SUSITNA
HYDROELECTRIC PROJECT

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WATANA AND DEVIL CANYON RESERVOIR TEMPERATURE/ICE AND SUSPENDED SEDIMENT CONCENTRATION STUDY

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HARZA-EBASCO
SUSITNA JOINT VENTURE

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Report by
Harza-Ebasco Susitna Joint Venture

Prepared for
Alaska Power Authority

Final Report
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NOTICE

ANY QUESTIONS OR COMMENTS CONCERNING
THIS REPORT SHOULD BE DIRECTED TO
THE ALASKA POWER AUTHORITY
SUSITNA PROJECT OFFICE

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1.0 INTRODUCTION

The potential effect of the Susitna Hydroelectric Project on the fishery resources of the Susitna River is an important concern in the development of the project. These potential effects include possible changes in both the quantity and quality of water in the Susitna River with respect to the fish and other wildlife habitats. The potential changes in river flows, water temperature, suspended sediments, and ice conditions must be evaluated carefully. Such concerns and the need to perform an environmental impact analysis associated with the license application of the project have motivated a program to collect data at the Eklutna Lake and Susitna basin; to develop and test a reservoir temperature model using Eklutna Lake data; and to apply the model to predict the temperature and suspended sediment regimes in the proposed Watana and Devil Canyon reservoirs. These efforts are briefly summarized in this report. The reservoir temperature simulation model, DYRESM, used in this study is outlined and the testing of the model with the Eklutna Lake data is discussed. The model's capability to simulate the operation of the proposed multi-level intake structures under different project operating policies, hydrologic and meteorological conditions, and environmental flow requirements is illustrated by several case studies.

The field data collection program has been conducted by R&M and has been reported separately (R&M, 1982, 1985a, 1985b, 1985c, 1985d and 1985e). The pertinent hydrologic and meteorological data have been collected at three sites; namely, Watana, Devil Canyon, and Eklutna Lake. At each site, an automated weather station has been installed and operated since June 1982. The data collected were processed, analyzed, and finalized in a format suitable for the DYRESM applications.

The DYRESM reservoir temperature simulation model was originally developed by Imberger and Patterson (Imberger and Patterson, 1981), and later extended and enhanced by Harza-Ebasco Susitna Joint Venture. The model was expanded with added capabilities to simulate suspended sediment concentrations in the reservoir and the winter ice-cover formation. Wind effects on temporary thermocline displacement were also incorporated. Testing of the model was conducted with Eklutna Lake data for the period June 1982 through May 1983 (R&M, 1985a, 1985b, 1985c and Harza-Ebasco, 1984a). Good agreements between predicted and observed outflow temperatures and winter ice-cover thicknesses were obtained.

Following successful testings of the DYRESM model, the model was applied to predict the temperature regimes of the proposed Watana and Devil Canyon reservoirs. A limited number of study years were selected to represent the range of conditions to which the project would be exposed. Both the initially proposed two-stage project scheme and the recently proposed three-stage project scheme have been incorporated in the study. The selective withdrawal capability of the proposed multi-level intake structures was simulated for different project operating conditions. The extended DYRESM model was applied to simulate the suspended sediment concentrations in the proposed reservoirs to assist in the determination of the outflow turbidity. To provide data for testing the suspended sediment portion of the model, R&M's Eklutna Lake data collection program was continued with special emphasis on suspended sediment sampling for the period from May to November 1984.

2.0 WATANA AND DEVIL CANYON RESERVOIR TEMPERATURE AND ICE STUDY

2.1 GENERAL CONSIDERATIONS

Application of the enhanced DYRESM model to the proposed reservoirs in the Susitna Basin required a successful testing of the enhanced DYRESM model on an existing lake of similar characteristics. Eklutna Lake, near Anchorage, was selected for testing the model because of its hydraulic and morphologic similarities to the proposed reservoirs. Eklutna Lake is also a glacially-fed lake and is also located in South-Central Alaska with hydroelectric power productions. The Eklutna Lake study is described in Section 5.0.

Following the successful testing of the DYRESM model with the Eklutna Lake data, the enhanced DYRESM model was applied to determine the temperature regimes of the proposed Watana and Devil Canyon reservoirs.

2.1.1 Application of the DYRESM Model

Daily DYRESM simulations of the reservoir hydrodynamics, thermal stratification and outflow temperatures of the Watana and Devil Canyon reservoirs have been performed for the two-stage project scheme as described in the license application (Alaska Power Authority, 1983) and the recently proposed three-stage scheme. Fifteen years of hydrologic and meteorological data have been assembled and analyzed. The data collected by R&M (R&M, 1985d and 1985e) at the Watana and Devil Canyon weather stations since 1980 were also used. These data provide the following basic meteorological input for the DYRESM model:

1. Mean air temperature (°C);
2. Daily and 6-hr wind speed (m/s);
3. Air vapor pressure (mb);
4. Precipitation (mm);

5. Cloud cover (sky fraction); and
6. Incoming short-wave radiation (KJ/m^2).

A reservoir operation study (Harza-Ebasco, 1985b and 1985c) was carried out to determine the inflow, outflow, and reservoir level of each reservoir based on the project stage, energy demand, natural stream inflows, and the downstream flow requirement considered. These results were input to the DYRESM model.

2.1.2 Conditions Considered

A limited number of study years were selected for simulations using the DYRESM model. These study years were chosen to represent the range of conditions to which the project would have been exposed. Periods representing dry, average, and wet hydrologic conditions and/or hot, average, and cold meteorological conditions were selected for the simulations in conjunction with the Case C downstream flow requirement (12,000 cfs minimum August flow)which was proposed in the Susitna Hydroelectric Project License Application (Alaska Power Authority, 1983). Through these Case C case studies, the selective withdrawal capability of the proposed multi-level intake structures was demonstrated. These simulated outflow temperatures were used to determine the downstream winter ice regimes (Harza-Ebasco, 1984b and 1985a). The Case C downstream flow requirement was later replaced by the Case E-VI flow requirement. The Case E-VI flow requirement as shown in Figure 1 represents a recommended refinement of Case C as described in the report "Evaluation of Alternative Flow Requirements" (Harza-Ebasco, 1984c) The Case E-VI hydrothermal and ice regimes of both reservoirs have been analyzed for both two-stage and three-stage project schemes. In addition, the Case E-I alternative downstream flow requirement as shown in Figure 2 was also investigated. In this report, the cases analyzed with the Case E-VI and Case E-1 downstream flow requirements and 1981-1982 inflow and meteorological conditions are described. The Case E-VI condition is the Alaska Power Authority's preferred operating condition with respect to the energy and instream flow requirements. The energy demands considered included energy demands predicted for Stage I, Stage II and late Stage III.

2.2 CASE STUDIES

A summary showing the project scheme, flow requirement, the energy demand (year) and the intake operating policy used in these case studies is given as follows:

1. Case E-VI with two-stage project (license application):

   (1) Stage I - (Watana only):
   Intake operating policy:

   (a) Inflow temperature matching (Exhibit A)
   (b) Warmest possible outflow (Exhibit B)

   (2) Stage II - (Watana and Devil Canyon):
   Intake operating policy:

   (a) Inflow temperature matching (Exhibit C)
   (b) Warmest possible outflow (Exhibit D)

2. Case E-VI with three-stage project:

   (1) Stage I (Watana only):
   Intake operating policy:

   (a) Inflow temperature matching (Exhibit E)
   (b) Combination of inflow temperature matching and level-5 only (Exhibit F)

   (2) Stage II (Watana and Devil Canyon):
   Intake perating policy:

   (a) Inflow temperature matching (Exhibit G)

(3) Stage II (Watana and Devil Canyon) allowing only 9-ft drawdown at Devil Canyon:
Intake operating policy:

(a) Inflow temperature matching (Exhibit H)

(4) Stage III (Watana and Devil Canyon) (full utilization of generating capacity):
Intake operating policy:

(a) Inflow temperature matching (Exhibit I)

3. Modified Case E-VI with two-stage project (APA 1983 license application):

(1) Stage II (Watana and Devil Canyon):
Devil Canyon Minimum W.S. at El. 1446

Intake operating policy:

(a) Inflow temperature matching (Exhibit J)
(b) Warmest possible outflow (Exhibit K)

4. Case E-1 with two-stage project (license application):

(1) Stage II (Watana and Devil Canyon):
Intake operating policy:

(a) Warmest possible water (Exhibit L)

5. Case E-1 with three-stage project:

(1) Stage II (Watana and Devil Canyon):
Intake operating policy:

(a) Inflow temperature matching (Exhibit M)

(2) Stage III (Watana and Devil Canyon) (full utilization of generating capacity):
Intake operating policy:

(a) Inflow temperature matching (Exhibit N)

In two-stage project scheme, the completed Watana reservoir would have a maximum depth of about 720 ft with a total volume of about 9.4 x 10^6 acre-ft and the Devil Canyon reservoir would have a maximum volume of about 1 x 10^6 acre-ft at the maximum depth of about 540 ft. Note that the size of the Devil Canyon reservoir in terms of volume would be about one-tenth of Watana. With an outlet works intake located deep in the reservoir, the hydrothermal regime in the Devil Canyon reservoir would be more dynamic than that of the Watana reservoir as demonstrated in the following analysis of the simulation results.

In the three-stage project scheme, the Watana reservoir (Figure 3) would have a maximum depth of about 540 feet and a total volume of about 4.25 x 10^6 acre-ft in the first and second stages. The Devil Canyon reservoir (Figure 4) would be completed in Stage II and the maximum depth would be about the same as that of Stage II Watana reservoir. However, the total volume of the Devil Canyon reservoir would be about one-quarter of that of the corresponding Watana reservoir in Stage II.

In the analyses, a normal allowable drawdown of 50-ft in the Devil Canyon reservoir was assumed unless stated otherwise as indicated in the above summary. The inflow temperature matching operation shown under intake operating policy represents an operation of the intake to release water from the project with temperatures similar to that of the natural conditions. In the simulations, the natural conditions were represented by the inflow conditions. The warmest possible water operating policy represents a requirement of releasing warmest near-surface water in the summer using near-surface intake ports and the warmer water near the bottom of the intake structure in the winter using lowest level intake ports.

The average reservoir temperature profiles and outflow temperatures as pre-
The multi-level intakes proposed for both Watana and Devil Canyon dams and for both two-stage and three-stage project schemes are shown in Figures 5, 6 and 7. These intake designs are incorporated in the respective case studies.

dicted by the DYRESM dynamic reservoir simulation model for the cases listed above are shown in Exhibits A-N.

2.3 SIMULATION RESULTS

The results of these case studies are summarized as follows:

2.3.1 Watana Reservoir

Regardless of the project operation schemes and project status (stages), the reservoir would develop stratifications in the summer months of June, July, August, and September. Overturns would occur in spring and fall, and ice-cover would also form in the winter.

