BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT

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HYDROELECTRIC DESIGN DIVISION

DEVELOPMENT DEPARTMENT

HAT CREEK PROJECT
WATER SUPPLY AND ASH DISPOSAL STUDY

DESIGN MEMORANDUM ON
ALTERNATIVE WET AND DRY ASH DISPOSAL SCHEMES

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DESIGN MEMORANDUM ON

ALTERNATIVE WET AND DRY ASH DISPOSAL SCHEMES

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SYNOPSIS

In April 1978 the Hydroelectric Design Division (HEDD) and three other consultants to the Thermal Division were instructed to proceed with ongoing studies to assist in a comprehensive comparison of alternative ash disposal schemes in the Medicine Creek valley. Basically, HEDD's responsibilities included the design and preparation of cost estimates for the main water supply reservoir, the ash disposal reservoir and any runoff collection facilities necessary to ensure the long-term security of the reservoirs and waste disposal areas in Medicine Creek. Concurrently, the consultants for the thermal plant (Integ-Ebasco), for mine development (Cominco Monenco Joint Venture), and for the water supply pipeline (Sandwell) were to evaluate the effects of the alternatives on their specific areas of interest. Overall evaluation is to be completed by the Thermal Division.

From four initial schemes two alternatives involving either wet or dry ash disposal were selected for detailed comparison. They comprise:

<u>Alternative A - Wet Ash Disposal</u>

(i) Water supply reservoir east of thermal plant.
(ii) Wet ash disposal in upper Medicine Creek.
(iii) A mine waste dump in lower Medicine Creek.
(iv) Full perimeter runoff collection facilities.

Except for small changes in capacity and in the arrangement of runoff facilities, this alternative is similar to the base scheme described in HEDD Report No. 916.

Alternative B - Dry Ash Disposal

(i) Water supply reservoir in upper Medicine Creek.

(ii) Dry ash disposal in mid-Medicine Creek and mine wastes in lower Medicine Creek.

(iii) Runoff facilities limited to the ash and waste disposal area.

The estimated total capital costs of the dams and runoff handling facilities at September 1978 price levels including contingencies, engineering, investigations, supervision and corporate overhead but excluding interest during construction are:

Alternative A (total 3 stages)	\$ 51.7 million
Alternative B	\$ 21.0 million

In addition to a significantly lower capital cost, Alternative B offers several other important advantages including the following:

1. Depending on the status of the existing irrigation diversion from Medicine Creek east to MacLaren Creek, an annual average of between 2.5×10^6 m^3 and 4.0×10^6 m^3 of runoff water from Medicine Creek would be available for plant use replacing water which otherwise would have to be pumped from the Thompson River.

2. Following decommissioning of the thermal plant, the water supply reservoir of Alternative B would have considerable value for irrigation.

3. The total land area occupied by the reservoir, disposal areas and runoff facilities of Alternative B is less than 60 percent of the equivalent works for Alternative A.

4. Because of the generally steep terrain, extremely variable foundation conditions and the probability of icing problems and high maintenance costs, the runoff canals of both schemes are considered potential problem areas. With Alternative B, the overall length of the runoff canals and their capacities are both reduced to about one-third of the Alternative A values.

5. For the first 15 years of plant operation with Alternative B no mine wastes would be deposited in Medicine Creek and ash would be deposited immediately downstream of the water supply dam. With no major disposal areas below the runoff canals in early years it would be possible, with dependence on maintenance for removal of potential canal icings, to defer construction of portions of the canals and the auxiliary piping system for low winter flows. This would permit, on the basis of actual canal operating experience and testing, a thorough assessment of whether or not the anticipated icing problems sufficiently justify the proposed piping system with its estimated total capital cost of nearly $700,000. Such flexibility does not exist for Alternative A where the Stage 1 runoff canals surround the ash disposal reservoir and involve much greater costs.

SECTION 1.0 - INTRODUCTION

1.1 TERMS OF REFERENCE AND SCOPE OF WORK

Under an extention to Assignment No. 477-028, the Hydroelectric Design Division (HEDD) was instructed on 7 April 1978 to proceed with ongoing studies to assist in a comprehensive comparison of alternative schemes of ash disposal in the Medicine Creek valley. Concurrent with HEDD's studies of the required embankment and runoff handling facilities, Cominco Monenco Joint Venture (CMJV) were requested to assess the effects of the ash disposal alternatives with respect to the proposed mine waste dump in Medicine Creek, Integ-Ebasco were to assess the effects on the ash handling and water systems of the thermal plant and Sandwell were to assess the effects on the cooling water pipeline from the Thompson River.

Initially the Thermal Division's instructions were to evaluate four alternatives briefly described as follows:

Alternative A

(i) Water supply reservoir east of plant (per HEDD Report No. 916).

(ii) Wet fly and bottom ash disposal in upper Medicine Creek per HEDD Report No. 916 except storage requirement increased from 97.5×10^6 m^3 to 126×10^6 m^3.

(iii) A mine waste dump containing from 100×10^6 m^3 to 450×10^6 m^6 in lower Medicine Creek.

1.1 TERMS OF REFERENCE AND SCOPE OF WORK - (Cont'd)

(iv) Runoff canals surrounding all the Medicine Creek facilities and having a capacity sufficient for the probable maximum flood (PMF), (In HEDD Report No. 916 the canals were very much shorter having been terminated immediately downstream of the ash dam).

Alternative B

(i) Water supply reservoir in upper Medicine Creek with capacity to store the PMF.

(ii) Dry fly and bottom ash disposal in mid-Medicine Creek.

(iii) A mine waste dump per Alternative A.

(iv) Short runoff canals surrounding only the ash and mine waste areas.

Alternative C

(i) Water supply reservoir east of plant.

(ii) Wet fly ash in upper Medicine Creek with additional capacity to store the PMF.

(iii) Dry bottom ash disposal together with the mine wastes in lower Medicine Creek.

(iv) Runoff canals surrounding all facilities but having reduced capacities since PMF storage would be provided in the fly ash pond.

1.1 <u>TERMS OF REFERENCE AND SCOPE OF WORK</u> - (Cont'd)

Alternative D

(i) Water supply reservoir in upper Medicine Creek with capacity to store the PMF.

(ii) Dry fly and bottom ash disposal together with mine wastes in lower Medicine Creek.

(iii) Short runoff canals surrounding the ash and mine waste area.

This scheme is similar to Alternative B except for the method of ash disposal.

The scope of work for these ongoing studies comprised primarily the following:

a) Optimization of alternative arrangements to minimize costs and alienation of land and to maximize use of Medicine Creek water.

b) Reconnaissance of perimeter runoff canal routes and associated outlet works. No drilling or other site investigations have been conducted specifically in these areas.

c) Hydrological studies to reassess the previous estimates of the probable maximum flood peaks and volumes for the Medicine Creek basin.

d) Research of cold climate canals subject to icing problems.

e) Hydraulic and structural design of canals and outlet works.

1.1 <u>TERMS OF REFERENCE AND SCOPE OF WORK</u> - (Cont'd)

f) Geotechnical design of the required embankments for the water supply and ash disposal reservoirs.

g) Preparation of cost estimates for the water supply and ash dams, runoff canals and outlet works.

h) Presentation of study results in a design memorandum complete with drawings.

1.2 SELECTED ALTERNATIVES

Early in the ongoing studies it was recognized that Alternative C as described in the preceeding sub-section offered no advantages over the other alternatives. The reduced capacity canals would only be marginally less expensive than those with a PMF capacity and this saving would be more than offset by the additional costs of a significantly higher ash dam and reservoir and by the costs of runoff water treatment prior to release. Alternative C was therefore dropped from further consideration.

As the mining consultants, CMJV, neared completion of their mine pit development and waste disposal studies their plans for the Medicine Creek waste dump were incorporated into these ongoing studies. With their proposed scheme of development there would be no mine wastes deposited in Medicine Creek until the sixteenth year of plant operation. Therefore, Alternative D, based on simultaneous waste and ash disposal, was also dropped from further consideration.

The two remaining alternatives, A and B, were examined in detail and, particularly in the case of Alternative B, were significantly changed during subsequent refinement and optimization studies. Descriptions and costs of Alternatives A and B are presented in Sections 3 and 4 respectively.

1.3 AVAILABLE INFORMATION

Foundation and construction material information for the study of the two water supply and ash disposal alternatives was based almost solely on previous site investigations conducted in the Medicine Creek area. These investigations include the foundation drill holes, test pits and rock outcrop mapping shown on Plate 1 and detailed in the following reports:

a) "Harry Lake Site, Preliminary Foundation Investigation for BCHPA, Hat Creek Project" dated February 1977 by Ebasco Services Incorporated.

b) "Hat Creek Geotechnical Study, Report No. 6" dated March 1977 by Golder Associates.

c) "Hat Creek Project, Diversion of Hat and Finney Creeks, Preliminary Design Report" dated March 1978 by B.C. Hydro (HEDD Report No. 913).

d) "Hat Creek Project, Water Supply and Ash Disposal Reservoirs, Preliminary Design Report" dated March 1978 by B.C. Hydro (HEDD Report No. 916).

The only supplementary information used for this study was obtained during a three-day site reconnaissance by HEDD staff at the end of May 1978.

SECTION 2.0 - CRITERIA FOR DESIGN AND COST ESTIMATES

2.1 DESIGN CAPACITIES OF EMBANKMENTS AND RUNOFF FACILITIES

As defined by the Thermal Division at the start of the studies, the water supply and ash disposal reservoir capacities were to be as follows:

a) Total wet disposal volume of fly and bottom ash — $126 \times 10^6 m^3$

(Volume used for HEDD Report No. 916 was $97.5 \times 10^6 m^3$).

b) Total dry disposal volume of fly and bottom ash — $79 \times 10^6 m^3$

c) Minimum live storage volume of water supply reservoir — $6.5 \times 10^6 m^3$

(The live storage volume of the reservoir per HEDD Report No. 916 and which has been adopted for Alternative A is $7.5 \times 10^6 m^3$).

As defined by CMJV on 12 July 1978 the total volume of wastes, including the retaining embankment, to be deposited in the Medicine Creek waste dump is $170 \times 10^6 m^3$. This quantity is based on an in-pit volume of $135.65 \times 10^6 m^3$ and a bulking factor of approximately 25 percent. Disposal in Medicine Creek would commence in the sixteenth year of plant operation.

2.1 DESIGN CAPACITIES OF EMBANKMENTS AND RUNOFF FACILITIES - (Cont'd)

Runoff canal and flood storage capacities are based on the probable maximum flood as described in HEDD Reports No. 913 and 916. The PMF volume for Medicine Creek has been derived from Monenco's* volume for Hat Creek Gauge 08LF061 pro-rated according to drainage basin area and adjusted to represent the May to July flood period only. A brief study was made using four different approaches to compare the value derived on the basis described above. The resulting volumes ranged from 56 to 115 percent of Monenco's volume pro-rated by area. Considering the paucity of both rainfall and runoff data in or near Medicine Creek, it was concluded that a rigorous analysis of the probable maximum flood for Medicine Creek could not be justified at the present time. The PMF volume derived from Monenco's study of Hat Creek has been adopted for the design of Alternative B where flood storage is provided and is considered adequately conservative for preliminary design purposes. Rainfall and runoff records are being obtained that should provide sufficient data to permit a better analysis in the final design phase.

Peak PMF discharges for design of the runoff facilities for both alternatives were obtained from Plate 5-10 of HEDD Report No. 913.

To prepare the mass curves necessary to determine the discharge and storage requirements for Alternative B, a PMF flood hydrograph was constructed using the volume and peak discharge derived as above and a shape generally the same as Monenco's PMF hydrograph for Hat Creek.

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* "Hat Creek Diversion Study", by Monenco Consultants Pacific Ltd. January 1977.

2.1 DESIGN CAPACITIES OF EMBANKMENTS AND RUNOFF FACILITIES - (Cont'd)

For the runoff canals of both alternatives two basic sections have been adopted: one for locations in overburden and a second for locations primarily in rock with comparatively steep sidehill slopes. For the most part, overburden material consists of unconsolidated glacial till lacking in the coarser gravel sizes. To prevent erosion, therefore, velocities have been limited to fairly low values varying, in accordance with U.S.B.R. canal design practice, between 0.4 m/s at a flow depth of 0.6 m to 1.0 m/s at a depth of 3.0 m. This criteria is intended to provide the optimum compromise in both non-scour and non-silt velocities.

For the steep, exposed rock and shallow overburden areas an earthfill canal section with comparatively flat excavation and fill slopes is impractical. An unlined rock section is also considered unacceptable because of the fracturing that would likely remain following blasting. To minimize leakage that would undoubtedly create stability problems with the steeply inclined surficials, cast-in-place concrete-lined sections have been adopted. These sections have been designed to provide velocities from about 1 m/s at low flows to about 2.7 m/s at full capacity. In setting these velocities consideration was given to minimizing the quantities of rock excavation and concrete, providing a size that will facilitate cleaning and, while preventing siltation, ensuring that gravel and larger materials would not be transported.

