluent on an alternating basis, and then allowed to dry out to rectify any anaerobic conditions, before flooding again. Based on existing experience in colder climates (7), part of the water freezes to form a thick ice layer. However, this does not interfere with the operation. The effluent flows under the ice simultaneously melting the ice above it and the ground below, in effect, floating the ice layer. The ice is actually said to be beneficial as it serves as an insulating layer for the soil below.

Periodically scarifying the dried bottom of the basins after use would further restore infiltration capacity.

The possibility exists for using treated lagoon effluent as a source of water for construction purposes such as for concrete mixing or mixing with soil prior to compaction.

6.1.2 Preliminary Design Criteria

Power Plant Camp dosing tank retention			10	min
Sewage Drop Line	-	Size	75	mm
	-	Velocity	4	m/s
	-	Depth of Bury	250	mm
	-	Heat Loss (max.)	60	w/m^2
Sewage Treatment	-	Design capacity	535	m^3/d
	-	Influent BOD	300	mg/l
	-	Influent SS	200	mg/l
Treatment Facultative Aerated Basin	-	Retention (min.)	7	d
	-	Storage	2	d
	-	Temperature (min.)	0.5	C
Aeration System	-	Oxygen utilization	20	%
	-	Oxygen transfer	300	% BOD
	-	Air Diffusion Tubing	32,000	$m/(m^3/s)$
Rapid Infiltration Basins	-	Number of Beds	4	each
	-	Mean Application Rate	40	m/a

6.1.3 Reliability

With the exception of the air blowers and effluent diversion valves, there are no mechanical systems to fail. In the unlikely event that both blowers failed at the same time, the most serious outcome would be unpleasant odours which may not be noticeable if the blower downtime was no longer than necessary to facilitate repair or replacement (2 days), and a shorter infiltration bed cycle time because of solids carryover.

6.1.3 Reliability (cont'd)

For the most part, the system would be overdesigned and would require minimal operator input to ensure adequate operation. The operator's duties would be reduced to weekly inspection, switching valves, sampling and arranging for occasional cutting of weeds and maintenance. Satisfactory operation would not otherwise be dependant upon the operator.

6.1.4 Environmental Impact

Once construction is over and the construction camps are dismantled, the only signs of the sewage disposal system that would persist would be the relatively small treatment lagoon and rapid infiltration basin berms and excavations. These would soon grow over with native vegetation. Alternately, they could be leveled.

It is not possible to quantitatively predict how the effluent will migrate through the soil without extensive drilling and testing. However, the numerous silty-clay seams (6) (and deeper clay seams) in the sand and gravel underlying the infiltration basins will disperse the water horizontally both by acting as a partial barrier and through capillary action ("wicking") along the seams. The greater the dispersion, the more insignificant will be the volume of effluent when compared to the volume of soil wetted by this effluent. Consequently it is not certain that the effluent will reach groundwater - it may be retained as moisture in the soils.

In addition, because the effluent would have to percolate at least 180 m and probably many times more because of horizontal dispersion before reaching groundwater, no phosphorous, ammonia, suspended and colloidal matter (bacteria, etc.) would reach the ground water. They would all be retained in the upper few metres of soil. By preventing over aeration of sewage during treatment, 6.1.4 Environmental Impact (cont'd)

nitrate nitrogen, which is mobile in groundwater, could be minimized, assuming that the nitrate ions do eventually reach groundwater and are not absorbed by the intervening clay.

6.1.5 Order of Magnitude Costs

Power Plant Camp dosing Tank, screen and housing	$ 20,000
Buried sewage drop line	90,000
Lagoon, exfiltration basin, earthwork	60,000
Blowers, piping and diffusers	60,000
TOTAL	$230,000

6.1.6 Further Investigations

a) Locate a suitable route for the sewage drop line down the hill below the Power Plant Camp, avoiding rock outcrops and steep grades.

b) Determine the infiltration capacity of the soil by conducting slug infiltration tests. This is needed for detailed sizing of infiltration basins and could also serve to assess moisture migration and soil anisotropy.

6.2 DEEP WELL INJECTION

Deep well injection of treated effluent is the charging of a deeply buried stratum of unconsolidated sediment or bedrock. The effluent usually requires a high degree of treatment equal to or better than BOD_5, 10 mg/l, S.S. 10 mg/l to reduce the probability of clogging the interstices.

6.2.1a Proposed System for Power Plant Camp

This option would be similar to the Rapid Infiltration option just discussed, except the sewage from the Power Plant Camp would be filtered and injected in a nearby injection well, rather than be treated in the Mine Site Camp lagoon.

After screening, sewage from the Power Plant Camp would pass into an 840 m^3 holding tank where some of the solids would settle out and accumulate at the bottom.

Supernatant from the holding tank would be pumped to one of two gravity sand filters (one as standby), at 400 l/min., where it would be chlorinated, filtered and injected into one or more deep wells.

The filter would be backwashed periodically with stored filtrate, to prevent clogging, and the backwash waters would return to the holding-settling tank. Backwash would be timer controlled on a 12 hour cycle, with high pressure drop override.

The sludge that would accumulate at the bottom of the holding-settling tank would be pumped out periodically for disposal in a sanitary landfill.