In the summer, a warmer surface mixing layer (epilimnion) would form due to solar surface heating. Typical predicted summer temperature profiles are shown in Figure 8. The surface temperature would vary from about 45 to 55 degrees F (7 to 13 degrees C), and the thickness the epilimnion would vary from about 60 to 200 feet depending on the weather and project operating conditions considered. In the underlying thermocline the water temperature would be reduced to near 39 degrees F (4 degrees C) at the top of the more uniform and colder zone above the reservoir bottom called hypolimnion. The thickness of the thermocline (also called the metalimnion) may vary from about 60 to 180 feet depending upon the conditions in the reservoir. Temporal secondary thermoclines may also exist from time to time in the metalimnion. The approximately 39 degrees F (4 degrees C) hypolimnion would be found below a depth of about 120 to 350 feet.

The near isothermal condition at approximately 39 degrees F (4 degrees C) would occur twice a year in early November and late May. The Watana reservoir would be dimictic in that it would mix twice a year. Mixing would occur between ice-cover meltout and the onset of thermal stratification in late spring and between the breakdown of the thermal stratification in fall and the onset of winter ice-cover. When the air temperature and solar insolation decrease rapidly in October and November, mixing and further cooling of the reservoir would continue until the surface of the reservoir freezes. The presence of ice-cover prevents further wind mixing and conserves the heat remaining in the reservoir. In general, the ice-cover would form in November and a total meltout would occur in May. A maximum ice thickness of two to five feet can be expected in March. With the formation of ice-cover in the relatively long subarctic winter, an inverse stratification in the reservoir would also occur. The water at the contact surface with the ice would be near 32 degrees F (0 degrees C) and the temperature would then increase with depth toward a maximum of approximately 39 degrees F (4 degrees C) at a depth of about 150 to 350 feet from the surface depending upon the weather conditions prior to the surface freeze-up. The near isothermal condition of 39 degrees F (4 degrees C) would then be maintained in the hypolimnion under normal operating conditions. The thickness of the hypolimnion would depend on the depth of the reservoir and stage of the project. Under the Stage I of the three-stage project condition, the reservoir level would be about 200 feet below the maximum Stage-III level, and a winter hypolimnion of only about 130 feet may be formed. In the later stage of the project during which the reservoir became deeper, a winter hypolimnion of up to about 460 feet can be expected.

2.3.2 Watana Reservoir Multi-Level Intake - Selective Withdrawal

The multi-level intake structures proposed for the Watana reservoir for different project stages provide the project capability to release water selectively from various levels of the stratified water body in the reservoir. These intakes can be operated: (1) to discharge water at temperatures as close to natural river temperatures as possible; (2) to discharge warmest possible water; and (3) to discharge water at a pre-determined level.

With the proposed multi-level intake structures, the Watana summer release temperatures can be approximately controlled to satisfy a predetermined objective. In the summer, the river inflows are more responsive to variations in the meteorological conditions than the reservoir due to the shallowness of the river. The river inflow warms up in the early summer and cools down in the late summer more rapidly than does the reservoir. Hence, the Watana discharge water would be colder in the early summer and warmer in the early fall than the natural river conditions. However, in most of the summer months (June, July, and August) the Watana discharge temperatures can be regulated to approximate inflow temperatures through operation of the multi-level intake except in times when large releases are made with the outlet works. In the winter, inflow temperatures would be near 32 degrees F (0 degrees C) and the temperatures in the reversed stratification zone would range from near 32 degrees F (0 degrees C) at the contact surface with the ice-cover to approximately 39 degrees F (4 degrees C) at top of the hypolimnion. Therefore, the Watana discharge temperatures would be slightly warmer during the winter than natural river conditions. As a result, the discharge temperatures would range from approximately 41 degrees F (5 degrees C) to 54 degrees F (12 degrees C) in the summer and approximately 33 degrees F (0.5 degrees C) to 37 degrees F (3 degrees C) in the winter depending on the project and meteorological conditions, and energy demand level.

2.3.3 Devil Canyon Reservoir

The DYRESM simulation model was applied to predict reservoir temperature regimes in both Watana and Devil Canyon reservoirs for Stage II of the two-stage project scheme and Stages II and III of the three-stage project scheme. The thermal regimes predicted for the Watana reservoir in these stages are similar to that predicted for the Watana only project conditions. In this section, only the predicted Devil Canyon reservoir temperature regimes are discussed.

In the analyses, the Watana outflow and the tributary inflows downstream of the Watana dam are input to the Devil Canyon model. Since the Devil Canyon reservoir receives water from the Watana reservoir, the inflow to the Devil Canyon reservoir would be thermally more stable than the inflow to the Watana reservoir. Hence, the main Devil Canyon inflow would be cooler in early summer and warmer in early fall than the natural inflows.

The simulation results indicate that the Devil Canyon reservoir would also exhibit the general pattern of early summer warming, summer stratification, and fall to winter cooling through a reservoir overturn to reverse stratification in winter ice-covered months. Typical temperature profiles of the Devil Canyon reservoir are shown in Figure 9.

As described in an earlier section, the maximum total volume of the Devil Canyon reservoir would be only about one-tenth of the completed Watana reservoir and about one-quarter of the Stage I and Stage II Watana reservoir of the three-stage project. Also, the low level outlets (cone valves) would be located at a depth of about 500 feet below the normal maximum pool level. The hydrothermal regime in the Devil Canyon reservoir would, therefore, be more dynamic and more sensitive to the operation of the outlet works as shown in the predicted 1981 September and October profiles in Figure 9 than would Watana. The temperature in the hypolimnion would vary from about 39 to 50 degrees F (4 to 10 degrees C) in summer.

2.3.4 Devil Canyon Reservoir Multi-Level Intake - Selective Withdrawal

The temperature regimes of the Devil Canyon reservoirs have been simulated for the Stage II condition of the two-stage project and the Stages II and III conditions of the three-stage project. The two-level intake design proposed for both the two-stage and three-stage project schemes was incorporated in the analyses. A three-level intake with an additional level added between the two levels proposed originally was also investigated for Stage II. However, no obvious advantage was observed in controlling the outflow temperature. The relatively large summer releases from the deep low level outlet works and the thinner epilimnion make the operation of the intake less effective in terms of selective withdrawal than at Watana.

Comparisons of the Watana and Devil Canyon outflow temperatures are shown in Figures 10-15. In Figures 10 and 11, outflow temperatures predicted for Stage II and year 2002 demand conditions and Case E-VI flow requirement are shown. The operation of the powerhouse intake was simulated to match the release temperature with the natural inflow temperature. The summer outlet works operations and the thin epilimnion reduced the effectiveness of the selective withdrawal using the multi-level intakes in both reservoirs. The effect would be greater in Devil Canyon reservoir since the outflow temperatures from the Devil Canyon reservoir would be affected by the operation of the outlet works in both reservoirs. Such situation may persist for a period of about 2 to 3 weeks until the water level was reduced to where the epilimnion was closer to the bottom level, or until the water level increased and the upper level intake ports could again be used.

The effectiveness of the multi-level intake in releasing warmest possible water from the Devil Canyon reservoir in stage II is reduced as demonstrated in Figures 12 and 13. In mid-June of 1981, the Devil Canyon intake releases were changed from the top-level ports to the bottom level ports due to decreased water level and caused a 7 degrees F (4 degrees C) reduction in outflow temperature while the Watana release temperature rose steadily. Thus, the Devil Canyon releases can be up to 9 degrees F (5 degrees C) colder than the Watana releases in June and July for a period of about 10 to 15 days. These occurrance would be significantly reduced in frequency when the project is fully developed and when the reservoir levels are more stable and the operations of the outlet works are less frequent such as in late Stage III condition as shown in Figures 14 and 15. Control of release temperatures improves as energy demand increase and outlet works releases decrease.

2.3.5 Outlet Works Effect on Watana Release Temperatures

The outlet works are provided to release flow required to meet minimum environmental flow requirements when the requirements exceed powerhouse flows and to release flood flows while minimizing reservoir surcharge and spillway usage.

The outlet works would normally be operated in the summer months of August and September during which the reservoir stratification would be relatively strong.

The control of the release temperature would be more difficult with the outlet works in operation. As shown in Figure 16, the outlet works intake which would be located near the second intake port level from the top in Stages I and II of the three-stage project scheme was simulated to be operated in August and September of 1981. This is higher, relative to the reservoir water surface, than in Stage III and, thus, water released through the outlet works in these stages is warmer than in Stage III. This affects the ability of the powerhouse intake to match outlet temperatures to inflow temperatures when temporary climatic changes cause inflow temperature to decrease sharply during periods of outlet works operations. If the outlet works discharge is high relative to the powerhouse discharge, selective operation of the multi-level intake may not be able to compensate for differences between inflow temperature and outlet works release temperature. As illustrated in Figure 16 for the Stage-I condition with Case E-VI flow requirement, the outlet works were not operated in June and July of 1981 and the inflow temperature varied from 43 to 54 degrees F (6 to 12 degrees C). The multi-level intake was operated to provide releases with temperature varied from 45 to 52 degrees F (7 to 11 degrees C). When the inflow temperature decreased 11 degrees F (6 degrees C) in mid-August, a maximum reduction in project outflow temperature of 7 degrees F (4 degrees C) was achieved by operating the lowest intake ports. In August, the outlet works were operated to discharge up to 24,000 cfs while the powerhouse was discharging at an average flow of 10,200 cfs. The relatively large releases from the outlet works reduced the effectiveness of the multi-level intake in controlling the outflow temperatures. The effectiveness of the Devil Canyon reservoir multi-level intake would be similarly affected by the large outlet works releases (Figure 15).

When the outlet works are not in operation, the operation of the multi-level intake would be effective in controlling release temperatures. As shown in Figure 17, the operation of the multi-level powerhouse intake was simulated to release inflow temperature matching outflows for Case E-VI downstream flow requirement and Stage I conditions of the three-stage project. The thermal characteristics of the inflow such as the range of the temperature and the pattern of temperature variations were similarily duplicated in the simulated powerhouse releases. In July and August of 1982, the inflow temperature varied from 46 to 54 degrees F (8 to 12 degrees C) and the simulated intake release temperature varied similarily from 46 to 55 degrees F (8 to 13 degrees C). The general pattern of the inflow temperature variation was also similarity duplicated in the simulation of the multi-level powerhouse intake operation.

A similar conclusion was obtained from the simulations of the final Stage II Watana reservoir of the two-stage project. These simulations were performed for Case C downstream requirement and various meteorological and hydrologic conditions including 1971-1977 conditions and both stages of the two-stage project.