2.2 COST ESTIMATING AND SCHEDULING CRITERIA

Cost estimating and scheduling criteria adopted for comparison of the two alternatives are as follows:

2.2 COST ESTIMATING AND SCHEDULING CRITERIA - (Cont'd)

1. All costs are presented in terms of September 1978 price levels.

2. The costs of lands and rights are excluded.

3. No allowances are made in the cost estimates for interest during construction, inflation or present worth discounting of future costs.

4. Contingency allowances have been included to reflect both the level of detail in the estimates and the extent of site investigations.

5. The costs of engineering, site investigations and supervision have been included in the estimates assuming a cost equivalent to between 13 and 16 percent of the total direct cost plus contingencies.

6. A corporate overhead allowance is included in the estimates based on 5 percent of the total direct cost plus contingencies, engineering, investigations and supervision.

7. The design life of the thermal plant and mine has been assumed as 35 years.

8. The following key dates have been assumed for scheduling:

   a. Commence final design - after 1 January 1979

   b. Project construction authorization - 1 April 1980

   c. Complete water supply reservoir - 1 July 1984

2.2 COST ESTIMATING AND SCHEDULING CRITERIA - (Cont'd)

d. Complete Stage 1 of ash disposal reservoir - 1 April 1985

e. On-line date of thermal plant - 1 January 1986

Evaluation of staged construction of the runoff facilities for Alternative A was done on the basis of the inflation, interest and discount rates given in the financial criteria compiled by Integ-Ebasco for Section 72.1-a (Rev. 3, July 1978) of the Station Design Manual.

SECTION 3.0 - ALTERNATIVE A - WET ASH DISPOSAL

3.1 ARRANGEMENT

The general arrangement of Alternative A is shown on Plate 2 and a profile through the main facilities in Medicine Creek is shown on Plate 4. Except for the ultimate volume of ash and the termination point of the runoff canals, the scheme is the same as that given in HEDD Report No. 916. It comprises:

a) A water supply reservoir east of the thermal plant having a live storage capacity of $7.5 \times 10^6 m^3$.

b) A wet ash disposal reservoir with an ultimate storage capacity of $126 \times 10^6 m^3$. The reservoir is located in upper Medicine Creek above an earthfill dam constructed at Axis 3B, some 5.5 km upstream and east of the confluence with Hat Creek.

c) A waste dump in lower Medicine Creek containing, after 35 years plant operation, approximately $170 \times 10^6 m^3$ of mine wastes.

d) Flood runoff canals surrounding all of the Medicine Creek facilities. The canals, designed to handle the PMF, dishcarge via buried conduits into the proposed Hat Creek Diversion Canal.

3.2 WATER SUPPLY RESERVOIR

The water supply reservoir adopted for Alternative A is completely unchanged from that described in HEDD Report No. 916. Briefly, the reservoir has a live storage capacity of 7.5 x 10^6m^3 between a minimum reservoir level of El. 1356 and a normal maximum reservoir level of El. 1372. A main dam 47 m high with a crest length of 780 m and a saddle dam 17 m high with a crest length of 220 m are required. The total fill volume in the two embankments is approximately 1.7 x 10^6m^3.

In addition to the main and north saddle dams discussed above, two other minor structures are required for the water supply reservoir. A very small saddle dam is required on the east side of the reservoir and a small saddle dam and overflow outlet works are required on the west side. For complete details of all of these facilities reference should be made to HEDD Report No. 916.

3.3 ASH DISPOSAL RESERVOIR

3.3.1 General Requirements

Subsequent to completion of HEDD Report No. 916 the ultimate storage capacity of the ash disposal reservoir was increased from 97.5 x 10^6m^3 to 126 x 10^6m^3. As a result the crest levels for all three stages of the ash dam have been raised; Stage 1 by 4.0 m to El. 1254.0, Stage 2 by 4.2 m to El. 1268.2 and Stage 3 by 5.4 m to El. 1281.0.

3.3 ASH DISPOSAL RESERVOIR - (Cont'd)

3.3.2 Ash Retention Dam

Except for raising the crest and berm levels, the cross-section of the ash retention dam as shown on Plate 5 has been kept the same as in HEDD Report No. 916. For descriptions of the embankment design, foundation preparation, diversion during construction and construction materials, reference should be made to the HEDD report.

Compared to the earlier report, the fill quantities for embankment construction are now from 14 to 31 percent higher, the total fill quantities for each of Stages 1, 2 and 3 being now $2.62 \times 10^6 m^3$, $1.71 \times 10^6 m^3$ and $0.95 \times 10^6 m^3$ respectively.

3.4 RUNOFF HANDLING FACILITIES

3.4.1 General Requirements

As shown on Plates 2, 6 and 7, the runoff facilities for Alternative A comprise a south runoff canal 11.3 km long discharging via a 2.6 km buried conduit having a diameter of 2100 to 2700 mm, and a north runoff canal 9.7 km long discharging via a 2.4 km buried conduit having a diameter of 1650 mm. Both conduits discharge at their western ends into the Hat Creek Diversion Canal.

As discussed in Sub-section 2.1, the runoff facilities have been designed to handle the PMF. Maximum design discharges for the north and south runoff canals are 8.9 m^3/s and 18.0 m^3/s respectively. (The total of these two flows is equivalent to the emergency capacity of the Hat Creek Diversion Canal, see HEDD Report No. 913). While hydraulic design of the canals and conduits presents no significant difficulties, concern with potential icing problems as previously discussed in HEDD Report No. 913 still remains.

3.4.1 General Requirements - (Cont'd)

Several weeks were spent researching both American and Russian experience with cold climate canals. Although considerable literature exists describing icing problems, little documentation of successful solutions was found. The only apparent solutions that appear at all practical for the Hat Creek runoff canals are as follows:

a) Maintenance program to remove ice build-up.

b) Narrow and deep slot in the canal invert to convey winter flows.

c) Buried conduit to convey winter flows.

d) Electric heating cables to prevent complete freezing in canal.

Because of the considerable length of canals involved, the extreme variability of foundations and the need to operate in perpetuity with a high level of security, the only scheme considered acceptable from both operational and economic viewpoints is the third - a separate buried conduit to convey the winter flows.

The only winter flow records available in Medicine Creek are for the period October to December 1977 for the two recently installed WSC gauges "Medicine Creek near the Mouth" (Station 08LF082) and "Medicine Creek Diversion near Ashcroft" (Station 08LF083) and, for much of this period, the gauges were ice-bound. Based on these and other hydrological records in the Hat Creek area, a more or less judgemental estimate of winter flow requirements had to be made. A winter flow of 1.6 $L/s/km^2$ has been adopted for design of the buried conduit with the diameter restricted to a minimum of 300 mm.

3.4 RUNOFF HANDLING FACILITIES - (Cont'd)

3.4.1 General Requirements - (Cont'd)

At the time HEDD Report No. 916 was prepared it appeared there would be no waste dump in lower Medicine Creek and the canals discharged into Medicine Creek immediately downstream of the ash dam. CMJV's current development plans now require disposal of 170 x $10^6 m^3$ of mine wastes in lower Medicine Creek during the 16th to 35th years of plant operation. It would therefore be possible to discharge the canals below the ash dam initially and in later years complete the remaining parts of the canals and the long discharge conduits leading to the Hat Creek Diversion Canal. A study of such staged construction showed overall costs, on a present worth basis, to be about 25 percent lower than for complete construction initially. It has therefore been assumed that the south canal and outlet conduit downstream of Station 7+100 and the north canal and outlet conduit downstream of Station 7+150 would be completed in the fourteenth and fifteenth years of plant operation.

3.4.2 Proposed Facilities

South Runoff Canal

The south runoff canal originates (Station 0+000) near the divide between MacLaren and Medicine Creeks at the east end of the ash disposal reservoir. The canal would have an ultimate length of 11.3 km with 7.1 km initially upstream of the Stage 1 outlet chute near the ash dam. Initially it would serve a drainage area of 26 km^2 with a peak PMF discharge of 14.4 m^3/s at the outlet. With completion of the second stage, the canal would have a total drainage area of 32 km^2 and a peak PMF capacity of 18 m^3/s at its downstream end.

3.4 RUNOFF HANDLING FACILITIES - (Cont'd)

3.4.2 Proposed Facilities - (Cont'd)

From Station 0+000 to Station 1+450 the south canal would lie just above El. 1300, a few metres above the existing diversion ditch that diverts the upper portion of Medicine Creek into MacLaren Creek for irrigation purposes. Since this reach of the canal would divert an area of about 2 km^2, approximately 10 percent of the drainage area of the existing diversion ditch, it is felt that works would have to be provided to enable return of water to the diversion ditch during periods of high demand. A small drop structure plus about 40 m of 1050 mm culvert would be provided at the canal intersection near Station 1+450 to pass the flows of the existing ditch under the runoff canal. A gated outlet on the runoff canal would permit discharge into the existing diversion ditch. Some realignment of the existing diversion ditch would also be required.

Except for approximately 300 m near the upstream end, the canal between Station 0+000 and 1+450 would be mostly in overburden. A canal section at Station 0+500, typical of this reach, is shown on Plate 6. Generally the overburden material is an unconsolidated till common to the entire Hat Creek area and, being relatively impervious, lining of the canal would not be required. However, where pervious materials are present, a 0.6 m lining of glacial till would be provided. The earth canal depths in this reach would vary from approximately 1.2 to 1.5 m including a 0.3 m freeboard. The gradient of the earth canal in all areas would be 0.04 percent. A 300 mm concrete pipe buried under the canal embankment is provided to convey low winter flows for prevention of canal icing. The winter flows would be drained from the canal by means of 10 m lengths of perforated pipe covered by drain gravel. These drains would be provided at intervals of about 300 m and at all major tributaries. Manholes and valves at all main line connections would be provided for maintenance.

3.4 RUNOFF HANDLING FACILITIES - (Cont'd)

3.4.2 Proposed Facilities - (Cont'd)

From Station 1+450 to 3+150 the canal would be located at about El. 1300, below the existing diversion ditch, and virtually all of the canal would be in till overburden. The canal depth would range from 1.5 to 1.9 m.

At Station 3+150 the uppermost part of Medicine Creek having a drainage area of 16.9 km^2 is intersected by the runoff canal route. At this and other major tributaries a pond would be constructed to permit settling of the bed load carried by the steep and fast flowing creeks. As indicated on the typical section on Plate 6, infiltration pipes would also be installed at these ponds to intercept winter flows.

Between Station 3+150 and Station 3+900 pervious materials have been observed in several areas. It has been assumed, therefore, that the earth canal throughout this reach would have to be lined.

From Station 3+900 to Station 6+300 the canal would again be located predominantly in impervious till overburden although some rock probably would be encountered. The depth of the canal at Station 6+300 would be about 3.0 m.

Between Station 6+300 and 9+700 foundation conditions are extremely variable. In addition to numerous outcrops, areas with a considerable depth of overburden are also evident and the terrain is generally very steep. For estimating purposes it has been assumed that half of this reach would be in rock or on steep slopes requiring a concrete flume as shown on Plate 6 (sections at Station 6+350 and 9+050). The maximum depth and width of the flume in this area would be 1.7 m and 2.6 m respectively with a gradient of 0.8 percent. The depths of the earth canal portions would range from 3.0 to 3.1 m.

Stage 1 of the south runoff canal would terminate at Station 7+100 where it would discharge via an open chute into a plunge pool downstream of the ash dam. These outlet works would be the same as described in HEDD Report No. 916 except that the chute would be about 25 percent longer because of a higher canal elevation.

From Station 9+700 to the canal's end at Station 11+300 it is expected that all of the canal would be in overburden. The canal depth would be approximately 3.2 m. The buried pipe for handling winter flows would have a diameter of 350 mm at this point, having been increased from 300 mm at about Station 6+800 near the ash dam. The pipe would discharge directly into the outlet conduit described following.

From Station 11+300 to the Hat Creek Diversion Canal at Station 13+930 flows from the south runoff canal would be conveyed in a buried outlet conduit as shown on Plate 7. From the reinforced concrete canal outlet structure at the upper end to the reinforced concrete conduit outlet structure near the Hat Creek Diversion Canal, the conduit would drop some 308 m over a length of about 2.6 km. Gradients of the "Multi-Plate" corrugated (150 mm x 50 mm corrugations) metal pipe would range from 2 to 20 percent. Flow depths would vary between about 35 and 65 percent of diameter at the design PMF discharge of 18 m^3/s with velocities up to a maximum of about 10 m/s. Typical conduit sections in overburden and in rock are shown on Plate 7. Although no site reconnaissance was made of the route shown on Plate 2 (the route was revised subsequent to the site reconnaissance) it has been assumed that some 25 percent of the conduit would be in rock.

3.4 RUNOFF HANDLING FACILITIES - (Cont'd)

3.4.2 Proposed Facilities - (Cont'd)

The outlet structure (Detail B, Plate 7) would comprise an impact type stilling basin with an earthfill-insulated cover slab to prevent icing. Between this structure and the Hat Creek Diversion Canal approximately 40 m of lined canal as shown on Plate 6-3 of HEDD Report No. 913 would be required.

