B.C. HYDRO

HAT CREEK PROJECT
225 MW THERMAL PLANT
WATER SUPPLY SYSTEM
FEASIBILITY STUDY

HYDROELECTRIC GENERATION PROJECTS DIVISION

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SYNOPSIS

B.C. Hydro is currently proceeding with feasibility studies for a 225 MW coal-fired thermal powerplant in the Hat Creek valley, located about 25 km west of Ashcroft, B.C. The powerplant would require a water supply system. This study considers the feasibility of using Hat Creek as the only source of water as opposed to deep wells or pumping from other sources such as the Thompson River.[10]

Review of available hydrologic and streamflow data indicated that a dependable supply of water could only be provided by constructing a storage dam on Hat Creek. Three potential dam sites were examined, Axis A about 16 km, Axis B about 9 km and Axis C about 4 km upstream of the thermal plant. The site at Axis B was found to be the most suitable.

Available geologic information at Axis B was reviewed with a view to providing a basis for the design of the earthfill dam and the pipeline.

A zoned earthfill dam, about 34 m high, with an upstream impervious blanket was found to be the most suitable at Site B. The construction materials for the earthfill dam would be obtained from a borrow area near the dam site or from the overburden planned to be removed during the development of the open pit coal mine near the powerplant. This would depend on the final construction schedules and relative costs.

A basic requirement of the water supply line was that the flows in it would be controlled at the powerplant. The 0.4 m diameter pressure pipe with a motor operated valve would have a capacity to deliver 130 L/s peak flow at minimum reservoir level. The closure time for the valve would be about 60 seconds, which would limit the pressure rise on closure to about 30 percent of the static head at the plant.

The pipeline would be buried in a trench as opposed to being surface mounted because of economy, security and better protection against freezing.

A reliable year-round water supply system can be provided on Hat Creek at an estimated construction cost of about $\$17 \times 10^6$ and can be operational in about 1 1/2 years from the award of a contract.

SECTION 1.0 - INTRODUCTION

1.1 BACKGROUND

A scaled-down thermal generating station with a capacity of 225 MW is one of the alternatives being considered for the Hat Creek Project. The plant would be located on the east side of the Hat Creek valley at about El. 970.0 and 2.5 km southeast of the junction of Highway 12 and the Hat Creek road. (see Figs. 1-1 and 2-1).

The 225 MW plant would have an estimated annual average water demand of 75 L/s, and a peak demand of 130 L/s.

The average annual flow in Hat Creek at the site of the proposed water supply dam is about 400 L/s and, after allowing for infiltration and evaporation losses and required downstream releases, the requirement of 75 L/s could still be met with reasonably achievable live storage capacity.

The above flows are based on the assumption that there would be no major diversion upstream of the recommended water supply storage dam, such as the Oregon Jack Creek diversion studied by the Provincial Government prior to 1977.

This report presents the results of a study to investigate the feasibility of a water supply system for the 225 MW plant that would make use of the flows in Hat Creek.

1.2 TERMS OF REFERENCE

Under Engineering Assignment No. 483-115 dated 21 September 1983, the Hydroelectric Generation Projects Division (HGPD) was authorized to provide engineering services as required to conduct feasibility studies for a water supply system for a 225 MW thermal plant at Hat Creek. The system would consist of:

1. an embankment dam forming a storage reservoir, and

2. a water supply pipeline from the storage reservoir to the plant.

1.3 SCOPE OF WORK

The scope of work included the following:

1. Review and evaluation of existing data and test results collected prior to this study.

2. Hydrologic studies to determine the flood frequency relationship and the recommended design flood for Hat Creek.

3. Hydraulic design of discharge facilities at the proposed dam.

4. Selection of a suitable site and design for the embankment dam.

5. Preparation of layouts of the water supply system.

6. Preparation of a construction cost estimate and a design-construction schedule for the recommended water supply system.

SECTION 2.0 - PROJECT DESCRIPTION

2.1 LOCATION AND ACCESS

The Hat Creek valley, as shown on Fig. 1-1, is situated between the Fraser River on the west and the Thompson River on the east, approximately midway between Lillooet and Cache Creek. The alignment of the valley is predominantly north-south.

The 225 MW Thermal Plant would use coal from an open pit mine in the valley bottom about 2 km south of Highway 12, (Fig. 2-1). The powerplant would be located near Harry Creek about 100 m above the bottom of the valley, 1 1/2 km northeast of the edge of the open pit mine and approximately 2 1/2 km southeast of the junction of Highway 12 and the Hat Creek road.

Existing access to the site is provided by Highway 12 from the junction of Highway 97 and the Trans Canada Highway at Cache Creek, B.C.

2.2 CLIMATE

The Hat Creek valley lies on the western extremity of a dry belt which extends from Lytton through Ashcroft to Kamloops. Precipitation is very light and some 130 mm (water equivalent) of the average annual 300 m precipitation falls as snow primarily in the higher levels of the basin.

Winters are cold and summers are warm with many very hot days. Summer nights, however, are generally cool and sometimes even cold. The mean daily temperature recorded on the valley floor is 3.4°C with a measured range between 36°C in July and -43°C in December. The mean frost free period is 72 days but has varied from 37 to 113 days.

2.3 POWERPLANT

The powerplant complex, occupying an area of about 10 ha, would be situated on the left bank of Harry Creek at about El. 970. The plant would consist of a turbine hall, a boiler house, filter house, a totally enclosed Flue Gas Desulphurization (FGD) system, a chimney, cooling tower, switchyard and administration building.

Cooling would be accomplished in a six cell, wet, mechanical draft tower. The water from the reservoir would be delivered via pipeline at the south end of the cooling tower at El. 970.

2.4 WATER SUPPLY SYSTEM

The proposed water supply system is shown on Fig. 2-2 and would consist of the following:

1. A 34 m high earthfill dam on Hat Creek, approximately 8.5 km upstream of the powerplant.

2. A reservoir with dead and live storage of about $2 \times 10^6 m^3$ and $11 \times 10^6 m^3$ respectively.

3. An 8.8 km long, gravity fed, 0.4 m diameter water supply steel pipeline.

The dam would incorporate discharge facilities to provide for downstream releases and a spillway capable of passing the Probable Maximum Flood (PMF).

Design data on the water supply system are summarized in Appendix A.

SECTION 3.0 - GEOLOGY

3.1 GENERAL

The regional geology of the Hat Creek coal basin is presented in earlier reports.[3,5]

The upper Hat Creek watershed is an upland valley about 30 km in length and 10 to 20 km in width located in the eastern foothills of the Coast Mountains. Rock outcrops are few, small and widely scattered on the floor of the valley, most of which is covered by a blanket of overburden. This blanket tends to be thick in the valley, but reduces to a thin veneer on hilltops and steep slopes.

The surficial deposits of the Hat Creek valley are varied and have diverse origins, indicating a complex recent geological history. These deposits consist of till, glaciofluvial and lacustrine deposits of glacial origin, slide deposits of post-glacial age along the valley walls and recent alluvial, colluvial and lacustrine deposits. The distribution of these materials is very irregular.

3.2 BEDROCK GEOLOGY

The bedrock geology of the Hat Creek coal basin is described in previous reports[4,5] and is shown on Fig. 3-1. In the project area the tertiary sediments include the Coldwater formation, Hat Creek Coal formation, Medicine Creek formation, Finney Lake formation and the Plateau Basalts. The Coldwater formation lies stratigraphically above the Kamloops Group of volcaniclastics and is comprised of soft, weak, bentonitic siltstone, claystone, sandstone and conglomerate.

The Hat Creek formation, a thick sequence of predominantly coal, overlies the Coldwater formation.

The Medicine Creek formation, composed of a sequence of very weak, soft, bentonitic siltstone and claystone, overlies the Hat Creek formation and generally forms the sub-crop at the selected dam site (Axis B). A heavily eroded surface was developed into this sequence and this eroded surface was in turn covered in part by late tertiary volcanic rocks. It contains discrete bands of bentonite.

The Finney Lake formation, overlying the Medicine Creek formation, is composed of a highly variable, moderately well indurated to poorly indurated unit of very fine to very coarse grained lahar. The lahar appears to be involved in the slide debris on the east bank of Hat Creek, downstream from the selected dam site (Axis B).

The youngest rock unit in the area is the Plateau Basalt of Miocene age. It occurs as a fresh, hard, well jointed, vesicular olivine basalt that caps the older rocks in a sporadic manner. Two of the more prominent being the east boundary and west boundary faults which lie along the sides of the valley.

Numerous high angle gravity faults exist within the area, the beds underlying the valley bottom have been folded into simple anticlines and synclines. However, the movement along the faults and the deformation of the beds is contemporaneous with the deposition of the coal sequence. As part of the seismicity study[8] trenches were excavated in overburden above the two most significant faults in the area. No field evidence has been found to indicate post-pleistocene fault movement.

3.3 Surficial Geology

The surficial geology has been described in a 1982 B.C. Hydro report[5] and is summarized as follows.

During the Pleistocene epoch the Hat Creek valley was eroded to a greater depth and width than the present valley. Due to a subsequent downstream ice dam and later glaciation, the valley floor has been infilled with glaciofluvial and glaciolacustrine sediments. Except for the valley bottom the Hat Creek area appears to be blanketed with a layer of basal till.

This till is dense to very dense, clayey gravel to gravelly clay, varying locally to clayey sand and silty gravel. It ranges in thickness from less than a metre to several tens of metres.

Overlying the till in some areas of the Hat Creek valley and at depth in the valley bottom is an extremely thick sequence of glaciofluvial sand and gravel. These beds infilling the old Hat Creek channel are dense to very dense but relatively free draining. They range in thickness up to several tens of metres.

Glaciolacustrine silts and clays are present near the surface in various locations. They also exist as discrete beds up to approximately 10 m thick within the glaciofluvial sand and gravel.

During a later stage of glaciation, these sediments were themselves eroded. A highly variable, loose to compact, ablation till generally consisting of silty gravel to gravelly silt was deposited over them. In some places the ablation till was deposited directly over the basal till. Concurrently, a blanket of ground moraine was deposited over most of the slopes to the west of Hat Creek.

Post-glacial sedimentation resulted in the deposition of silt, sand and gravel in the bottom of the Hat Creek valley in a floodplain environment. These sediments are generally highly permeable, loose beds from approximately 5 to 30 m thick. These beds are commonly separated from the glaciofluvial sediments by 1 to 3 m of till.

Alluvial fans resulting from fluvial deposition by Ambusten, Medicine and Harry Creeks extend along parts of the right bank of Hat Creek. These deposits consist of moderately loose, relatively free-draining sand and gravel with some interbeds of silt. The thickness of these materials is highly variable.

The last major alterations to the topography are due to recent slides or sloughs, generally involving surficial materials and bedrock.

3.4 SEISMICITY

The results of a seismicity study made by Klohn Leonoff Consultants Ltd. of the Hat Creek area are presented in their report.[8]

The 1970 Seismic Zone Map for Canada places the project area in Zone 1, an area of low earthquake hazard. The design of ancillary structures would have to conform to the requirements of the proposed 1985 National Building Code (NBC).

For the design of major structures such as the dam, a peak horizontal acceleration of not less than 10 percent gravity (0.10 g) and a peak velocity of 15 cm/s were adopted as this is consistent with ICOLD (International Commission on Large Dams) recommendations.

The contour maps of acceleration and velocity for the proposed 1985 NBC show that the peak horizontal acceleration is 8 percent of gravity (0.08 g) and peak velocity is 14 cm/s for the project site. The annual probability of a seismic event with the above acceleration and velocity is estimated to be 1:475 or 10 percent in about 50 years.

SECTION 4.0 - HYDRAULIC AND HYDROLOGIC STUDIES

4.1 FLOOD HYDROLOGY

(a) General

The flood hydrology of the Hat Creek basin had been studied by B.C. Hydro and outside consultants in 1977 and 1978. Results from those studies are used as the basis for deriving design floods for the present study.

Based on B.C. Hydro's proposed guidelines[2] for selecting project design floods the PMF was chosen as the inflow design flood.

(b) Flood Frequency Analysis

The relatively short period of usable runoff records (from 5 to 19 years) in the Hat Creek basin is not sufficient for a meaningful frequency analysis. In addition, some of the earlier data were based on once-a-day readings of manual gauges. For the above reasons, the flood frequency analysis was made on the basis of a regional approach using data from nearby gauged basins having longer periods of record and similar hydrologic characteristics.

A regional frequency curve had been established for the Hat Creek Basin and documented in a report by B.C. Hydro.[3] This curve for the purposed storage damsite as shown in Fig. 4-1.

(c) Probable Maximum Flood

The probable maximum flood (PMF) was derived for WSC gauging station (08LF061), Hat Creek near Upper Hat Creek, by Monenco

Consultants Pacific Limited using maximized meteorological conditions with a watershed simulation model. This study is documented in a report by Monenco.[9]

Results of the PMF study by Monenco[9] were reviewed by B.C. Hydro[3] during the 1978 Hat Creek Diversion Study. It was found that Monenco's estimate of the PMF appeared to be too conservative. More data have been collected since the previous study; however, an update of Monenco's analysis was not considered at this stage. The PMF hydrograph adopted for the present study (Fig. 4-2) was based on that produced by Monenco, prorated to the drainage area upstream of the proposed damsite. The PMF peak inflow was estimated to be about 59 m^3/s as compared to the average annual flow of 0.38 m^3/s.

4.2 FLOW ANALYSIS

(a) Water Demand

Based on the proposed annual operating pattern, the powerplant is expected to be operated at 100 percent load from mid-September to mid-May (8 months). For the balance of the year, the units would be on standby or under maintenance.

Fishery requirements downstream of the WSC gauging station 08LF061 were recommended in a report by Beak Consultants Limited.[1] The required mean monthly fishery releases vary from 210 to 280 L/s with flushing flow bringing the annual average fishery release to 290 L/s. Part of the requirements could be met by the streamflow from the three tributaries (Anderson Creek, Ambusten Creek and Medicine Creek) which enter the Hat Creek downstream of the proposed damsite. Hence, the mean monthly release required from the storage reservoir would be 140 L/s.

The peak cooling water requirement is estimated by the Thermal Engineering Department to be 130 L/s and the average annual demand about 75 L/s. Allowing 140 L/s for average annual downstream releases, 12 L/s for evaporation and 42 L/s for seepage the mean annual total water requirement would be 269 L/s.

(b) Flow Availability and Storage Requirement

The available flow at the proposed damsite was computed from historical streamflow (see Tables 4-1 and 4-2) recorded at the WSC gauging station, Hat Creek, near Upper Hat Creek (Station 08LF061). Observed daily flows at the above gauging station vary widely between 28 L/s and 14 600 L/s.

The above WSC station gauges a drainage area of 350 km^2. The drainage area above the proposed damsite is estimated to be 200 km^2. Flows from the three major tributaries between the WSC station and the damsite have been gauged since 1978. Analysis of available flow data indicates that the discharge in Hat Creek at the proposed damsite is approximately 66 percent of that measured at the gauging station 08LF061 while the corresponding drainage area is only 57 percent. Since only limited data are available from the tributaries, in order to be conservative, the 57 percent factor was used to compute daily inflow to the proposed storage reservoir.

Based on a mass curve analysis (see Fig. 4-6) for the period 1964 to 1982 in which continuous data are available, the storage volume required to maintain a continuous supply of 269 L/s through the most critical dry period (July 1975 to April 1981) was estimated to be $10.9 \times 10^6 m^3$s.

An assessment of low flow characteristics of Hat Creek was made by Monenco Consultants Pacific Ltd. and was presented in a report[10] dated October 1981. The low flow characteristics of Hat Creek from various assumed durations of a series of low flow years, as shown on Fig. 4-7, is derived from data available in that report[10]. It is apparent from Fig. 4-7 that, for about a 6-year low flow period (the dry period bridged over by storage behind the dam at Axis B) there would be just enough water in Hat Creek to satisfy the total demand of 269 L/s during the assumed useful life (35 years) of the powerplant. Any low flow period of shorter than about a 6-year duration is not critical to the water supply system because of storage. However, should a low flow period of longer than 6-year duration occur, downstream releases would be reduced.

4.3 DESIGN CAPACITIES OF DISCHARGE FACILITIES

(a) Diversion Capacity

The design capacity for temporary river diversion during construction was determined from the flood peak frequency curve given in Fig. 4-1. A return period of 10 years was selected with a corresponding diversion design flood peak of 7 m^3/s.

(b) Spillway Capacity

An ungated spillway would be proposed. The spillway crest elevation would be set by the storage requirement. The reservoir storage curve (Fig. 4-3) shows that, with the minimum reservoir level at about El. 1034, and the spillway crest at El. 1049 the required level storage volume would be provided for.

The spillway design capacity and the size of spillway opening were determined by routing the PMF hydrograph through the proposed reservoir based on the following assumptions:

Spillway crest elevation	-	EL. 1049
Maximum surcharge due to PMF	-	3.0 m
Initial reservoir water level	-	El. 1049

The results indicate that a 5.25 m wide spillway crest would be adequate to pass a PMF peak outflow of 57 m^3/s with a 3 m surcharge on the crest. The stage-discharge rating curve for the spillway is shown in Fig. 4-4 and a tailwater rating curve is given in Fig. 4-5.

(c) Powerlant Water Supply

The powerplant water supply line should be capable of delivering the peak cooling water demand of 130 L/s with the minimum reservoir level at El. 1034.

(d) Downstream Releases

The mean monthly release required from the storage reservoir would be 140 L/s (see Section 4.2(a)). However, throughout the year the downstream releases would vary as follows:

1. May through July - little or no release from the reservoir as inflows from the tributaries would be sufficient to meet the demand except in extreme dry years.

2. July and August - releases from the reservoir would normally be slightly higher than 140 L/s.

3. Other months - releases from the reservoir would be fairly constant and would normally be below the mean monthly flow allotment of 140 L/s.

SECTION 5.0 - EARTHFILL DAM AND RESERVOIR

5.1 COMPARISON OF ALTERNATIVE DAMSITES

Three alternative axes (Axes A, B and C) were considered for a water storage dam on Hat Creek as shown on Fig. 2-1. A gravity feed system would be feasible with a dam at Axis A or B. With a dam at Axis C, the closest to the proposed powerplant the pipeline length would be minimized, however, pumping would be required.

Table 5-1 compares the main features of the three alternative damsites studied (Axes A, B and C). Estimated costs for the three damsites are given in Section 7.1 (Table 7-1). Axis B has the lowest estimated cost and has several advantages as given in Table 5-1 and therefore has been selected as the preferred location for an earthfill dam.

For the comparison in Tables 5-1 and 7-1 the design of the dam at each site considered such factors as depth to bedrock, seepage control, head-on dam and geometry. The strength and permeability parameters at each site were assumed to be identical.

Review of available drilling information (Section 5.2) indicates that about 0.5 km upstream (south) of the recommended site, bedrock may be somewhat higher than the estimated bedrock contours shown on Fig. 5-1. Field investigations would be required to establish the bedrock conditions and should be carried out during the next stage of design. If this is the case it may be more economical to adjust the location of the earthfill dam near Axis B.

5.2 INFORMATION AVAILABLE AT AXIS B

Several holes were drilled near Axis B during previous investigations in 1975 and 1976 as indicated on Fig. 5-2. A profile through these drill holes shows that the average depth to bedrock at the site is about 30 m (Fig. 5-2). Information on the overburden and groundwater conditions is lacking. The earlier 1975 and 1976 investigations in this area were primarily intended to obtain information on the various underlying bedrock types and coal stratum.

Comprehensive overburden investigations[5] were carried out in 1981 by B.C. Hydro Geotechnical Department. These studies were undertaken north of the recommended damsite; however, the information has been used as a guide for the preferred site. The information available includes detailed test pit logs, graphic drill logs, laboratory test results and permeability data. Information on permeability was also presented in earlier studies[3].

The available drilling information on the overburden indicates that clay, silt, sand, gravel, cobbles and boulders occur in varying proportions at various locations. The right bank at Axis B was inspected during a site visit and was found to consist of a silty sand matrix with some gravel, cobbles and boulders.

Based on the available information, an average permeability value 2×10^{-3} cm/s has been assumed for the overburden materials in the area of the damsite. Field and laboratory investigations would be required to obtain detailed permeability data.

5.3 EARTHFILL DAM DESIGN (Axis B)

(a) Control of Seepage

The design of an earthfill dam at Axis B would have to minimize seepage losses, as Hat Creek provides a relatively low flow. At the maximum normal operating level, El. 1049, the reservoir would have a surface area of about 115 ha and an average depth of about 12 m.