2.3.6 Effect of Intake Operation on Winter Release Temperature

In most of the cases analyzed in this study, two consecutive winter conditions were simulated to determine the ice-cover thickness and formation and break-up of the ice-cover. The ice-cover formation is strongly dependent upon the meteorological condition prior to the surface freeze-up. After the fall overturn, the reservoir destratifies and becomes isothermal with relatively uniform vertical temperature distribution. Mixing and further cooling would continue toward winter until the surface of the reservoir freezes. Freeze-up could occur when the surface water reaches 32 degrees F (0 degrees C) on a cold, calm winter night. Ice would form on the top of the reservoir due to a unique property of water that its density at the freezing point is less than its maximum density which occurs at 39 degrees F (4 degrees C). Thus, the water colder than 39 degrees F (4 degrees C) stays at the reservoir surface. When the ice-cover forms it prevents further mixing and hence conserves the heat remaining in the reservoir. The amount of heat stored in the reservoir prior to the freeze-up can be altered and hence the timing of the reservoir surface freeze-up and the subsequent winter release temperature can also be modified, to some extent, by changing the operating policy of the multi-level intake.

As an example, the outflow temperatures and ice-cover formation simulated for the intake operating policies of inflow temperature matching and warmest possible water for Stage II Watana reservoir (two-stage project) with Case E-VI downstream flow requirements are shown, respectively, in Figures 18 and 19. By releasing the warmest possible water downstream, less heat would be preserved in the water body in the pre-freeze-up period, the surface water temperature would be reduced to the freezing point sooner and hence an ealier freeze-up of the surface water would be attained. A comparison of Figures 18 and 19 indicates that, in this simulation, by operating the intake to pass the warmest water downstream in the summer, a surface freeze-up would be induced about two weeks earlier than in the case of operating the intake by matching the inflow temperatures. With ice-cover formed two weeks sooner, the water body in the reservoir would then be protected from additional surface mixing and cooling. The water body underneath the ice-cover would therefore preserve more heat for the remaining winter season and an increase of the outflow temperature of up to about 2 degrees F (1 degree C) would be obtained.

2.3.7 The Effectiveness of the Multi-level Intakes

In this section, the effectiveness of the multi-level intake structures of the Watana and Devil Canyon dams on selective withdrawal is discussed. The effectiveness of a multi-level intake depends mainly on the stability of the thermal stratification in the reservoir.

For the range of the hydrologic and meteorological conditions considered, the summer stratifications in both Watana and Devil Canyon reservoirs would remain stable regardless of the project operating conditions. The reservoir stratification and its stability were analyzed using the results of a reservoir operation study for 14 years of stream flow data and Case C flow requirements (two-stage project). A maximum outflow of 33,000 cfs from Watana reservoir and 39,000 cfs from Devil Canyon reservoir were used.

Based on these maximum outflows and the simulated vertical temperature and density distributions, the densimetric Froude number and internal Froude number were calculated for both reservoirs. The results show that these Froude numbers are at least one order-of-magnitude less than their respective critical values. Therefore, the hydrothermal characteristics of the Watana and Devil Canyon reservoirs are expected to remain predominantly one-dimensional in the vertical direction for the maximum outflow conditions and such large outflows are not expected to significantly disturb the thermal structure in the reservoirs. Thus, a one-dimensional model, such as DYRESM, would be appropriate for analyzing reservoir performance.

Additional analyses indicate that the hydrothermal conditions in both reservoirs would also be stable under the three-stage project scheme and Case E-VI flow requirements. The maximum summer releases would be at least 4,000 and the reservoirs would be similarly stratified.

In the Watana Reservoir, the selective withdrawal of reservoir water would be accomplished by directing flow from the reservoir through an approach channel into the intake ports. Water would be withdrawn through the multi-level intake at a pre-determined level. To assess the effectiveness of the multi-level intake, the stability of the stratification in the approach channel was analyzed.

A reservoir operation study carried out for Case C downstream flow requirements indicates that a maximum winter outflow of about 12,000 cfs would be expected for both reservoirs in the months of December, January and February. These extreme outflow conditions were used to study the stability of the thermal stratification in the approach channels. The stratification in the approach channel would be more stable with lesser outflows. The flow conditions with Case E-VI would be slightly different from those of Case C but the extreme flow conditions would be similar. Therefore, the analysis made for Case C would be applicable to the Case E-VI flow conditions.

The Watana approach channel thermal stratification would remain relatively stable in the summer with the powerhouse intake in operation. During the outlet works operation period, the outlet works intake, which is located near the bottom of the approach channel in two-stage project, would withdraw water from most of the water column and would discharge water at a near average temperature in the channel. Its effect on the powerhouse intake withdrawal is expected to be minimal since the upper limit of the outlet works withdrawal zone would not reach the water surface, for the conditions studied. Therefore, the flow stratification in the approach channel would not be disturbed significantly. However, the resulting outflow temperature would be controlled by the outlet works releases due to its large discharge compared to the powerhouse release as shown in Figure 13 and would be colder than operations without outlet works discharges.

The Devil Canyon outlet works intake, which is located below the approach channel of the powerhouse intake, is expected to behave similarly to that of Watana. However, some mixing in the approach channel would be expected if the outlet works intake were raised to the elevation of the upper intake ports as has been suggested1/. Under such conditions, the intake will loss its ability to withdraw warmer surface water exclusively. However, the release temperature would still be above those if a lower intake were used.

1/ Comments by the National Marine Fishery Service on the Susitna Hydroelectric Project License Application (Alaska Power Authority, 1983).

In the winter seasons, it would not be possible for both Watana and Devil Canyon intakes to withdraw near 32 degrees F (0 degrees C) water due to their relatively large discharges compared to the winter inflow rate of about 2000 cfs. The near 32 degrees F (0 degrees C) outflow could only be obtained by reducing the discharges and keeping the intake ports as close to the surface as possible while maintaining proper submergence to prevent the formation of the undesirable air-entraining vortices. Such a practice would severely constrain project energy production and would not be practical. With large winter releases, the outflow temperature would approximate the average water column temperature which may vary from 35.5 to 39.0 degrees F (2 to 4 degrees C) in the approach channel. Such winter releases with warmer than natural near-freezing temperature may be beneficial to the downstream fishery as they would reduce ice cover formation. With smaller winter releases, it would be possible to release water at about 34 degrees F (1 degree C) or less. The reservoir stratifications would remain stable regardless of the thermal stability conditions in the approach channels.

3.0 WATANA AND DEVIL CANYON RESERVOIR SUSPENDED SEDIMENT CONCENTRATION ANALYSIS

3.1 SUSPENDED SEDIMENT CONCENTRATION

Both the outflow temperature and the turbidity level of the reservoir releases may affect downstream fisheries. The turbidity level of a glacially-fed reservoir or lake appears to depend mainly on the suspended sediment concentration of the water body. Therefore, to provide basic information for assessment of the turbidity effects, the DYRESM model was extended to include modeling of the suspended sediment concentration (SSC) as one of the parameters in the simulation of reservoir dynamics. A description of the simulation approach is given in Section 4.2. This extended version of the DYRESM model has been tested with suspended sediment data collected at the Eklutna Lake by R&M (R&M, 1985a, 1985b and 1985c) for the period from November 1983 to October 1984. Good agreements on outflow SSC were obtained. After the extended DYRESM model had been verified it was applied to predict the suspended sediment concentrations of the Watana reservoir outflows for the three-stage project scheme. Case E-VI flow requirements and 1970 and 1981-1982 meteorological conditions were considered. River sediment inflow data were obtained from USGS records on the Susitna River near Cantwell and at Gold Creek stations. The average particle size distribution of the river suspended sediments were obtained from samples taken at the Cantwell station as shown in Figure 20. Based on the Eklutna Lake tailrace sediment data and simulations of Watana reservoir, which show that most material between 3 and 10 microns settles in the reservoir, the suspended sediments in the Watana reservoir outflow are expected to be comprised primarily of particles of size less than 3-4 microns. Larger size particles would generally settle out rapidly to the bottom without significantly affecting the average concentration levels in the reservoir and outflows. In the analysis, sediments of up to 10 microns were analyzed. The incoming suspended sediments of up to 10 microns were divided into two groups of 0-3 and 3-10 micron sediments and each group was assigned with an average representative settling velocity. Settling velocities of 1.5×10^{-6} m/sec and 2.0×10^{-5} m/sec were selected for the 0-3 and 3-10 micron sediments respectively.

These settling velocities were estimated based on the Stokes law. Simulations of Eklutna Lake showed that use of these velocities resulted in good agreement with measured data.

The total sediment influent to the Watana reservoir was estimated from the USGS data at Gold Creek gaging station and transposed to the Watana reservoir (Harza-Ebasco, 1985d). The particle size distribution curve shown in Figure 20 was used to determine the suspended sediment influent of each sediment group from the total sediment influent. Fifteen percent of the total suspended sediment influent was assigned to 0-3 micron sediments and 12 percent to the 3-10 micron sediments. The 1982 operating flow conditions for Case E-VI downstream flow requirements were used in the analysis. Simulations were made for Stage I, Stage II and Stage III project conditions. In the Stage I analysis, the 1970 and 1981 flow conditions were also investigated. The 1970, 1981, and 1982 flow conditions represent low sediment influent, high sediment influent, and average sediment influent years respectively. The operation of the multi-level intakes were simulated to withdraw the near surface water since it allows for withdrawal of water with lowest level of suspended sediment concentration and is similar to the "inflow temperature matching" policy selected for temperature simulations. In each case, the corresponding flow and the meteorological conditions were repeated for several years in the simulation in order for the reservoir to reach a "quasi-equilibrium" state with regard to sediment settling and to study the long term cumulative effect of the suspended sediments in the reservoirs. The results indicate that, in general, the outflow suspended sediment concentration will reach a minimum level of about 10 to 20 mg/l in March or April and a maximum level of about 100 to 200 mg/l in July or August. Due to the larger storage capacity and longer residence time, the

Stage III project outflow will have lower SSC levels than the Stage I and II reservoirs. These would reach a maximum level of about 100 mg/l in late July. In Stages I and II, the outflow SSC may exceed 100 mg/l in summer and fall months (i.e. June through October or November).

The Stage I Watana outflow SSC simulated for the low, high, and average sediment influent years are shown in Figures 21, 22, and 23 respectively. The results show that the downstream suspended sediment concentration (SSC) would become more uniform throughout the entire year after the project is completed. The Stage I outflow SSC would reach its lowest level of about 10 to 20 mg/l in early May and increase toward a maximum of about 150 mg/l in July or August while the main-stem sediment influent varies from about 2 to 180 mg/l in October to April to as much as 200-2200 mg/l in July to September. These results are summarized in Table 1. A large amount of the 0-3 micron sediments which enter the reservoir in summer would remain in suspension for a relatively long period of time and would continue to affect the SSC level of the winter reservoir outflow. The outflow SSC level would decrease from a maximum concentration of about 120 to 200 mg/l in July or August to a near constant value of 100 mg/l at the end of October. The outflow SSC level would continue to decrease in winter toward a minimum value of about 10 to 20 mg/l in May.

The Devil Canyon reservoir would be completed in Stage II and would receive the suspended sediment influent from the Watana reservoir. Figures 24 to 27 and Tables 2 and 3 show the predicted project outflow SSC from both the Watana and Devil Canyon reservoirs for Stages II and III conditions. Although additional settlement of these suspended sediment influent from the Watana reservoir is expected to take place in the Devil Canyon reservoir, the reservoir is relatively small or the through-flow is relatively strong that only a small portion of the Watana outflow SSC is expected to settle in Devil Canyon.