North Runoff Canal

Like the south canal the north runoff canal originates (Station 0+000) near the divide between MacLaren and Medicine Creeks. The north canal would have an ultimate length of 9.7 km with 7.15 km initially upstream of the Stage 1 outlet works immediately downstream of the ash dam. Stage 1 of the north canal would serve a drainage area of about 11.7 km^2 with a peak PMF discharge of 7.8 m^3/s. With completion of Stage 2, the canal would have a total drainage area of 13.6 km^2 and a peak PMF design discharge of 8.9 m^3/s at its downstream end. Although somewhat smaller in size, sections for the north runoff canal would be generally the same as those shown for the south canal on Plate 6.

From Station 0+000 to Station 6+200 the north canal would be almost entirely in overburden with rock probably confined to short lengths intermittently between Station 0+000 and 0+600. Most of the overburden materials are relatively impervious and canal lining has been assumed in only about 10 percent of this 6.2 km reach. Depths of the earth canal in this area would vary from about 1.2 to 2.4 m.

3.4.2 Proposed Facilities - (Cont'd)

From Station 6+200 to Station 8+100 the north canal would be located primarily on steep rock slopes requiring the use of a concrete flume. Through this reach the width of the flume would vary from 1.8 to 2.0 m while the depth would range from 1.2 to 1.35 m.

Stage 1 of the north runoff canal would terminate at Station 7+150, discharging via a reinforced concrete, baffled chute into Medicine Creek below the ash dam. This chute would be the same as described in HEDD Report No. 916 except that it would be about 20 percent longer as a result of raising the level of the canal.

From Station 8+100 to the end of the north canal at Station 9+660 the canal would once again be predominantly in overburden materials. The earth canal section here would have a depth of about 2.5 to 2.6 m.

The buried pipe for winter flows would have a diameter of 300 mm throughout the entire length of the north canal. Construction details would be as described for the south canal.

From Station 9+660 to the Hat Creek Diversion Canal at Station 12+150 flows would be conveyed in a buried discharge conduit as shown on Plate 7. The conduit would drop a total of about 309 m over a length of approximately 2.4 km at gradients ranging from about 5 to 20 percent. The design discharge of the 1650 mm "Multi-Plate" corrugated metal pipe is 8.9 m^3/s. Conduit sections and details of the reinforced concrete structures at either end are shown on Plate 7 and, except for dimensions, are generally the same as those described for the south canal conduit.

3.4 RUNOFF HANDLING FACILITIES - (Cont'd)

3.4.3 Operation and Maintenance

Because of the steep terrain over much of the canal routes and the existence of numerous steeply inclined and fast flowing tributary streams, it is expected that considerable annual maintenance, particularly in early years, would be required to remove accumulated sediment and debris from the 21 km of canal. Also, despite the provision of the buried pipe to handle low winter flows, it is probable that in severe winters some ice blockages would occur, requiring some additional maintenance.

3.5 COST ESTIMATES

The estimated total direct costs, at September 1978 price levels, plus indirect costs including contingencies, engineering, site investigations and corporate overhead but excluding interest during construction, are summarized on Table 3-1. Also tabulated is the estimated cash flow based, for the most part, on the engineering and construction schedule shown on Plate 2-1 of HEDD Report No. 916. Stage 2 of the runoff handling facilities would be constructed during the fourteenth and fifteenth years of plant operation with engineering and site investigations commencing in the twelfth year.

TABLE 3-1

WATER SUPPLY AND ASH DISPOSAL STUDY
ALTERNATIVE A - WET ASH DISPOSAL
WATER SUPPLY & ASH DISPOSAL RESERVOIRS AND RUNOFF FACILITIES

SUMMARY ESTIMATE OF TOTAL CAPITAL COSTS
(Costs at September 1978 Price Levels)

		$Thousand
1.	Water Supply Reservoir	
	(a) Main dam and reservoir	7,730
	(b) North saddle dam	1,150
	(c) East saddle dam and overflow outlet	30
	Subtotal 1	8,910
2.	Ash Disposal Reservoir - Stage 1	9,390
3.	Runoff Handling Facilities - Stage 1	
	(a) South canal & outlet chute	2,530
	(b) North canal & outlet chute	2,060
	Subtotal 3	4,590
	TOTAL DIRECT COST, STAGE 1	22,890
4.	Contingencies (15% of 1 & 2, 20% of 3)	3,660
5.	Engineering, Investigations and Supervision (13%)	3,450
6.	Corporate Overhead (5%)	1,500
	TOTAL CAPITAL COST, STAGE 1	31,500
7.	Total Capital Cost, Ash Dam Stage 2*	6,760
8.	Total Capital Cost, Ash Dam Stage 3*	4,110
9.	Total Capital Cost, Runoff Handling Facilities, Stage 2**	9,360
	TOTAL CAPITAL COST, STAGES 1,2 & 3	51,730
10.	Annual Maintenance Cost of Runoff Handling Facilities - Stage 1	30
	- Stage 2	50

* Includes contingencies at 15%, engineering, investigations and supervision at 15% and corporate overhead at 5%.

** Includes contingencies at 20%, engineering, investigations and supervision at 15% and corporate overhead at 5%.

TABLE 3-1 - (Cont'd)

ESTIMATED CASH FLOW

Fiscal Year	$Thousand
1. All Facilities - Stage 1	
1980/81	200
1981/82	1,500
1982/83	1,100
1983/84	10,800
1984/85	17,900
2. Ash Dam - Stage 2	
1993/94	340
1994/95	270
1995/96	6,150
3. Runoff Handling Facilities - Stage 2	
1997/98	680
1998/99	380
1999/2000	4,100
2000/01	4,200
4. Ash Dam - Stage 3	
2003/04	210
2004/05	160
2005/06	3,740

SECTION 4.0 - ALTERNATIVE B - DRY ASH DISPOSAL

4.1 ARRANGEMENT

The general arrangement of Alternative B is shown on Plate 3 with a profile through the principal facilities shown on Plate 4. The scheme comprises the following:

a) A water supply reservoir in upper Medicine Creek having a storage capacity of 6.7 x $10^6 m^3$ for the thermal plant plus a supplementary dry storage capacity of 15 x $10^6 m^3$ for that portion of the PMF not discharged through the outlet works. The outlet works consists of 5.7 km of 1650 mm diameter pipe discharging into the downstream end of the Hat Creek Diversion Canal.

b) A dry ash and mine waste disposal area in lower Medicine Creek that will contain the fly and bottom ash from 35 years of plant operation together with the mine wastes deposited in Medicine Creek between the 16th and 35th years of plant operation.

c) Flood runoff canals above the ash and waste disposal area. The two canals, designed to handle the PMF discharge via short inclined conduits into the water supply reservoir.

The principal differences between this scheme and that originally defined by the Thermal Division are the much smaller water supply reservoir and dam made possibly by the provision of outlet works, and the reversed flow direction of the runoff canals which permits shorter canals and outlet chutes and increases the amount of Medicine Creek runoff available for plant supply.

4.2 WATER SUPPLY RESERVOIR

4.2.1 General Requirements

The water supply reservoir is created by construction of an earthfill dam at Axis 3B, the same location as that for the ash dam in Alternative A. The water supply damsite was originally defined by the Thermal Division as Axis 4, (see HEDD Report No. 916) about 1 km upstream but it was found more economical overall to adopt Axis 3B despite some lowering of the reservoir and increased pumping costs. Significant savings resulted from the smaller dam and shorter runoff canals.

A live storage volume of 6.7 x $10^6 m^3$, slightly more than the specified minimum, is provided between a minimum reservoir level of El. 1215 and a maximum normal reservoir level of El. 1230. As shown on the reservoir volume and area curves on Plate 8, some 0.8 x $10^6 m^3$ of dead storage lies below the minimum reservoir level of El. 1215. The surface area of the reservoir at El. 1230 is 0.85 x $10^6 m^3$, less than one-fifth the area of the ash pond of Alternative A.

Between reservoir levels of El. 1230 and 1242.5 some 15 x $10^6 m^3$ of dry storage is provided for holding part of the PMF. This represents 37 percent of the total PMF flood volume of 40.5 x 10^6 derived for the 51.6 km^2 drainage area above the Axis 3B dam and the two runoff canals. With a crest level of El. 1245 the dam required to provide 15 x $10^6 m^3$ of dry storage is about 55 m high. To contain the entire PMF volume of 40.5 x $10^6 m^3$ the dam would have a height of 69 m. A comprehensive optimization study was completed to determine the most economical diameter of outlet conduit and height of dam. A conduit size of 1650 mm was selected from the range of 1200 mm to 2100 mm diameters studied.

4.2.1 General Requirements - (Cont'd)

Since the outlet works would be required not only during the 35-year plant life, but thereafter as well, it was felt that the outlet works should be generally free of special operating procedures. The design selected, with an outlet set at the normal maximum reservoir level of El. 1230, would be operated as follows:

a) During 35-Year Plant Life

The gate in the upstream end would normally be kept closed. The 15 x $10^6 m^3$ of dry storage provided is equivalent to more than twice the flood volume having a 10-year frequency and about 30 percent greater than the flood having a 100-year frequency. With the gate closed all runoff would normally be used for plant make-up. Only in the event of an extremely severe snowpack would the gate be opened to allow spillage.

b) After Plant Decommissioning

Unless regulated for irrigation purposes the upstream gates would normally be kept open. All yearly floods would be automatically regulated by the limiting capacity of the conduit and storage within the reservoir.

4.2.2 Water Supply Dam

Details of the water supply dam are shown on Plate 8. The 55 m high earthfill dam would have a length of 340 m and, with upstream and downstream slopes of 3:1 and 3.75:1 respectively, would contain approximately 1.8 x $10^6 m^3$ of fill. Design of the cross-section was based on the following considerations:

4.2.2 Water Supply Dam - (Cont'd)

a) Including the PMF storage, the reservoir could be drawn down over a depth of up to 27.5 m at rates of 0.3 to 2.0 m/day which, in terms of embankment design, is essentially instantaneous.

b) Foundation material is generally impervious glacial till overlying bedrock.

c) Large quantities of glacial clayey till are available just downstream of the damsite. Pitrun free-draining sand and gravel is available on the east side of Hat Creek within the mine pit.

The selected modified homogeneous earthfill cross-section consists of a central core of selected impervious till connected to an upstream till blanket, an upstream shell of pervious sands and gravels and a downstream shell of random impervious till. Gravel drains and filters are located on the downstream side of the core and pass beneath the random till shell to the downstream toe. The upstream slope is protected from wave action by a 0.75 m thick layer of rip-rap. Principal earthfill quantities are as follows:

	Quantity $10^6 m^3$
Impervious core, blanket and D/S shell	1.09
Sand and gravel, U/S shell	0.33
Drain and filters	0.32
Rip-Rap	0.03
Total	$1.77 \times 10^6 m^3$

4.2 WATER SUPPLY RESERVOIR - (Cont'd)

4.2.2 Water Supply Dam - (Cont'd)

For a description of the damsite foundations reference should be made to HEDD Report No. 916. Foundation preparation would include stripping of topsoil to a nominal depth of about 0.5 m plus stripping of any surficial sand lenses. A 3 to 5 m deep cutoff trench would be excavated to seat the impervious core into dense glacial till. Excavated material would be placed upstream of the dam on the lower left abutment to flatten the bank slopes and improve the sliding stability in this area. Where bedrock is encountered in the core contact area, slush grout and shotcrete would be applied.

Stability analyses of the embankment were carried out by using the simplified Bishop Method aided by the LEASE II Computer Program. The following parameters for the various embankment materials were assumed in the analyses:

	Unit Weight t/m^3	Cohesion kPa	Shear Strength Friction Angle Degrees
Core & Random Till Shell*	2.16	0	27
Drain & Transition	2.20	0	38
Till in Foundation*	1.92	0	30
U/S Sand & Gravel Shell	2.24	0	38

* For the construction case, a cohesion of 120 kPa with zero friction angle was assumed for the foundation material and a pore pressure coefficient ($\overline{B}$) of 0.5 was used in the core and the random till shell.

4.2 WATER SUPPLY RESERVOIR - (Cont'd)

4.2.2 Water Supply Dam - (Cont'd)

The long term stability including full pool, rapid drawdown and steady seepage cases were analysed and an earthquake coefficient of 0.1 g was also applied to the above cases. In the construction case upstream and downstream slopes with foundation material were analysed by the $\emptyset=0^{o}$ method because a build up of pore pressure would occur in the foundation during construction. The results of the analyses are as follows:

Case	Factor of Safety Static	Earthquake Coeff. = 0.1 g
Full pool, U/S slope	2.0	1.2
Rapid drawdown, U/S slope	1.6	1.1
Steady Seepage, D/S slope	1.9	1.4
End of Construction		
U/S slope	1.1	-
D/S slope	1.0+	-

Based on limited foundation and permeability information the seepage passing through the dam and foundation is estimated to be about 5 L/s at maximum normal reservoir ponding to El. 1230, and might be double this amount if the reservoir level reaches El. 1242.5. This seepage will have to be handled in drainage piping and/or pervious drain material, possibly bottom ash, placed in the creek bed beneath the ash and mine wastes downstream of the water supply dam.