A comparison of powerplant requirements, downstream release requirements and evaporation losses (maximum 12 L/s) with available flows indicated that the seepage loss should not exceed 42 L/s (Section 4.2). Based on an average overburden permeability of 2×10^{-3} cm/s, it was determined that either a seepage cut-off or an impervious upstream blanket would be required to prevent seepage larger than this from escaping under and around the earthfill dam.

With about 30 m of overburden at dam Axis B and bedrock not rising near the abutments, construction of a cut-off would not appear to be practical and economical. An upstream impervious blanket would provide the best means to reduce seepage loss. The results of the seepage studies for an earthfill dam with an impervious blanket are summarized on Fig. 5-3. The studies indicate that at the centre of the dam, the upstream impervious blanket should extend 65 m upstream of the toe of the earthfill dam. The shape and thickness of blanket up the sides of the reservoir would be varied to give a uniform head loss ratio across the blanket.

The seepage study results indicate a high sensitivity to variations in the permeability coefficient (Fig. 5-3). Drilling and overburden testing should be carried out for future studies to determine the nature of the overburden materials and their permeability. In particular, the presence or absence of free draining gravel zones needs to be determined.

In addition to the upstream impervious blanket, two lines of pressure relief drains would be required to reduce piezometric pressure at or near the downstream toe of the dam.

(b) Zoning of Earthfill Dam and Foundation Treatment

Prior to construction of the earthfill dam, the foundation would be cleared of vegetation and roughly levelled. The slope of the right bank would be flattened to 2H:1V to facilitate placement of the earthfill dam and impervious blanket.

The zoning of the earthfill dam and its interaction with the diversion pipe are shown on Fig. 5-4. It would consist of a well graded calyey till core flanked by granular shells with appropriate transitions, filter, drains and slope protection. The impervious core, a well graded clayey till, would extend upstream to the toe of the dam and would provide a continuous impervious layer to the upstream impervious blanket. All impervious materials would be placed and compacted in thin lifts in the dry.

The upstream and downstream cofferdams would be constructed of impervious material and would become integral parts of the earthfill dam and impervious blanket. The crest of the earthfill dam would be at El. 1054 providing a 2 m freeboard allowance above PMF level giving a maximum height of 34 m and a length of 360 m. An upstream slope of 3H:1V and a downstream slope 2.5H:1V has been adopted for the earthfill dam based on assumed shear strength parameters of $C' = 0$ and $\emptyset = 35^\circ$ for the granular shells. Additional field investigation and analysis may permit some steepening of these slopes.

Design data for the dam are summarized in Appendix A.

(c) Construction Materials

Construction material investigations for an earthfill dam were not carried out for this study. Construction materials could come from potential borrow areas[6] which were investigated in 1977. The pervious and impervious materials were assumed to be obtained from borrow areas on Ambusten (about 3 km northeast of the site) and Medicine creeks (about 5 km north of the site) respectively. Investigations to locate and assess alternative construction material sources would be required prior to final design.

It may be feasible to use excavated overburden material stripped from the pit No. 1 if the material is suitable. However, the inherent differences of scale of the pit development and dam constructions operations and their respective scheduling requirements would require detailed studies to determine how these operations could be coordinated to best economic advantage.

5.4 RESERVOIR

The reservoir would have a surface area of 115 ha with a maximum normal operating level of El. 1049 (Fig. 5-5). If drawn down to the minimum normal operating level, El. 1034 (Fig. 5-5), the surface area would be reduced to 35 ha. Extensive fluctuation in reservoir level could result in many months exposure of much of the impervious upstream blanket.

The portion of the blanket subject to exposure will need protection against summer and winter conditions. In summer, drying out and cracking could occur, with the possibility that wind may blow fines from the blanket. In winter, ice and frost heave could crack or otherwise damage the blanket if unprotected. During future studies, the effects of month by month fluctuations in the reservoir level on the integrity of the upstream blanket should be assessed and appropriate protection provided. (A layer of granular cover). The unit cost of impervious material in the blanket has a contingency allowance for such a protection.

Design data for the reservoir are summarized in Appendix A.

SECTION 6.0 - STRUCTURES AND WATER SUPPLY PIPELINE

6.1 GENERAL

The proposed water supply system for the dam site at Axis B (Section 5.0) consists of an earthfill dam, a spillway and a water supply pipeline on the right abutment. The principal structural components of the project, as shown on Fig. 2-2, would be as follows:

1. Diversion pipe, and concrete plug.

2. Approach channel, spillway headworks, chute and stilling basin;

3. Water supply intake structure, intake pipe, valve house, downstream release pipe and water supply pipeline.

Design data on the structures and water supply pipeline are summarized in Appendix A.

6.2 DIVERSION FACILITIES

During construction of the earthfill dam a diversion pipe would be required to divert creek flow through the construction site. The design capacity of the diversion pipe is based on an average Hat Creek flow of 0.38 m^3/s, and the 10-year flood peak outflow at the dam site of about 7 m^3/s.

The diversion pipe, as shown on Fig. 6-1, is designed with outlet control and would slope at 100H:1V. Different pipe sizes with corresponding cofferdam heights were studied. Cost estimates showed the arrangement with a 1.83 m diameter by 210 m long concrete encased corrugated steel pipe with 3.5 m high upstream cofferdam (El. 1025) and 2.5 m high downstream cofferdam (El. 1022) to be the most economical.

In order to improve the hydraulic efficiency of the inlet the end of the pipe would be bevelled to conform with the cofferdam embankment slope. The outlet end would be square.

Upon completion of the earthfill dam, the diversion pipe would be closed with a 3 m long concrete plug constructed in the pipe at the inlet. For construction sequence see Fig. 7-2.

6.3 DISCHARGE FACILITIES

(a) Spillway

The spillway structure, as shown on Fig. 6-2, would be located on the right abutment and is designed to pass 57 m^3/s, the peak outflow resulting from the PMF, with the reservoir at El. 1052, 3 m above the spillway crest (El. 1049) and 2 m below the earthfill dam crest (El. 1054).

Upstream of the spillway headworks the spillway approach channel would be curved in plan with the invert at El. 1048.4 and the width varying from 15 m at the entrance to 5.25 m at the spillway headworks. For the present study the approach channel would be concrete lined, however, for more detailed studies consideration should be given to having the approach channel lined with riprap upstream of the spillway headworks. The channel side would be excavated at a slope of 2H:1V.

The spillway headworks would comprise a single bay ungated ogee shaped crest with a sloping upstream face at 45°, 5.25 m wide. Downstream from the spillway headworks the 5.25 m wide spillway chute would have 1 m high vertical walls with the invert sloping at 3H:1V and terminating in an 18 m long stilling basin.

The stilling basin would contain the hydraulic jump for a flow up to 19 m^3/s, the 1000-year design flood. For larger floods the hydraulic jump would be swept out of the stilling basin. Some damage to the river channel downstream is to be expected for flows greater than the 1000-year flood but is considered acceptable. The stilling basin would have 4.6 m high vertical side walls above the invert (El. 1017.4).

Downstream from the stilling basin the outlet channel would be lined with riprap and would slope upward at 12H:1V to the natural creek bed. In plan the outlet channel would flare out at 7^{o} on each side of the stilling basin with channel side slopes of 2H:1V.

(b) Water Supply Intake, Intake Pipe and Valve House

The water supply intake structure, as shown on Fig. 6-3, would be located on the right abutment near the upstream toe of the earthfill dam. It is designed to deliver water to the valve house near the spillway up to a rate of 270 L/s of which 140 L/s would be for the average downstream releases and 130 L/s (at peak demand) for plant water supply at minimum reservoir level (El. 1034).

The reinforced concrete intake structure would have a common slot for trashracks and stoplogs, and a bell mouth entrance leading into a 0.5 m diameter intake pipe.

Between the intake structure and the valve house, the 0.5 m diameter, 134 m long steel intake pipe would be encased in concrete and would be trenched into the right bank. The pipe would be doubly protected from corrosion by an external extruded coating and concrete encasement. The insulated, heated, reinforced concrete valve house would be located between the downstream earthfill dam toe and the spillway chute on the pipeline alignment. A 3 m wide service road at 8 percent grade across the downstream face of the earthfill dam would provide service vehicle access to the valve house.

(c) Downstream Release Pipe

The downstream release pipe, as shown on Fig. 6-3, is designed to release water at a rate up to 140 L/s at minimum reservoir level (El. 1034).

In the valve house the 0.2 m diameter branch of the 45° wye would be equipped with a shutoff valve. Connected to the valve would be the 0.2 m diameter by 16 m long downstream release pipe. Outside of the valve house the downstream release pipe would be buried below ground for its full length before it discharges onto the spillway chute invert. An external pipe coating would provide corrosion protection to the pipe.

6.4 WATER SUPPLY PIPELINE

The upstream end of the proposed water supply pipeline would originate at the shutoff valve of the 0.4 m diameter 45° wye branch of the intake pipe located in the valve house. The pipe would be 0.4 m in diameter and 8800 m long, terminating at the cooling tower basin by Harry Creek at El. 970. It would be buried to a depth of about 2 m full length to prevent freezing.

The proposed pipeline route plan and profile is shown on Fig. 6-4. Based on maps and field reconnaissance the pipe would be located on the east bank of the Hat Creek valley. Surficial geological information indicates that the surficial material consist of sand, gravel and some clay, very thick in many places and generally greater than 2 m deep to bedrock. Access along the pipeline route is excellent and other construction conditions are favourable.

At Ambusten Creek and Medicine Creek crossings the pipeline would be buried (and riprap-protected) in a trench below the creek bed to eliminate the need for saddles, piles and external rigid insulation.

Previous pipeline studies by Sandwell[11], Monenco[9], and Golder Associates[7] have examined the suitability of several pipe materials for use in the Hat Creek diversion and have recommended steel or polyehtylene as having the most desirable properties. For the present study only steel pipe was considered as both steel and polyethylene pipes are similar in cost and as most of the problems would be common regardless of the material selected for the pipeline. During future studies polythylene pipe together with other types of pipe materials should be considered. In order to limit pressure rise within reasonable bounds a 60 second valve closure time is recommended. The relative location (upstream end vs downstream end) of the closure valve for the steel pipe alternative has no impact on the wall thickness of pipe as it is already the thinnest available in the size selected for hydraulic purposes. The pipe would be protected from corrosion by an exterior coating.

Pipeline construction inspection and testing methods would be typical for the industry.

Full-bore ball valves would be used as main shutoff valves in the system. Air release valves, designed to release entrapped air in the pipe, would be provided at all local summits along the pipeline route. Heat-traced vent valves would be used to allow entry and escape of air during line filling and draining. Heat-traced drain valves would be located at local low points in the pipeline for draining operations.

SECTION 7.0 - CONSTRUCTION COSTS AND SCHEDULE

7.1 COST ESTIMATES

A summary of main feature costs for the three alternative dam sites (Axis A, B and C) is shown on Table 7-1. The estimated cost for Axis A is more than double and for Axis C more than three times the cost of Axis B.

A summary of the total construction cost estimate for Axis B is shown in Table 7-2.

The total construction cost for the dam and pipeline is estimated to be $16.9 million at October 1983 prices. This includes, contingencies at 20 percent of the direct construction costs; engineering, investigations and supervision at 15 percent of the direct construction cost plus contingencies; and, construction insurance and bonds at 1 percent of the direct construction cost plus contingencies.

The cost estimating criteria is as follows:

1. The costs of lands and rights and flowage are excluded.

2. Contingency allowances have been included to reflect both the level of detail in the estimates and the extent of site investigations. Environmental contingencies are excluded.

3. Licensing expenses are excluded.

4. No allowances are included for inflation, corporate overheads or interest during construction.

5. The materials for the dam would be obtained from a borrow area about 3 km from Axis B.

7.2 ENGINEERING AND CONSTRUCTION SCHEDULE

A simplified bar schedule of final design engineering and the proposed construction schedule for the water supply dam and water supply pipeline is shown on Fig. 7-1.

The schedule has been based on independent but coordinated construction of a 440 000 m^3 earthfill water supply dam and an 8800 m long pipeline with the overall construction of a 225 MW plant.

The overall schedule duration from start of final design to completion of dam and pipeline (i.e. to commencement of reservoir filling) would involve a period of about 2½ years.

The schedule of work is based on the assumption of a single contract package with a possible separate contract for construction of the water supply pipeline. The fill placement for the 440 000 m^3 dam would be in the order of 80 000 m^3 per month, on a two shift, 5 day work week basis. This rate requirement would be within the capability of small local contractors with moderate equipment spreads of 10 to 15 truck haul units. Pipeline work is scheduled at a rate of about 450 m per week over a 20-week period.

Principal schedule events are summarized as follows:

1. Final design for the dam and pipeline would commence early in Year 3 in time to permit issue of tender documents for a single contract later that year.

2. Construction of the dam and pipeline would commence early in Year 4. The pipeline and the majority of the dam would be completed in Year 4 and in Year 5 the dam would be topped out, access roads completed and diversion pipe plugged, prior to and in readiness to commence impounding the freshet inflows.

3. Reservoir filling would be completed by Mid-year 5 in time for testing of powerplant equipment.

A more detailed description of the construction sequences involving the water supply dam and the required diversion of the Hat Creek flows is shown on Fig. 7-2.

SECTION 8.0 - CONCLUSIONS AND RECOMMENDATIONS

8.1 CONCLUSIONS

The main conclusions of the study are that:

1. It is feasible to obtain the needed water supply for a 225 MW thermal plant from Hat Creek, however, downstream releases may need to be curtailed once or twice during the life of the project.

2. The water supply system would consist of an earthfill storage dam and a pipeline.

3. Three alternative sites for the storage dam were examined and based on available information Axis B was selected as most suitable.

4. The time required from award of first contract to in-service would be about 1½ years.

8.2 RECOMMENDATIONS

Based on the results of this study, it is recommended that:

1. During preliminary design the streamflow characteristics be re-assessed with the longer period of data obtained for Hat Creek and its tributaries.

2. During preliminary design geotechnical explorations be carried out to determine bedrock contours, permeability of substrata and index and strength properties of foundation materials at Axis B and B1.

3. During preliminary design the diversion scheme be optimized with a view to eliminate pumping to satisfy downstream release requirements during impounding.

4. The engineering and construction schedule presented in this report be integrated into the overall project schedule to ensure timely commencement of exploratory, design and construction work.

REFERENCES

1. Beak Consultants Ltd., Hat Creek Project - Fisheries and Benthos Study, December 1977.

2. B.C. Hydro, Guidelines for Selecting Project Design Floods, March 1984.

3. B.C. Hydro, Hat Creek Project - Diversion of Hat and Finney Creeks - Preliminary Design Report, Report No. 913, March 1978.

4. B.C. Hydro, Hat Creek Project, Preliminary Geological Report, No. 2 Deposit, June 1980.

5. B.C. Hydro, Report on 1981 Site Investigations for Hat and Finney Creek Diversion and Access Road, Report No. H 1478, March 1982.

6. B.C. Hydro, Hat Creek Project - Water Supply and Ash Disposal Reservoirs, March 1978.

7. Golder Associates, Hat Creek Project - Diversion Study, Final Report, Vol. 1 - Main Text, December 1982.

8. Klohn Leonoff Consultants Ltd., Hat Creek Project - Seismicity Assessment and Seismic Design Criteria, August 1982.

9. Monenco Consultants Pacific Ltd., Hat Creek Diversion Study, January 1977.

10. Monenco Consultants Pacific Ltd., Hat Creek Hydrology, Assessment of Low Flow Characteristics, October 1981.

11. Sandwell and Co. Ltd., Hat Creek Project - Cooling Water Supply, Preliminary Design Study, Vol. 1 of 3, Report V4191/1, March 1978.

ACKNOWLEDGEMENTS

This report has been prepared by the Hydroelectric Generation Projects Division of B.C. Hydro under the direction of the Manager of Development and Design. The study was conducted, and this report prepared, by a Project Team whose designated members included:

Engineering Coordination	T. Pataky
Estimating and Scheduliing	C.H. Turner/D.F. McLean
Hydraulics	K.Y.C. Yung
Drafting	A. Vennesland/A.H. Hicks
Project Layout, Earthfill Dam	N.G. Stephenson/A.P. Joseph
Project Layout, Structural Components	T.L. Chen

This report was reviewed by the functional Section Supervisors, Department Managers and the Manager of Development and Design.

TABLE 4-1

MONTHLY DISCHARGES (m^3/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
HAT CREEK NEAR UPPER HAT CREEK - STATION NO. 08LF061												
1960	-	-	-	-	-	-	-	-	-	0.186	0.252	0.215
1961	0.189	0.165	0.329	0.303	1.540	1.410	0.287	0.118	0.153	0.240	0.225	0.205
1962	0.197	0.268	-	1.550	2.650	3.000	0.628	0.275	0.270	0.428	0.332	-
1963	-	-	0.436	0.494	1.690	1.810	0.675	0.281	0.246	0.262	0.250	0.238
1964	0.227	0.216	0.263	0.619	1.190	7.160	1.700	0.496	0.882	0.756	0.552	0.403
1965	0.308	0.287	0.365	1.320	2.480	2.620	1.240	0.711	0.527	0.359	0.337	0.230
1966	0.236	0.196	0.646	0.703	1.710	1.840	2.070	0.829	0.340	0.429	0.369	0.293
1967	0.191	0.166	0.184	0.424	2.570	4.440	0.761	0.228	0.127	0.220	0.295	0.203
1968	0.178	0.185	0.236	0.287	1.520	2.730	1.080	0.312	0.251	0.284	0.309	0.259
1969	0.194	0.164	0.192	0.425	3.040	1.530	2.360	0.384	0.319	0.354	0.335	0.291
1970	0.183	0.168	0.220	0.249	0.513	0.806	0.182	0.098	0.092	0.116	0.124	0.138
1971	0.162	0.024	0.126	0.361	2.290	2.950	0.932	0.158	0.107	0.186	0.214	0.164
1972	0.169	0.185	0.371	0.341	2.200	3.990	1.330	0.461	0.319	0.339	0.279	0.208
1973	0.183	0.210	0.259	0.386	0.805	0.565	0.209	0.091	0.118	0.178	0.175	0.202
1974	0.180	0.186	0.295	0.464	0.985	4.570	0.951	0.355	0.195	0.203	0.223	0.254
1975	0.239	0.174	0.186	0.404	1.230	3.050	0.816	0.198	0.243	0.182	0.208	0.188
1976	0.171	0.124	0.133	0.297	0.862	0.946	0.429	0.634	0.314	0.234	0.249	0.202
1977	0.096	0.148	0.112	0.253	0.372	0.426	0.143	0.042	0.098	0.232	0.270	0.136
1978	0.148	0.145	0.285	0.759	1.990	3.290	0.624	0.174	0.315	0.279	0.209	0.162
1979	0.138	0.139	0.250	0.315	0.726	0.305	0.142	0.068	0.071	0.140	0.177	0.139
1980	0.118	0.105	0.174	0.256	0.746	5.000	0.822	0.425	0.472	0.405	0.203	0.402
1981	0.463	0.432	0.532	0.631	4.730	2.650	1.040	0.437	0.326	0.317	0.268	0.177
1982	0.151	0.171	0.219	0.295	0.733	1.880	1.290	0.446	0.302	0.381	0.218	0.194

TABLE 4-2

MONTHLY DISCHARGES (m^3/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
MEDICINE CREEK NEAR THE MOUTH - STATION NO. 08LF082												
1977	-	-	-	-	-	-	0.005	0.003	0.005	0.008	0.005	0.003
1978	0.003	0.005	0.024	0.138	0.568	0.328	0.015	0.008	0.012	0.016	0.018	0.012
1979	0.006	0.006	0.033	0.052	0.108	0.025	0.014	0.009	0.009	0.006	0.004	0.002
1980	0.002	0.002	0.003	0.027	0.024	0.113	0.036	0.033	0.018	0.020	0.011	0.017
1981	0.027	0.027	0.017	0.040	0.232	0.233	0.038	0.018	0.012	0.028	0.013	0.012
1982	0.016	0.016	0.016	0.032	0.072	0.022	0.026	0.023	0.015	0.027	0.017	0.011
AMBUSTEN CREEK NEAR THE MOUTH - STATION NO. 08LF081												
1977	-	-	-	-	-	0.021	0.015	0.008	0.005	0.007	0.010	0.008
1978	0.007	0.006	0.006	0.012	0.156	0.244	0.080	0.026	0.029	0.022	0.013	0.008
1979	0.007	0.007	0.008	0.012	0.034	0.022	0.013	0.009	0.007	0.005	0.006	0.005
1980	0.003	0.002	0.002	0.007	0.032	0.099	0.019	0.021	0.023	0.020	0.019	0.014
1982	0.037	0.011	0.010	0.015	0.316	0.185	0.055	0.029	0.018	0.014	0.011	0.012
1982	0.010	0.014	0.011	0.007	0.024	0.040	0.046	0.023	0.013	0.014	0.009	0.010
ANDERSON CREEK ABOVE DIVERSION - STATION NO. 08LF084												
1978	-	-	-	-	-	-	0.152	0.057	0.046	0.034	0.039	0.102
1979	0.101	0.091	0.087	0.085	0.381	0.265	0.057	0.024	0.021	0.017	0.013	0.012
1980	0.011	0.009	0.009	0.046	0.157	0.729	0.225	0.109	0.060	0.044	0.044	0.045
1981	0.043	0.028	0.026	0.028	0.562	0.440	0.174	0.045	0.033	0.024	0.021	0.026
1982	0.017	0.037	0.038	0.040	0.143	0.353	0.288	0.156	0.061	0.068	0.048	0.055

TABLE 5-1

COMPARISON OF ALTERNATIVE SITES

Item	Axis A	Axis B	Axis C
Dam			
Type:	Earthfill	Earthfill	Earthfill
Crest Elevation (m):	1148	1054	967
Maximum Height (m):	23	34	52
Crest Length (m):	825	360	800
Volume (m^3):	1.4×10^6	0.6×10^6	2.5×10^6
Water Supply Pipeline			
Type:	Gravity Feed	Gravity Feed	Pumped, maximum Head 52 m
Length (km) of 0.4 m Diameter Steel Pipeline:	17.6	8.8	4.0
Disadvantages	Longest pipeline Dam volume greater than Axis B Cost higher than Axis B		Largest volume dam Pumping required Highest cost*1
Advantages	Gravity feed	Lowest dam volume Gravity feed Lowest cost*1	Shortest pipeline

*1 For costs estimates refer to Section 7.0.