In summary, these analyses indicate that the suspended sediment concentration level of the summer release flows from the project would be decreased from the pre-project condition of about 60 to 3000 mg/l to about

50 to 200 mg/l. In the winter, the SSC level would be increased from about 1 to 80 mg/l to about 10 to 100 mg/l. Suspended sediment concentrations, with-project, would be highest in Stage I, would be slightly reduced in Stage II and would be further reduced in Stage III.

3.2 TURBIDITY

In an earlier study, PN&D (PN&D, 1982) had provided a relationship for estimating turbidity from suspended sediment concentration. This relationship was derived from the sediment data obtained at Cantwell, Chase, and Gold Creek. For concentrations less than 100 mg/l, the turbidity expressed in NTU (Nephelometric Turbidity Unit) is approximately 20 percent of the SSC values expressed in mg/l. In 1984, R&M Consultants, under contract to Harza-Ebasco Susitna Joint Venture performed settling column studies (R&M, 1985f) of the Susitna River water near Watana camp site. The test results indicated that the turbidity (NTU) would be approximately twice the value of the suspended sediment concentration (mg/l). Based on this later approximate correlation, it is estimated that the Susitna project outflow turbidity would vary approximately from 20 to 200 NTU in winter to about 100 to 400 NTU in summer.

4.0 DYRESM MODEL

Predictions of temperature stratification and distribution of suspended sediments in the proposed Watana and Devil Canyon reservoirs and the respective outflow temperatures and suspended sediments have been made using the dynamic reservoir simulation model called DYRESM. The model was originally developed by Imberger and Patterson (1981) and has been modified and enhanced by the Harza-Ebasco Susitna Joint Venture to include simulations of multi-level intake operations, frazzil ice inflow, and suspended sediment concentrations. A winter ice-cover simulation model as developed by Patterson and Hamblin for Canadian lakes was also incorporated in the DYRESM model.

The following summary provides a general description of the model including the main physical processes incorporated and its extension to include an ice-cover, and suspended sediments.

4.1 RESERVOIR DYNAMICS - TEMPERATURE AND ICE

In the formulation of the modelling strategy of the model, DYRESM, its developers, Drs. J. Imberger and J. Patterson have sought to parameterize the principal physical processes responsible for the mixing of heat and other water quality components. This approach is in contrast to other simulation models which are largely empirically based. While the modelling philosophy employed in DYRESM requires a reasonable understanding of the key processes controlling water quality, so that they may be parameterized correctly, this process related approach to modelling has the advantage that the resulting model may require less calibration and is more generally applicable than the empirically based methods. A second major consideration in model formulation has been to keep the computational overhead as low as is possible in order to keep the running costs of the simulation of a number of variables over time periods of up to three years within reason. This has necessitated the restriction of spatial variability to only one dimension (in the vertical) and the adoption of a fundamental time increment of one day. Certain physical processes require time steps shorter than one day, and, in these cases, the model allows for subdaily time intervals as small as one quarter hour. This limitation of spatial variation in a reservoir to the vertical direction is not unduly restrictive. The following discussion demonstrates that the principal processes responsible for the mixing and which are two or even three-dimensional in character may be adequately parameterized and thus may be represented satisfactorily within a one-dimensional framework.

The DYRESM model first subdivides the reservoir or lake in question into a series of horizontal slabs of varying thicknesses, volumes and cross-sectional areas in accordance with the prescribed reservoir geometry. The number of layers is allowed to vary according to the requirements of representing the vertical distribution of heat and salt (not a parameter in Susitna) to within a specified accuracy. The uppermost layer corresponds to the lake's surface layer or epilimnion with its base being located at the thermocline depth and its top at the lake surface. This layer is the most important as it receives the direct input of atmospheric forcing and is usually associated with the largest gradients in water quality properties. This layer receives special attention in the model compared to the other layers. Within each layer the variables are considered to be uniform. Heat in the form of solar radiation is input to each layer according to the physics of absorption of short wave radiation (Beer's Law).

The transfers of heat and salt between the layers are determined by the vertical turbulent fluxes as specified by the turbulent eddy diffusivity and the differences in properties between the layers except between the uppermost layer and the layer immediately adjacent to it. The value of the vertical diffusivity is not set empirically but follows the energy arguments of Ozmidov. In this way the vertical mixing process responds to changes in the level of energy available for mixing caused by storms (wind stirring) and also by the potential energy released from inflowing rivers. In addition, this internal mixing formulation includes the inhibiting effect of the local stratification rate on the mixing process.

The mixing processes in the uppermost layer which is known as the upper mixed layer is treated differently since experience has shown that it is necessary to consider the individual processes controlling the mixing in a more detailed manner than in the deeper layers. These processes are wind stirring, convective cooling, the shear across the base of the mixed layer, the stabilizing effects of the absorption of short wave radiation and the density gradient at the base of the layer. The method used involves the consideration of three conservation equations within the layer, the conservation of heat, salt and turbulent kinetic energy. Solution of these equations provides an estimate of the energy available for mixing the upper layer with the lower layers. A feature of this upper mixed layer formulation is that it accounts for the influence of strong internal motions known as seiches on the mixing and deepening of the upper layer.

A brief explanation of the wind generation of these internal motions or seiches provides an example of how a two and three-dimensional process occurring in a reservoir is treated within the context of a one-dimensional model. When the wind starts to blow along the longitudinal axis of a lake which is initially at rest, the shearing motion at the base of the upper layer is considered to grow at a constant rate until either the wind ceases or reverses in direction, a period of time equal to one quarter the period of the natural seiche has elapsed, or the earth undergoes a period of revolution on its axis. When any one of these limits is attained the shear is set to zero and the build-up of internal motion recommences. This wind shear may influence the deepening of the thermocline or the upper layer thickness and may destabilize the stratification. In the latter case the temperature profile would be smoothed to the point where it remains stable with respect to shearing motion of the wind forced seiche.

River inflow dynamics are also two-dimensional. If the river water is lighter than the uppermost layer of the lake then it forms a new upper layer ver the old one and may ultimately be amalgameted into the old upper layer. For an underflowing river, an entrainment coefficient is computed for the incorporation of a portion of the surrounding lake water into the descending river plume. The coefficient is based on the river discharge, the density contrast between lake and river water, the slope of the reservoir bottom and the geometry of the river bed. The volumes of the layers are decremented according to the computed daily entrainment volumes at the same time as the inflowing river water is diluted by lake water until it either reaches the deepest layer or the dam wall. In some cases, the density of the plunging river plume may be reduced to that of the adjacent layer density whereupon the inflow would begin to intrude into the main body of the reservoir. This intrusion process may be dominated by viscous-buoyancy forces or by an inertia-bouyancy balance and this is determined by the computation of a non-dimensional parameter depending on the discharge, the local density gradient and the mixing strength at the level of insertion. This parameter then sets the overall thickness of the inflow and therefore how the inflowing volume is subdivided among the existing layers surrounding the inflowing depth.

Outflows from the reservoir at a surface level or up to two subsurface levels are governed by the same parameter which determines the amounts to be withdrawn for each of the layers in the vicinity of the outflow points. To illustrate how this may work in practice it is useful to consider two extreme cases, one where the outflow volume is large relative to the stabilizing effect of the ambient stratification (inertia/bouyancy balance). In this case the outflow is withdrawn nearly uniformly from all the layers. In the other case a weak outflow occurs (viscous-bouyancy balance). In this case the density gradient severely confines the vertical range of outflow layers to those in the immediate vicinity of the offtake.

The model has been recently extended to include the influence of ice and snow cover, and a suspended ice concentration in the inflowing rivers known as frazil ice. The conduction of heat and the penetration of solar radiation across a composite of two layers, one composed of snow and the other of ice, is computed from the physical properties of snow and ice, namely, their thermal conductivities, their extinction coefficients for solar radiation and their densities, and from the energy transfers at the surface to the atmosphere. Components of the surface energy budget, as in the case of an ice-free surface, are the incoming and outgoing longwave radiation, solar radiation, the sensible heat transfer and latent heat exchanges. Several cases may be distinguished. If more heat flows upward through the ice than can be supplied by the turbulent and molecular transfers of heat from the water to the ice, ice is created and added to the existing ice cover. Conversely, the ablation of ice at the base of the ice sheet occurs when an excess of heat is present. Similarly, the snow or upper surface of the ice may be melted when sufficient heat is present to elevate the surface temperature above the freezing point.

An additional physical process incorporated in the model with ice cover is an allowance for partial ice cover either during the freeze-up or break-up period. Partial ice cover accounts for the wind action in dispersing thin ice sheets that might be formed and is based on an assumed minimum ice thickness of 10 cm. Additionally, the thickness of the snow cover on the ice is limited by the supporting bouyancy force associated with a given thickness and density of ice. Finally, the amount of solar radiation transmitted through the snow layer depends on the thickness, age and temperature of the snow cover. Frazil ice input from the inflowing rivers is either used to cool the upper layers if no ice is present or is added to the fraction of partial ice cover or to the thickness of the full ice cover.

The treatment of the ice and snow effects, frazil ice input, bottom heat flux, and suspended sediments are explained further in the following discussion.

(a) Ice and Snow Effects

The influence of ice and snow on the heat transfer across the water surface of a reservoir is taken into account by simulating the percentage of snow and ice cover and their thicknesses as functions of time. The effect of snow and ice is to reduce the amount of short wave radiation reaching the upper layers of the reservoir through their absorptive properties and to reduce the cooling of the reservoir surface that would otherwise occur by providing a covering layer of reduced thermal conductivity and by creating additional ice at the ice-water boundary.

Specific physical processes incorporated into the model of ice and snow are:

1. A minimum ice thickness of 10 cm is assumed.

2. The melting of either snow or ice on the surface as well as ice melting at the ice water interface are simulated.

3. The exclusion of salt from the ice upon freezing is simulated.

4. The reduction of snow or ice thicknesses by surface evaporation is considered.

5. The effect of ice or snow on surface vapor pressure is considered.

6. The snow albedo is allowed to vary as a function of snow age and temperature.

7. The absorption of short wave radiation in snow and ice is considered.

8. The ice-water heat flux due to molecular conduction across the ice-water interface plus turbulent sensible heat flux due to

inflow and outflow induced current in the upper layer of the reservoir are simulated.