4.2.3 Reservoir Outlet Works

The reservoir outlet works are shown on Plates 3, 8 and 9. The conduit intake and gate shaft are located on bedrock beneath the uppper right abutment of the water supply dam. The crest of the intake is set at El. 1230.5, 0.5 m above the normal maximum reservoir to permit minor reservoir fluctuation without unnecessary spillage. The box style, reinforced concrete intake would be trashracked to prevent entry of debris during periods of flood runoff spillage.

A cast-in-place reinforced concrete conduit with an inside diameter of 1650 mm is provided through the dam to Station 0+125 where the conduit changes to precast, reinforced concrete pipe.

A reinforced concrete gate shaft located just upstream of the dam axis would house two manually-operated slide gates 1200 mm wide by 1650 mm high, operated as discussed previously in Sub-section 4.21.

From Station 0+125 to 3+900 the conduit comprises 1650 mm reinforced concrete pipe buried as shown in typical rock and overburden sections on Plate 9. From the intake to the beginning of the inclined conduit at Station 3+900 the conduit has been designed as a pressure conduit operating under a maximum head (at the intake) of 13 m. Because of the very large quantity of pipe involved, special consideration has been given to the choice of pipe. The two major suppliers of concrete pipe have both recommended the use of pipe manufactured in accordance with ASTM Specification C76. Though basically intended for non-pressure uses, this pipe is considered by the manufacturers to have sufficient strength for well over the internal pressures that will be encountered in this application. Pressure pipe in accordance with ASTM Specification C361 is considered over-designed and uneconomical for such a large project. Reinforced concrete pipe with gaskets in accordance with C76 Classes III and IV has therefore been adopted. Because of external load restrictions the depth of ash and mine wastes placed over

4.2 WATER SUPPLY RESERVOIR - (Cont'd)

4.2.3 Reservoir Outlet Works - (Cont'd)

the pipe would have to be limited to about 4 or 5 m assuming an additional live load equivalent to H20 loading (CSA Standard S6-1974). To provide for possible road crossings over the conduit, an allowance has been made in the estimates for 125 m of cast-in-place conduit.

The maximum capacity of the outlet conduit, based on the PMF level of El. 1242.5 and a Manning friction factor of n = 0.014, is 8.4 m^3/s, about one third of the estimated peak PMF inflow to the reservoir.

From Station 3+900 to Station 5+700 the outlet conduit comprises a 1650 mm diameter buried, "Multi-Plate" metal pipe having large 150 x 50 mm corrugations. With gradients varying from 5 to 20 percent, flow in this inclined portion of the conduit is at partial depth. At the maximum discharge of 8.4 m^3/s, the flow depths would range from 46 to 72 percent of diameter with corresponding velocities of 8.6 and 5.0 m/s. A minimum cover of 1.5 m over the pipe has been provided.

As shown on Plate 3, the inclined outlet channel terminates in an energy dissipating outlet structure at Station 5+700 located near the north end of the Hat Creek Diversion Canal in the vicinity of Harry Creek. The outlet structure would comprise a reinforced concrete, impact type, stilling basin identical to that shown on Plate 7 for the north canal of Alternative A. Approximately 35 m of lined canal (see Plate 6-3 of HEDD Report No. 913) would be required between the outlet structure and the Hat Creek Diversion Canal.

4.3 ASH DISPOSAL

For Alternative B it is understood that both bottom and fly ash will be disposed of in dry fill form downstream of the water supply dam for the first 15 years as ash alone and, for the remaining 20 years of plant life, as ash alone or as a mixture of ash and mine wastes. Apart from the runoff handling facilities described in Sub-section 4.4, all facilities related to the disposal of ash or waste are the responsibility of others. This includes all drainage facilities below the level of the north and south runoff canals and any works necessary to convey seepage from the water supply dam.

4.4 RUNOFF HANDLING FACILITIES

To ensure the perpetual security of the ash and mine waste disposal area for Alternative B, runoff canals designed to handle the PMF are provided on both sides of Medicine Creek. As shown on Plate 3, both the north and south runoff canals flow in an easterly direction, discharging into the water supply reservoir. The canals are located generally between elevations of 1245 and 1265 on terrain underlain by greenstone and covered by glacial materials varying greatly in depth but commonly less than 2 m. As shown on Plate 1 numerous rock outcrops occur along the canal routes particularly in the last 1.5 km adjacent to the Axis 3B damsite.

South Runoff Canal

The south runoff canal starts some 4.5 km west of the water supply dam and, based on a drainage area of 7.2 km^2, has a design PMF capacity of 5.4 m^3/s at its downstream end. Typical sections for the canal and discharge conduit adjacent to the reservoir are shown on Plate 10.

4.4 RUNOFF HANDLING FACILITIES - (Cont'd)

From Station 0+000 to 3+250 the canal is located predominantly in relatively impervious till overburden although some short lengths of rock would likely be encountered particularly downstream of Station 2+200. The earthfill canal for this reach would have a depth varying between 1.2 and 1.9 m and a gradient of 0.04 percent. A 300 m concrete pipe buried separately below the canal would be provided to convey low winter flows and prevent icing of the canal. The 300 m pipe would begin at about Station 0+500 draining the canal at intervals of 300 m and at all major tributaries. The canal drains would comprise 10 m lengths of 200 m perforated pipe covered by drain gravel. Manholes and valves at all main line connections would be provided for maintenance.

From Station 3+250 to 4+550 a reinforced concrete canal section would be necessary because of the steep and rocky terrain. The concrete flume would have an invert width of 2.0 m, a depth of 1.4 m and a gradient of 1.0 percent. To drain low winter flows, perforated pipes in drain gravel would be installed below openings in the flume invert. A rock trap would be provided at the downstream end of the canal to prevent passage of debris through the outlet chute into the reservoir.

The outlet chute comprises reinforced concrete intake and outlet structures joined by approximately 160 m of 1200 mm diameter corrugated metal pipe. The chute is buried on the abutment upstream of the dam and seepage blanket. Flow in the conduit would be at partial depth down to reservoir level where the energy would be dissipated. To ensure dissipation within the pipe, the outlet has been located below minimum reservoir level. Under normal conditions, however, dissipation would occur at much higher water levels.

4.4 RUNOFF HANDLING FACILITIES - (Cont'd)

North Runoff Canal

The north runoff canal, except for capacity and dimensions, is similar to the south runoff canal. However, it has an overall length of only 2.4 km draining an area of 2.0 km^2. Its design PMF capacity at the outlet is 2.0 m^3/s. Typical canal sections are shown on Plate 10.

From Station 0+000 to 0+700 the canal would be in overburden. It would have a depth varying between 1.2 and 1.4 m and, like the south canal, would have a gradient of 0.04 percent.

From Station 0+700 to 2+450 the canal would be mostly in rock. The concrete flume for this reach would have an invert width of 1.5 m, a depth of 1.0 m and a gradient of 1.0 percent.

The outlet chute for the north canal would be very similar to the south canal chute except for a smaller conduit diameter of 900 mm.

Like Alternative A, the runoff facilities for Alternative B would require considerable maintenance. However, with only 7 km of canal compared to 21 km for Alternative A these costs would be substantially reduced.

4.5 COST ESTIMATES

The estimated total direct costs, at September 1978 price levels, plus indirect costs including contingencies, engineering, site investigations, supervision and corporate overhead but excluding construction interest are summarized on Table 4-1. Also tabulated is the estimated cash flow based on the engineering and construction schedule shown on Plate 2-1 of HEDD Report No. 916. Because of their similarity in size, it has been assumed that the schedule for the water supply dam would be the same as shown in the HEDD report, that is; construction in 1983 and 1984 with completion by 1 July 1984. Two-year construction of the reservoir outlet works and runoff facilities would be completed prior to the winter of 1984/85.

TABLE 4-1

WATER SUPPLY & ASH DISPOSAL STUDY
ALTERNATIVE B - DRY ASH DISPOSAL
WATER SUPPLY RESERVOIR & RUNOFF FACILITIES

SUMMARY ESTIMATE OF TOTAL CAPITAL COSTS
(Costs at September 1978 Price Levels)

		$Thousand
1.	Water Supply Reservoir	
	(a) Dam and reservoir	8,680
	(b) Reservoir outlet works	3,780
	Subtotal	12,460
2.	Runoff Handling Facilities	
	(a) South runoff canal and outlet chute	1,790
	(b) North runoff canal and outlet chute	640
	Subtotal	2,430
	TOTAL DIRECT COST	14,890
3.	Contingencies (15% of 1, 20% of 2)	2,350
4.	Engineering, Investigations and Supervision (16%)	2,760
5.	Corporate Overhead (5%)	1,000
	TOTAL CAPITAL COST	21,000
6.	Annual Maintenance Cost of Canals	20

ESTIMATED CASH FLOW

Fiscal Year	$Thousand
1980/81	100
1981/82	1,100
1982/83	600
1983/84	6,600
1984/85	12,600

4.6 WATER SUPPLY BENEFITS

Since the water supply reservoir of Alternative B permits the use of runoff from the Medicine Creek basin Alternative B provides a considerable energy benefit as a result of reduced pumping requirements from the Thompson River. Based on a total drainage basin area of 51.6 km^2 and an estimated average annual runoff of about 80 mm, the average annual volume of water available for plant supply would be approximately $4 \times 10^6 m^3$. However, assuming that the existing diversion into MacLaren Creek is maintained and that the runoff is constant over the entire basin, some $1.5 \times 10^6 m^3$ on average would be lost to the existing diversion which drains an area of 18.9 km^2. (The diversion is currently licenced for an annual withdrawal of up to $2.23 \times 10^6 m^3$ if available). Because flows from Medicine Creek in dry periods are negligible, a reduction in capacity of the Thompson River pipeline is not possible. However, the energy benefits resulting from an annual average reduction in volume of $2.5 \times 10^6 m^3$ to $4 \times 10^6 m^3$ must be considered. The value of this water is assessed by Sandwell in their evaluation of the effects of the two ash disposal alternatives on the cooling water pipeline from the Thompson River.

4.7 OTHER BENEFITS

In addition to water supply benefits and a significantly lower total capital cost, Alternative B offers several other important advantages over Alternative A.

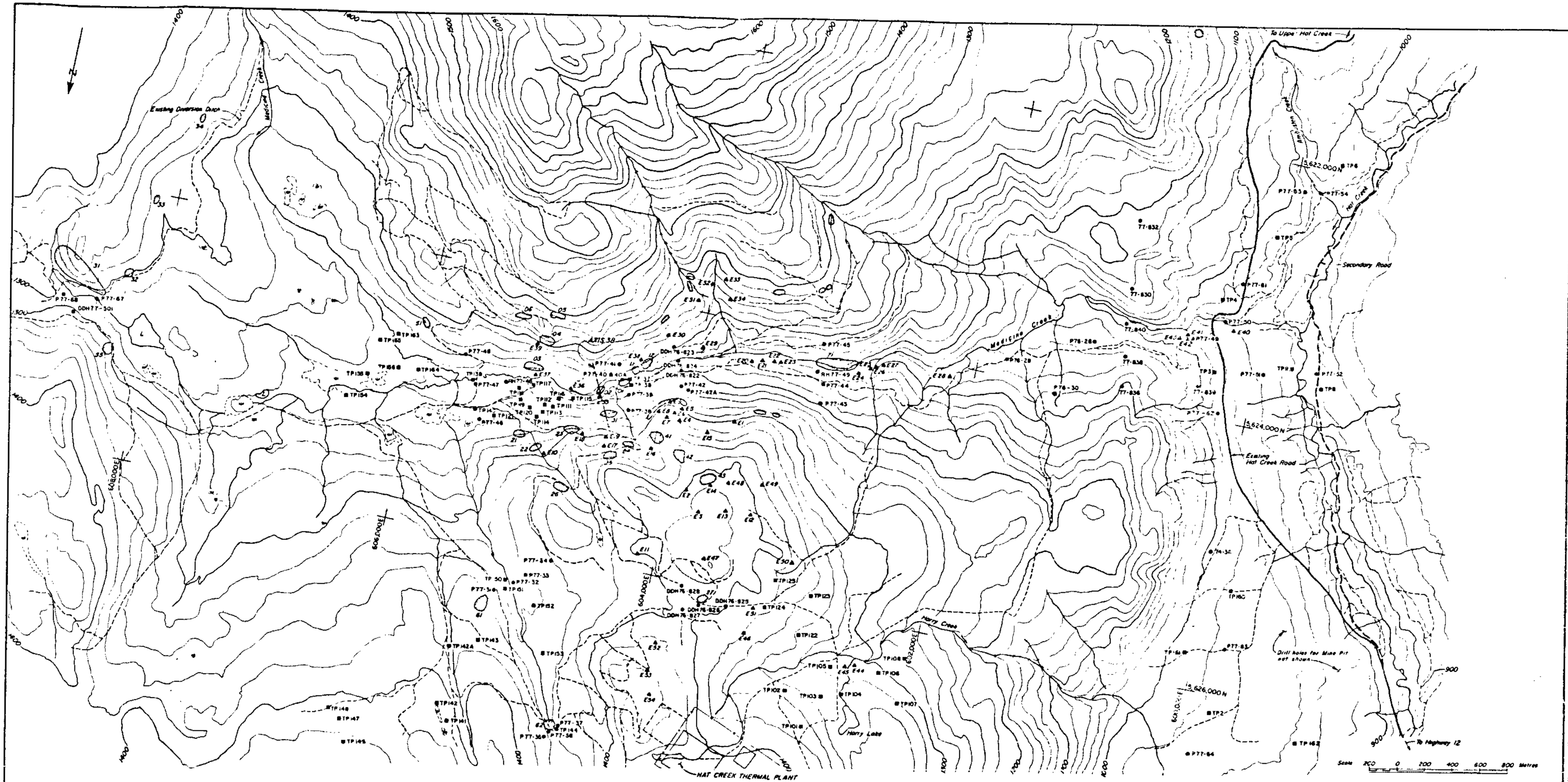
Following decommissioning of the thermal plant, the water supply reservoir of Alternative B could be used to regulate the flows of upper Medicine Creek to provide irrigation water for the reclaimed ash and waste disposal areas in Medicine Creek, for the Hat Creek valley or, depending on pumping costs, for lands east of the Medicine Creek valley. With no appreciable drainage area, the water supply reservoir of Alternative A would have no value following plant shut-down and, to provide long-term security, the main dam would most likely have to be breached, further adding to its cost.