TABLE 7-1

ALTERNATIVE DAM SITES COST COMPARISON
($M)

Feature	Axis A	Axis B	Axis C
1. Dam and spillway structure	21.0	8.5	37.5
2. Water supply pipeline	5.1	2.5	1.2
Pumping	-	-	2.0
Total Direct Costs*[1,2]	26.1	11.0	40.7

*1 Costs to Direct Construction Costs level. Excludes contingencies, design and construction insurance etc.

*2 Based on October 1983 price levels.

TABLE 7-2

SUMMARY ESTIMATE OF TOTAL CONSTRUCTION COST
($ THOUSANDS)

1.	Clearing and Access Roads	540
2.	Water supply dam and spillway	8 460
3.	Water supply pipeline	2 540
4.	Construction Services	580
	Direct Construction Cost*1	12 120
3.	Contingencies (20 percent)2	2 430
4.	Engineering, investigations and supervision (15 percent)*3	2 180
5.	Construction Insurance and Bonds (1 percent)	170
	Total Construction Cost*4	16 900

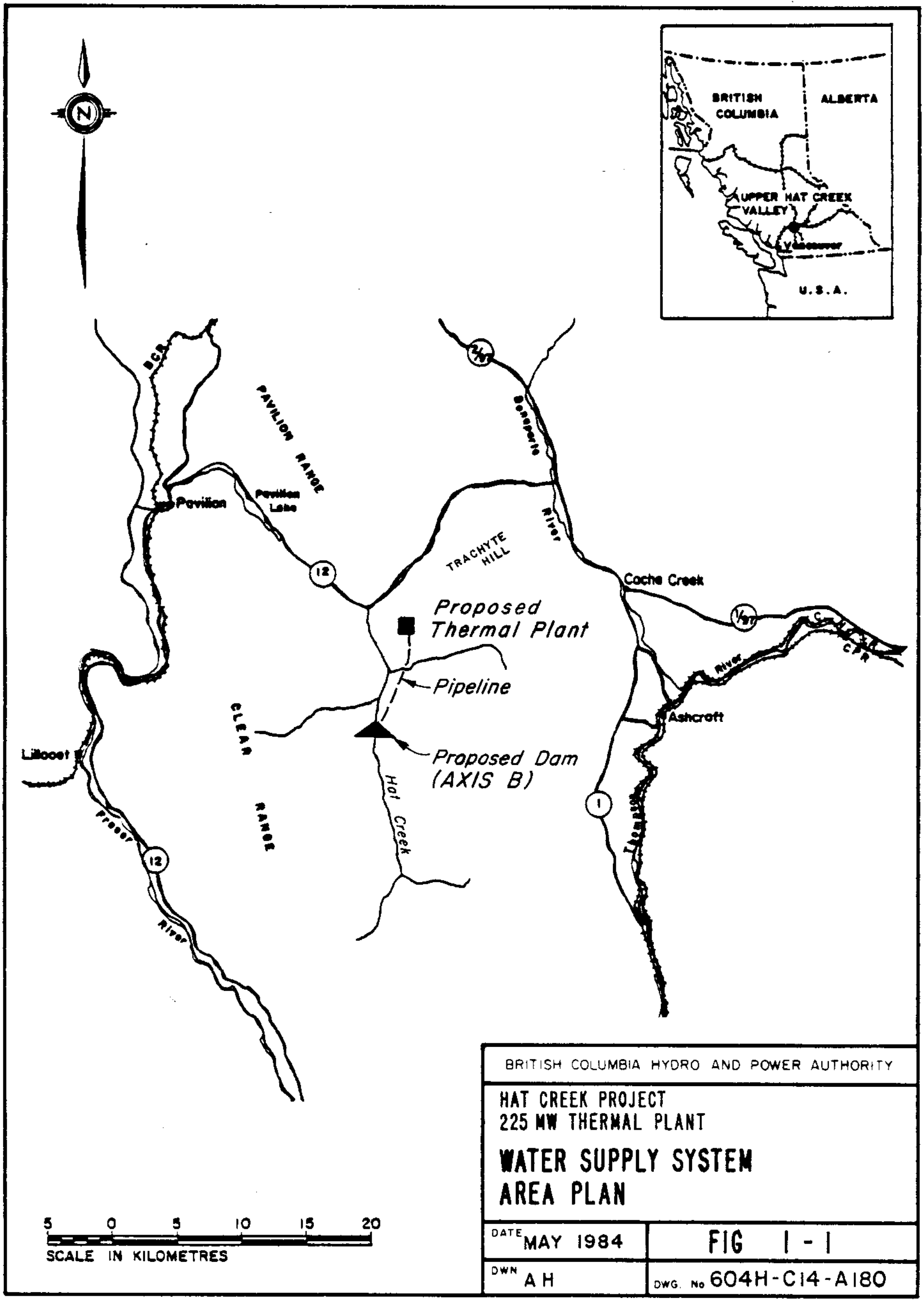
*1 Excludes Lands and Rights, and Flowage costs.

*2 Excludes Environmental Contingencies.

*3 Excludes Licensing expenses.

*4 Based on October 1983 price levels.

Fiscal Budget Distribution	($ Thousands)
Pre Project Approval	600
Year 2/3	280
Year 3/4	1 280
Year 4/5	12 800
Year 5/6	1 900
TOTAL	16 900



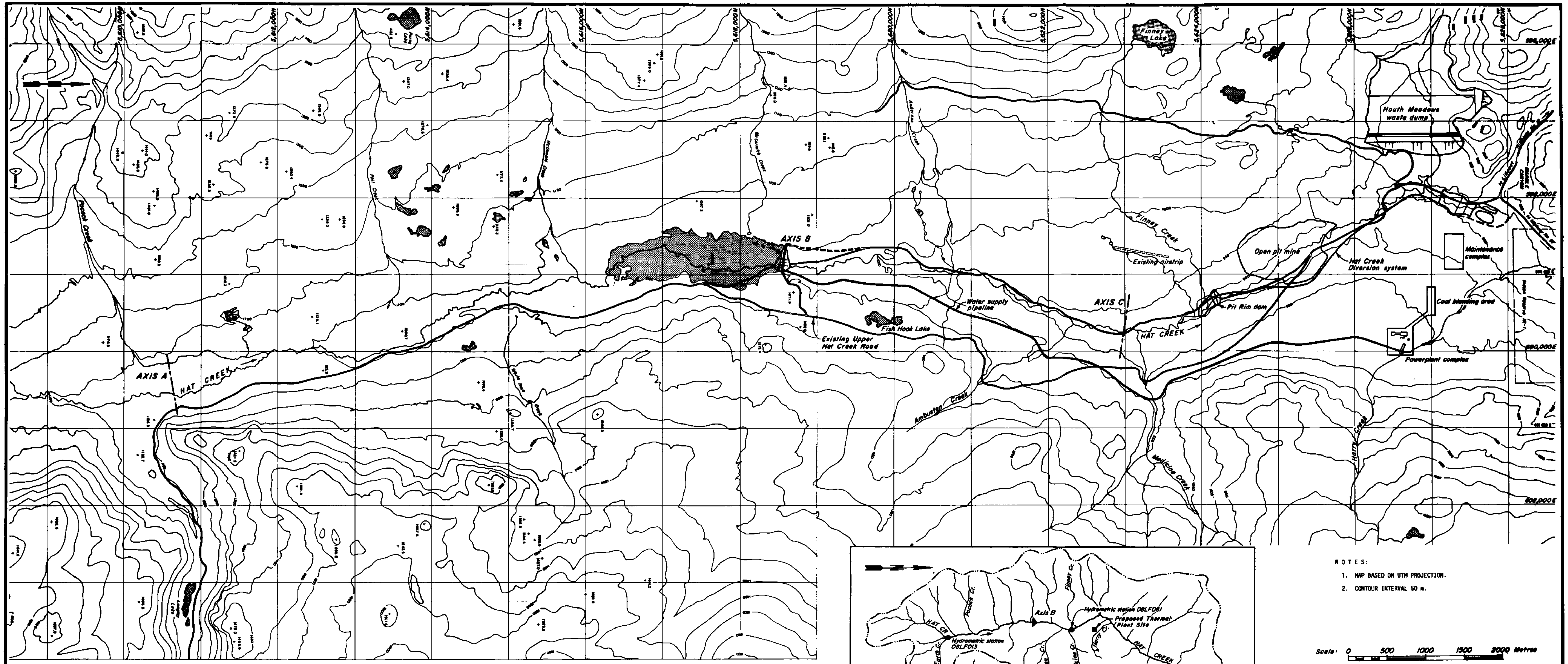
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT
225 MW THERMAL PLANT

WATER SUPPLY SYSTEM
AREA PLAN

DATE MAY 1984	FIG 1 - 1
DWN A H	DWG. No 604H-C14-A180

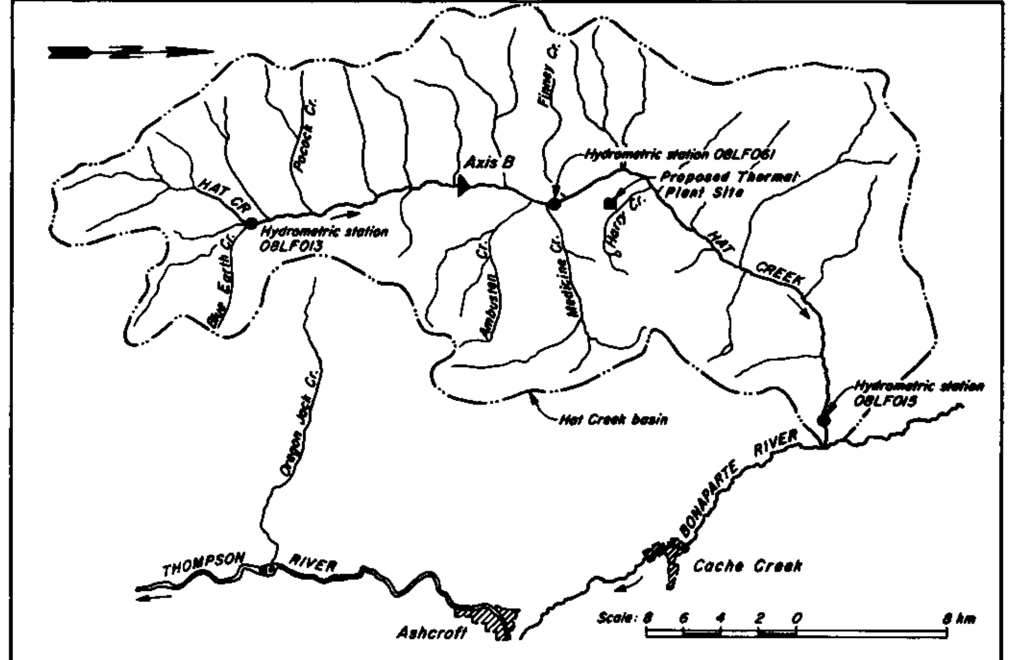
REPORT No H1694



NOTES:

1. MAP BASED ON UTM PROJECTION.
2. CONTOUR INTERVAL 50 m.

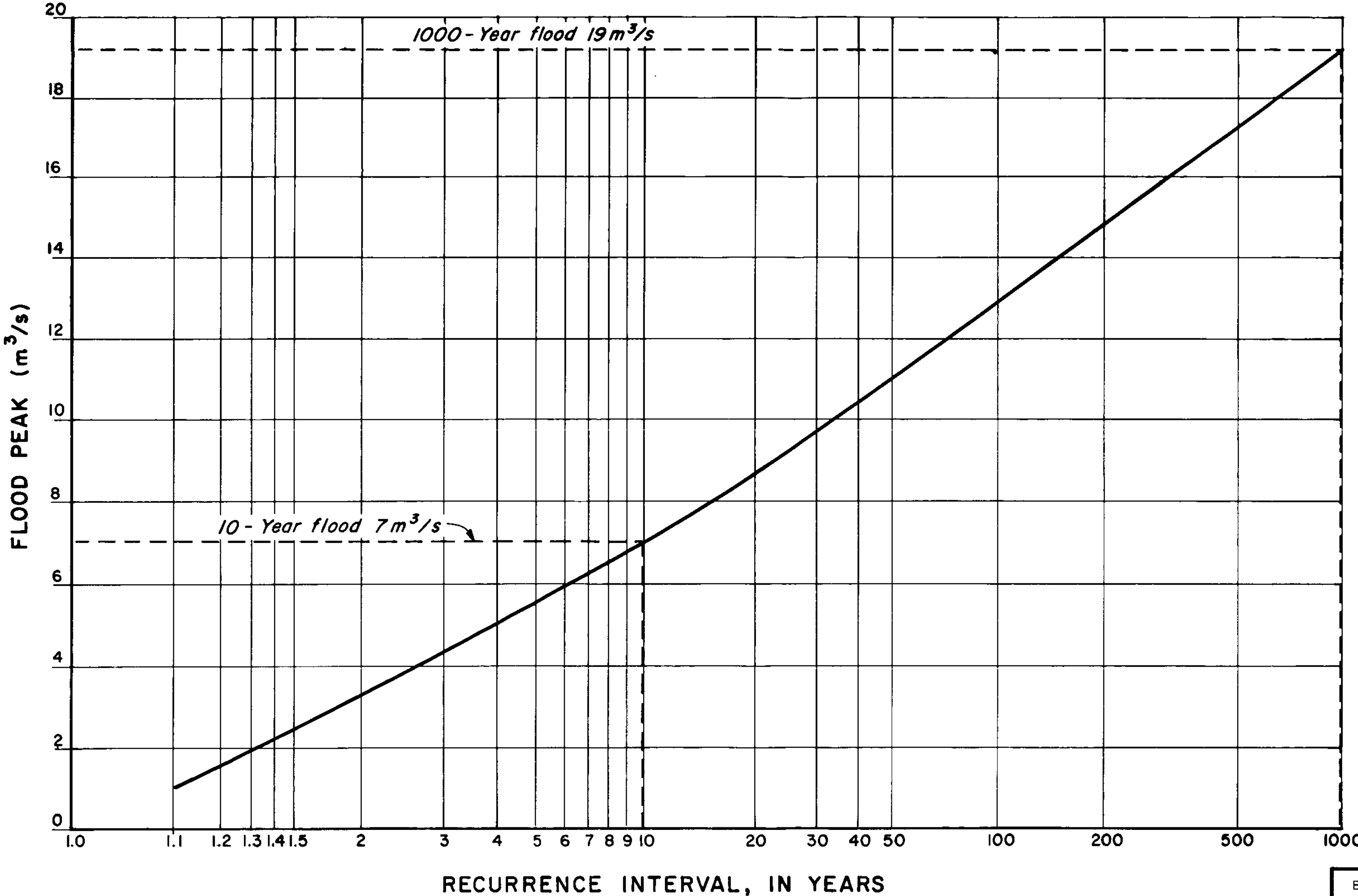
Scale: 0 500 1000 1500 2000 Metres



KEY MAP

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY		
HAT CREEK PROJECT 225 MW THERMAL PLANT WATER SUPPLY SYSTEM PROJECT LOCATION PLAN		
DATE MAY 1984	FIG 2-1	R
DWN AV	DWG No. 604H-C14-U181	

REPORT No. H1694



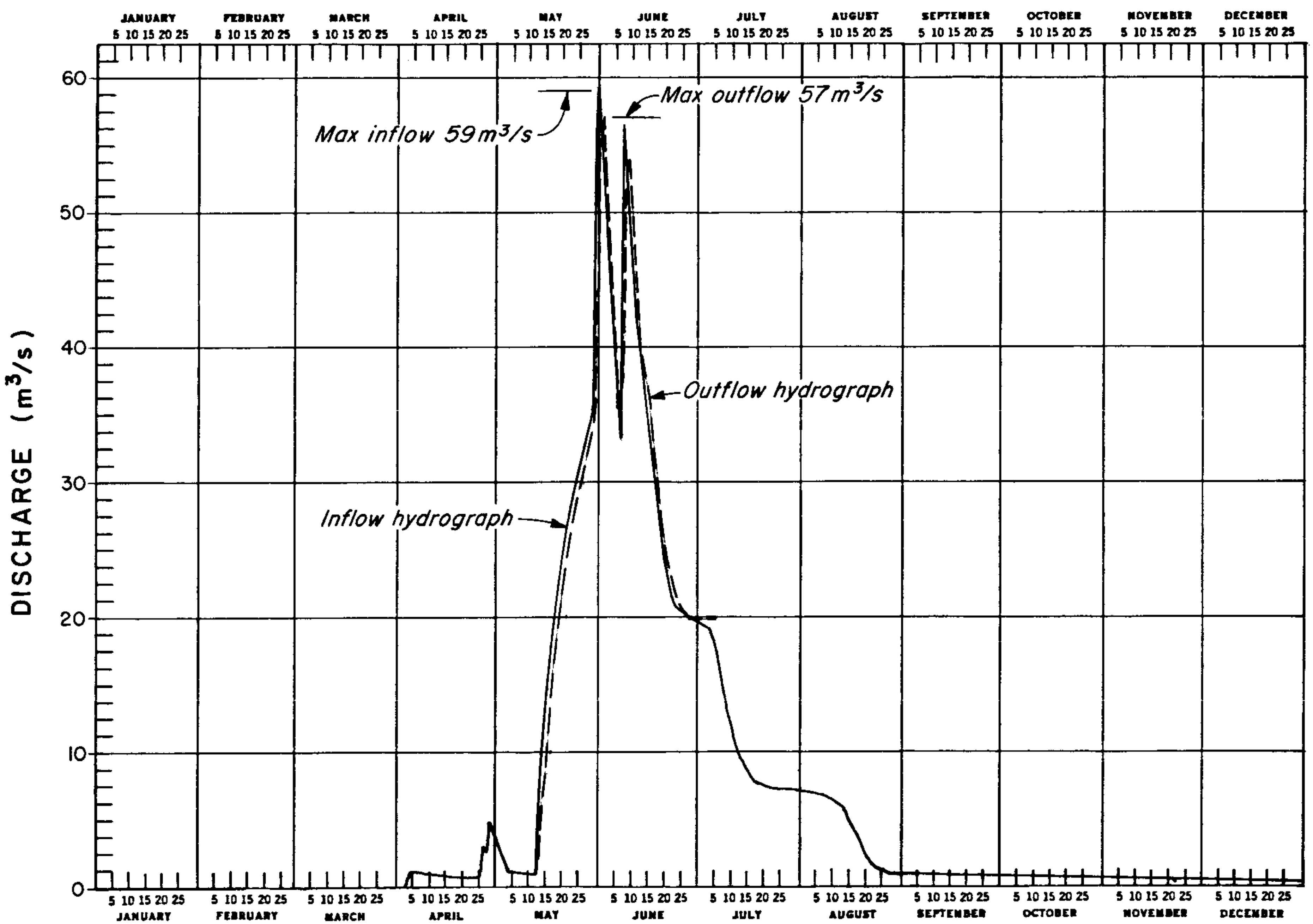
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT
225 MW THERMAL PLANT

WATER SUPPLY SYSTEM
FLOOD PEAK FREQUENCY CURVE

DATE MAY 1984	FIG 4 - 1
DWN A H	DWG. No. 604H-C14-B184

REPORT No H 1694



NOTES:

1. DRAINAGE AREA = 200 km^2
2. BASED ON PMF HYDROGRAPH DERIVED BY MONENCO CONSULTANTS LIMITED FOR WSC GAUGING STATION 08LF061 (DRAINAGE AREA = 350 km^2) AND PRORATED FOR THE DRAINAGE AREAS.