9. The surface temperature of the snow or ice is computed from the surface heat budget.

10. The maximum snow thickness is limited by the ice buoyancy relative to snow loading.

11. The frazil ice input in the inflow is included in the total ice volume in the reservoir.

(b) Frazil Ice

The mass of frazil ice contained in the inflow is computed and added to the existing ice thickness in both the cases of full or partial ice assuming that the input of the volume of frazil ice is provided as a percentage of the daily inflow. In the case of a partial ice cover the frazil ice input reduces the percentage of ice cover until full ice cover is reached. Any frazil ice left over in the daily time step is then added to the total ice volume of the lake. In the event of frazil ice input to an ice free lake, all the frazil ice is assumed to be melted in the daily time step by mixing with the upper layers. First, the uppermost layer is cooled and, if necessary, to the freezing point. Any frazil ice remaining is used to cool the next lower layer. This process is continued until all the frazil input for the day is melted. Frazil ice input is likely to be most important at the onset of ice formation in the lake since, after that time, frazil ice in the river upstream of the reservoir will likely contribute to the river ice cover and not reach the reservoir.

(b) Bottom Heat Flux

Although not considered to be very important in deep reservoirs, bottom heat flux is accounted for in the model by a simple conduction across the sediment-water interface. It is assumed that at some depth below the bottom the temperature remains constant throughout the year. The heat flux between the bottom and the individual layer of the model (reservoir) is computed from the gradient of temperature across the bottom based on an assumed thermal conductivity for the bottom sediments and the invariant bottom sediment temperature. The total amount of heat either added or subtracted from the layer in a day is computed from the portion of the layer area in contact with the bottom. Finally the new layer temperature is calculated from the thermal heat capacity of water and the layer volume. Typical values of the constant sub-bottom temperature and the depth to constant temperature observed in a northern lake are 10.8 degrees F (6 degrees C) and 2 m respectively.

4.2 SIMULATION OF SUSPENDED SEDIMENTS

The ice-covered version of the DYRESM simulation model has also been extended to include the modeling of horizontally averaged profiles of suspended sediment. As with temperature and total dissolved solids, a suspended sediment profile is prescribed initially from field data or from estimation and thereafter daily inflow values of suspended sediment concentration from up to 4 rivers are input. Suspended sediment profiles are changed in the model by three processes, namely by mixing, by convective overturn and by settling. The convective adjustment includes the contribution to water density due to the suspended sediment. Density inversions are checked and unstable layers are mixed.

A method has been incorporated to determine the change in suspended sediment concentration in any layer due to setting. The vertical distance which a particle of sediment sinks at a prescribed setting velocity is compared to the minimum layer thickness. If this distance is greater than the layer thickness then the subdaily time step is divided by a factor of 2 successively until the particle no longer sinks through the layer. In each refined subdaily time step the suspended sediment leaving the layer is computed and removed from the layer. The portion of this sediment which falls into the layer below is added to the next layer below and the portion which falls into the layer from above is added to that layer.

The testing of the extended DYRESM model with Eklutna Lake data is described in Section 5.0.

5.0 EKLUTNA LAKE STUDY

Eklutna Lake was selected for an intensive field study to facilitate the testing of the DYRESM model on a existing glacially-fed lake. The Eklutna Lake is located approximately 30 miles northeast of Anchorage and 100 miles south of the project site. The purpose of testing the DYRESM model was to verify the changes made to the model relating to ice cover and suspended sediment and to demonstrate the applicability of the model to the proposed Watana and Devil Canyon reservoirs. Both the proposed reservoirs and Eklutna Lake are located in the south-central region of Alaska. The Eklutna Lake is also operated for hydroelectric production and has a similar average residence time (1.65 years) to that of the Watana reservoir (1.77 years).

A meteorological and limnological data collection program was initiated in June 1982 with a weather station established at the south-east end of the lake. R&M Consultants, Inc. was responsible for the collection and processing of the data. The collection of data began in June 1982 and proceeded until December 1984. The Eklutna Lake data thus collected and processed have been summarized and reported by R&M (1982, 1985a 1985b and 1985c). These data include inflow and outflow discharges and temperatures, vertical temperature and turbidity profiles, and pertinent meteorological data such as solar radiation, air temperature, relative humidity, and wind speeds.

The testing of the DYRESM model was performed in two phases. In Phase I, the basic DYRESM model for temperature and ice simulation was tested. In Phase II, the suspended sediment option was added to the model and the testing of the model was conducted in conjunction with an expanded reservoir sediment sampling and turbidity data collection program. This expanded program was started in May 1984 and continued until November 1984.

5.1 EKLUTNA LAKE TEMPERATURE AND ICE SIMULATION: TESTING OF THE BASIC DYRESM MODEL

The DYRESM model was applied to simulate the average temperature distribution in the Eklutna Lake for the period starting June 1, 1982 and ending May 30, 1983. The inflow, outflow, and meteorological data collected by R&M were used. An analysis of the initial results led to several improvements of the model. These improvements included application of the Anderson's long-wave radiation equation instead of the Swinbank equation during the subfreezing condition and incorporation of intake design and wind effect in estimation of outflow temperatures. The results of the Phase I study are described in a report entitled "Eklutna Lake Temperature and Ice Study-With Six Months Simulation for Watana" (Harza-Ebasco, 1984a).

The reservoir outflow temperature is a principle input parameter for the river temperature, and river ice studies being undertaken to determine project effects on the natural thermal regime of the Susitna River. Therefore, close agreement between simulated and measured outflow temperatures is desirable. The simulated and observed outflow temperatures for Eklutna are shown in Figures 28(a) & (b). The differences between the predicted and observed winter outflow temperatures were within one degree Celcius. However, short term deviations of up to about ± 3.5 degrees F (2 degrees C) also occurred, especially during and after high wind periods. The surface wind shear effects and the internal wave motions near the intake structure are extremely difficult to model with a one-dimensional approach and three-dimensional modeling is not considered practical. The differences between observed and simulated results on a weekly average basis are considered small and the model is considered to be satisfactory for predicting the effects of Watana and Devil Canyon. The results of the simulation also show an excellent correspondence between measured ice thickness and predicted ice thickness except for one observation in March. There was no ice measurements made near the center of the lake in March. The relatively thick ice measured at Station 13 in March may be considered due to local accumulation of rafted ice caused by persistent downlake winds. Therefore, the relatively large difference (Figure 28(b)) between observation and prediction shown in March is not considered significant.

The results of the study demonstrate the capability of the DYRESM model to properly simulate the hydrothermal behavior of a reservoir in the specific region of the Susitna Project.

5.2 EKLUTNA LAKE SUSPENDED SEDIMENT SIMULATION: TESTING OF THE EXTENDED DYRESM MODEL

The updated model has also been tested using the Eklutna Lake data to determine its applicability to predict suspended sediment concentrations of the outflows from the Susitna project. The hydrological and meteorological data collection program was continued by R&M with special emphasis on suspended sediment sampling for the period from May to November 1984.

Measured suspended sediment concentrations ranged from 0.15 to 570 mg/l in the inflow streams, from 0.1 to 200 mg/l in the lake, and from 0.56 to 36 mg/l in the outflow. Peak values in the inflow occurred in late July or early August, in the lake in about September (as a depth-averaged concentration at Station 9), and in the outflow in late July to mid-August. During the winter, inflow, lake and outflow suspended sediment concentrations were on the order of 0.1 mg/l. During the summer, the average suspended sediment concentrations were substantially higher than winter values and were increased further following large rainfall events or periods of significant glacial melt.

Turbidity values generally followed the trends in the suspended sediment concentration, dropping off in the winter at inflow, lake, and outflow sites and peaking in mid-to-late summer. Observed values ranged from 0.5 to 580 NTU in the inflow streams, from 1.8 to 220 NTU in the lake, and from 3.0 to 46 NTU in the outflow.

The total suspended sediment influent to the lake were determined based on the total suspended sediments obtained from Glacier Fork and East Fork.

The incoming suspended sediments were first divided into three groups representing three different particle size ranges. These particle size ranges selected were 0-3 microns, 3-10 microns and greater than 10 microns. Test runs indicated that particles greater than 10 microns would settle very rapidly to the bottom of the lake and have little effect on the average suspended sediment distributions. The greater than 10 micron sediments were therefore ignored in the study.

The total incoming suspended sediments of each particle size range were estimated based on the weighted particle size distributions determined from the samples taken from East Fork and Glacier Fork as shown in Figures 29 & 30. These samples were obtained in three field trips made on July 21, August 28, and October 23, 1984. The daily particle size distributions were interpolated from these three basic distributions. To apply the extended DYRESM model, it was necessary to specify an initial vertical distribution of suspended sediment, the particle settling velocity, and the average density of the particles. The settling velocity of a particle was determined in accordance with the Stoke's Law as shown in Figure 31. A settling velocity of 1.53×10^{-6} meter per second was used for the 0-3 micron sediments and 4.00×10^{-5} meter per second for the 3-10 micron sediments. A particle density of 2.60 was used in the study while the measured density varied from 2.50 to 3.00. The DYRESM simulations were made for 0-3 micron sediments and 3-10 micron sediments were made separately. The resulting outflow suspended sediments of these two separate analyses were then combined to indicate the total outflow suspended concentrations as shown in Figure 32. The predicted outflow suspended sediment concentrations were in good agreement with data obtained from the powerhouse tailrace. In two occasions, the field data showed temporary increases in suspended sediment concentrations that were not predicted by the DYRESM model. The cause of these temporary deviations was probably due to the occurrences of relatively heavy rains prior to these events. A small stream which flows into the lake near the intake may have carried significant amount of sediments and caused the suspended sediment concentration to increase locally and temporarily near the intake area.

6.0 SUMMARY

Reservoir temperature, ice and suspended sediment simulations have been made for the proposed Watana and Devil Canyon reservoirs using the enhanced DYRESM dynamic reservoir simulation model. These simulations provide important information for the evaluation of the potential changes in water temperature, suspended sediment concentration and ice conditions of the Susitna River downstream of the Susitna project site and for the evaluation of the potential effects of the Susitna Hydroelectric Project on the fishery and wildlife resources.

The DYRESM model, in addition to its capacity to simulate temperature and ice conditions in a reservoir, has been extended and enhanced by adding capabilities to simulate suspended sediment concentrations in a reservoir and the operation of a multi-level intake. The testing of the enhanced DYRESM model were made using the data collected at Eklutna Lake which has a number of properties in common with the proposed reservoirs. Good agreements were obtained between the simulated and observed outflow temperatures. In general, the differences between the predicted and observed winter outflow temperatures were within 0.5 degrees C. In summer, a difference of up to 2.0 degrees C were obtained occasionally during and after high wind periods. The results also showed an excellent correspondence between measured and predicted ice thicknesses. The predicted outflow suspended sediment concentrations were also in reasonable agreement with data obtained from the Eklutna powerhouse tailrace. The results of these testings demonstrate the applicability of the DYRESM model to simulate the hydrothermal behavior of the proposed Susitna reservoirs.

Fifteen years of hydrologic and meteorological data collected at the Susitna Basin have been assembled and processed for the application of the DYRESM model. Both the original two-stage project scheme and the current three-stage project scheme have been studied. The simulations made with Case E-VI (the Alaska Power Authority's preferred condition) and Case E-I downstream flow requirements and 1981 - 1982 inflow and meteorological conditions are discussed. The energy demands considered included energy demands predicted for all stages of the two-stage and three-stage project schemes.