4.7 OTHER BENEFITS - (Cont'd)

For Alternative A the total land area occupied by the water supply reservoir, ash disposal reservoir, mine waste dump, and runoff handling facilities would be about 1030 hectares. For Alternative B the corresponding land area would be about 580 hectares, less than 60 percent of the Alternative A area.

Because of the generally steep terrain, extremely variable foundations and the probability of icing problems and high maintenance costs, the runoff canals for both Alternative A and B are considered potential problem areas. With Alternative B, the overall length of the runoff canals and their capacities are both reduced to about one-third of the Alternative A values.

For the first 15 years of plant operation with Alternative B no mine wastes would be deposited in Medicine Creek and, initially, bottom and fly ash would be deposited immediately downstream of the water supply dam. Since there would be no major disposal areas below the runoff canals in early years it would be possible to defer construction of the auxiliary piping system for low winter flows and depend instead on increased maintenance for removal of potential canal icings. In fact, upstream portions of the runoff canals could also be deferred. This would permit, on the basis of actual canal operating experience, a thorough assessment of whether or not the presently anticipated icing problems are serious enough to fully warrant the supplementary piping system with its estimated total capital cost of almost $700,000. Such deferment would also enable construction of a short length of the piping system as a test installation to provide needed design data. This flexibility does not exist for Alternative A where the Stage 1 runoff canals surround the ash disposal reservoir and involve much greater costs.



LEGEND

- DRILL HOLE
- TEST PIT
- ROCK OUTCROP, MAY 1978 RECONNAISSANCE

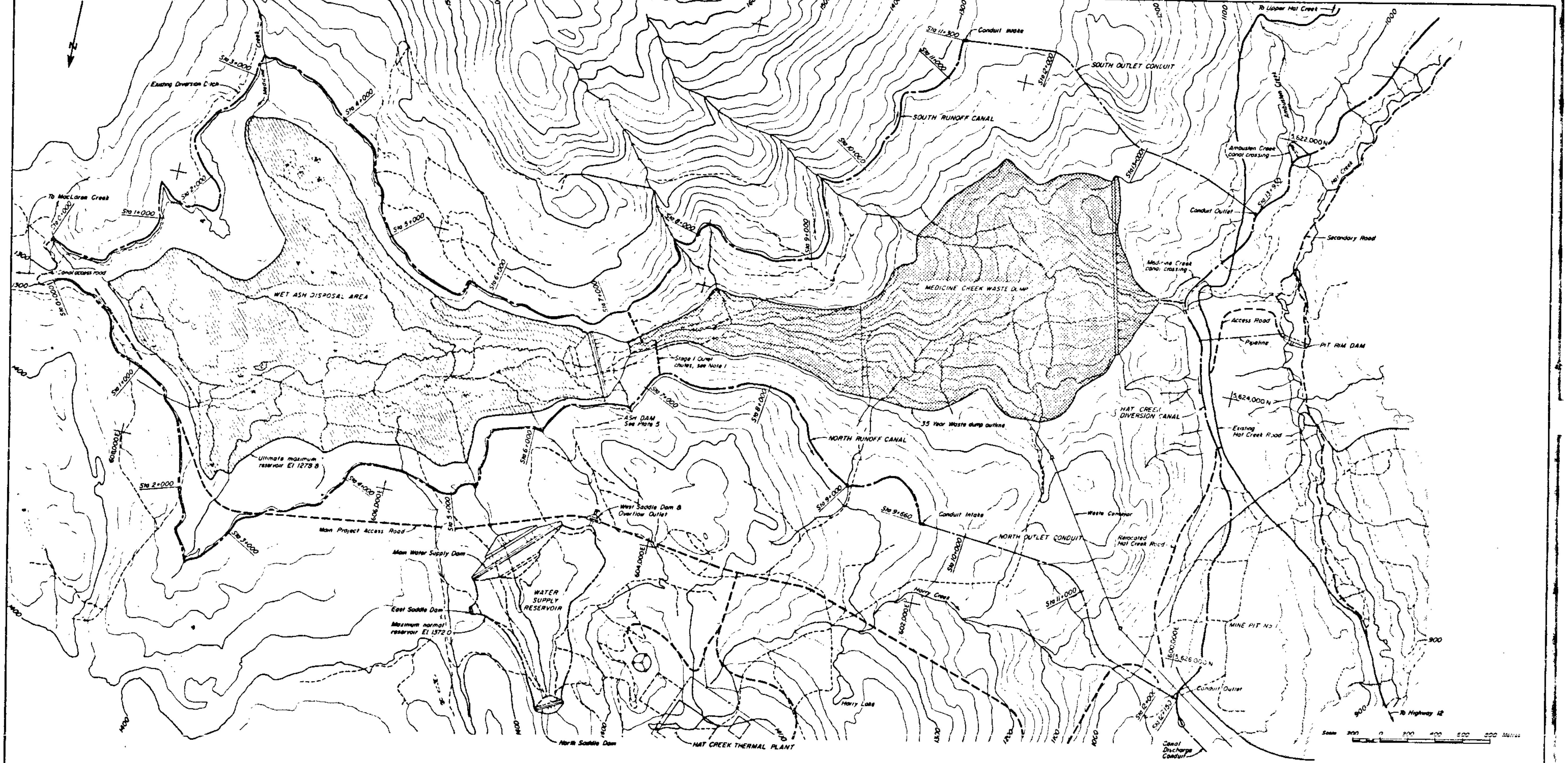
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT

WATER SUPPLY & ASH DISPOSAL STUDY STUDY AREA

DATE	AUG 1978	PLATE I	R
DWN	G C	DWG No. 604H-C14-X88	

REPORT No. DD 122



NOTES:

1. ARRANGEMENT SHOWN IS FOR ULTIMATE DEVELOPMENT. WITH NO MINE WASTES IN MEDICINE CREEK UNTIL THE 16TH YEAR OF OPERATION, RUNOFF FACILITIES WOULD BE CONSTRUCTED IN 2 STAGES WITH OUTLETS INITIALLY NEAR THE ASH DAM. EXCEPT FOR HIGHER CANAL LEVELS, THESE OUTLET CHUTES WOULD BE AS SHOWN IN HEDD REPORT NO. 916.

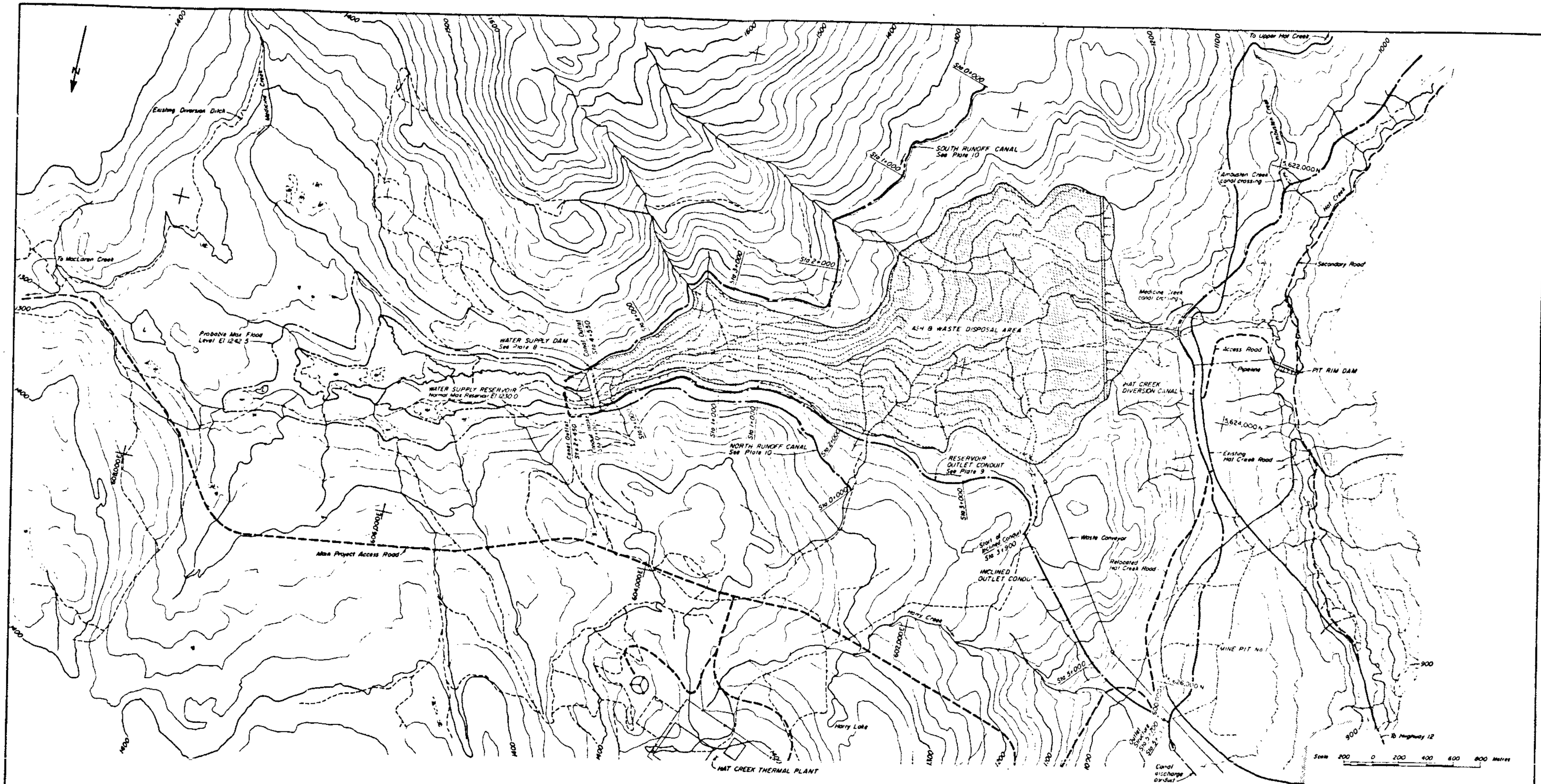
BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT