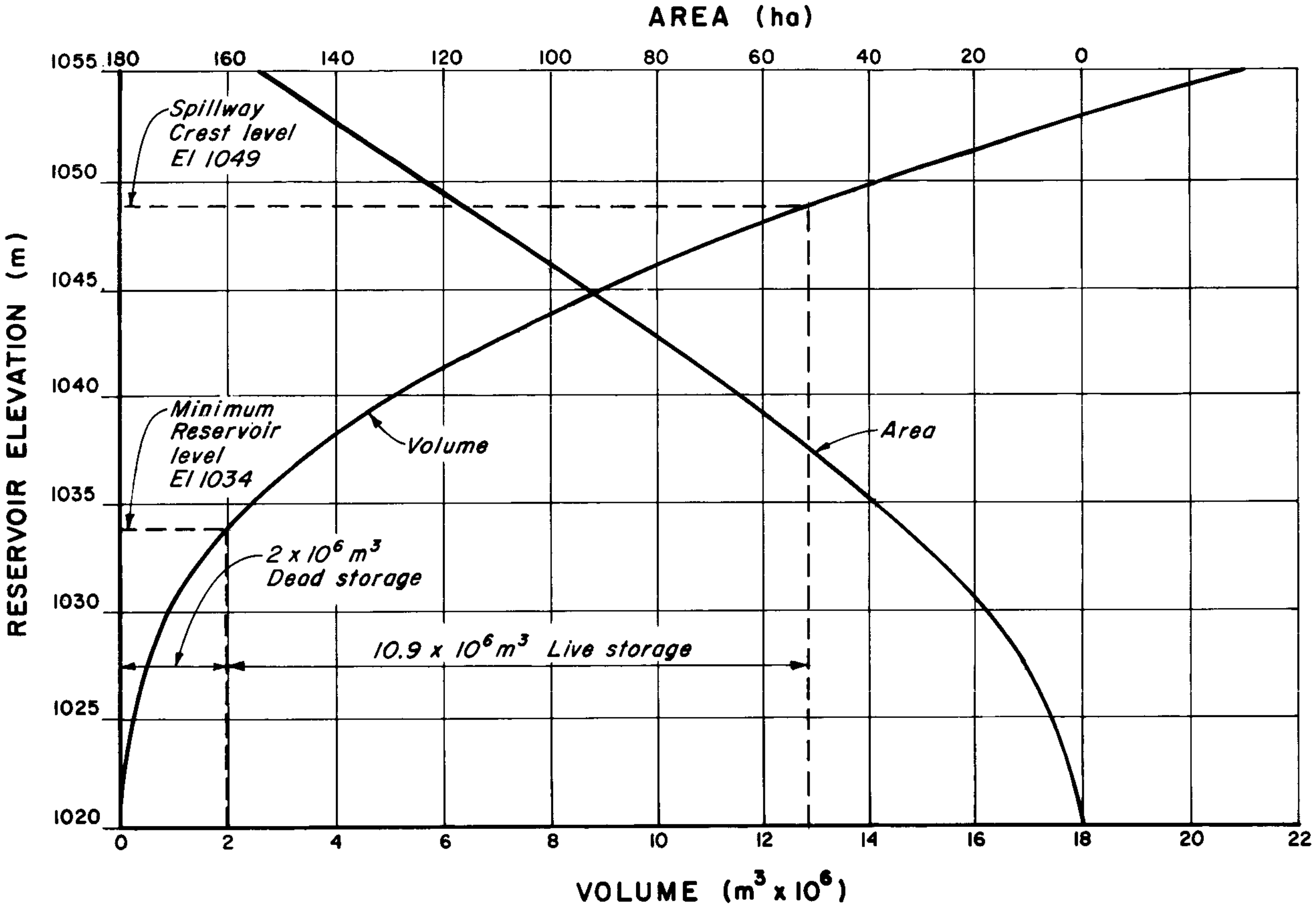
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT
225 MW THERMAL PLANT

WATER SUPPLY SYSTEM PROBABLE MAXIMUM FLOOD HYDROGRAPHS

DATE MAY 1984	FIG 4-2
DWN A H	DWG. No 604H-C14-B185

REPORT No H1694



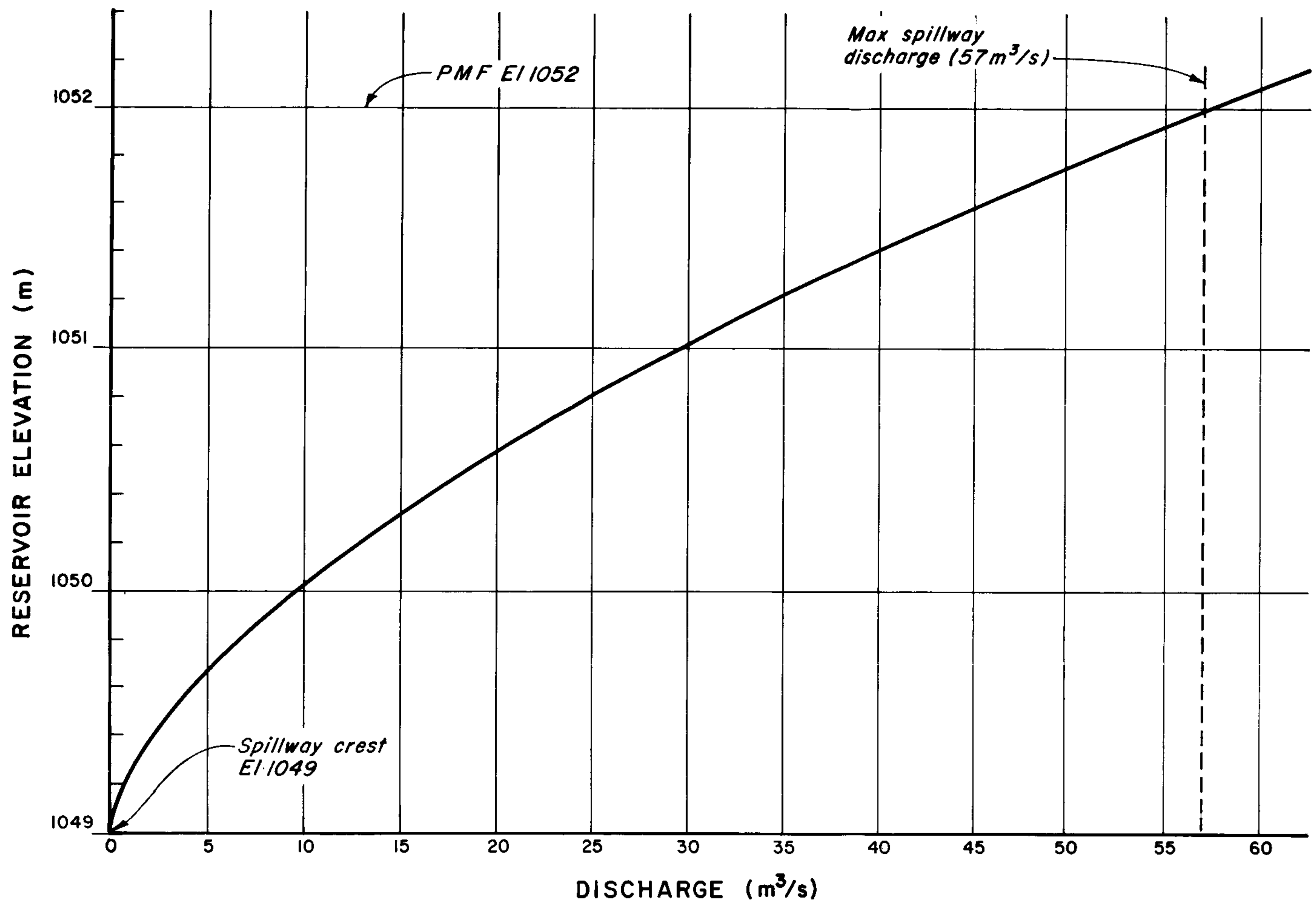
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT
225 MW THERMAL PLANT

WATER SUPPLY SYSTEM
RESERVOIR STORAGE CURVE

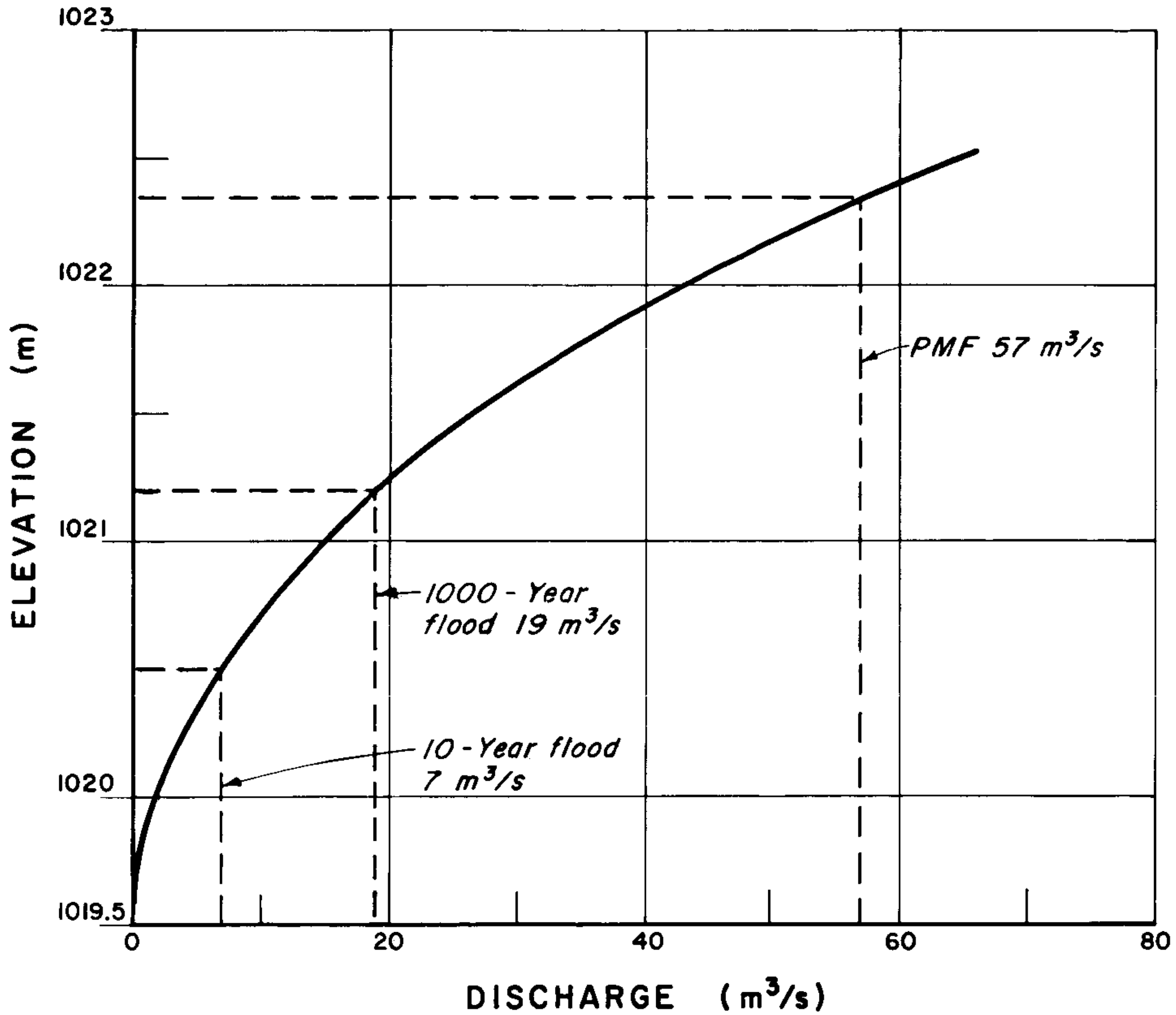
DATE MAY 1984	FIG 4 - 3
DWN A H	DWG. No 604H-C14-B186

REPORT No. H 1694



BRITISH COLUMBIA HYDRO AND POWER AUTHORITY	
HAT CREEK PROJECT 225 MW THERMAL PLANT **WATER SUPPLY SYSTEM SPILLWAY RATING CURVE**	
DATE MAY 1984	FIG 4-4
DWN A H	DWG. No 604 H-C14-B187

REPORT No H 1694



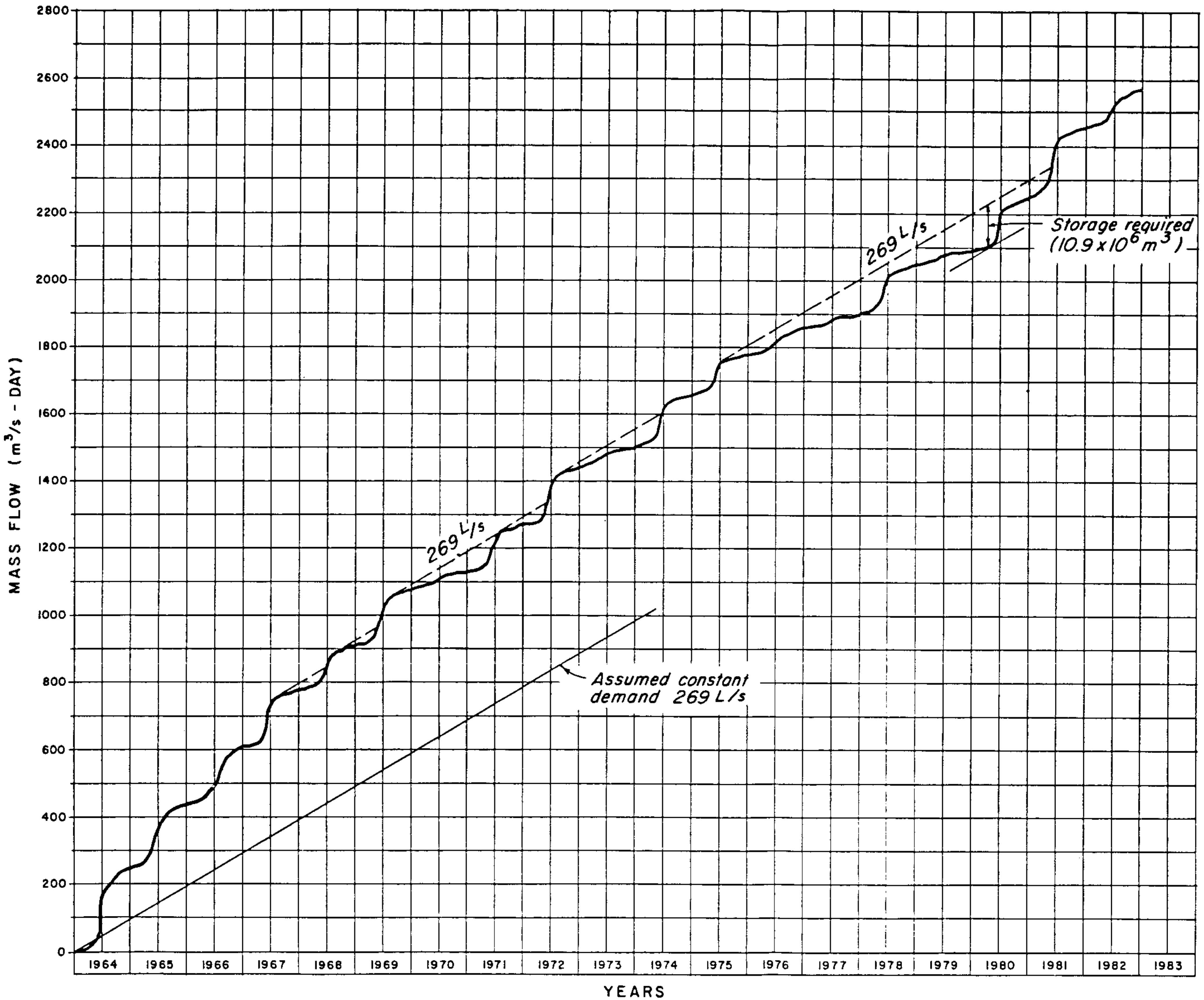
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT
225 MW THERMAL PLANT

WATER SUPPLY SYSTEM
TAILWATER RATING CURVE

DATE MAY 1984	FIG 4 - 5
DWN A H	DWG. No 604H-C14-B188

REPORT No H1694



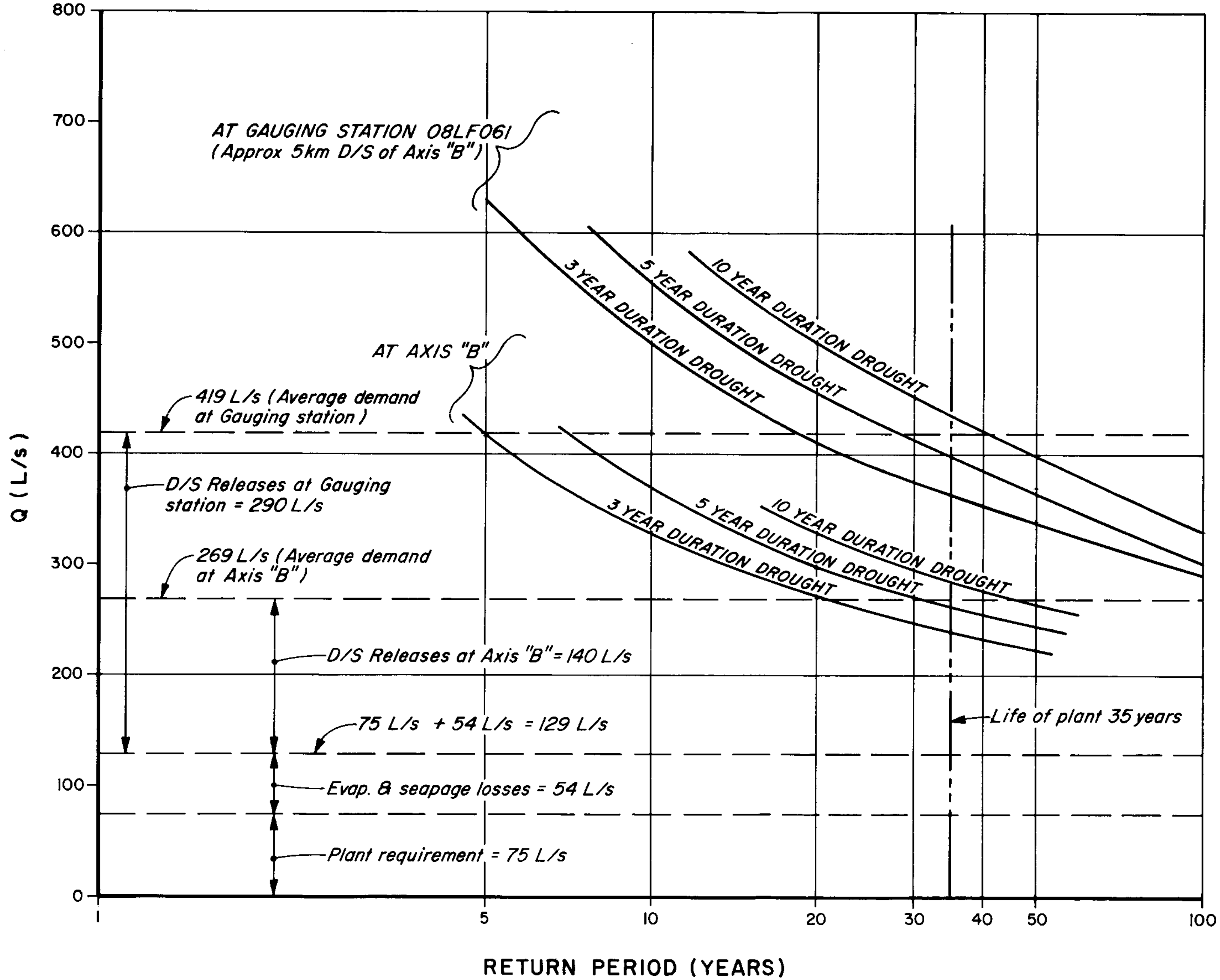
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT
225 MW THERMAL PLANT