The results of the study indicate that both the Watana and Devil Canyon reservoirs would develop stratifications in the summer months of June, July, August and September regardless of the project operation schemes and project stages. Overturns would occur in spring and fall and ice-cover would form in the winter. The Watana release temperature would be slightly warmer during the winter than natural river conditions and would range from 0.5 to 3.0 degrees C (33 to 37 degrees F). In the summer, the Watana release temperature would range from 5 to 12 degrees C (41 to 54 degrees F) depending on the project and meteorological conditions. The Devil Canyon reservoir would also exhibit the general pattern of early summer warming, summer stratification and fall to winter cooling through a reservoir overturn followed by a reservoir surface freeze-up. The hydrothermal regime of the Devil Canyon reservoir, especially in the hypolimnion, would be more sensitive to the operation of the outlet works than Watana due to its smaller reservoir volume. Therefore, the Devil Canyon release temperature may be up to 5 degrees C (9 degrees F) colder than Watana releases temporarily in June and July when the intake port level is changed due to the drawdown of the reservoir.

The summer outlet works operations and the relatively thin epilimnion would reduce the effectiveness of selective withdrawal using the multi-level intakes in both reservoirs, especially in the Devil Canyon reservoir. Control of release temperatures improves as energy demand increases and operation of outlet works decreases.

The suspended sediment concentration level of the summer project releases would decrease from the pre-project condition of about 60 to 3000 mg/l to about 50 to 200 mg/l. In the winter, the concentration level would increase from a range of 1 to 80 mg/l to a range of 10 to 100 mg/l. It is also estimated that the corresponding Susitna project outflow turbidity would vary approximately from about 20 to 200 NTU (Nephelometric Turbidity Unit) in winter to about 100 to 400 NTU in summer.

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7.0 REFERENCES

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TABLES

Table 1

SUSPENDED SEDIMENT CONCENTRATIONS (MG/L)
WATANA OPERATION, STAGE I

Month	Range of Observed Concentration[1]	Range of Estimated Concentration[2]	Average Concentration in Reservoir Releases[3] 1970 (Minimum)	1982 (Average)	1981 (Maximum)	Range of Concentration in Reservoir Releases[3] 1970 (Minimum)	1982 (Average)	1981 (Maximum)
Jan	1-8	2-55	65	65	85	40-90	45-85	50-120
Feb	N/A[4]	2-93	40	55	65	20-70	35-70	30-95
Mar	1-6	2-23	30	40	45	10-50	20-60	20-75
Apr	N/A	2-183	25	30	50	10-40	10-50	20-75
May	65-1,110	5-1,480	20	35	45	5-50	10-65	10-70
Jun	151-1,860	620-1,705	75	85	90	35-90	45-145	70-95
Jul	100-2,790	506-2,062	105	130	110	85-115	120-145	70-190
Aug	158-1,040	198-2,150	105	110	165	90-115	85-125	130-200
Sep	23-812	5-1,511	95	90	130	85-105	85-100	100-170
Oct	7-140	2-144	85	100	125	80-100	90-110	100-140
Nov	N/A	2-71	90	95	115	75-100	85-110	90-130
Dec	N/A	3-47	80	85	95	60-90	70-95	70-110

1/ Based on data from the Susitna River near Cantwell (period 1962-72, 1980-82) and at Gold Creek (period 1962, 1974-82).

2/ Estimated from daily sediment transport in tons per day and corresponding mean daily discharge in cfs at Watana, 1970, 81 and 82 flow conditions.

3/ Based on DYRESM simulation results.

4/ N/A = not available.

Table 2

SUSPENDED SEDIMENT CONCENTRATIONS (MG/L)
WATANA - DEVIL CANYON OPERATION, STAGE II

Month	Range of Observed Concentration[1/]	Range of Concentration[2/]	Average Concentration[3/] (Average Year)	Range of Concentration[3/] (Averge Year)
Jan	1-8	1-20	60	50-75
Feb	N/A[4/]	1-30	45	30-60
Mar	1-6	1-20	40	30-50
Apr	N/A	30-170	30	25-35
May	65-1,110	130-1,270	30	10-35
Jun	151-1,860	930-1,470	55	20-100
Jul	100-2,790	600-1,600	110	70-140
Aug	158-1,040	200-1,070	110	80-130
Sep	23-182	200-1,530	90	70-130
Oct	7-140	1-30	80	75-85
Nov	N/A	1-30	80	75-80
Dec	N/A	1-30	75	60-80

1/ Based on data for the Susitna River near Cantwell (period 1962-72, 1980-82) and at Gold Creek (period 1974-82).

2/ Estimated from daily sediment transport in tons per day and corresponding mean daily discharge in cfs at Watana, 1982 flow conditions (average year).

3/ Based on DYRESM simulation for 1982, releases from Devil Canyon Reservoir.

4/ N/A = not available.

228171/TBL
860701

Table 3

SUSPENDED SEDIMENT CONCENTRATIONS (MG/L)
WATANA - DEVIL CANYON OPERATION, LATE STAGE III

Month	Range of Observed Concentration 1/	Range of Concentration 2/	Average Concentration 3/ (Average Year)	Range of Concentration 3/ (Averge Year)
Jan	1-8	1-20	55	40-70
Feb	N/A 4/	1-30	50	30-65
Mar	1-6	1-20	25	14-40
Apr	N/A	30-170	25	15-40
May	65-1,110	130-1,270	20	10-30
Jun	151-1,860	930-1,470	35	15-60
Jul	100-2,790	600-1,600	75	60-100
Aug	158-1,040	200-1,070	75	55-100
Sep	23-182	200-1,530	55	40-70
Oct	7-140	1-30	50	40-65
Nov	N/A	1-30	70	65-70
Dec	N/A	1-30	65	55-70

1/ Based on data for the Susitna River near Cantwell (period 1962-72, 1980-82) and at Gold Creek (period 1974-82).

2/ Estimated from daily sediment transport in tons per day and corresponding mean daily discharge in cfs at Watana, 1982 flow conditions (average year).

3/ Based on DYRESM simulation for 1982, releases from Devil Canyon Reservoir.

4/ N/A = not available.