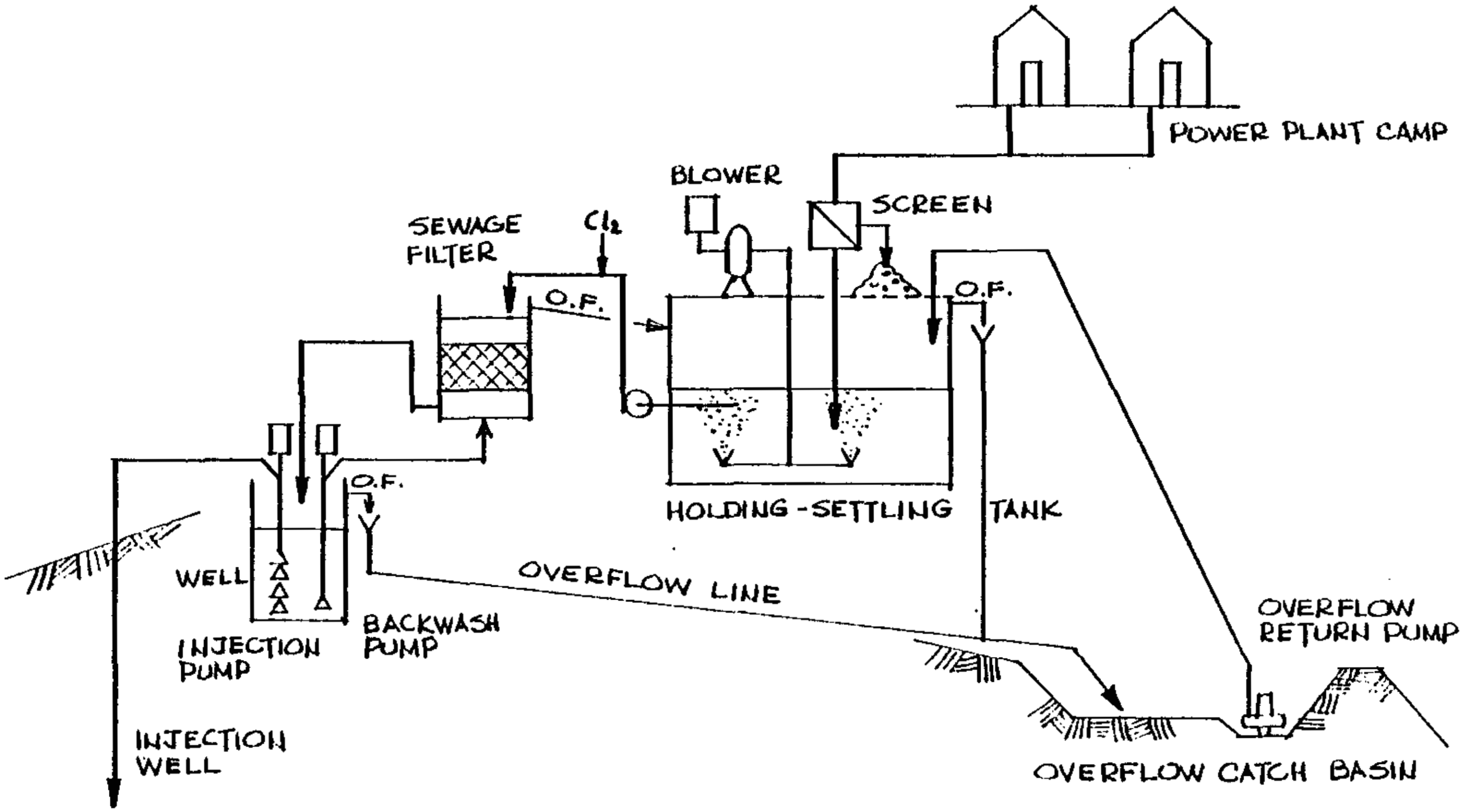


FIGURE 6.2.1 DEEP WELL INJECTION OPTION - SCHEMATIC

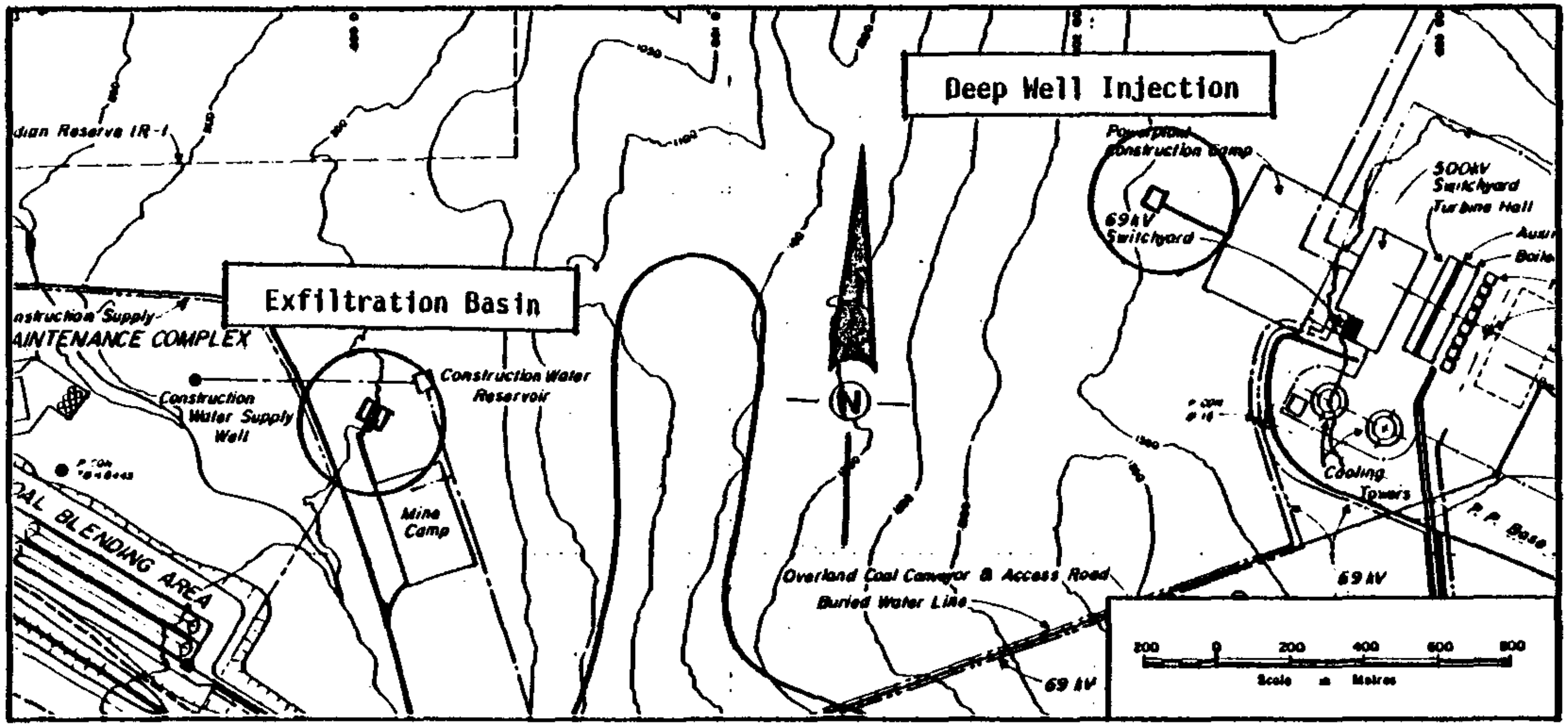


FIGURE 6.2.2 - DEEP WEEL INJECTION OPTION - SITING

6.2.1a Proposed System for Power Plant (cont'd)

In order to reduce odours at low flows, either before or after the camp population has peaked, and to prolong filter runs, the holding-settling tank would be alternately aerated, settled and discharged on a timer controlled batch basis.

6.2.1b Proposed System for Mine Site

Mine Site Camp sewage would be treated in a lagoon and disposed of in rapid infiltration basins as in the total combined disposal option described in 6.1.1. However, rapid infiltration basins would be about 1/5 the area required for option 6.1.1 and aeration would not be required in the treatment lagoon, which would still have a working volume of 3,750 m^3 and a depth of 6 m.

6.2.2 Preliminary Design Criteria

Holding Settling Tank	- Design Inflow	420 m^3/d
	- Minimum Storage	420 m^3/d
	- Maximum Storage	840 m^3/d
Sand Filter	- Design Flow	600 m^3/d
	- Filtration Rate	8 m/h
	- Backwash Rate	24 m/h
	- Backwash Duration	3 - 10 min.
	- Air Blow Rate	60 m/h
	- Air Scour Duration	2 - 8 min.
	- Filtration Cycle	4 - 12 h
	- Sand Effective Size	1.5 mm
	- Sand Depth	1.2 m
Wet Well	- Minimum Storage	12 m^3
	- Maximum Storage	25 m^3

6.2.2 Preliminary Design Criteria (cont'd)

Injection Well Pump	- Capacity	600 m^3/d
	- Head	N/A
Injection Well	- Bore	N/A
	- Depth	N/A

6.2.3 Reliability

Although the sewage filtration process would be quite simple, filtration of sewage is very variable and, as a consequence, the filtration and injection system controls would be involved to allow for suitable sequencing, interlocking, and over-riding of operations. Malfunction of one timer, sensor or relay, if not noticed, could result in sewage overflowing and causing considerable erosion. The operation would require constant monitoring which would require a full time operator.

In addition, the settling-filtration system would require periodic adjustments to adapt to large variations in the camp population, something that may be forgotten.

The chlorination system would require constant attention to ensure an on-line supply of chlorine and also to ensure adequate and consistent chlorination. Prolonged failure of the chorination system could result in the loss of an injection well.

In short, the system would be operator dependent and would be vulnerable to human error and neglect. Designing a high degree of safeguards into the system would reduce some of the operator dependence, but it would then increase the dependence on a more skilled instrument or electronic technician.

6.2.3 Reliability (cont'd)

The Mine Site Camp sewage disposal system, on the other hand, would become slightly more reliable, with the elimination of the aeration system and should operate with minimal attention.

6.2.4 Environmental Impact

Providing deep well injection is feasible and the Power Plant Camp disposal system is operated correctly, the environmental impact of this option should be minimal, even less than the Rapid Infiltration option.

On the surface, only the Mine Site Camp lagoon and exfiltration basin berms and excavations would persist after sewage has ceased, and these would slowly revert to a natural state, or could be leveled and seeded.

Impact on surface waters should also be immeasurable because of the reduced amount of exfiltration from the Mine Site Camp and the considerable distance of the injection well to any surface waters.

6.2.5 Order of Magnitude Costs

Feasibility Test Wells	$ 50,000
Power Plant Camp Holding-Settling Tank and Screen	$100,000
Sewage Filtration System, Pumps and Controls	$200,000
Injection Wells - Allowance	$100,000
Overflow Lagoon, Return Pump and Piping	$ 80,000
Enclosure for Settling-Filtration-Injection Equipment	$ 70,000
TOTAL	$600,000

6.2.6 Further Investigations

a) Drilling at least one test well (abandon approach) or at least three test wells (promising results) to determine technical feasibility of deep well injection in the vicinity of the Power Plant Camp.

b) Infiltration test in the vicinity of the Mine Site Camp.

6.3 SURFACE WATER DISCHARGE

6.3.1 Description

In this option, the combined sewage from both camps would receive a high degree of treatment, disinfection and phosphorous removal and it would then be discharged into Hat Creek in a controlled manner to ensure optimum dilution. This option is shown in Figures 6.3.1 and 6.3.2.

The Power Plant Camp screen, dosing tank and sewage drop line would be identical to that already described for Rapid Infiltration disposal in Section 6.1.

The Power Plant Camp sewage combined with the Mine Site Camp sewage would be treated in two aerated lagoons in series for a total detention time of 32 days at peak sewage flows of 535 m^3/d. The effluent would then be chlorinated in a 50 m^3 baffled section of the second lagoon.

The lagoon effluent, after vigorous mixing with carefully proportioned hydrated lime or alum for phosphorous removal, would be clarified in a large setting-holding lagoon capable of 30 days storage. It would then be discharged into Hat Creek at a controlled rate to ensure a minimum dilution of 20:1. The long detention in this storage lagoon would ensure dechlorination and the chemical precipitation step would provide a high quality effluent.