WATER SUPPLY & ASH DISPOSAL STUDY
ALTERNATIVE A-WET ASH DISPOSAL
GENERAL ARRANGEMENT

DATE AUG 1978	PLATE 2
DWN G.C.	DWG. No. 604H-C14-X89

REPORT No DD123

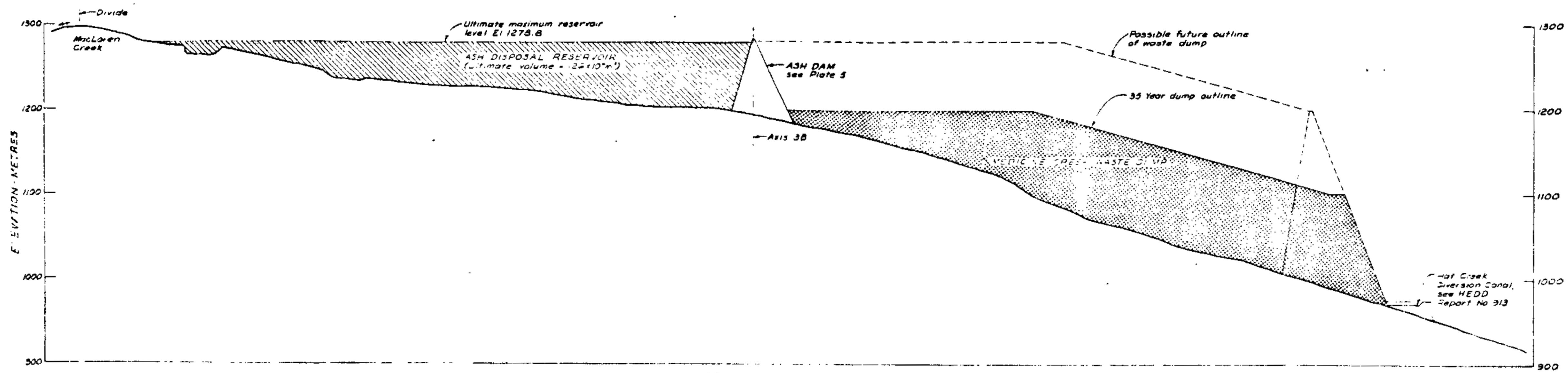


BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

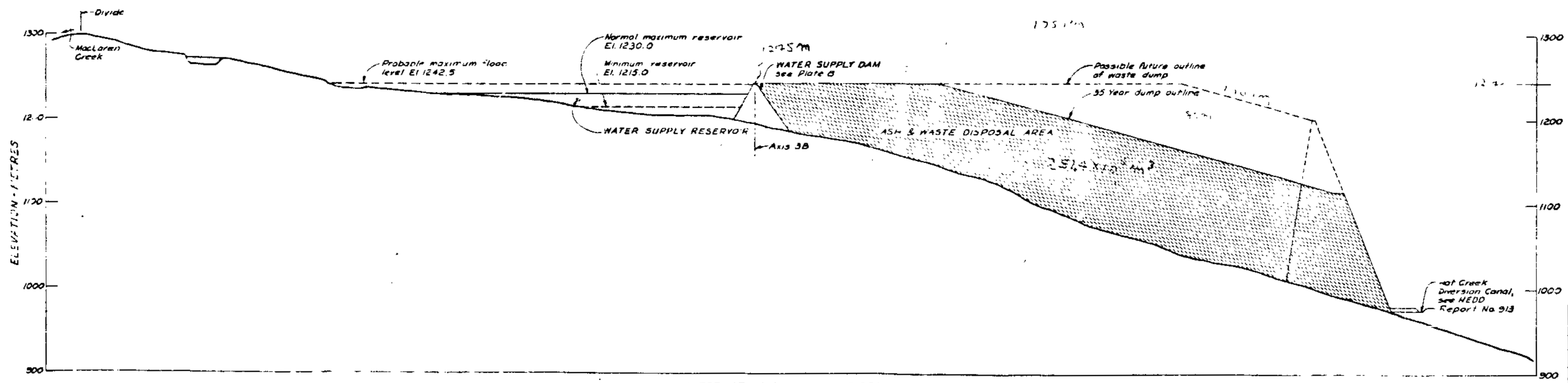
HAT CREEK PROJECT
WATER SUPPLY & ASH DISPOSAL STUDY
ALTERNATIVE B-DRY ASH DISPOSAL
GENERAL ARRANGEMENT

DATE AUG 1978	PLATE 3
DWN K.L.	DWG No. 604H-C14-X90

REPORT No. DD122



ALTERNATIVE A - WET ASH DISPOSAL



ALTERNATIVE B - DRY ASH DISPOSAL

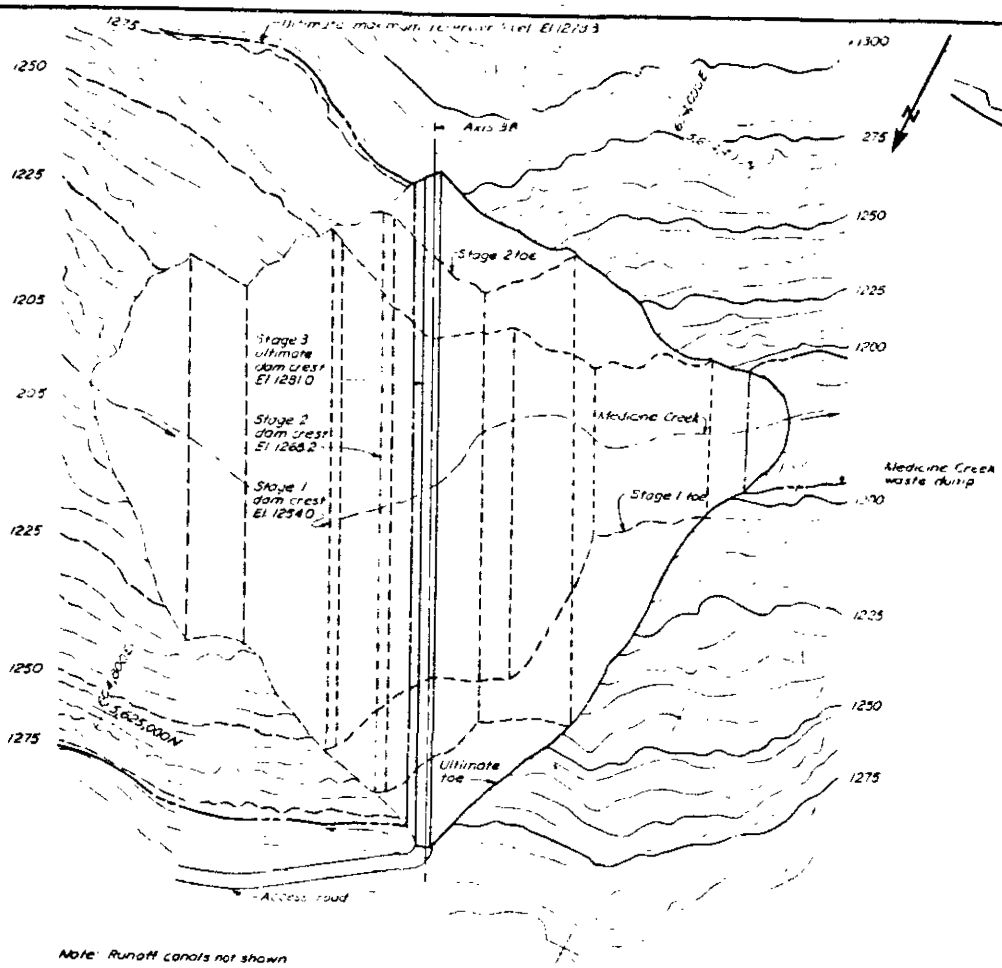
Vert Scale: 50 0 50 100 150 Metres

Horiz Scale: 250 0 250 500 750 1000 Metres

HAT CREEK PROJECT
WATER SUPPLY & ASH DISPOSAL STUDY
MEDICINE CREEK PROFILES
ALTERNATIVES A & B

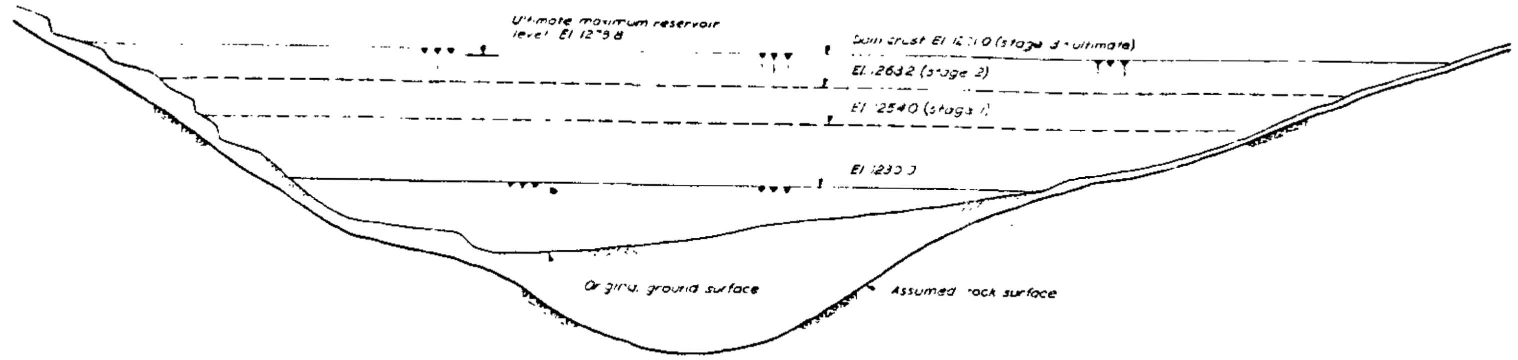
DATE AUG 1978	PLATE 4
DWN G.C.	DWG No 604H-C14-X91

REPORT No D0122

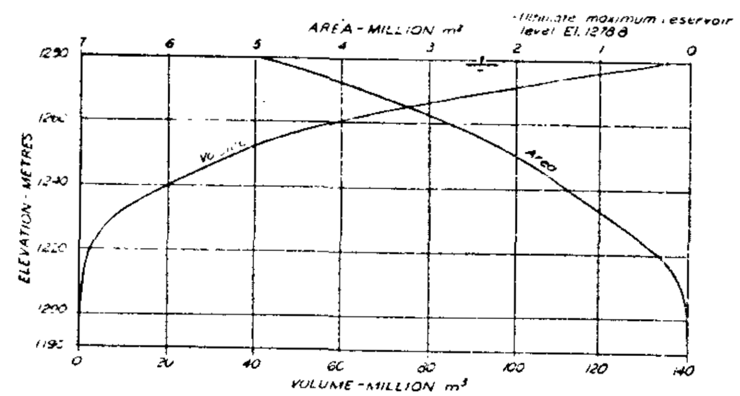


Note: Runoff canals not shown

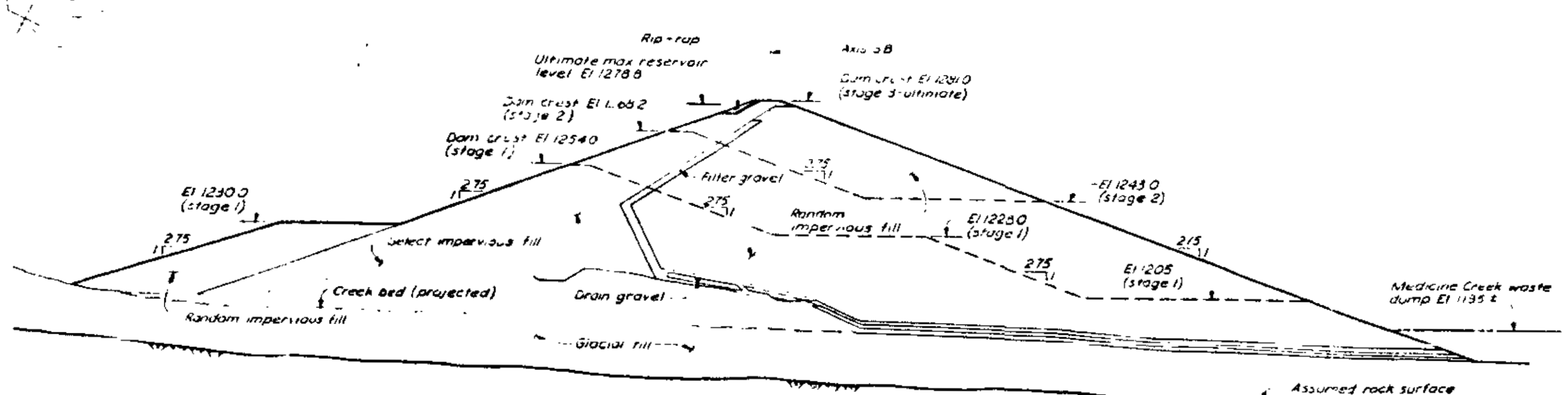
PLAN
ASH RETENTION DAM
Scale A



U/S ELEVATION OF DAM
Scale B



RESERVOIR AREA AND VOLUME CURVES



SECTION THROUGH DAM
Scale B

Scale B 20 0 20 40 60 80 Metres

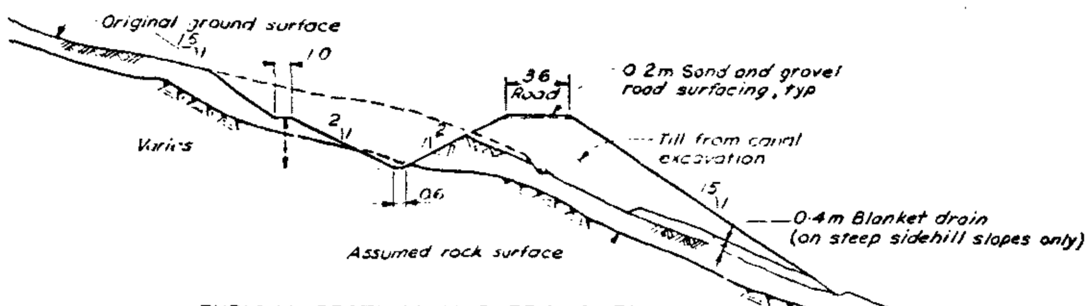
Scale A 50 0 50 100 150 Metres

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

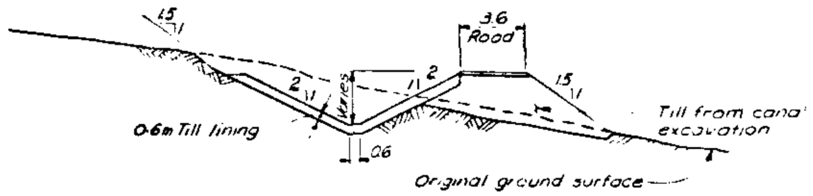
HAT CREEK PROJECT

WATER SUPPLY & ASH DISPOSAL STUDY
ALTERNATIVE A - WET ASH DISPOSAL
ASH RETENTION DAM - PLAN & SECTIONS

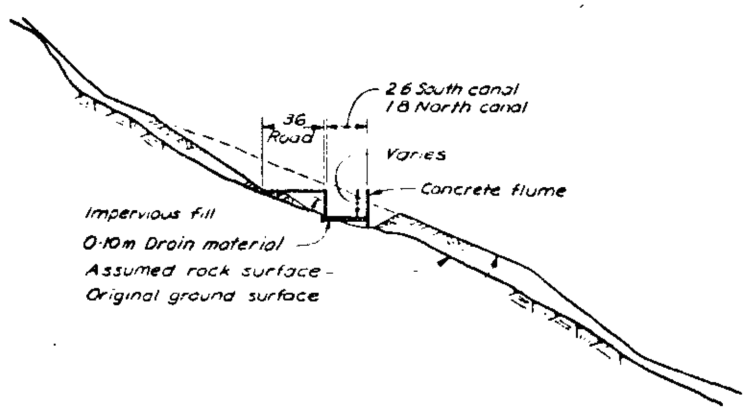
DATE AUG 1978	PLATE 5	R
DWN K.L./J.McG.	DWG No. 604H-C14-U92	