FIGURES

ENVIRONMENTAL FLOW REQUIREMENTS CASE E VI

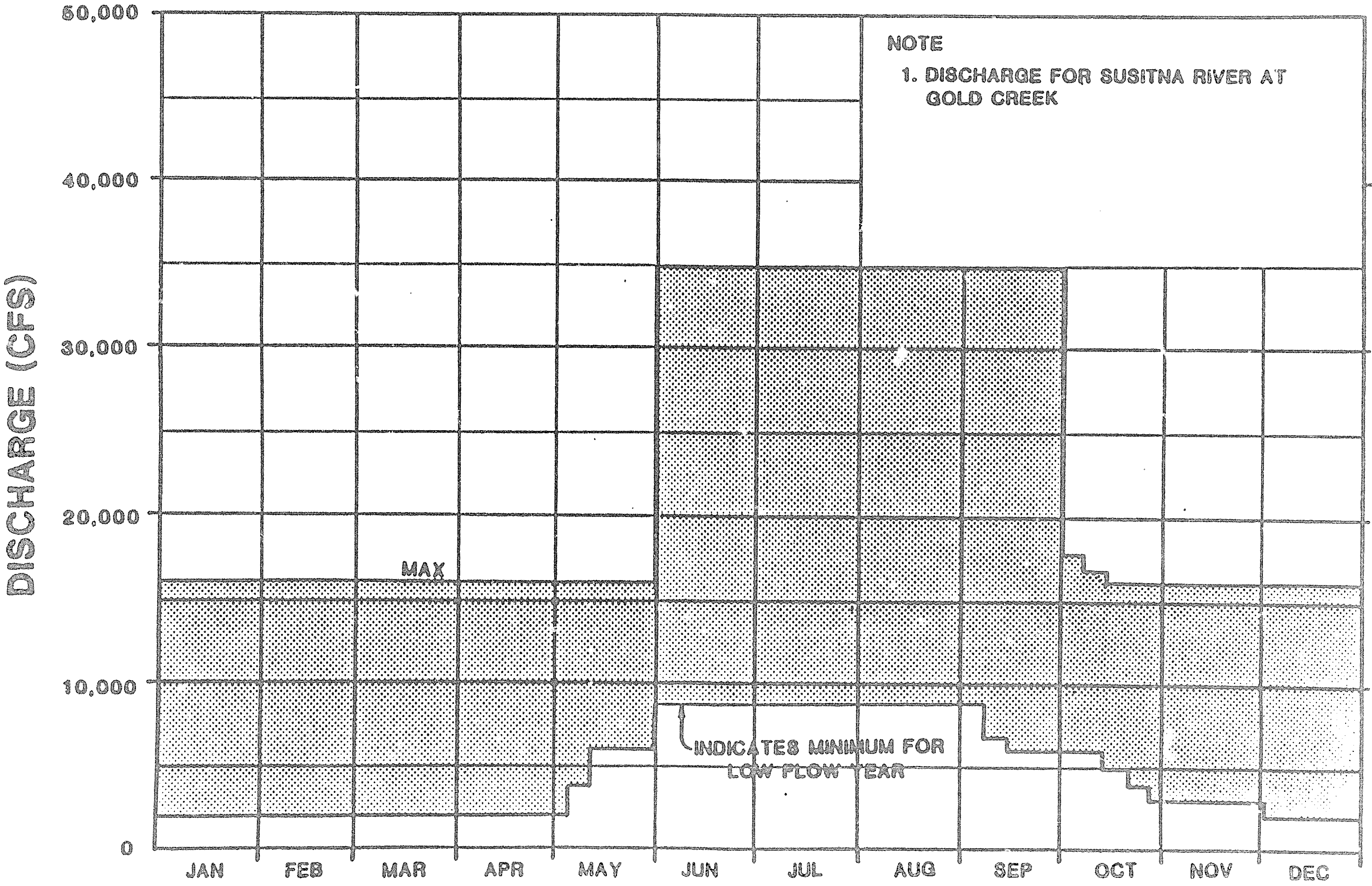


FIGURE 1

ENVIRONMENTAL FLOW REQUIREMENTS CASE E I

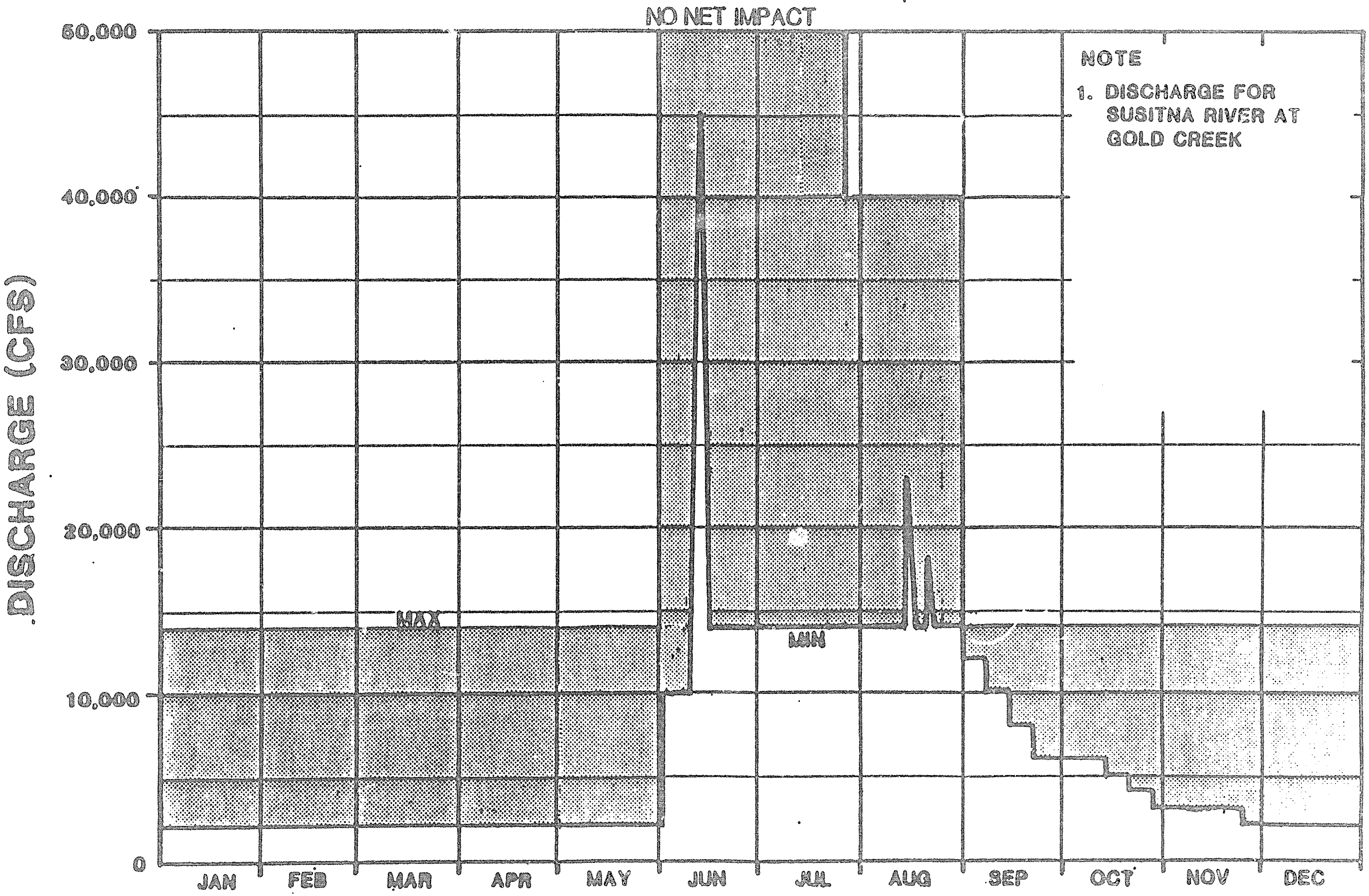


FIGURE 2

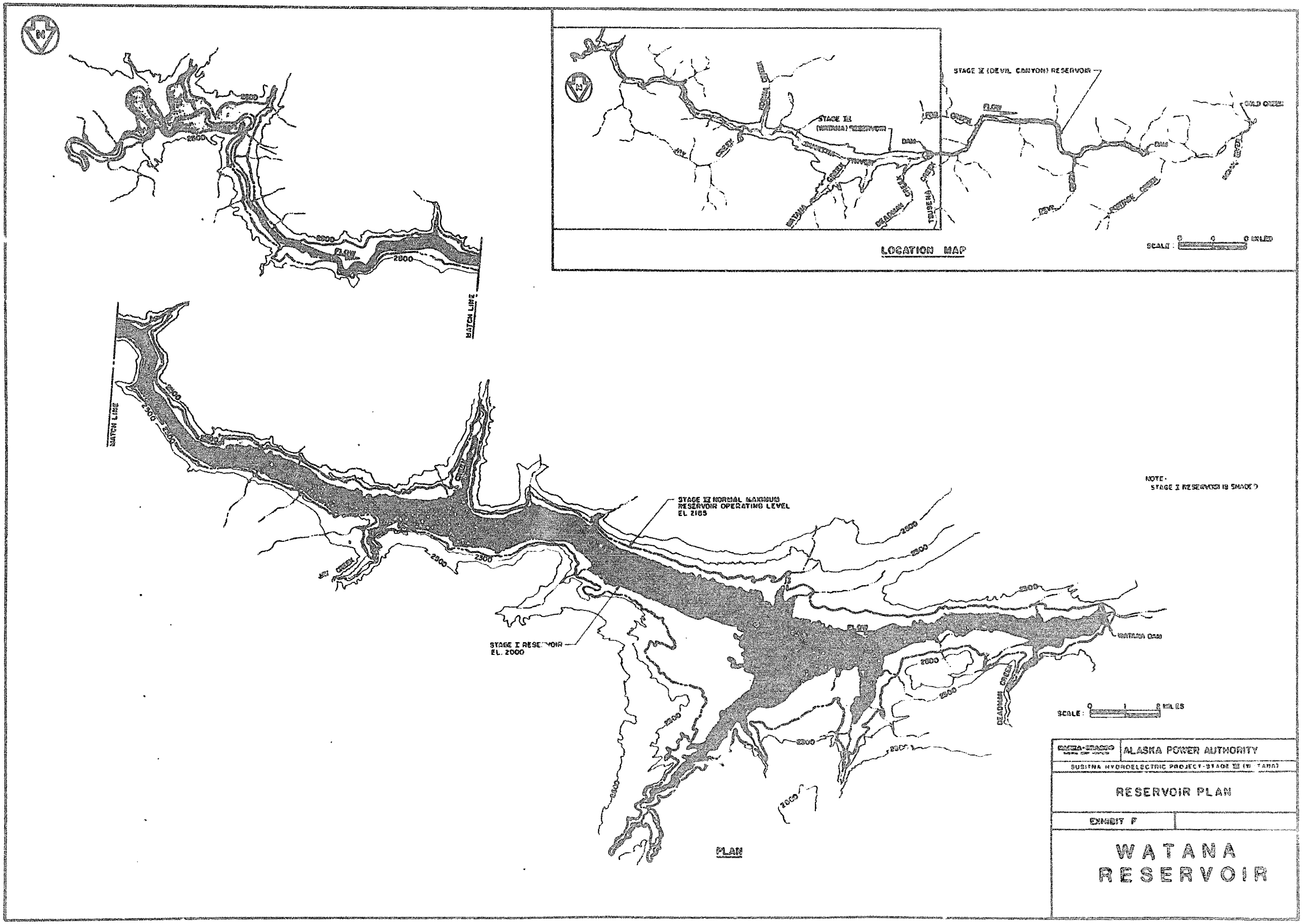
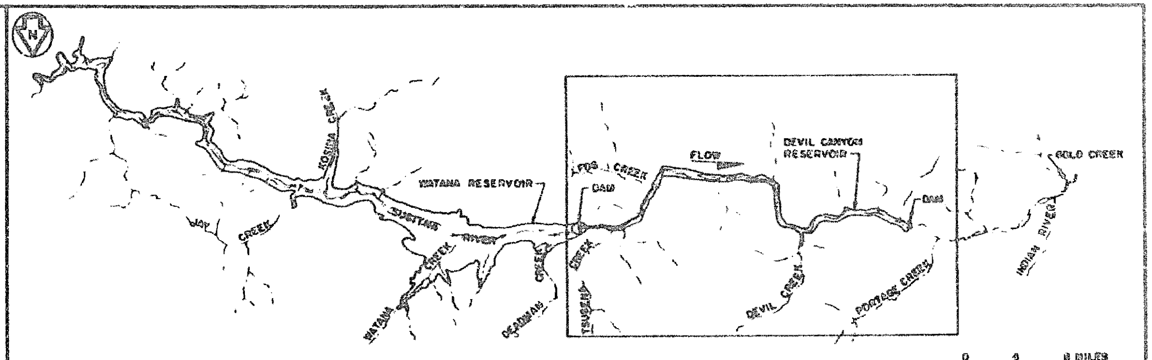
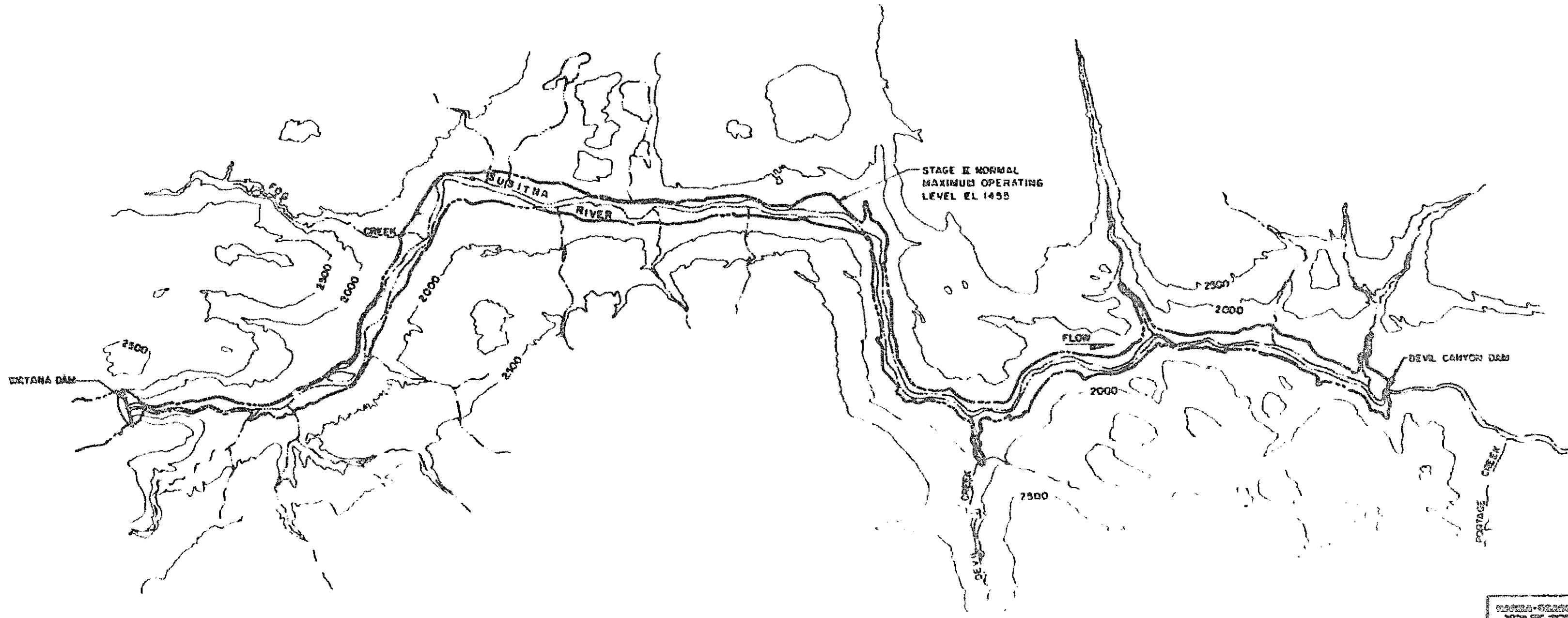