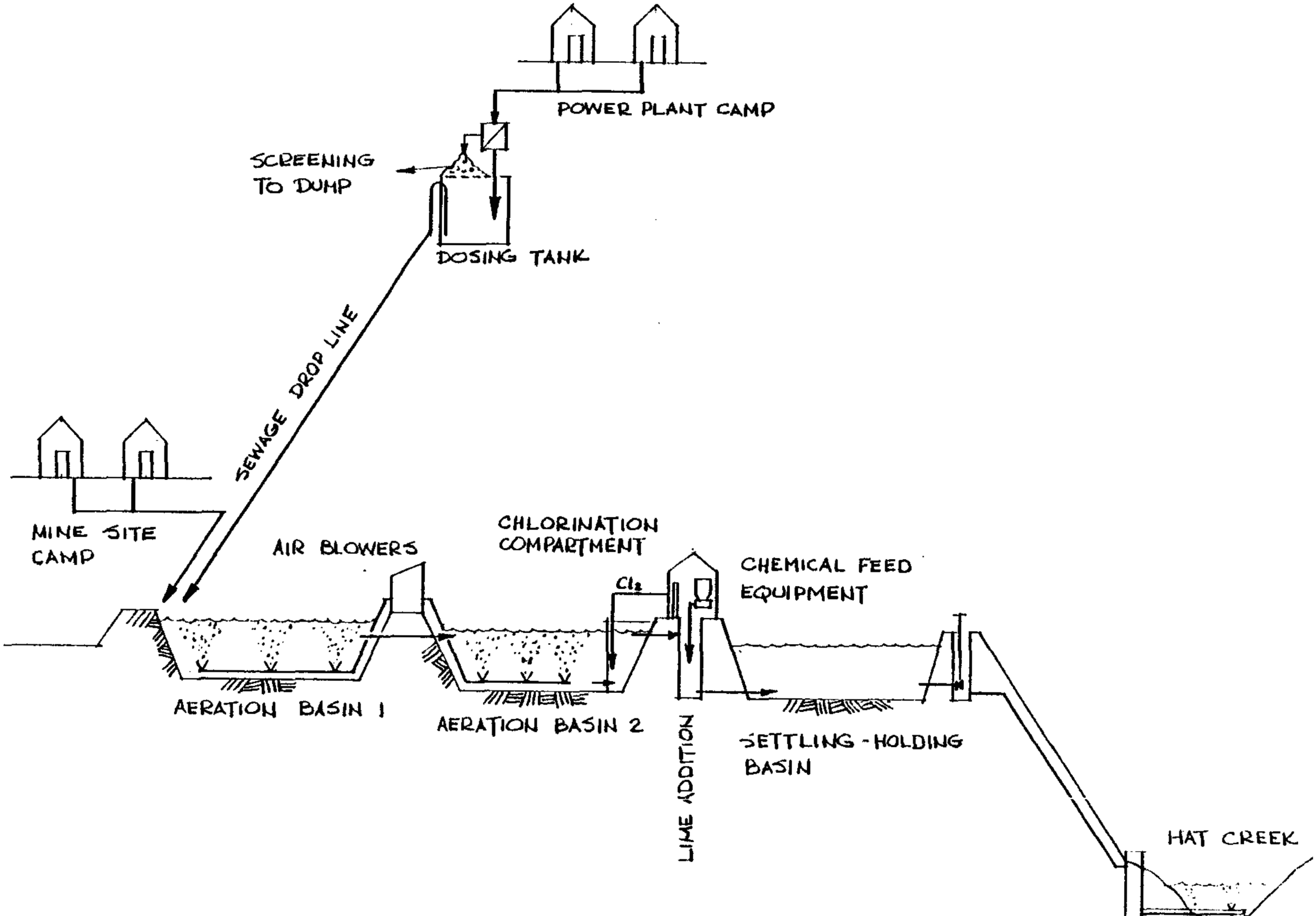


FIG. 6.3.1 SURFACE WATER DISPOSAL OF HIGHLY TREATED SEWAGE EFFLUENT - SCHEMATIC

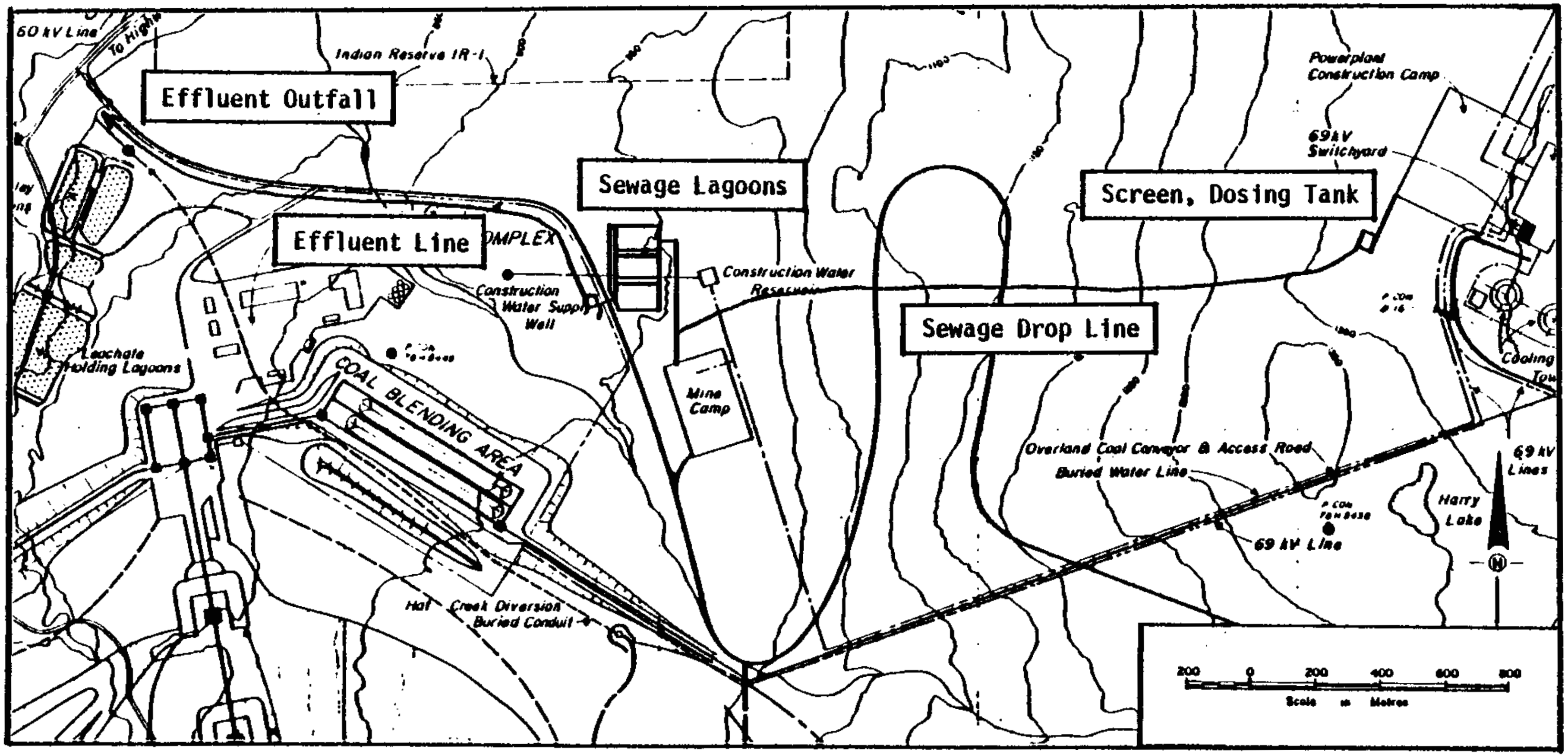


FIG. 6.3.2 - SURFACE WATER DISCHARGE OF HIGHLY TREATED SEWAGE EFFLUENT- SITING

6.3.2 Preliminary Design Criteria

Power Plant Camp Dosing Tank Retention (min.)			10 min.
Sewage Drop Line	-	Size	75 mm
	-	Velocity	4 m/s
	-	Depth of Bury	25 cm
	-	Heat Loss (max.)	60 w/m^2
Sewage Treatment	-	Number of Cells	2
	-	Design Capacity	535 m^3/d
	-	Influent B.O.D.	300 mg/l
	-	S.S.	200 mg/l
	-	Treatment	Fac-Aerated Lagoon
	-	Retention, Cell 1	16 d
		Cell 2	16 d
	-	Temperature (min.)	0.5 °C
Aeration System	-	Oxygen Utilization	20%
	-	Oxygen transfer	300% BOD
	-	Air Diffusion Tubing	32 000 $m/(m^3/s)$
Chlorination	-	Dosage	2 - 10 mg/l
	-	Residual (60 min.)	0.5 mg/l
	-	Retention (min.)	60 min.
Lime Addition	-	Dosage	100 - 200 mg/l
Holding Lagoon	-	Storage	30 d

6.3.3 Reliability

Because of the long detention times, the consequences of a mechanical failure of one or even both the air blowers, or of the chlorination or lime feeding equipment, would not be very pronounced, providing such failures were rectified in a few days. Longer failures would result in pollution of Hat Creek, with unpredictable political and regulatory consequences.