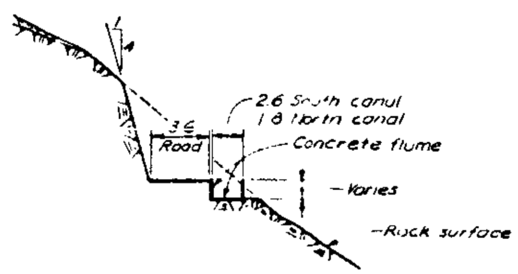
TYPICAL SECTION IN OVERBURDEN
(Shown: south canal sta 0+500)



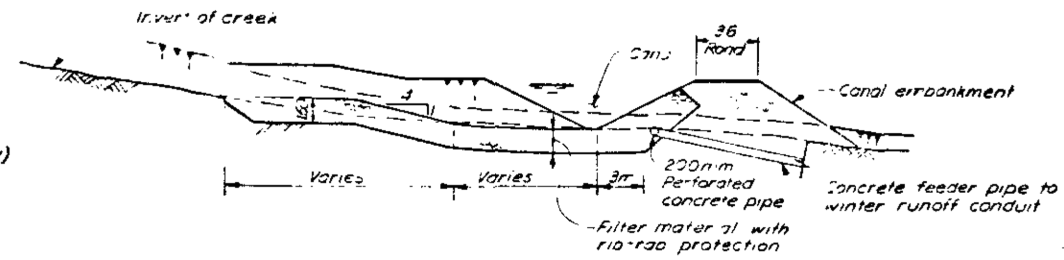
TYPICAL SECTION IN OVERBURDEN WITH LINING
(Shown: south canal sta 3+400)



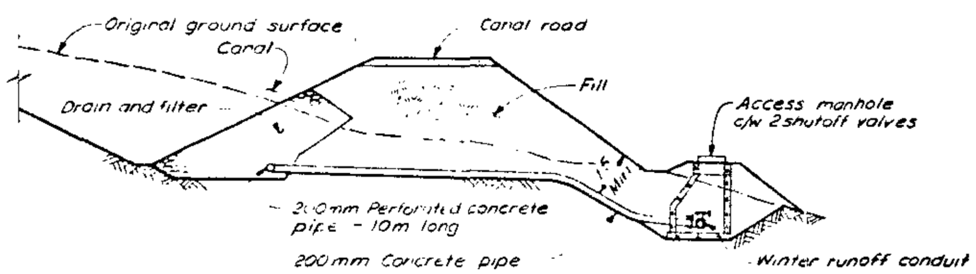
TYPICAL SECTION ON STEEP SLOPE
(Shown: south canal sta 9+050)



TYPICAL SECTION IN ROCK
(Shown: north canal sta 6+350)



TYPICAL SECTION THROUGH STILLING & FILTRATION POOL
(Typical at all major tributaries)
NTS



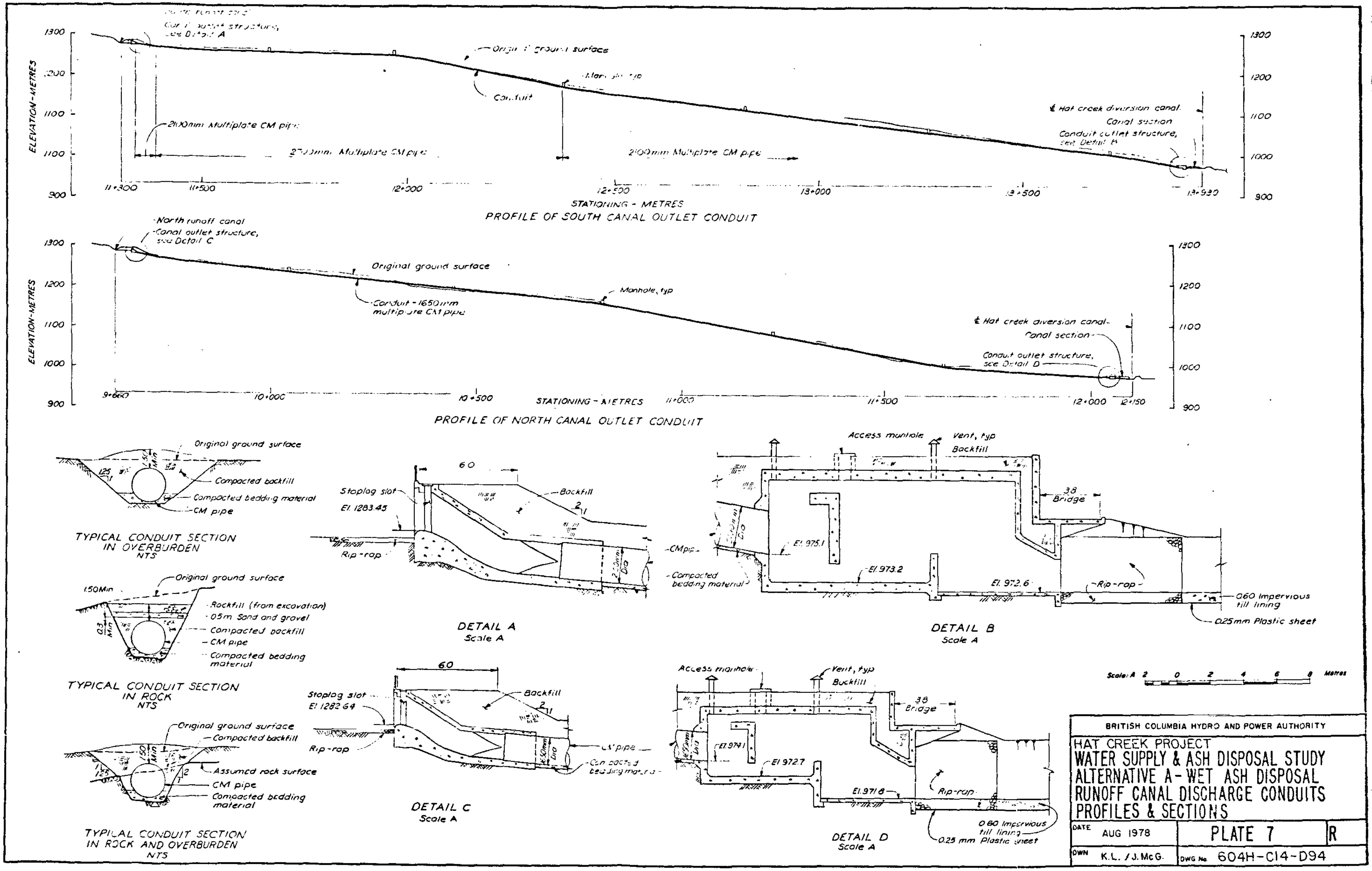
TYPICAL SECTION OF DRAIN AND FILTER FOR WINTER RUNOFF
(~50m approx spacing)
NTS

Scale: 5 0 5 10 15 Metres

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT
WATER SUPPLY & ASH DISPOSAL STUDY
ALTERNATIVE A - WET ASH DISPOSAL
RUNOFF CANALS
TYPICAL SECTIONS

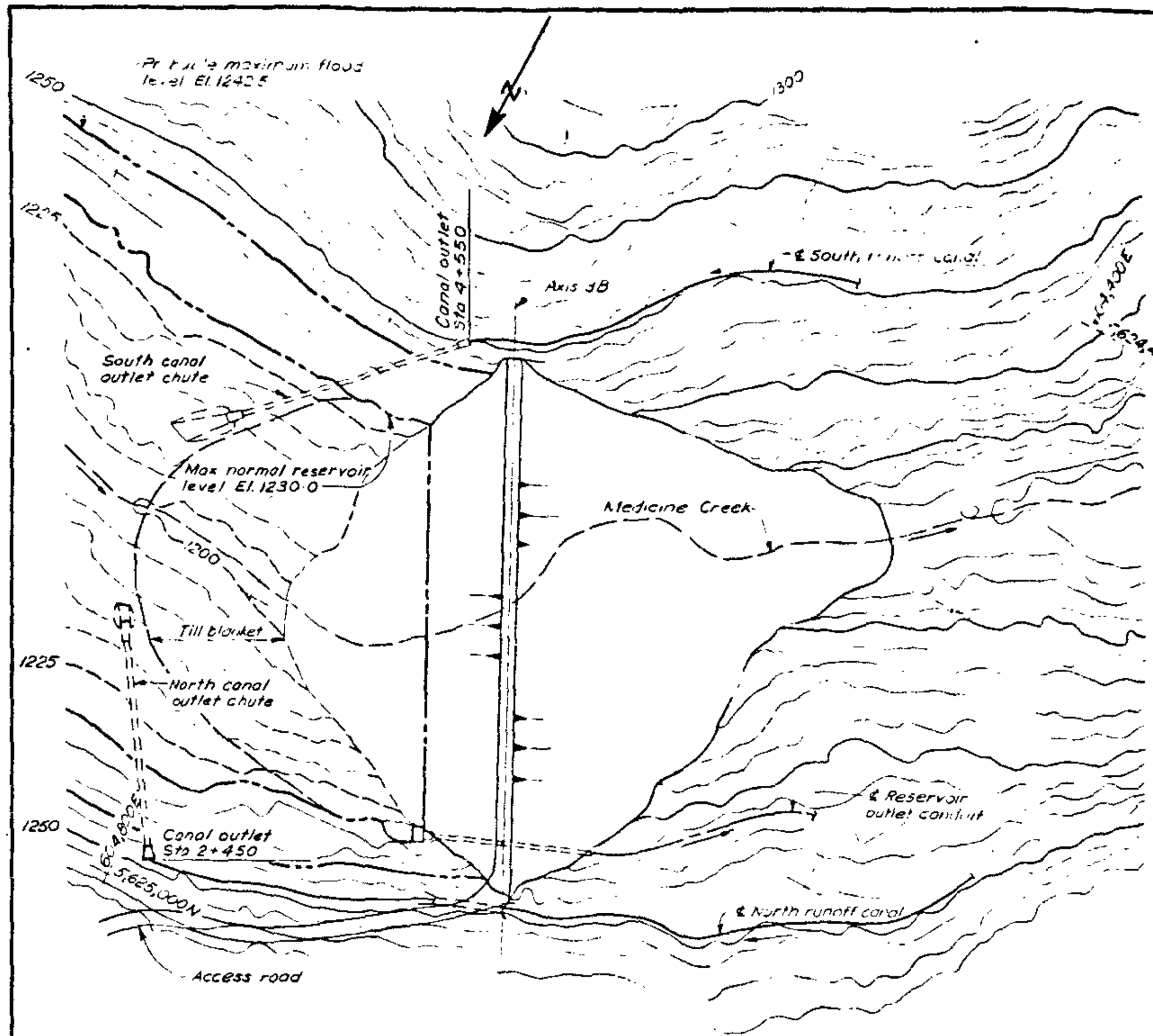
DATE AUG 1978	PLATE 6	R
DWN K.L./J Mc G.	DWG No. 604H-C14-D93	



BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

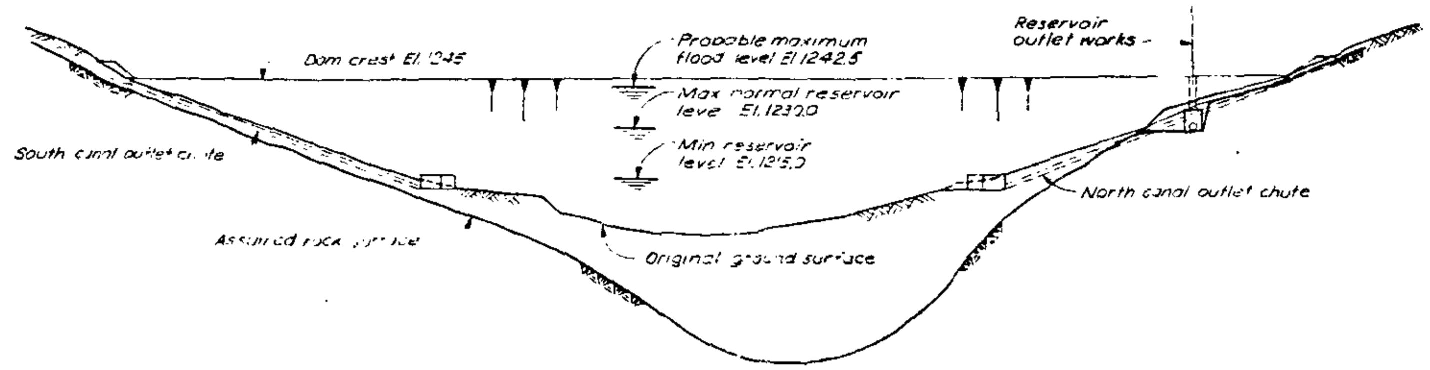
HAT CREEK PROJECT
WATER SUPPLY & ASH DISPOSAL STUDY
ALTERNATIVE A - WET ASH DISPOSAL
RUNOFF CANAL DISCHARGE CONDUITS
PROFILES & SECTIONS