WATER SUPPLY SYSTEM MASS CURVE

DATE MAY 1984	FIG 4 - 6
DWN A H	DWG. No 604H-C14-B189

REPORT No H 1694

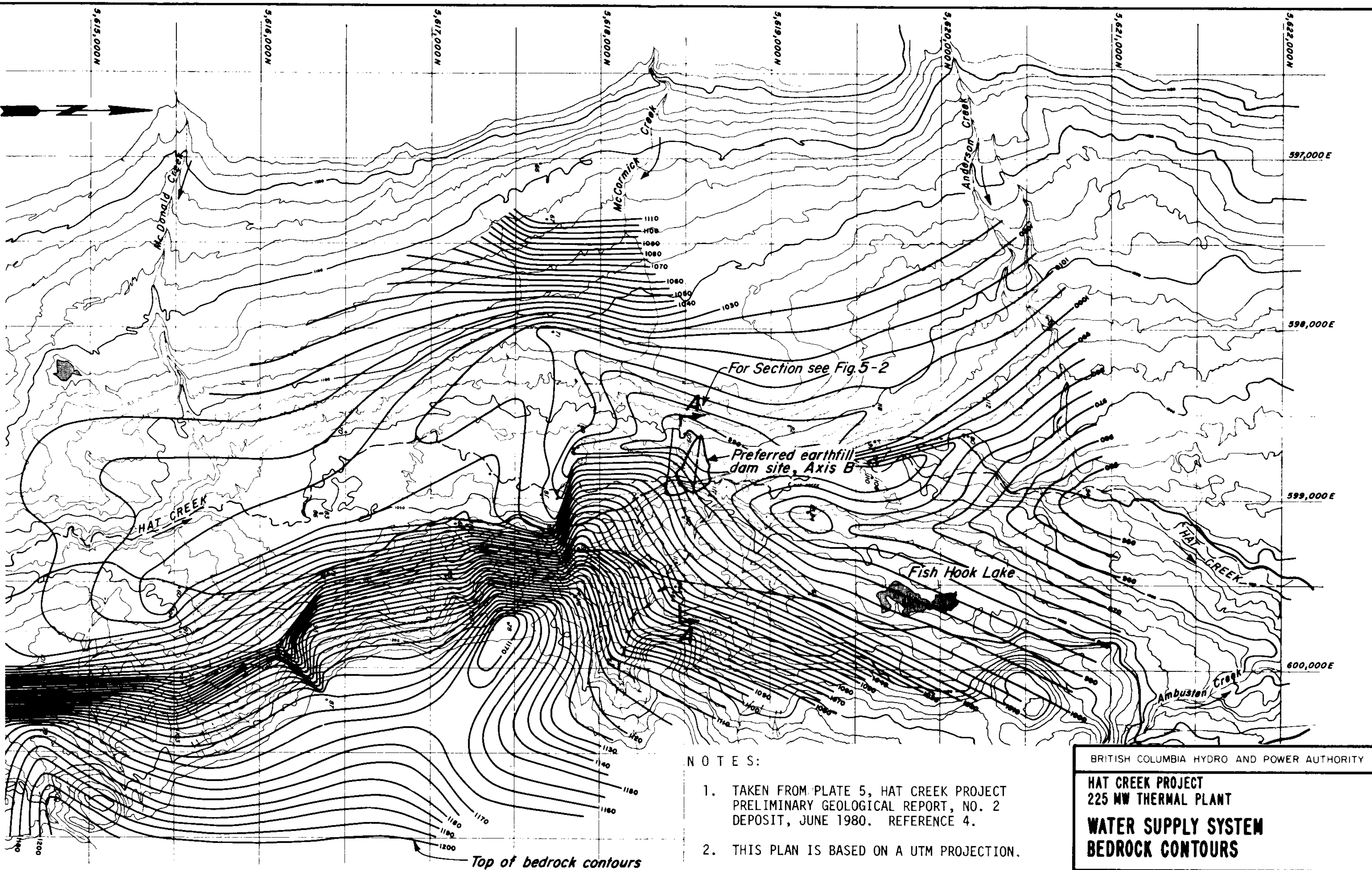


NOTE:

THIS FIGURE IS BASED ON TABLE 1 IN A REPORT BY MONENCO CONSULTANTS PACIFIC LTD. REFERENCE 10.

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY	
HAT CREEK PROJECT 225 MW THERMAL PLANT **WATER SUPPLY SYSTEM LOW FLOW CHARACTERISTICS (AXIS B)**	
DATE MAY 1984	FIG 4-7
DWN A H	DWG. No. 604H-C14-B190

REPORT No. H 1694



NOTES:

1. TAKEN FROM PLATE 5, HAT CREEK PROJECT PRELIMINARY GEOLOGICAL REPORT, NO. 2 DEPOSIT, JUNE 1980. REFERENCE 4.

2. THIS PLAN IS BASED ON A UTM PROJECTION.

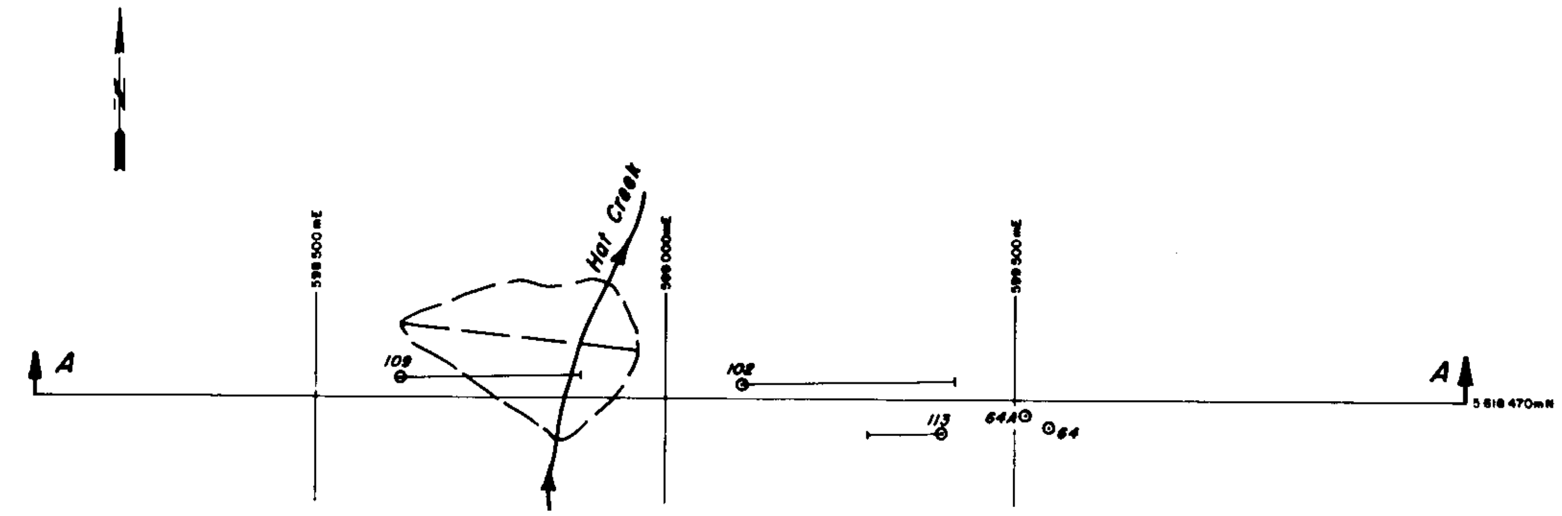
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT
225 MW THERMAL PLANT

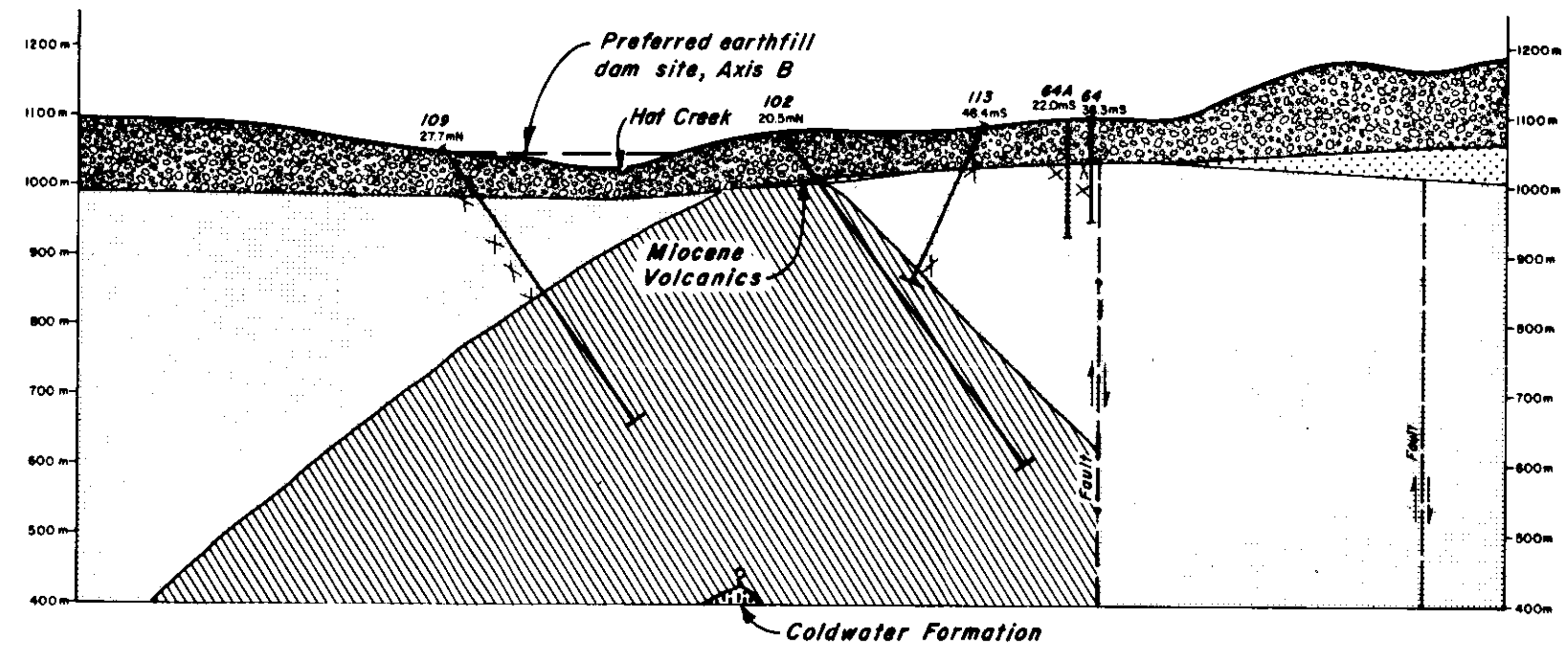
WATER SUPPLY SYSTEM
BEDROCK CONTOURS

DATE MAY 1984	FIG 5-1
DWN AV	DWG. No 604H-C14-B191

REPORT No H1694



PLAN



SECTION A-A (FIG. 5-1)
(Looking downstream)

LEGEND:

- OVERBURDEN
- MIOCENE VOLCANICS
- MEDICINE CREEK FORMATION
- HAT CREEK FORMATION
- COLDWATER FORMATION
- INCLINED DRILL HOLE
- VERTICAL DRILL HOLE

NOTES:

1. THIS GEOLOGICAL SECTION IS TAKEN ALONG LATITUDE 5,618,470 N.
2. ADAPTED FROM PLATE 6, HAT CREEK PROJECT, PRELIMINARY GEOLOGICAL REPORT, NO. 2 DEPOSIT, JUNE 1980. REFERENCE 4.

Scale: 0 100 200 300 400 500 Metres

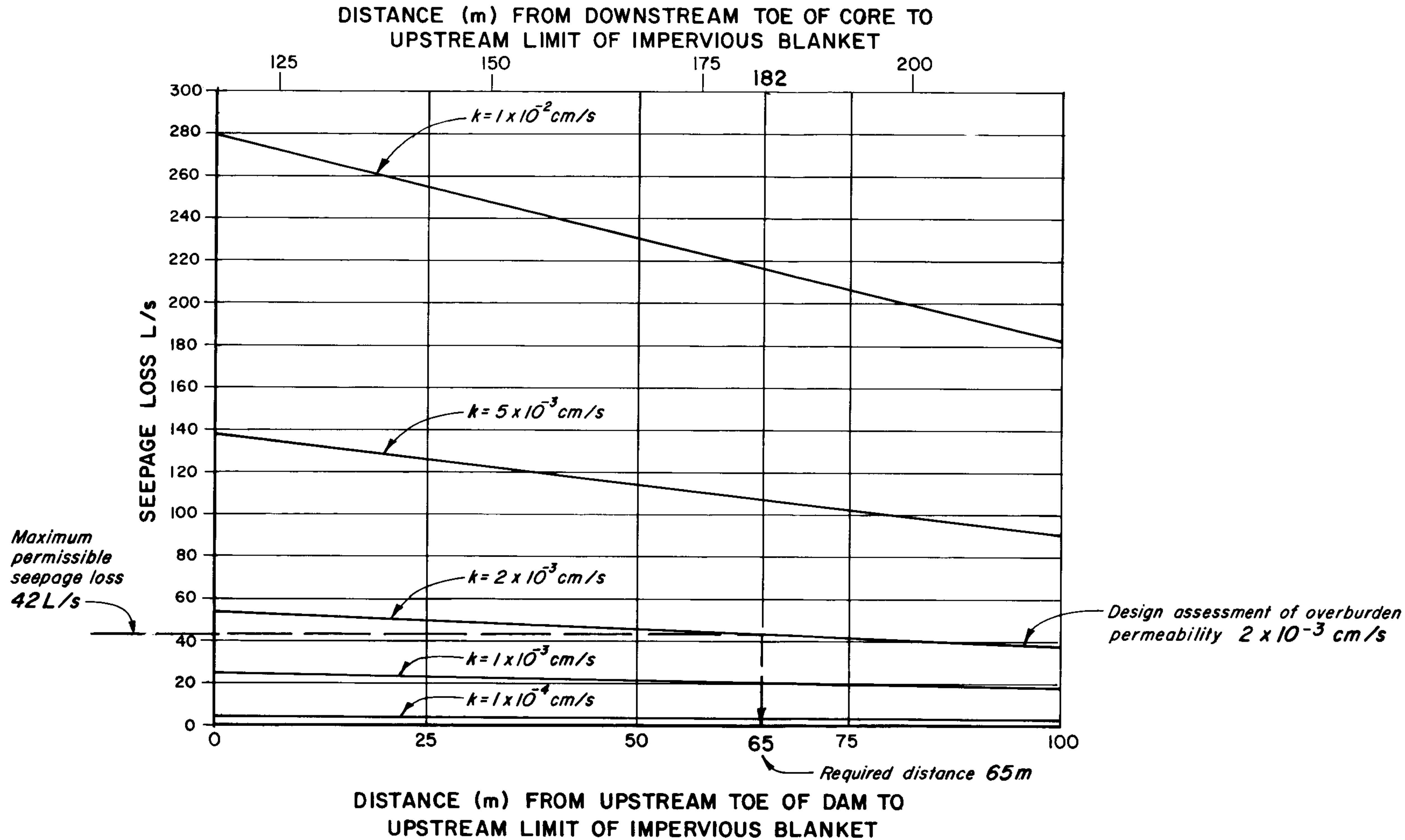
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT
225 MW THERMAL PLANT

WATER SUPPLY SYSTEM
GEOLOGICAL SECTION NEAR AXIS B

DATE MAY 1984	FIG 5-2
DWN AV	DWG No 604H-C14-B192

REPORT No H1694



NOTES:

1. THE FOLLOWING ASSUMPTIONS WERE MADE IN THE SEEPAGE ANALYSES.
   a) OVERBURDEN WITH A UNIFORM PERMEABILITY OF 2×10^{-3} cm/s.
   b) AVERAGE OVERBURDEN DEPTH OF 30 m.
   c) RESERVOIR LEVEL EL. 1049, TAILWATER LEVEL EL. 1020.
   d) SEEPAGE UNDER THE EARTHFILL DAM AND THROUGH THE ABUTMENTS.

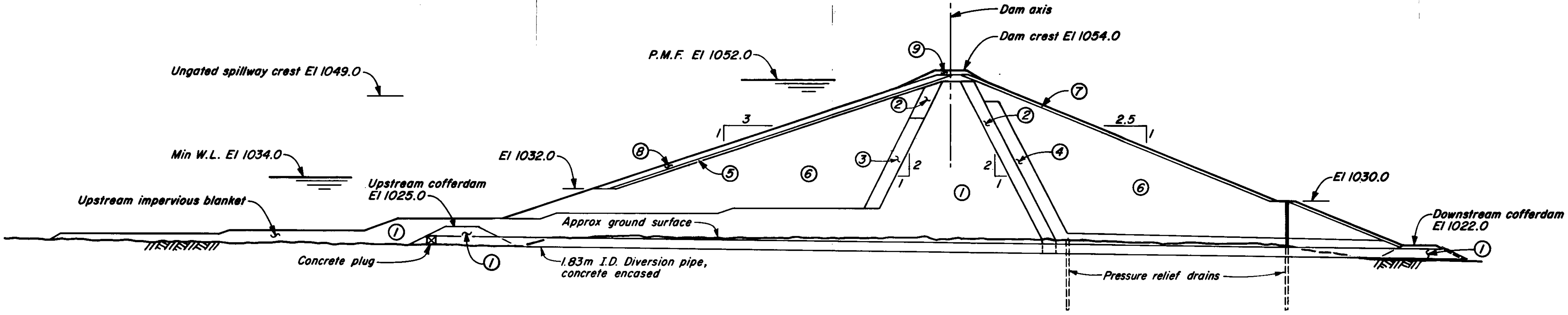
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT
225 MW THERMAL PLANT

WATER SUPPLY SYSTEM
DAM AXIS B
SEEPAGE ANALYSES

DATE MAY 1984	FIG 5 - 3
DWN A H	DWG. No 604H-C14-B193

REPORT No H 1694



SECTION THROUGH EARTHFILL DAM ALONG DIVERSION PIPE

LEGEND:

ZONE	DESCRIPTION
1	IMPERVIOUS CORE, COFFERDAMS, U/S IMPERVIOUS BLANKET
2	FILTER
3	UPSTREAM TRANSITION
4	DRAIN
5	RIPRAP BEDDING
6	SHELL
7	SLOPE PROTECTION
8	RIPRAP
9	GRANULAR BASE COURSE AND ROAD SURFACING