Good operation of the system would require operator intervention and decisions and hence the system would be operator dependant. The operator must be one, trained, capable and reliable person with access to proper maintenance support.

Weekly inspections of the control and mechanical systems would be the minimum required to ensure proper operation.

6.3.4 Environmental Impact

Barring serious neglect, the effluent discharged into Hat Creek would be of a very high quality which would not significantly affect the Creek oxygen levels directly, nor would it be toxic.

At a dilution of 20:1 the effluent would contribute to an increase in phosphorous of about 0.05 mg/l which normally is not significant, but can be enough, under certain conditions to promote algae growth in the stream. Aside from being aesthetically displeasing, it is not clear whether any such algae does indeed affect the fish in any way. The nitrogen in the effluent would be diluted and occur mostly as nitrate, which is not toxic to fish, but can promote algae growth when there is enough phosphorous present.

TABLE 6.3.1 - DISCHARGE FIGURES (m^3/d) AT HAT CREEK

Basis: Water Survey of Canada, British Columbia, Station 08LF015

YEAR	MINIMUM MONTHLY AVERAGE	MINIMUM DAILY FLOW	MAXIMUM MONTHLY AVERAGE	MAXIMUM DAILY FLOW	ANNUAL MEAN FLOW
1963	25,900 (Sept)	18,800 (Nov.23)	228,000 (June)	521,000 (May 23)	--
1964	25,700 (Feb)	22,000 (Feb.27)	832,000 (June)	1,713,000 (June 12)	132,000
1965	29,100 (Dec)	23,000 (Dec.29)	226,000 (June)	376,800 (May 29)	78,000
1966	18,300 (Feb)	17,400 (Feb.11)	199,000 (July)	413,500 (Mar.29)	87,600
1967	13,000 (Sept)	7,100 (Oct.8)	443,000 (June)	1,243,000 (June 5)	85,900
1968	29,100 (Jan)	23,200 (Feb.20)	286,000 (June)	438,000 (June 10)	69,200
1969	19,300 (Feb)	17,600 (Mar.8)	264,000 (May)	577,000 (May 25)	71,900
1970	12,500 (Oct)	12,200 (Nov.21)	62,400 (June)	96,400 (June 7)	27,200
1971	17,900 (Jan)	10,300 (Mar.17)	289,000 (May)	492,000 (June 3)	--
1972	22,300 (Dec)	18,100 (Dec.19)	467,000 (June)	754,000 (June 1)	92,500
1973	10,800 (Sept)	9,100 (Aug.1)	91,000 (May)	225,000 (May 20)	30,100

6.3.4 Environmental Impact (cont'd)

Once the construction is over, disturbances to the Creek ecology, such as those due to increased localized flows, trace nutrient increase, etc., would cease. The only persistant evidence of the entire system would be the lagoon berms and excavations, which would eventually be overgrown with native vegetation. They could be levelled and seeded to speed restoration.

6.3.5 Order of Magnitude Costs

Power Plant Camp Screen, Dosing Tank and Housing	$ 20,000
Buried Sewage Drop Line	90,000
Lagoon Excavations, Berms and Baffles	120,000
Aeration Equipment, Piping, Diffusers and Housing	80,000
Chlorine and Lime Feed Equipment and Housing	40,000
Effluent Discharge Line and Outfall	75,000
TOTAL	$425,000.

The cost of an environmental impact study required by the WMB is not included and could be high, depending on how extensive a study would be dictated by the WMB at the time of application.

6.3.6 Further Investigations

a) Determine practical locations for the sewage drop line and effluent discharge line, avoiding excessive grades and rock outcrops. Determine the timing of the Project Access Road to see if the effluent line could be run along with it.

b) Examine water analyses once the potable water source has been selected to determine whether alum, hydrated lime or ferric chloride should be used as a phosphorous scavenger.

c) Explore with WMB the possibility of discharging treated effluent into Harry Creek, thereby reducing the length of the effluent discharge line.

6.4 AGRICULTURAL IRRIGATION

6.4.1 Description

This option would be contingent on reaching an iron-clad agreement with the ranch operator on the west bank of Hat Creek, opposite Ambusten Creek, to use all treated camp effluents for crop irrigation. This option is shown in Figures 6.4.1 and 6.4.2.

The one area available (Site D, Figure 4.1) does not have sufficient capacity for the peak sewage volumes for this option and has not been considered further. Sewage could be delivered to farms further south, but, because of the greater distances and higher elevations, sewage transfer would become more complex, less reliable and more expensive.