DATE AUG 1978	PLATE 7		R
DWN K.L. / J. McG.	DWG No. 604H-C14-D94		



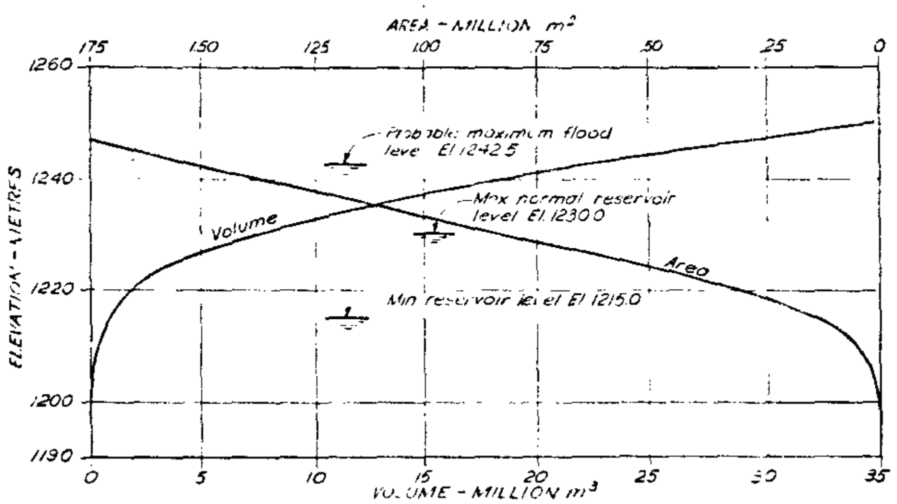
PLAN
WATER SUPPLY DAM

Scale: A

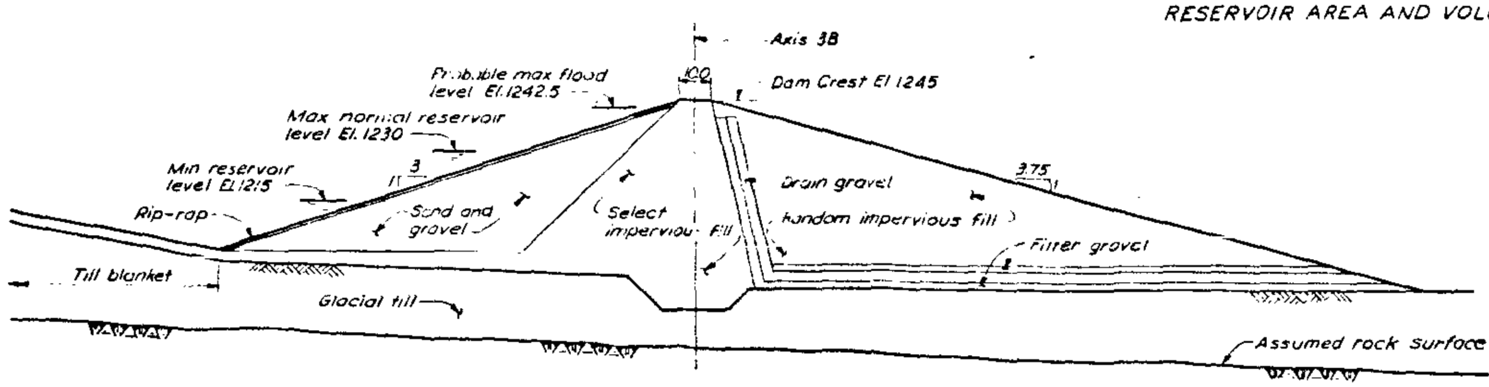


U/S ELEVATION OF DAM

Scale: B



RESERVOIR AREA AND VOLUME CURVES



SECTION THROUGH DAM

Scale: B

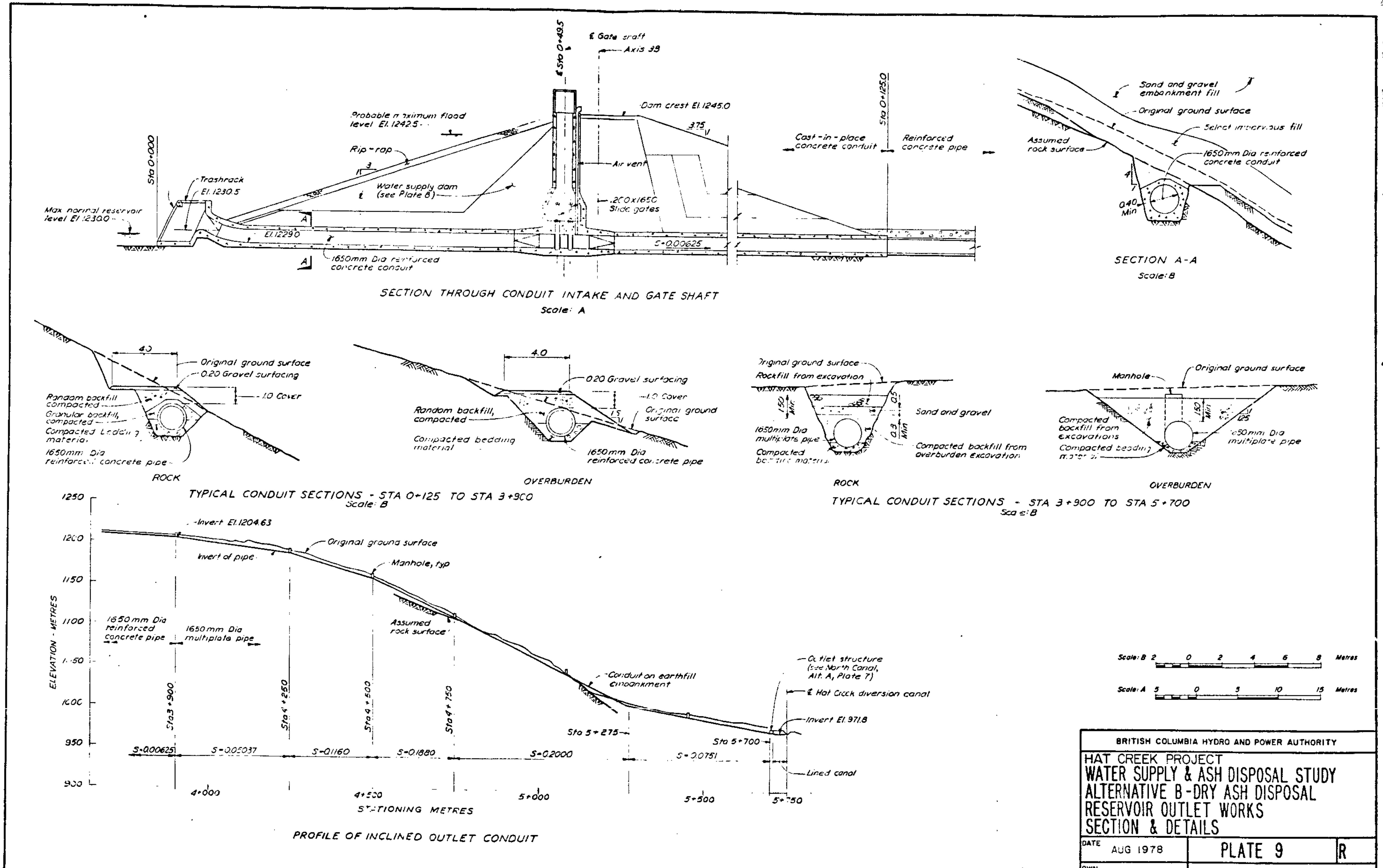
Scale: B 20 0 20 40 60 80 Metres

Scale: A 50 0 50 100 150 Metres

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT
WATER SUPPLY & ASH DISPOSAL STUDY
ALTERNATIVE B-DRY ASH DISPOSAL
WATER SUPPLY DAM
PLAN & SECTIONS

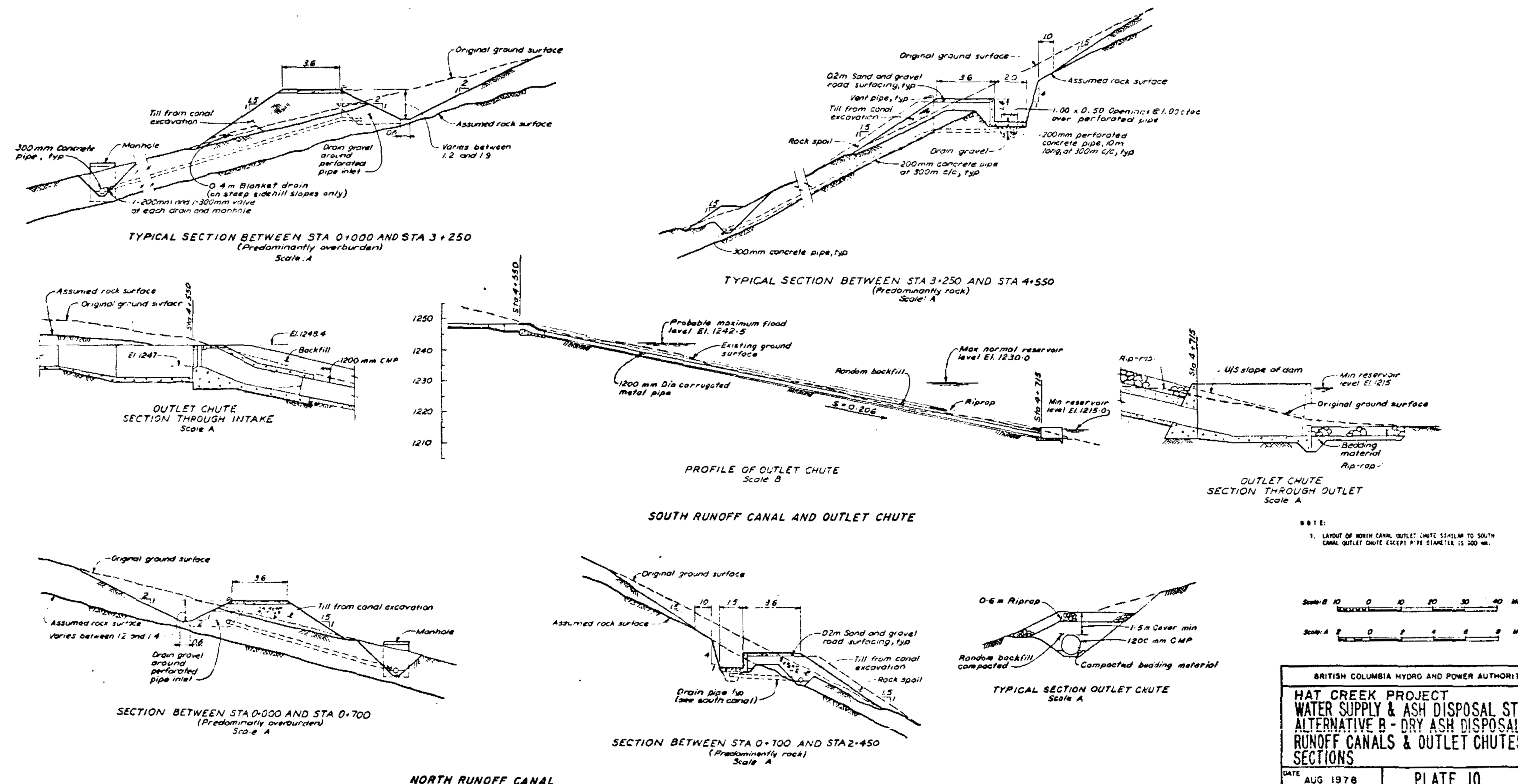
DATE AUG 1978	PLATE 8	R
DWN K.L.	DWG No. 604H-C14-D95	



BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT
WATER SUPPLY & ASH DISPOSAL STUDY
ALTERNATIVE B-DRY ASH DISPOSAL
RESERVOIR OUTLET WORKS
SECTION & DETAILS

DATE AUG 1978	PLATE 9	R	
DWN K.L.	DWG No. 604H-C14-D96		



NOTE:

1. LAYOUT OF NORTH CANAL OUTLET CHUTE SIMILAR TO SOUTH CANAL OUTLET CHUTE EXCEPT PIPE DIAMETER IS 300 mm.

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT
WATER SUPPLY & ASH DISPOSAL STUDY
ALTERNATIVE B - DRY ASH DISPOSAL
RUNOFF CANALS & OUTLET CHUTES
SECTIONS

DATE AUG 1978	PLATE 10	R
DWN K.L.	DWG No. 604H-C14-U97	