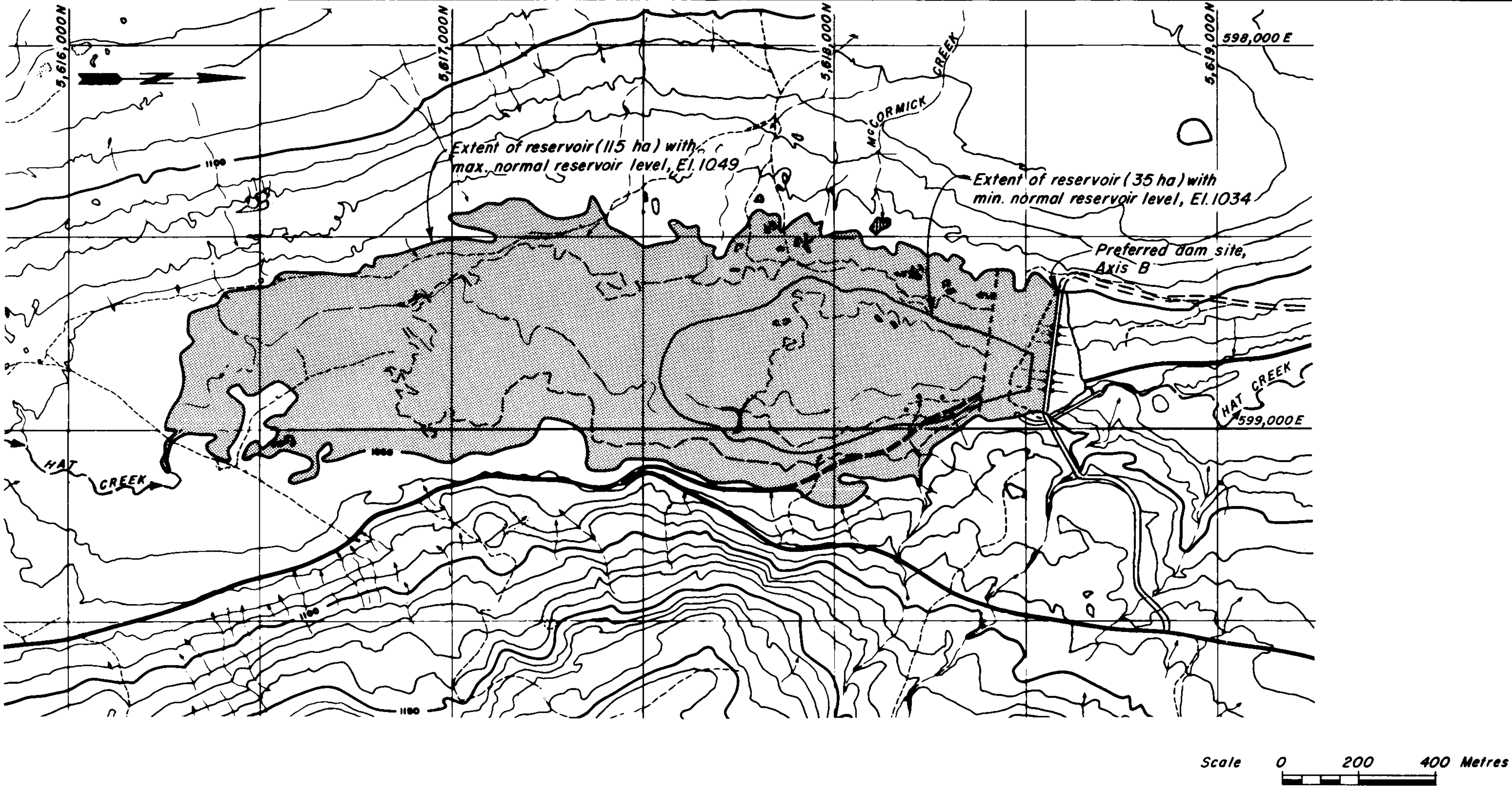
Scale: 1:500 — 10 0 10 Metres

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT
225 MW THERMAL PLANT
WATER SUPPLY SYSTEM
EARTHFILL DAM
SECTION

DATE MAY 1984	FIG 5-4
DWN A V	DWG. No 604H-C14-D194

REPORT No H 1694



NOTES:

1. THIS PLAN IS BASED ON A UTM PROJECTION.

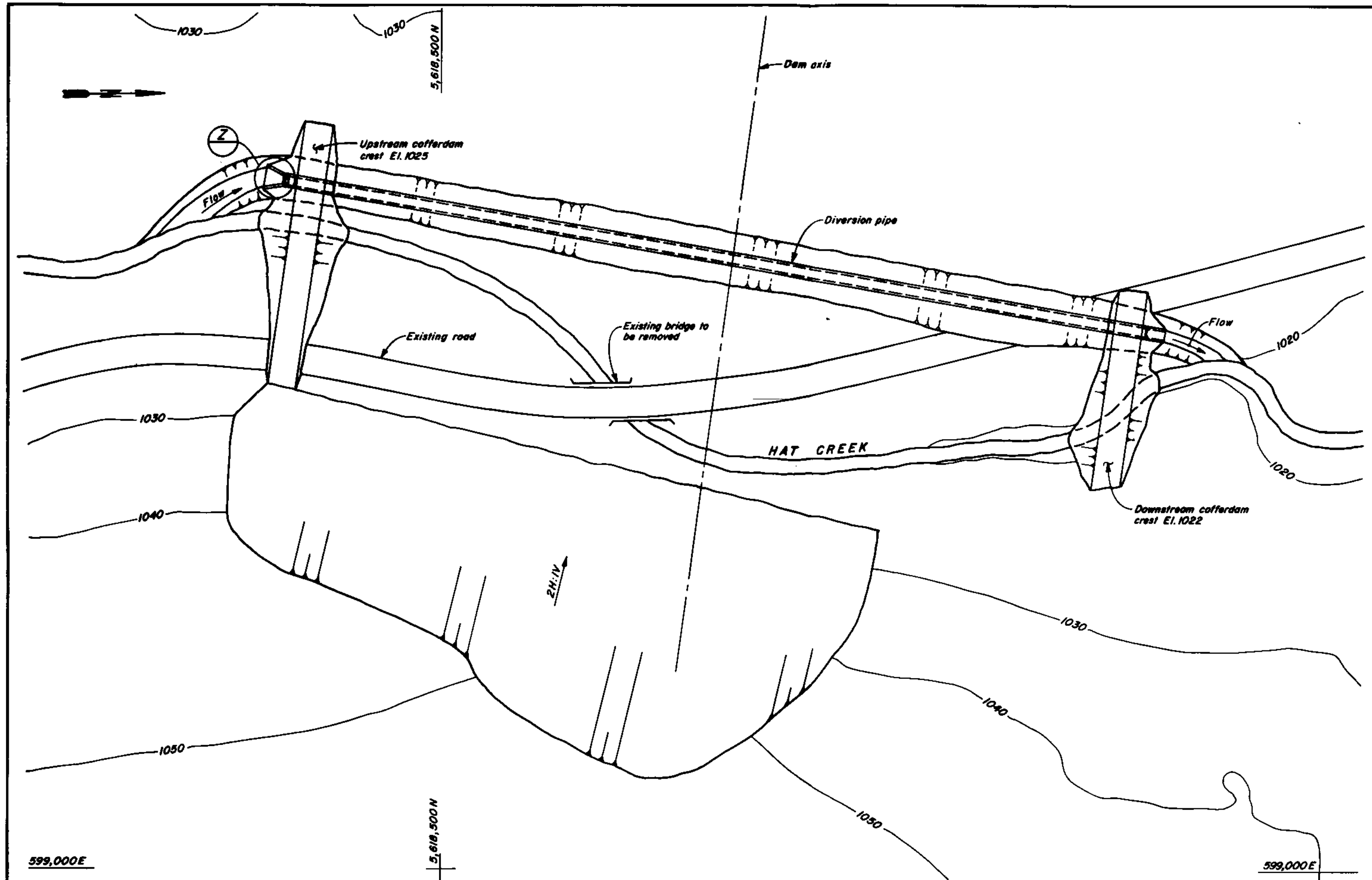
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT
225 MW THERMAL PLANT

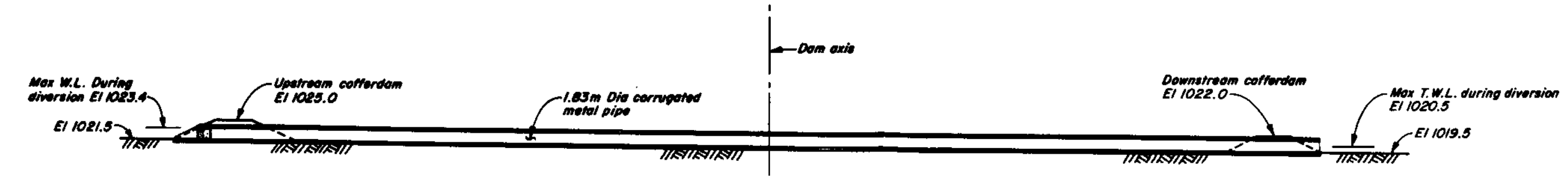
WATER SUPPLY SYSTEM
DAM AXIS B
RESERVOIR PLAN

DATE MAY 1984	FIG 5 - 5
DWN A H	DWG. No 604H-C14-B195

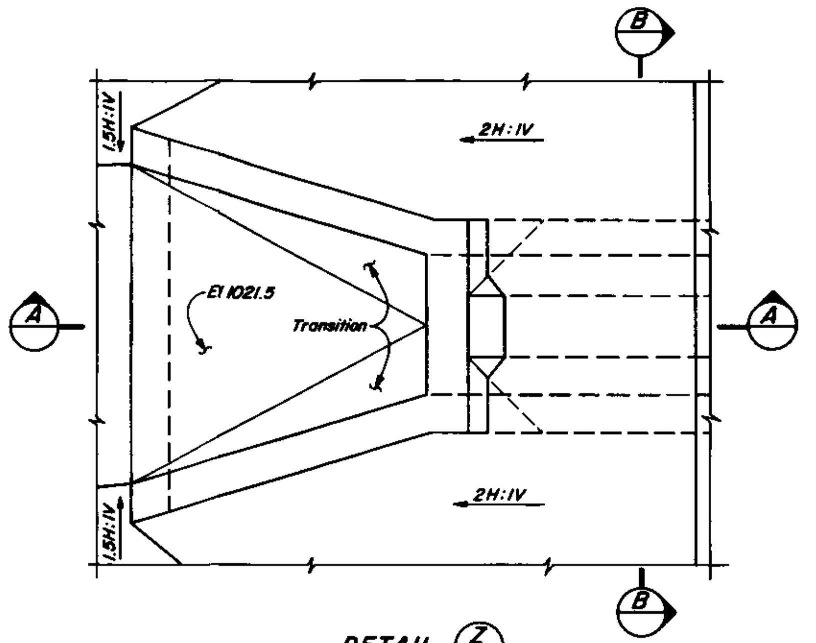
REPORT No H1694



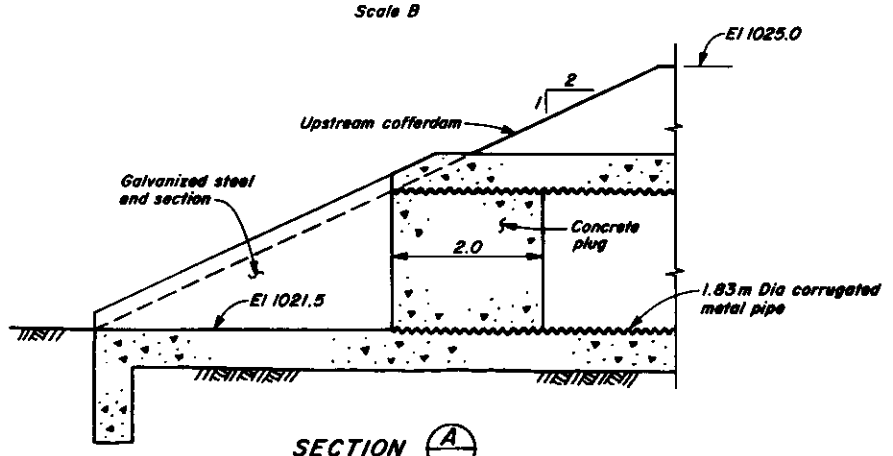
PLAN (Phase B, see Fig 7-2)
Scale A



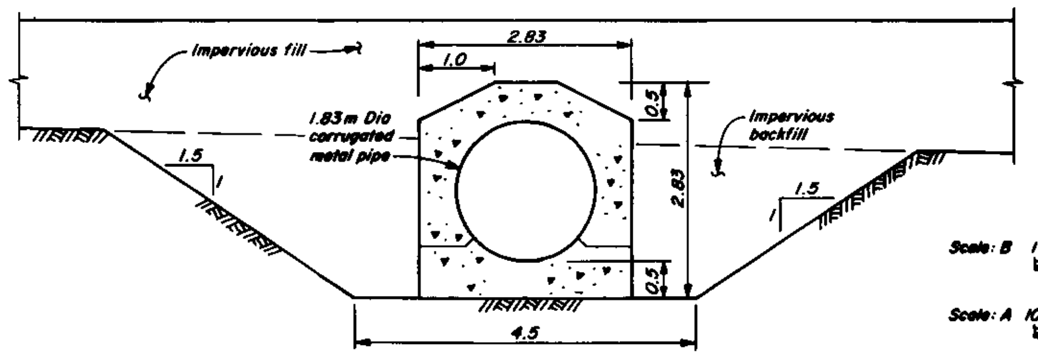
SECTION THROUGH DIVERSION PIPE
Scale A



DETAIL Z
Scale B



SECTION A
Grouting details not shown
Scale B



SECTION B
Scale B

NOTES:
1. For construction sequence see FIG. 7-2

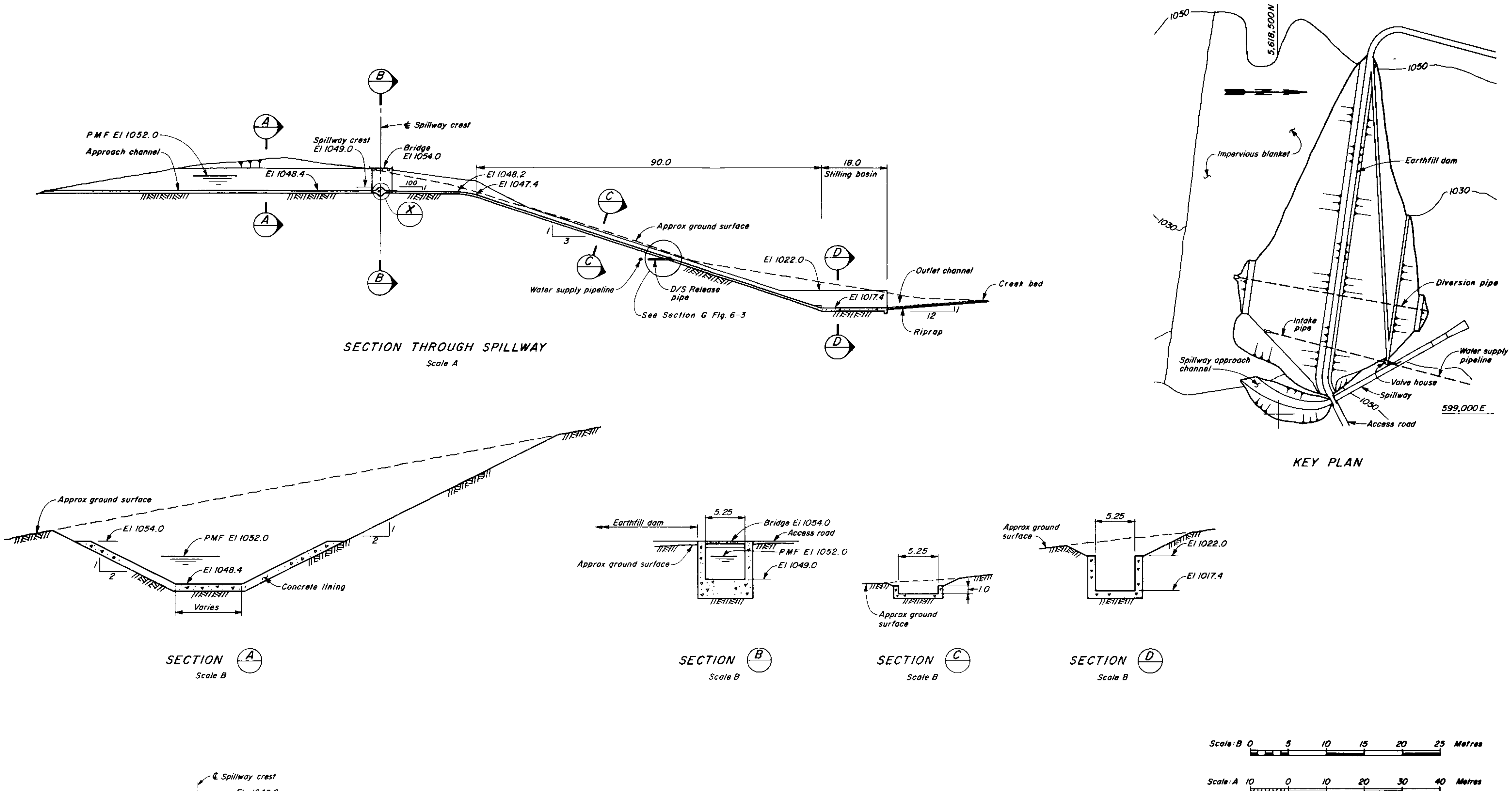
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

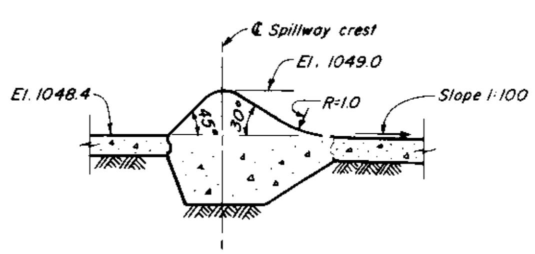
HAT CREEK PROJECT
225 MW THERMAL PLANT

WATER SUPPLY SYSTEM
DIVERSION PIPE

DATE MAY 1984	FIG 6 - 1
DWN AV	DWG No 604H-C14-U196

REPORT No H 1694





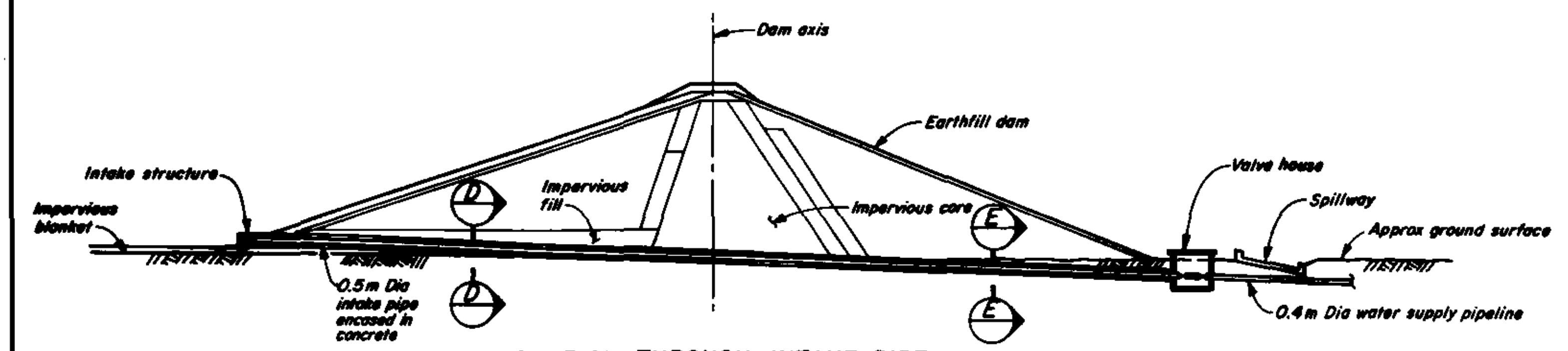
DETAIL X
NTS

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

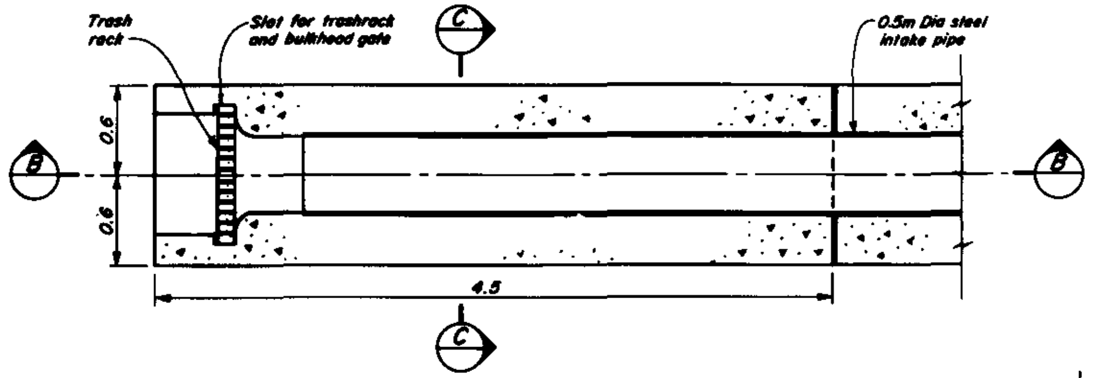
HAT CREEK PROJECT
225 MW THERMAL PLANT

WATER SUPPLY SYSTEM SPILLWAY

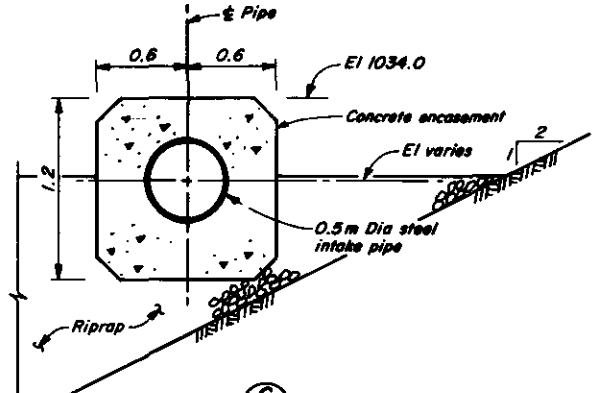
DATE MAY 1984	FIG 6-2
DWN AV	DWG No 604H-C14-D197