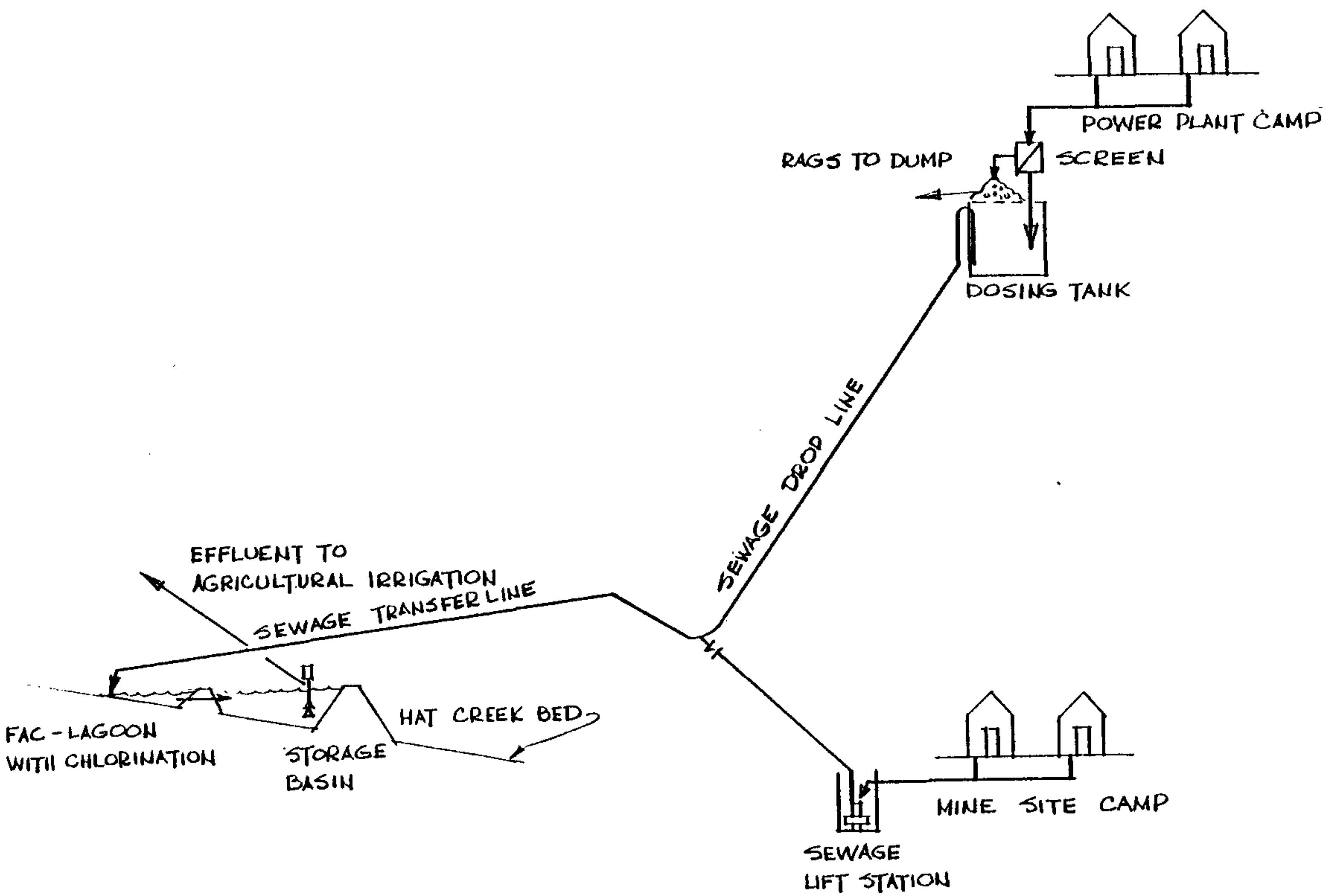


FIG. 6.4.1 AGRICULTURAL IRRIGATION WITH TREATED SEWAGE EFFLUENT - SCHEMATIC

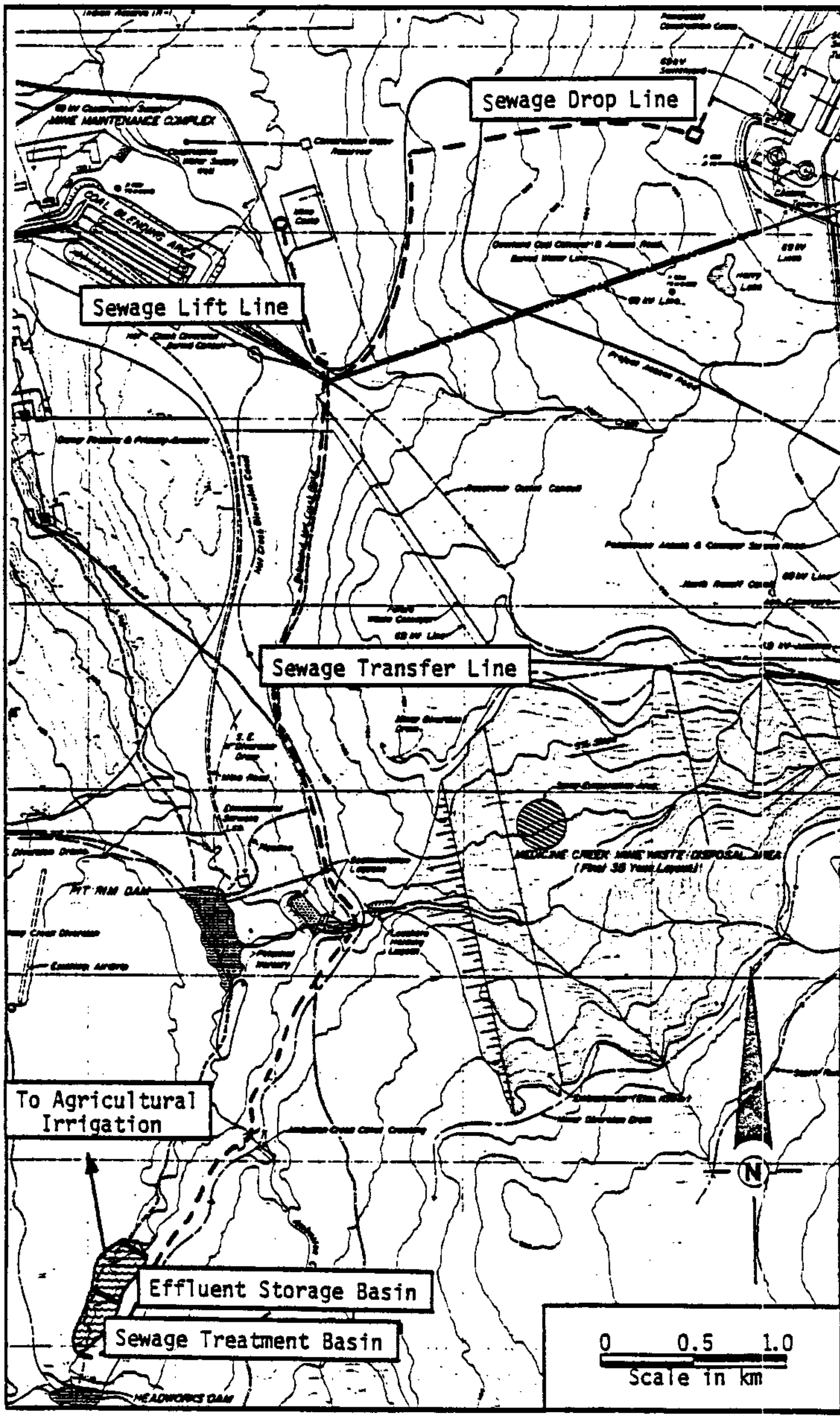


FIG. 6.4.2 - AGRICULTURAL IRRIGATION WITH TREATED SEWAGE EFFLUENT

6.5 RANGE IRRIGATION NEAR HARRY LAKE

Spray irrigation disposes of the effluent by applying it to plants that evapotranspirate the water and absorb the nutrients in the plant tissue. A large storage reservoir is required to effect a minimum 30 day retention of the effluent in storage and to provide storage during the non-irrigating period. This proposal is for the irrigation of the grassy slopes south and west of Harry Lake.

6.5.1 Description

The Harry Lake site (Site C Fig. 4.1) has a gross potential capacity far greater than the required sewage flow, however, the specific area to be irrigated would require careful selection due to the presence of rock near the surface and slope variations.

The proposed system would consist of lagoon treatment facilities at the Mine Camp and the Power Plant. A storage site would be required at Harry Lake. The required effluent quality would be BOD_5 45 and SS 60.

The effluent would be applied during the 100 day irrigation season. Low application rates have been used to minimize soil erosion and to permit utilization of slopes up to 20%.

The pump line from the Mine Camp to Harry Lake would follow the Power Line/Conveyor/Water Line corridor from the Mine Complex to the Power Plant. The conceptual system is shown on Fig. 6.5.1.

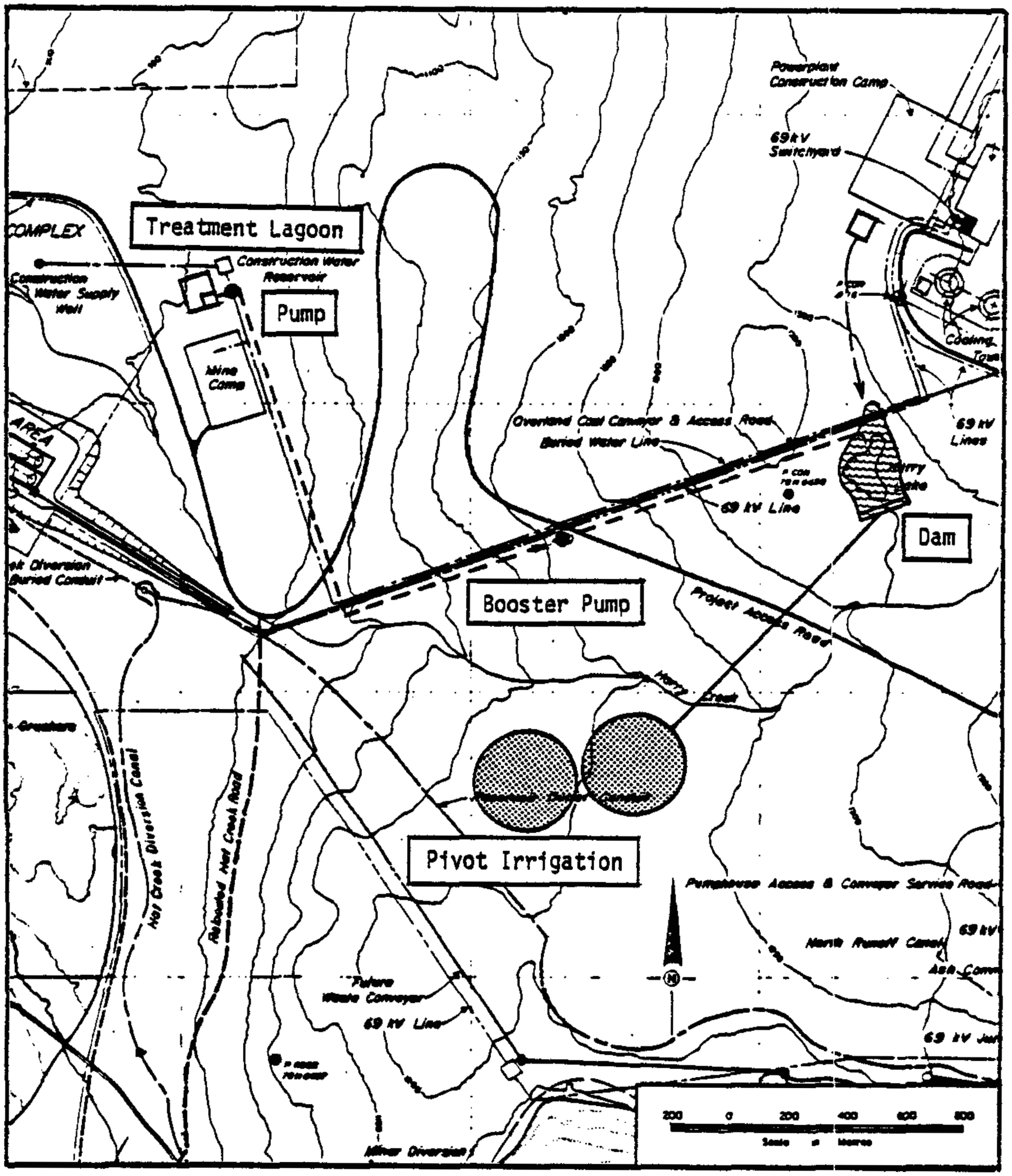


FIG. 6.5.1 - RANGELAND EFFLUENT IRRIGATION DISPOSAL

6.5.2 Design Criteria

Treated Effluent Quality	- BOD_5	45 mg/l
	- SS	60 mg/l
Aerated Stabilization Basins - Mine Camp		
	Q Design Flow	115 m^3/d
	- Influent: BOD	300 mg/l
	- Influent: SS	300 mg/l
	- T. Minimum	4 °C
	- T. Maximum	25 °C
	- Efficiency of BOD Removal	85 %
	- Retention Time for Treatment	60 days
	- Subsurface Aeration	
Pump to Harry Lake	- Total dynamic head	440 m
	- Flow at above head	1.33 l/s
	- Connected Power	60 kw
Power Plant Camp Treatment	- Q Design Flow	420 m^3/d
	- Influent BOD	300 mg/l
	- Influent SS	300 mg/l
	- T. Min.	4 °C
	- T. Max.	25 °C
	- Efficiency of BOD Removal	85 %
	- Retention Time	60 days
	- Subsurface aeration	--
	- Gravity Flow to Harry Lake	--
Harry Lake Storage Pond	- Minimum retention time Volume	16,000 m^3
	- Winter Storage Volume	142,000 m^3
	Total Volume	158,000 m^3

6.5.2 (cont'd)

Spray Irrigation Area	- Maximum Application rate	3.56 mm/h
	- Peak Potential E.T.	4.07 mm/d
	- Average Seasonal E.T.	330 mm/a
	- Soil Type	Silt Loam
	- Max. Infiltration rate	8.90 mm/h
	- Available Water Storage Capacity	208 mm/m
	- Max. Effective Rooting Depth (Limits plants to shallow rooted clovers and grasses)	500 mm
	- Design Irrigation Interval at Peak E.T.	12 d
	- Area Required for Irrigation	38.1 ha

6.5.3 <u>Reliability</u>

The treatment portion of this option (sewage lagoon) is very reliable as discussed in Sec. 6.1. The pumping segment could prove troublesome. The most reliable series booster pump would be a wet well type. The controls are simpler. The number of pumps have been reduced by utilizing high pressure steel pipe (100 mm Ø SCH.40) or PVC Permstran 350.

The recommended irrigation system would be a pivot type with electric drive. These systems are well proven and the units could be salvaged for service in the Spray Evaporation System to be used on the Mine Waste Disposal Areas at a later date.

This option will require a full time operator to monitor the pivot move irrigation equipment during the summer (clean heads, etc.) and a partime operator to monitor and maintain pumps and blowers on a year round basis.

6.5.4 Environmental Impact

The most noticeable environmental impact would be the change in grassland under irrigation and the change back to native species when the irrigation ceases.

The secondary impact would be the physical structure of the dam at Harry Lake. It would have to be taken out of operation by cutting out a portion or leveling it to prevent a future failure caused by a lack of maintenance and to eliminate the need for continued maintenance.

6.5.5 Order of Magnitude Costs

Mine Camp		
Treatment Lagoons	$100,000.00	
Pumps and Booster	70,000.00	
Forcemain	160,000.00	
	$330,000.00	$ 330,000.00
Power Plant Camp		
Treatment Lagoon	$200,000.00	
Line to Harry Lake	35,000.00	
	$235,000.00	$ 235,000.00
Harry Lake Dam and Reservoir	$700,000.00	$ 700,000.00
Pivot Moves - Irrigation and Main	$120,000.00	$ 120,000.00
	TOTAL	$1,385,000.00

6.5.6 Further Investigation

a) Determine soil depths, slopes and native grasses.

b) Select irrigable area to be utilized.

c) Determine soil type and suitability in dam area.

d) Determine accurate topography of the disposal site and the storage site.

6.6 FOREST IRRIGATION

6.6.1 Description

This disposal option is not practical due to the physical constraints of irrigating a forest. However, it has been included for the purpose of illustration.

The treatment facilities of this option would be very similar to the Rapid Infiltration option, except that the infiltration basins would be replaced by a large storage lagoon to hold effluent over the winter for summer application to the surrounding forest, as shown in Figures 6.6.1 and 6.6.2.

The Power Plant Camp screen, dosing tank and sewage drop line as well as the Mine Site Camp sewage lagoons, would be identical to that already described for Rapid Infiltration in Section 6.1.

The effluent from the sewage lagoons would be stored in a 190,000 m^3 storage lagoon (approximately 6 ha) over the winter months. The lagoon would be sealed with high quality bentonite or a plastic liner to minimize exfiltration, which would be very significant over such a large area for the flows involved, considering the permeable sand and gravel subsoils.

Effluent would be sprayed in the surrounding forests through a network of irrigation pipes laid along the forest floor and medium flow, medium pressure spray heads on 30 m centers, terrain permitting. In order not to unduly disrupt the native vegetation, the application rate would be limited to 150 mm/a requiring over 1,400 spray heads.

Because of the difficulty in moving irrigation equipment in the forest, the pipes and heads would be fixed. As a consequence, over 45 km of assorted irrigation pipe would be required to irrigate about 1.3 km^2 of forests.