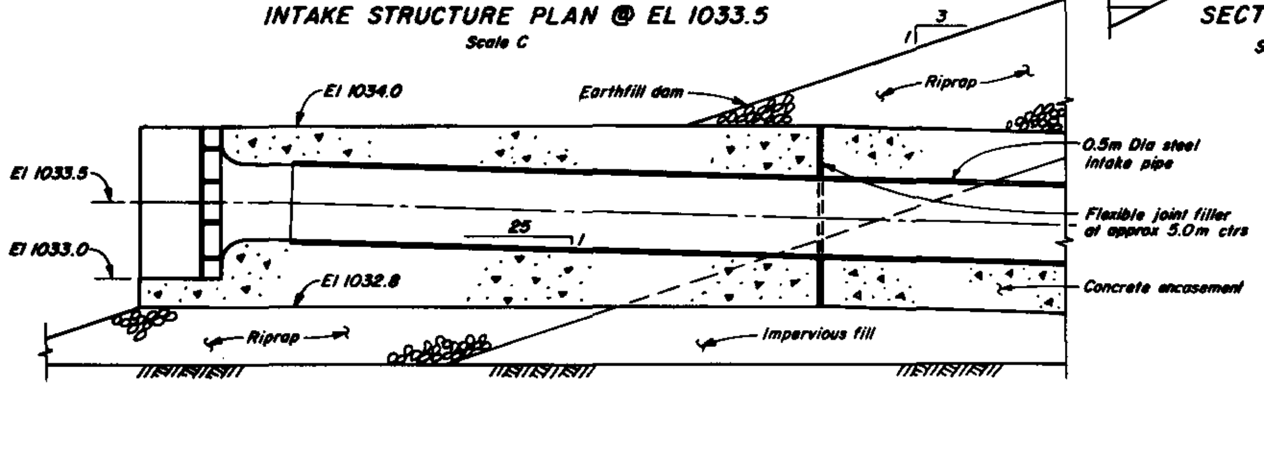
SECTION THROUGH INTAKE PIPE
Scale A



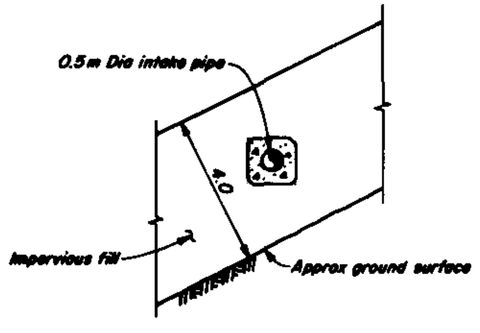
INTAKE STRUCTURE PLAN @ EL 1033.5
Scale C



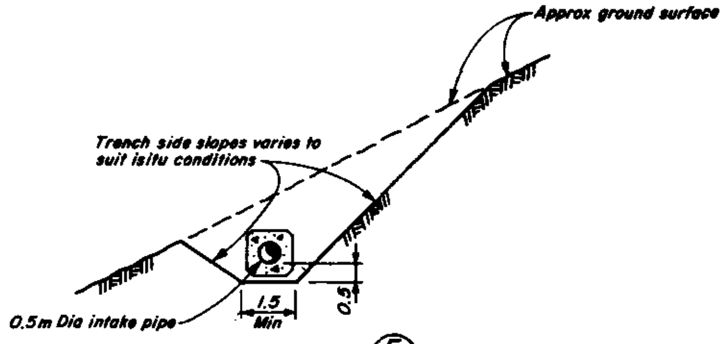
SECTION C
Scale C



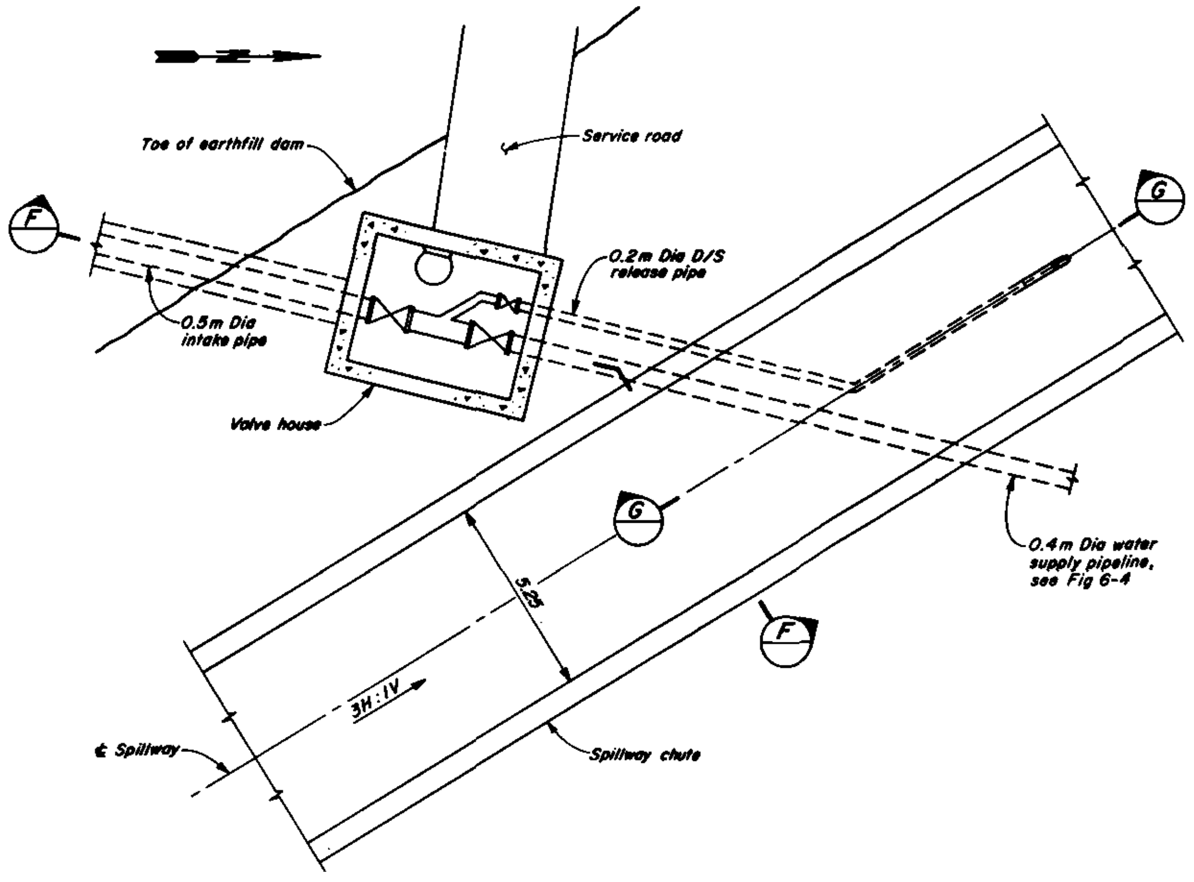
SECTION B
Scale C



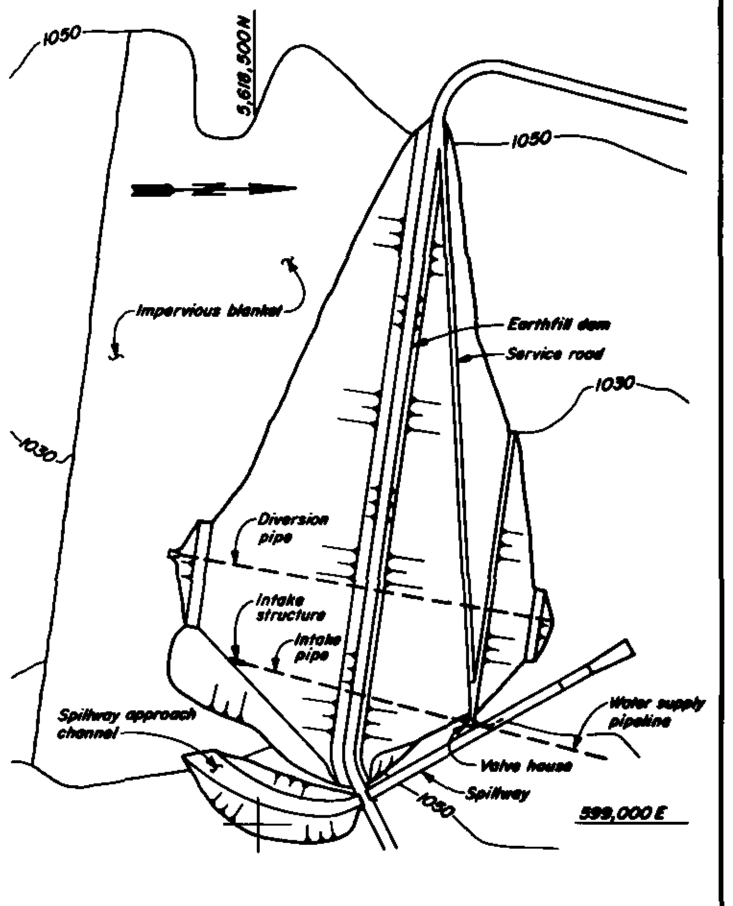
SECTION D
Scale B



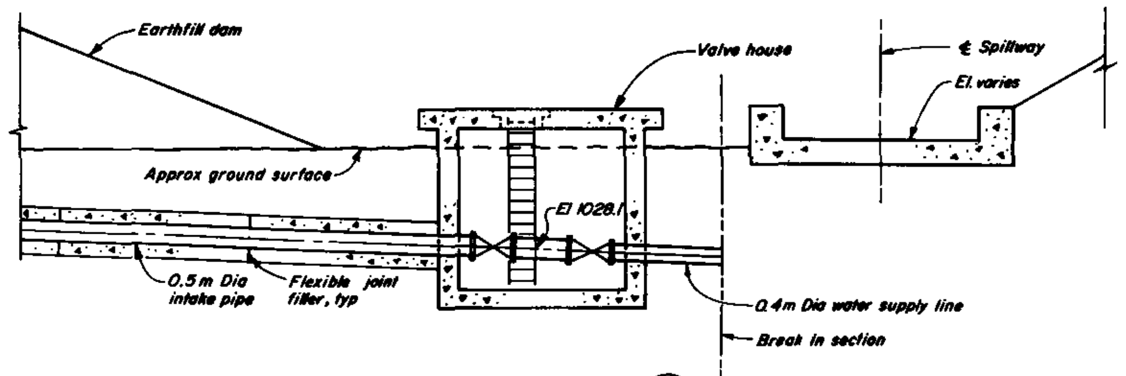
SECTION E
Scale B



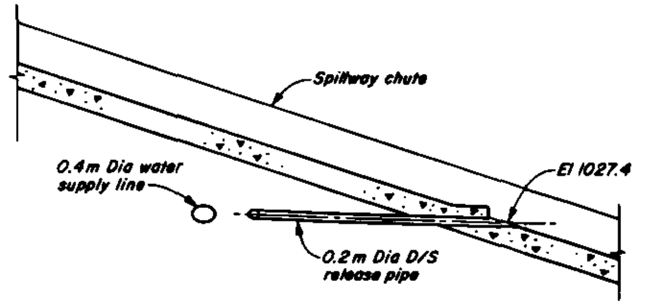
VALVE HOUSE PLAN
Scale B



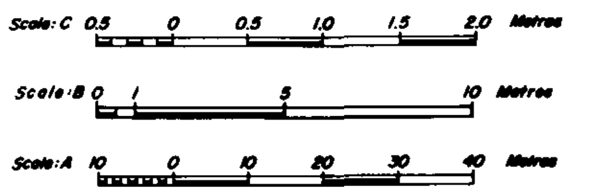
KEY PLAN



SECTION F
Scale B



SECTION G
Scale B



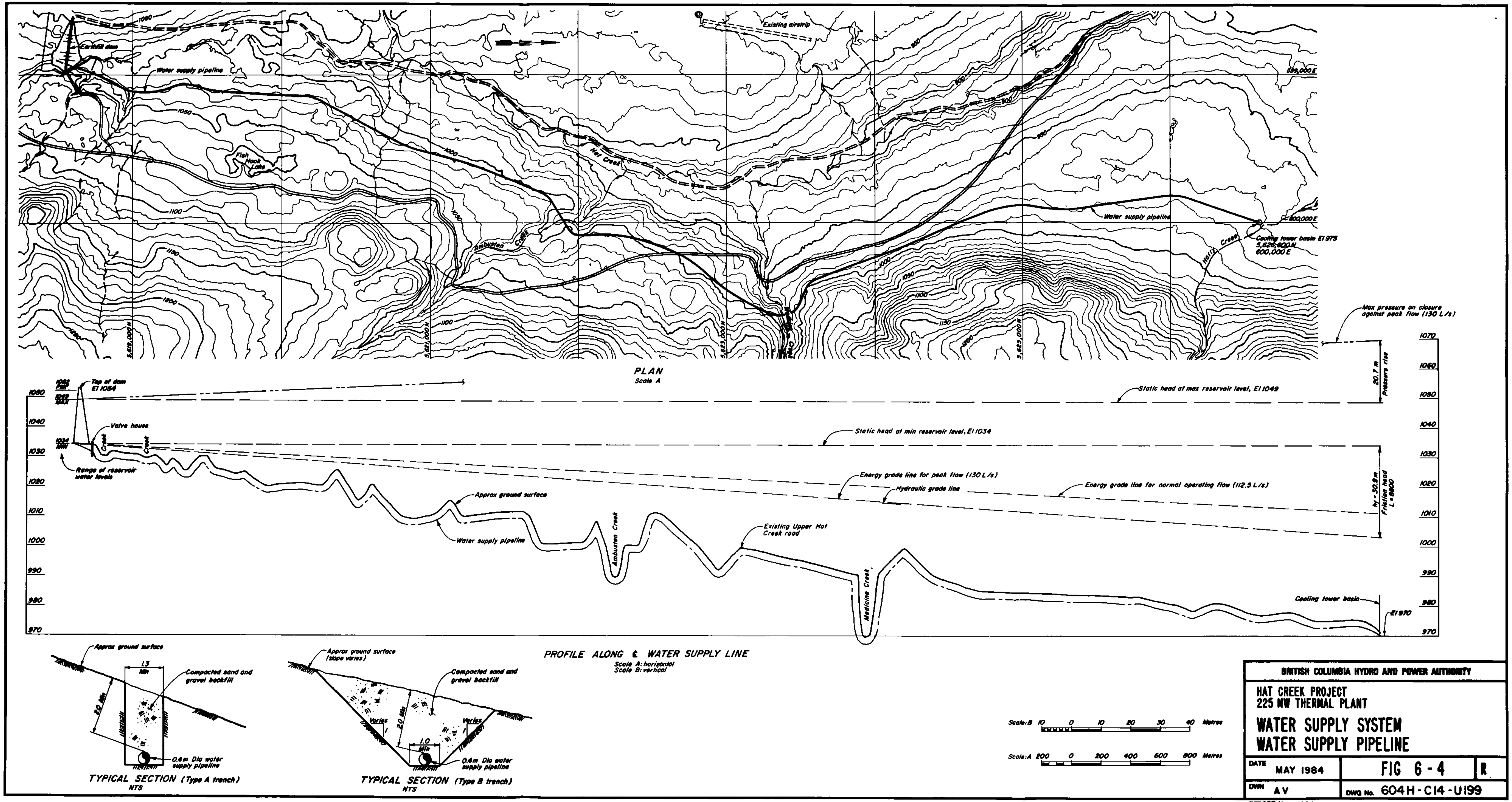
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT
225 MW THERMAL PLANT

WATER SUPPLY SYSTEM
INTAKE STRUCTURE, INTAKE PIPE
AND VALVE HOUSE

DATE MAY 1984	FIG 6-3
DWN AV	DWG No. 604H-C14-U198

REPORT No H1694



BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT
225 MW THERMAL PLANT

WATER SUPPLY SYSTEM
WATER SUPPLY PIPELINE

DATE MAY 1984

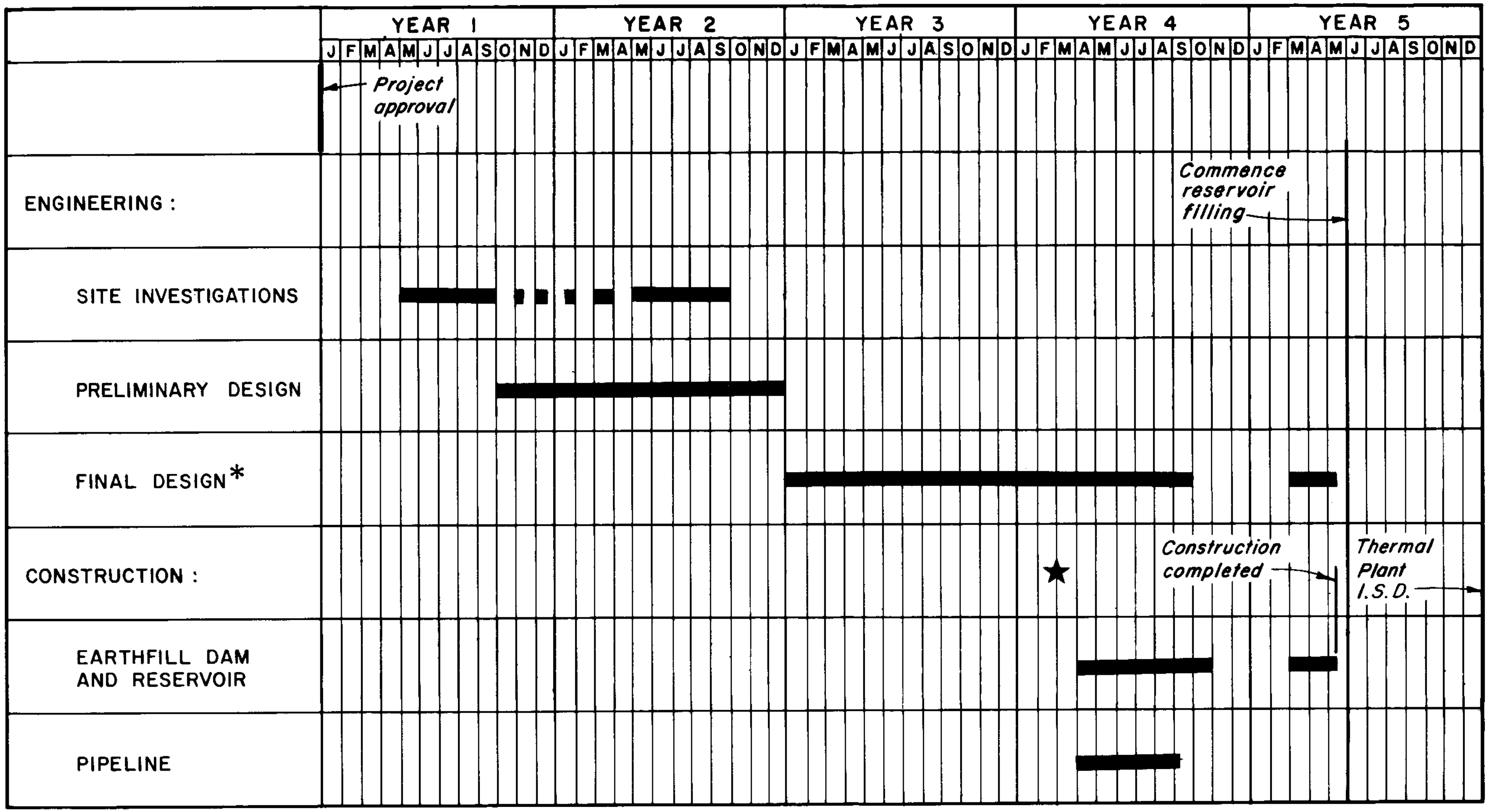
FIG 6 - 4

R

DWN A V

DWG No. 604H - C14 - U199

REPORT No. H 1694



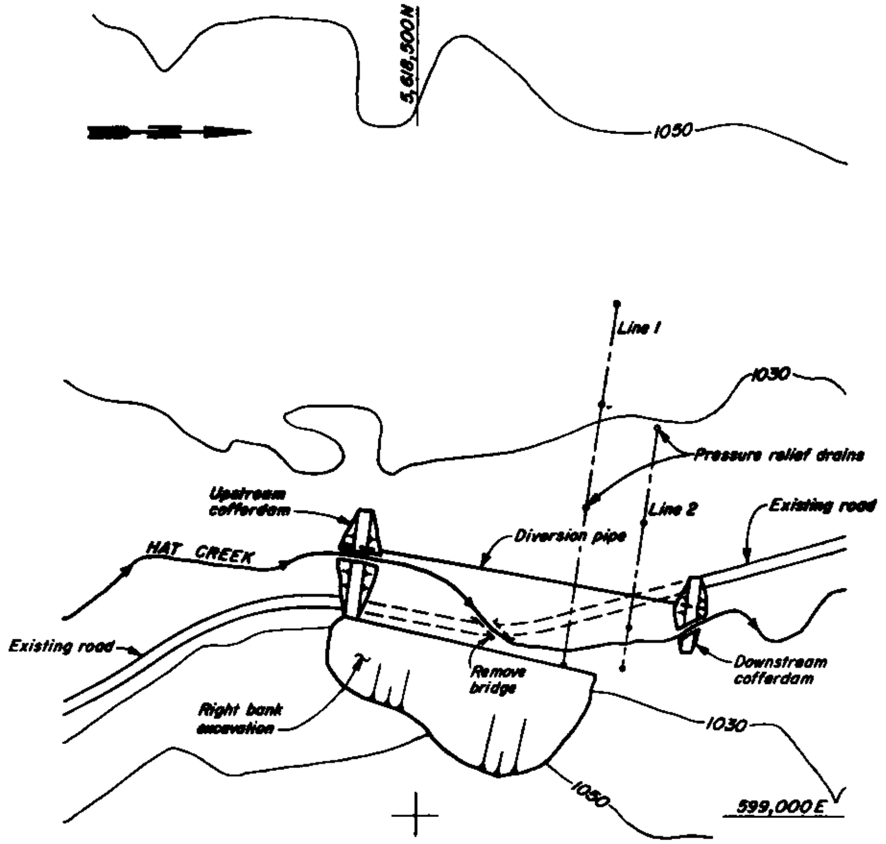
LEGEND:

* INCLUDES CONSTRUCTION SUPERVISION

★ CONTRACT AWARD

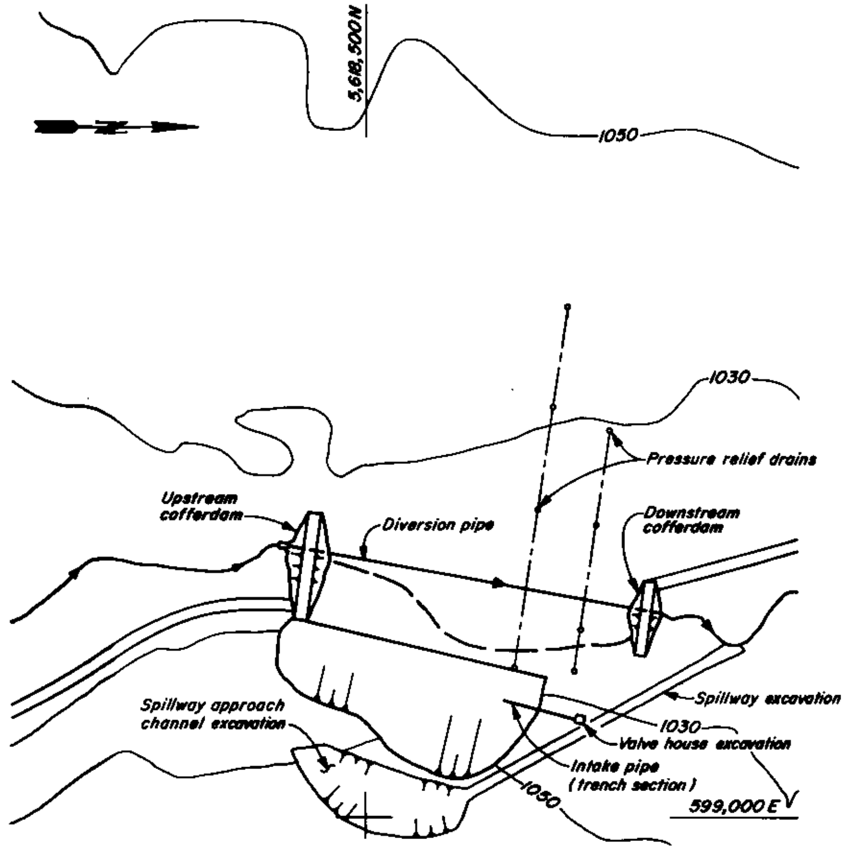
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY	
HAT CREEK PROJECT 225 MW THERMAL PLANT **WATER SUPPLY SYSTEM ENGINEERING AND CONSTRUCTION SCHEDULE**	
DATE MAY 1984	FIG 7 - 1
DWN AH	DWG. No 604H-C14-B200

REPORT No. H 1694



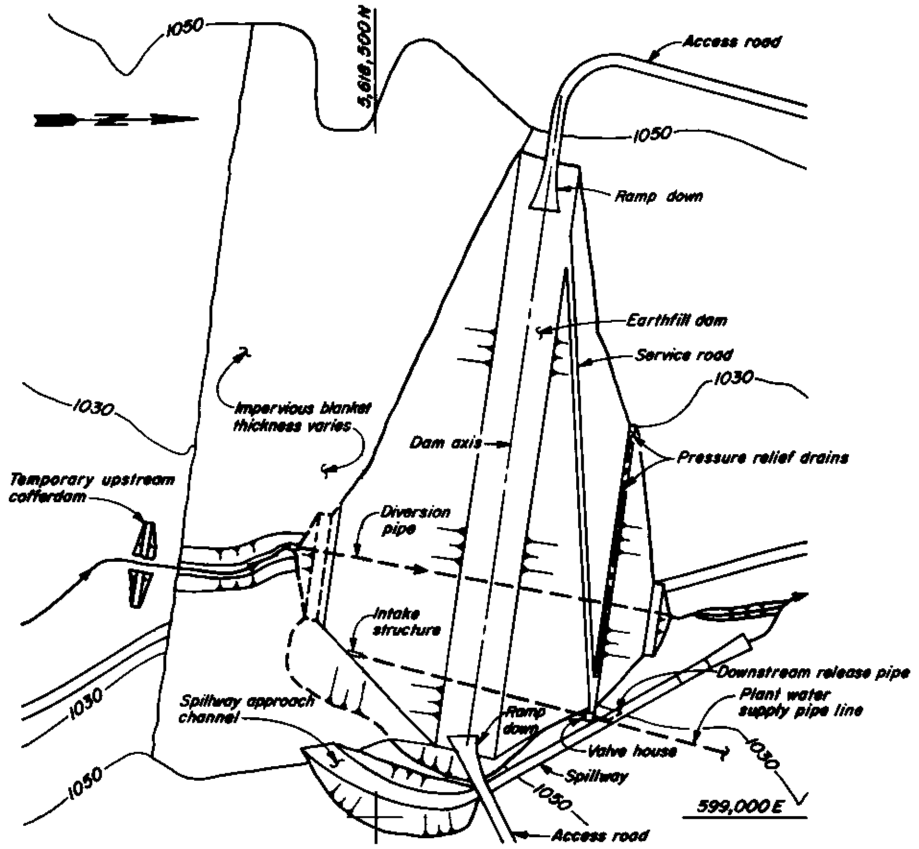
PHASE A (YEAR 4, APRIL)

- U/S AND D/S COFFERDAMS COMMENCED.
- MAJORITY OF DIVERSION PIPE COMPLETED.
- RIGHT BANK EXCAVATION COMPLETED
- INSTALLATION OF PRESSURE RELIEF DRAINS COMMENCED.



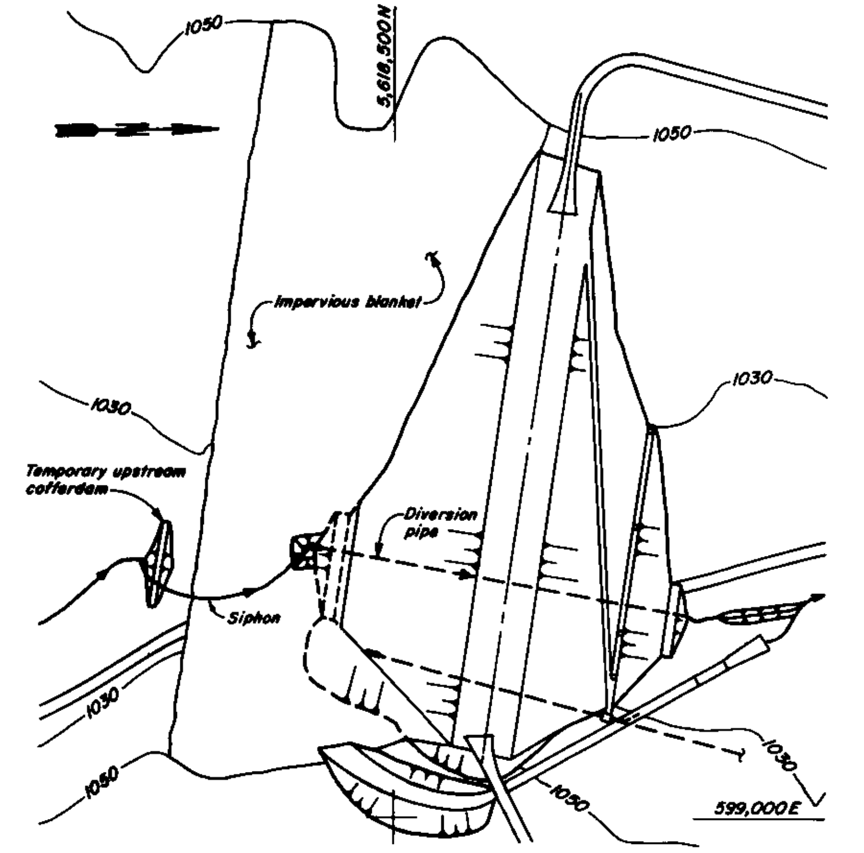
PHASE B (YEAR 4, MAY)

- U/S AND D/S COFFERDAMS COMPLETED.
- DIVERSION PIPE COMPLETED.
- INTAKE PIPE COMMENCED.
- PRESSURE RELIEF DRAINS COMPLETED.
- EXCAVATIONS FOR SPILLWAY APPROACH CHANNEL, SPILLWAY AND VALVE HOUSE COMMENCED.
- DAM PLACEMENT COMMENCED.



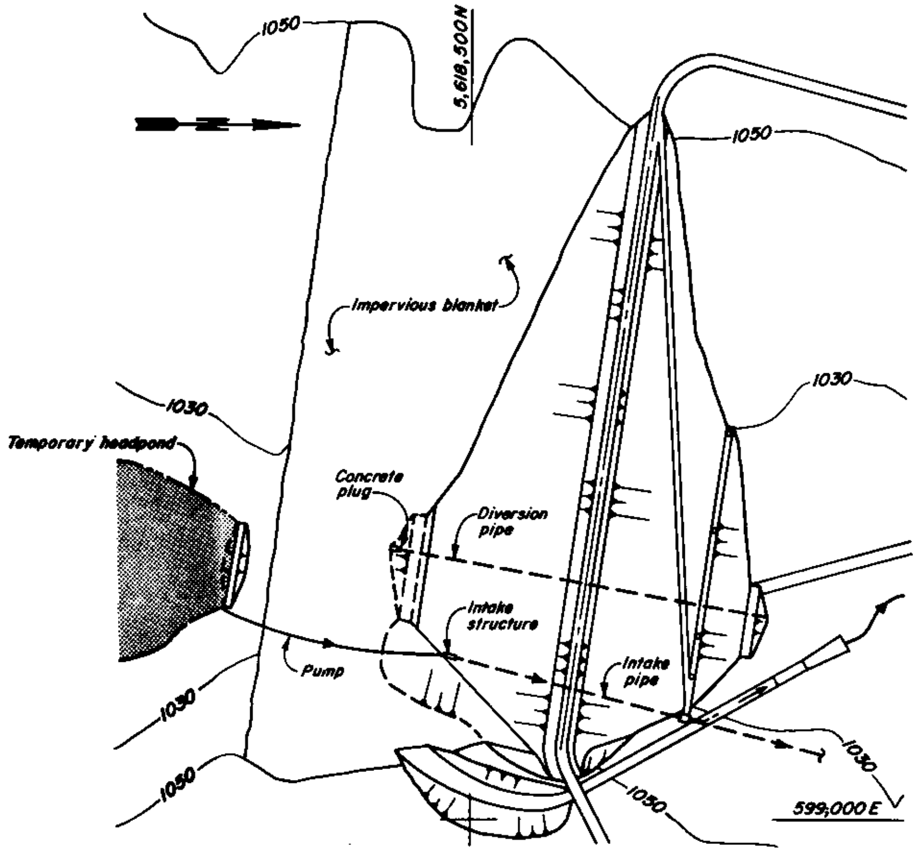
PHASE C (YEAR 4, JUNE TO YEAR 5, FEBRUARY)

- MAJORITY OF EARTHFILL DAM COMPLETED.
- IMPERVIOUS BLANKET COMPLETED EXCEPT FOR CREEKBED PORTION.
- SPILLWAY APPROACH CHANNEL, SPILLWAY AND VALVE HOUSE COMPLETED.
- ACCESS ROAD PARTIALLY COMPLETED.
- MAJORITY OF TEMPORARY U/S COFFERDAM COMPLETED, BUT NOT CLOSED.
- RESERVOIR CLEARING COMPLETED.
- INTAKE STRUCTURE AND PIPE COMPLETED



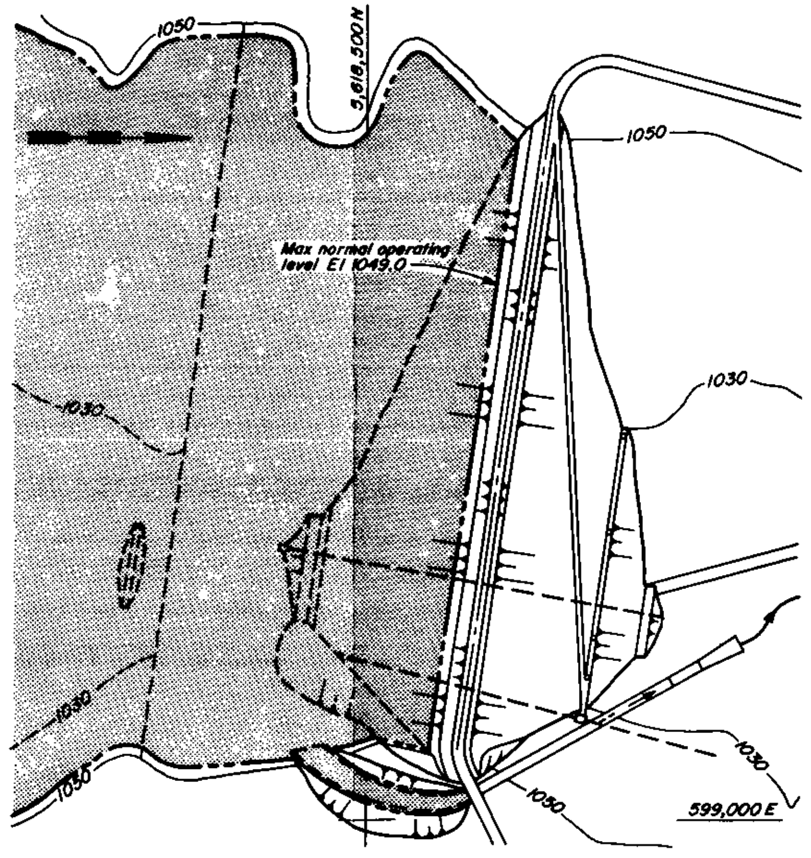
PHASE D (YEAR 5, MARCH & APRIL)

- ALL DAM AND BLANKET REPAIR WORK COMPLETED.
- TEMPORARY UPSTREAM COFFERDAM CLOSED, HAT CREEK FLOW SIPHONED TO DIVERSION PIPE AND DEWATERED CREEKBED DOWNSTREAM OF TEMPORARY COFFERDAM.
- MAJORITY OF IMPERVIOUS BLANKET IN CREEKBED COMPLETED.



PHASE E (YEAR 5, MAY)

- EARTHFILL DAM AND INSTRUMENTATION COMPLETED.
- CONCRETE PLUG IN DIVERSION PIPE COMPLETED.
- HAT CREEK FLOW PUMPED FROM TEMPORARY HEADPOND TO INTAKE STRUCTURE FOR DEWATERING AND/OR D/S RELEASE AS REQUIRED.
- IMPERVIOUS BLANKET COMPLETED.
- ACCESS ROAD COMPLETED.



PHASE F (YEAR 5, JUNE)

- DURING FILLING TO INTAKE PIPE INVERT, HAT CREEK FLOWS PUMPED TO INTAKE STRUCTURE, IF D/S RELEASE REQUIRED.
- RESERVOIR FILLED.

Scale: 0 50 100 150 200 Metres

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT
225 MW THERMAL PLANT

WATER SUPPLY SYSTEM CONSTRUCTION SEQUENCE FOR EARTHFILL DAM

DATE MAY 1984	FIG 7-2
DWN AV	DWG No 604H-C14-U201

REPORT No H 1694

APPENDIX A

PROJECT DATA FOR RECOMMENDED ALTERNATIVE

APPENDIX A

PROJECT DATA FOR RECOMMENDED ALTERNATIVE

1. Design Flows

Diversion, 10-year Flood:	7 m^3/s
Stilling Basin, 1000-year Flood:	19 m^3/s
Probable Maximum Flood (PMF):	57 m^3/s

2. Diversion Facilities

Upstream Cofferdam	
Crest Elevation:	1025
Height:	3.5 m
Downstream Cofferdam	
Crest Elevation:	1022
Height:	2.5 m
Diversion Pipe	
Type: Corrugated Steel, Conc. Encased	
Diameter:	1.83 m
Length:	200 m

3. Dam

Type: Earthfill with U/S Impervious Blanket	
Height of dam from creek bed:	34 m
Crest Elevation:	1054
Crest Length:	360 m
Fill Volume (incl. imp. blk.):	564 000 m^3
Upstream Slope:	2.5H:1V
Downstream Slope:	3H:1V

4. Reservoir

Length at Normal Reservoir Level:	2.3 km
Maximum Reservoir Level for PMF:	1052
Maximum Normal Reservoir Level:	1049
Minimum Normal Reservoir Level:	1034

Maximum Reservoir Surface Area (El.1049):	115 ha
Minimum Reservoir Surface Area (El. 1034):	35 ha
Dead Storage:	$2.0 \times 10^6 m^3$
Live Storage:	$10.9 \times 10^6 m^3$

5. Water Demand

Average Plant Requirement:	75 L/s
Peak Plant Requirement:	130 L/s
Average Downstream Releases:	140 L/s
Maximum Evaporation Loss:	12 L/s
Maximum Seepage Allowance:	42 L/s

6. Spillway

Type: Single Bay, Ungated	
Crest Elevation:	1049
Width:	5.25 m
Chute Slope:	3H:1V
Stilling Basin Length:	18 m

7. Intake Pipe

Type: Steel with External Coating	
Diameter:	0.5 m
Length:	134 m
Wall Thickness:	3.96 mm

8. Donwstream Release Pipe

Type: Steel with External Coating	
Diameter:	0.2 m
Length:	16 m
Wall Thickness:	3.96 mm

9. Water Supply Pipeline

Type: Steel with External Coating	
Diameter:	0.4 m
Length:	8800 m
Wall Thickness:	3.96 mm