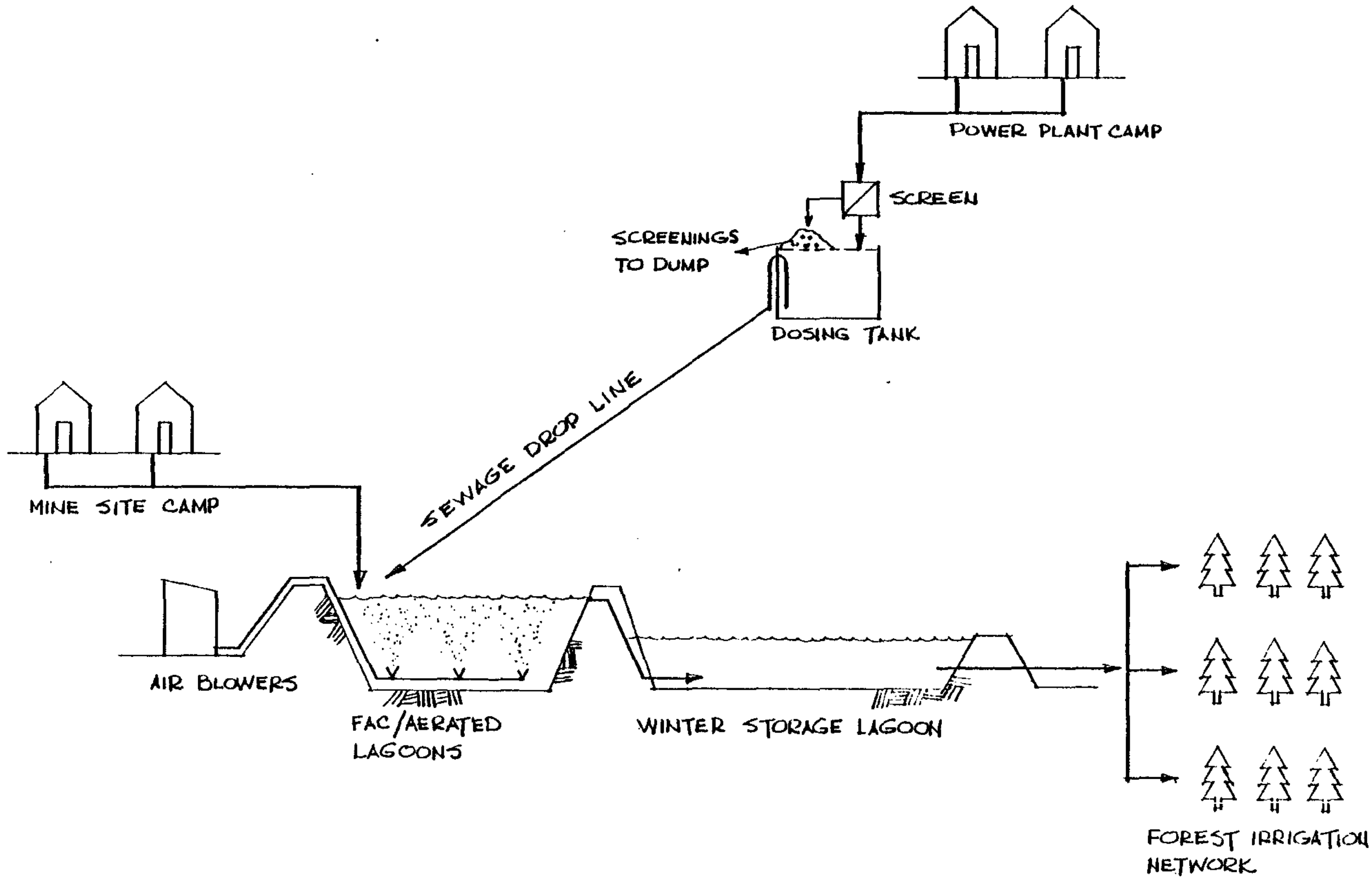


FIG. 6.6.1 FOREST IRRIGATION WITH TREATED SEWAGE EFFLUENT - SCHEMATIC

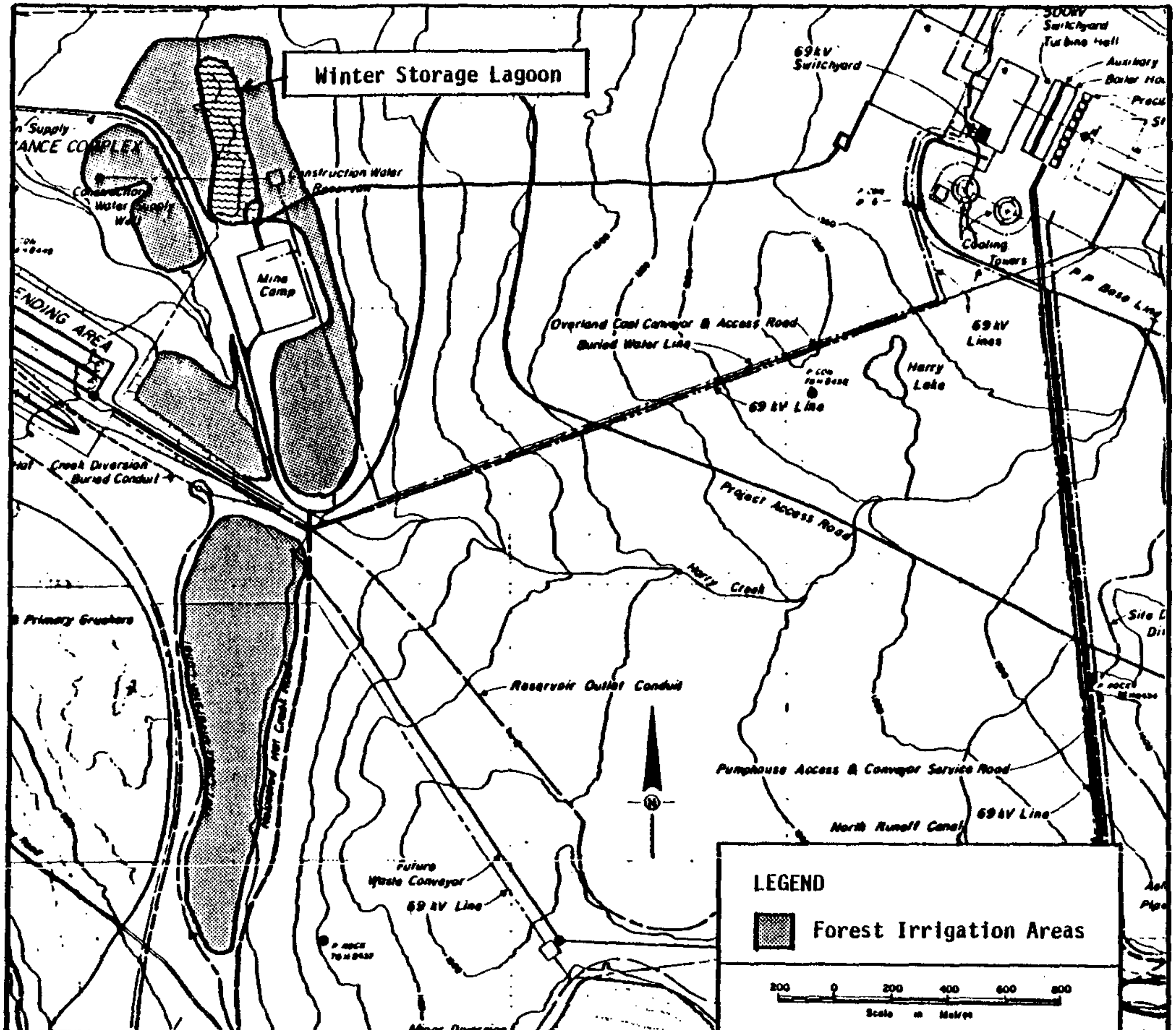


FIG. 6.6.2 - FOREST IRRIGATION WITH TREATED SEWAGE EFFLUENT- SITING

6.6.2 Preliminary Design Criteria

Power Plant Camp Dosing Tank Design Inflow		420 m^3/d
	- Minimum Retention	10 min.
Sewage Drop Line	- Size	75 mm
	- Velocity	4 m/s
	- Depth of Bury	0.25 m
	- Insulation	Nil
	- Temperature Loss (Max)	1.5° C
Sewage Treatment	- Design Capacity	535 m^3/d
	- Influent BOD	300 mg/l
	- S.S.	200 mg/d
	- Treatment	Fac-Aerated Lagoon
	- Retention (Min.)	7 d
	- Temperature (Min.)	0.5° C
Aeration System	- Oxygen Utilization	20%
	- Air Diffusion Tubing	32 000 $m/(m^3/s)$
Storage Lagoon	- Live Storage	365 d
Forest Irrigation	- Season Application Rate (Maximum)	150 mm
	- Distance between Nozzles	30 m
	- Maximum Application Rate	5 mm/h
	- Irrigation Cycle	10 d
	- Buffer around Camp	100 m
	- Buffer along road	15 m

6.6.3 Reliability

Because of its size, the number of heads and the terrain involved, the irrigation system would have to be divided into numerous pressure zones and irrigation sub-zones. Assuming a 10 day cycle, with a 12 hour sprinkling time, a minimum of 20 sub-zones would be required. This in addition to 1 400 or more sprinkler heads spells a high probability of either human or mechanical failure, be it a head sticking in one position, a zone not being shut off when it should, a pressure reducing valve malfunctioning and or a line rupturing, etc..

6.6.4 Environmental Impact

Because of the size and complexity (multiple pressure zones, etc.) of the irrigation system and the grades of the terrain, there is a very good chance of failure which could result in very serious erosion. Because of the large area involved, a serious rupture or malfunction may not be detected for several days, or, perhaps, even weeks.

Over irrigation or irrigation during or after a rain could also result in widespread erosion and damage to surface vegetation, making the ground even more susceptible to erosion.

Finally, depending to what degree the native vegetation is disturbed, quite a different vegetation, consisting mostly of weeds, would set in and persist after irrigation is discontinued. Some groundwater recharge would also result.

6.6.5 Order of Magnitude Costs

Power Plant Camp Dosing Tank, Screen and Housing	$ 20,000
Buried Sewage Drop Line	90,000
Lagoon, Storage Basin Excavation and Berms	240,000
Blowers, Piping and Diffusers	60,000
Forest Irrigation Piping, Control Valves, Spray Heads, Pumps, etc.	900,000
TOTAL	$1,310,000

6.6.6 Further Investigations

a) Extensive surveying of the area in the vicinity of the Mine Site Camp to determine the availability of about 1.3 square km of forest suitable for spray irrigation.

b) Determine a practical route for the sewage drop line.

c) Survey the area in the vicinity of the Mine Site Camp to locate the 6 ha winter storage lagoon.

6.7 DRAINAGE FIELDS

6.7.1 Description

Evapo-transpiration bed drainage fields that would not contaminate ground water (i.e. Harry Creek area) would not be practical because of their size and complexity. Percolation drainage fields would be more feasible, but they would offer no advantage over rapid infiltration, would cost more and be less reliable.

The only practical location for a drainage field would be over the permeable soil in the vicinity of the Mine Site Camp. However, this method of disposal would end up requiring at least 20 km of drainage trenches with a complex effluent distribution system. As a result, the entire system would cost over $0.5 million and would offer no advantages over Rapid Infiltration and many disadvantages (i.e. complexity, likelihood of failure, etc.). Current costs of absorption trench installations are $20/m and up.

Other locations are not practical for drainage fields because of the proximity of bedrock, slopes and/or distance.

6.8 USE OF EXISTING PACKAGE SEWAGE TREATMENT PACKAGE PLANTS

There are two package sewage treatment plants at other B.C. Hydro sites which could possibly be made available for the Hat Creek Project:

7 Mile Plant	114 m^3/d extended aeration unit
Site One Plant	243 m^3/d extended aeration unit

Unfortunately, neither one of these units is large enough to handle the combined sewage flow from both construction camps, nor from the Power Plant Camp alone. Using both of these units together still does not provide the required capacity.

In spite of the capacity mismatch, there are other reasons for not using these units in Hat Creek:

a) These units require considerably more operation attention than sewage lagoons. They are very operator dependant.

b) Because of their short retention time, they are more prone to upsets than sewage lagoons. They do not have the large dilution required to handle shock loadings.

c) These units do not operate reliably at much less than 1/4 of their design capacity, and initial and final sewage flows are going to be a small fraction of the design flows.

d) The final installed (ready to operate) cost of one of these units is typically 2 to 4 times the cost of the unit itself because of transportation, foundations, installation, supply of power, commissioning, project management, etc.... Even at zero equipment cost, the final installed cost is likely to be higher than an equivalent lagoon ... and for a less reliable set-up.

7.0 SANITARY FACILITIES FOR CONSTRUCTION AND OPERATING PERSONNEL

7.1 REGULATIONS

There are no government regulations relative to sanitary facilities on a construction site. However, United Steel Workers of America demand one portable toilet per eight men (i.e. Highmont and Lornex construction projects).

Once a plant is operating, the B. C. Factories Act stipulates the following ratio of employees per unit:

	Male	Female
Toilet	25	9
Urinal	25	--
Basin	15	15.

There is a possibility that the commissioning period could be considered outside of the operating period, for sanitary facilities, but it may be prudent to have this confirmed with the Ministry of Labour of B. C. and the B. C. Hydro unions as well as B. C. Hydro's policy.

7.2 PORTABLE TOILETS

These are very convenient because they can be installed or removed readily on very short notice. In winter it is advisable to supply them with electric heat and light and hence, proximity to power is desirable. Propane heat and light is also feasible.

The costs for a 300 man commissioning crew would be as follows:

7.2 PORTABLE TOILETS (cont'd)

Fixed Costs - for 300 men			
Set Up	- 38 x $10		$ 380.00
	- 166 miles x $0.50/mile		83.00
Heaters	- 38 x $200 allowance		7,600.00
Removal	- 38 x $10		380.00
	- 166 miles x $0.50/mile		83.00
With Heaters			$8,526.00
Without Heaters			$ 926.00
Variable Costs - for 300 men			
Rental	- 38 x $85/month		$3,230.00
Pumpout, Chemicals	- 38 x $5/unit	$190	
	- 166 mi. x $0.75/mi.	125	1,356.00
		$315/wk	$4,595.00/month

These costs do not include janitorial service which should be at least daily.

Sewage pumped out of the toilets would be trucked to the Mine Site Camp sewage disposal facility. Trucking off site may open the possibility of improper disposal and should be avoided.

7.3 PORTABLE LAVATORY TRAILERS

ATCO lease the following standard washroom trailers:

Size	10' x 18'
Toilets	5
Urinals	2
Basins	4
Heat	Electrical

These units would require water, electrical, and sewer hook-ups. They are otherwise complete. Their recommendations are 60 people per trailer, which, barring women and urinals, is within the Labour Act requirements.

Sewage from such a trailer would be slightly under 100 l per person per day. For a commissioning crew of 300 men, this would amount to 30 m^3/d or one semi-tank truck load per day which would be neither practical, economical or reliable. Installation of a sewer collection system, on the other hand would be expensive as a temporary measure. Sewage would be disposed of along with the construction camp sewage.

Chemical toilets would reduce the amount of sewage, but suppliers are reluctant to lease trailers with specialty toilets and special rates and arrangements would have to be negotiated. Finally, there are composting toilets and incinerating toilets, which if available in a lease trailer, could make sewage connection unnecessary.

Typical estimated costs of 6 washroom trailers to serve a commissioning crew of 300 men would be as follows:

<u>Fixed Costs</u>:

Delivery	6 X 200 miles @ $2/mile	$2,640.
Set up	6 X $400.	$2,400.
Removal - gratis		

<u>Variable Costs</u>:

Rental	6 X $500/mo	$3,000./mo

The fixed costs do not include running water, sewer and electricity to each location. The variable costs do not include daily janitorial service, the cost of specialty (water conservation) fixtures nor the cost of sewage collection and removal. Specialty toilet (low volume flush, vacuum, etc.) are about $1,600.00 each, installed. Larger lavatory trailers are available from other suppliers but these may be less convenient than several smaller units strategically located around each site.

7.4 RECOMMENDATIONS

Provision of sanitary facilities during commissioning should be reviewed as more information becomes available on project staging (when and for how long), manpower (how many) and layout (where to locate facilities) becomes available. At this point, only the options can be discussed in a general way.

Sizing of the Construction Camp sewage treatment and disposal facilities would have to be increased slightly to accommodate the extra load from these additional toilets.

8.0 POWER PLANT OPERATION SEWAGE DISPOSAL

8.1 DESCRIPTION

It has been proposed that the sewage from the Power Plant be mixed with blowdown from cooling towers and the waste streams and disposed of by mixing with fly ash. This would provide optimum compaction for dust free transport of ash by conveyor to the ash disposal area.

8.2 DISCUSSION

The Waste Management Branch and the local Medical Health Office were contacted. Neither agency had any objections in principal to the proposal.

There was concern that the effluent may present a health hazard to operating personnel at the ash treatment operation or the ash disposal area.

The ash temperature will be over 300°F. The effluent will be sprayed on it and mixed in an enclosed, ventilated chamber, all of which will ensure disinfection and worker protection from aerosols.

The percentage of sewage effluent in the boiler blowdown ash quench water is about 11% but this remains to be finalized in the Power Plant Design.

8.3 RECOMMENDATIONS

We recommend the following items be considered in the Power Plant Operation Sewage Disposal.

a) The effluent be treated in a facultative lagoon to ensure simple reliable treatment to a quality of BOD_5 130, SS 130 mg/l.

8.3 Cont'd

b) The lagoon should have adequate reserve capacity or have a separate surge basin of capacity to store all effluent in the event of any scheduled or contingency shut down of the Power Plant Ash Disposal System.

c) Special precautions be taken in the ash/effluent mixing process design to ensure adequate ventilation of vapors.

9.0 MINE OPERATION SEWAGE DISPOSAL

9.1 DESCRIPTION

It has been proposed that the sewage from the Mine Operations be discharged to the "Zero Discharge System" which also retains the leachate from the Mine Waste Disposal Area. Ultimate disposal of the liquid effluent would be by use of the water for dust control on the internal Mine Roads and the remainder, by a summertime Spray Irrigation system on top of the Mine Waste Areas.

9.2 DISCUSSION

The Waste Management Branch and the Medical Health Office at the Thompson Nicola Health Unit were approached and neither agency had any objection in principle to this proposal.

Whereas the Sewage Effluent could constitute up to 25% of the effluent for disposal, there was a real concern for the Health aspects of the proposal. However, the general opinion of the agencies was that with adequate treatment, and the winter storage factor, the risks were reduced.

9.3 RECOMMENDATIONS

We recommend the following items be considered in the Mine Operation Sewage Disposal.

a) The effluent be collected and treated in a faculative lagoon to ensure simple reliable treatment to a quality of BOD_5 = 130 and SS 130 mg/l.

b) The sewage effluent be discharged to the inlet of the leachate collection Ponds and the effluent draw off be at the furthest end of the system to ensure adequate retention of the sewage in storage.

9.3 cont'd

c) The spray evaporation areas on the Mine Wastes be barricaded off to prevent the random entry of personnel and equipment. A buffer area of 30 meters is recommended.

d) The leachate/sewage used for dust control be applied with a low pressure, baffle plate type application commonly used for watering roads. The effluent should be chlorinated by placing sufficient hypochlorate into the water tank prior to filling it to ensure a 1.0 mg/l chlorine residual 15 minutes after filling.

TABLE 10.1 - COMPARISON OF SEWAGE DISPOSAL OPTIONS

OPTIONS	(1) O of M COSTS	ENVIRONMENTAL IMPACT	SYSTEM RELIABILITY	TECHNICAL FEASIBILITY	COMMENTS
Rapid Infiltr-ation.	230,000.	minor	good	good	Simple and not dependant on project staging.
Deep Well Injection.	600,000.+	minimal	fair	unknown	Cost of determining feasibility could be high, with negative results.
Surface Water Discharge.	430,000.+	unknown	good	good	Politically sensitive. Environmental Assessment rules may be unpredictable.
Agricultural Irrigation.	790,000.	insignifi-cant	good	good	Not enough suitable land available.
Rangeland Irrigation.	1,385,000.	fair	fair	good	High capital and operating costs.
Forest Irrigation.	1,310,000.	fair	poor	fair	Availability of suitable land in doubt.
Percolation Fields.	500,000.	fair	poor	fair	No advantage over Rapid Infiltration.
Evapo-Beds	7,000,000.	high	very poor	very poor	Availability of suitable land in doubt.

(1) Order of magnitude Capital Costs

10.0 CONCLUSIONS AND RECOMMENDATIONS - CONSTRUCTION CAMP SEWAGE DISPOSAL OPTIONS

As seen in the summary presented in Table 10.1, the only sewage disposal options worth considering are Rapid Infiltration and Surface Water Discharge, in order of increasing cost, with Rapid Infiltration being by far the most reliable and economical option.

We recommend the Rapid Infiltration option be considered and the recommended further investigation be carried out to support an application to the Waste Management Branch.

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1980 - 11 - 14.

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