FIGURE 3

AUG 1989



LOCATION MAP



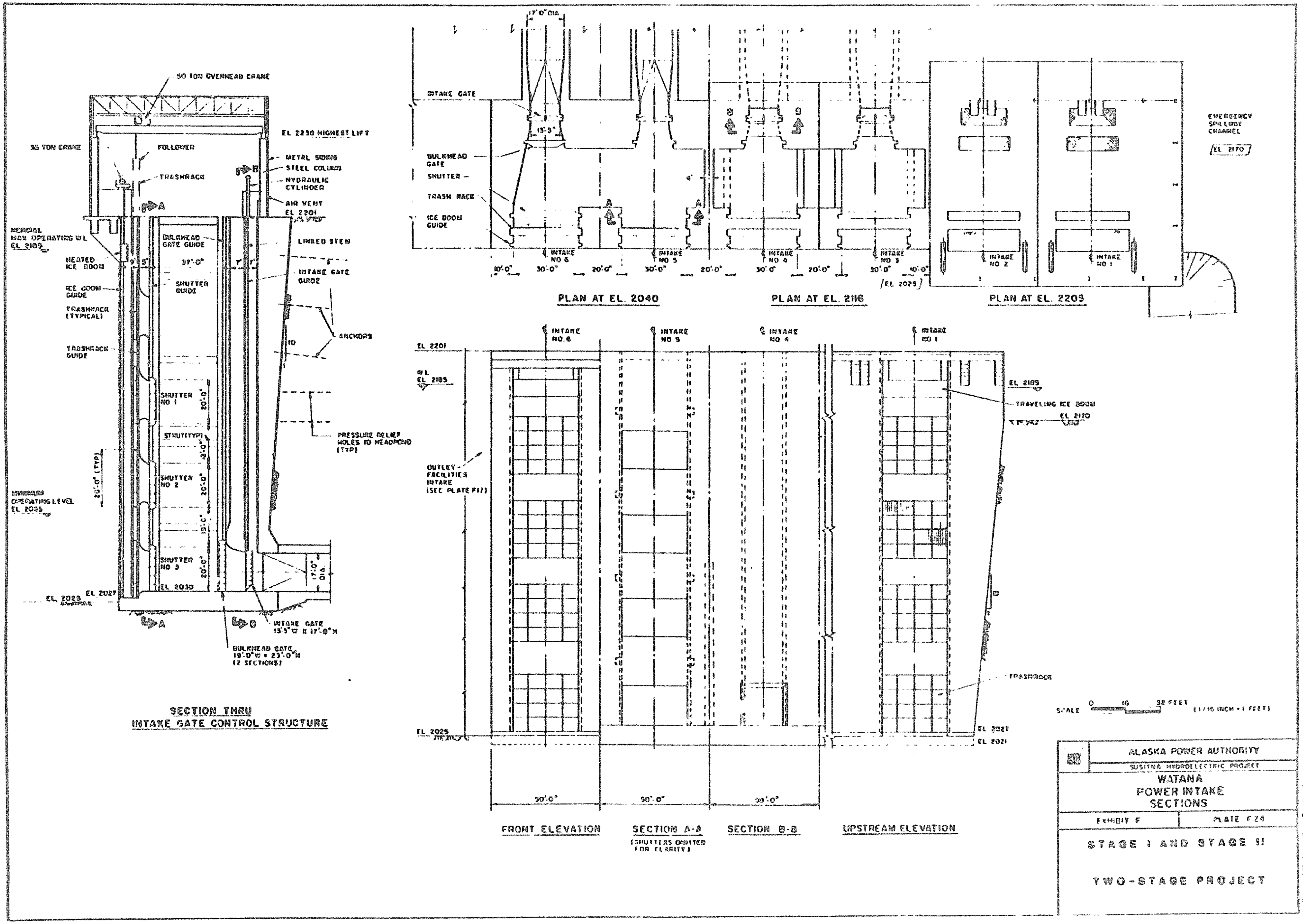
PLAN

	ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT - STAGE II (DEVIL CANYON)	
RESERVOIR PLAN	
EXHIBIT F	

DEVIL CANYON RESERVOIR

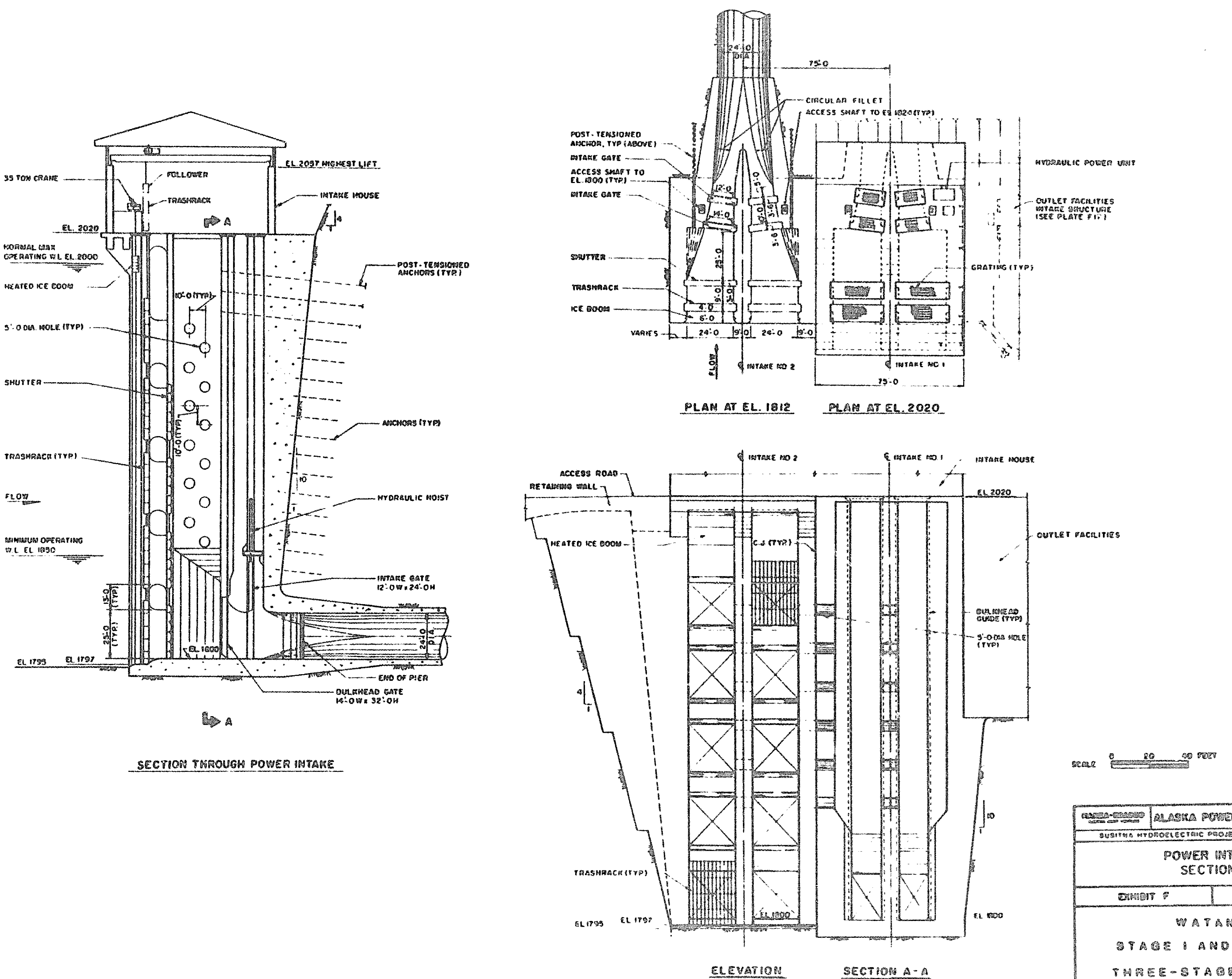
FIGURE 4

AUG 1985



50 TON OVERHEAD CRANE
35 TON CRANE
FOLLOWER
TRASHRACK
EL 2230 HIGHEST LIFT
METAL SIDING
STEEL COLUMN
HYDRAULIC CYLINDER
AIR VENT
EL 2201
NORMAL MAX OPERATING W.L EL 2185
HEATED ICE BOOM
BULKHEAD GATE GUIDE
LINED STEM
37'-0"
INTAKE GATE GUIDE
ICE BOOM GUIDE
SHUTTER GUIDE
TRASHRACK (TYPICAL)
ANCHORS
TRASHRACK GUIDE
SHUTTER NO 1
STRUT (TYP)
PRESSURE RELIEF HOLES TO HEADPOND (TYP)
MINIMUM OPERATING LEVEL EL 2035
SHUTTER NO 2
SHUTTER NO 3
EL 2030
EL 2027
EL 2025
INTAKE GATE 15'-5"W x 17'-0"H
BULKHEAD GATE 19'-0"W x 23'-0"H (2 SECTIONS)
SECTION THRU INTAKE GATE CONTROL STRUCTURE
17'-0" DIA
INTAKE GATE
BULKHEAD GATE
SHUTTER
TRASH RACK
ICE BOOM GUIDE
INTAKE NO 6
INTAKE NO 5
INTAKE NO 4
INTAKE NO 3
INTAKE NO 2
INTAKE NO 1
EMERGENCY SPILLWAY CHANNEL
EL 2170
EL 2029
PLAN AT EL. 2040
PLAN AT EL. 2116
PLAN AT EL. 2205
EL 2201
W L EL 2185
EL 2185
TRAVELING ICE BOOM
EL 2170
OUTLET FACILITIES INTAKE (SEE PLATE F17)
TRASHRACK
EL 2025
EL 2027
EL 2021
30'-0"
FRONT ELEVATION
SECTION A-A (SHUTTERS OMITTED FOR CLARITY)
SECTION B-B
UPSTREAM ELEVATION
SCALE 0 16 32 FEET (1/16 INCH = 1 FEET)
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
WATANA
POWER INTAKE
SECTIONS
EXHIBIT F
PLATE F24
STAGE I AND STAGE II
TWO-STAGE PROJECT

FIGURE 6



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT-STAGE I (WATANA)

POWER INTAKE SECTIONS

EXHIBIT F | PLATE F24

WATANA

STAGE I AND STAGE II

THREE-STAGE PROJECT

AUG 1985

FIGURE 6(a)

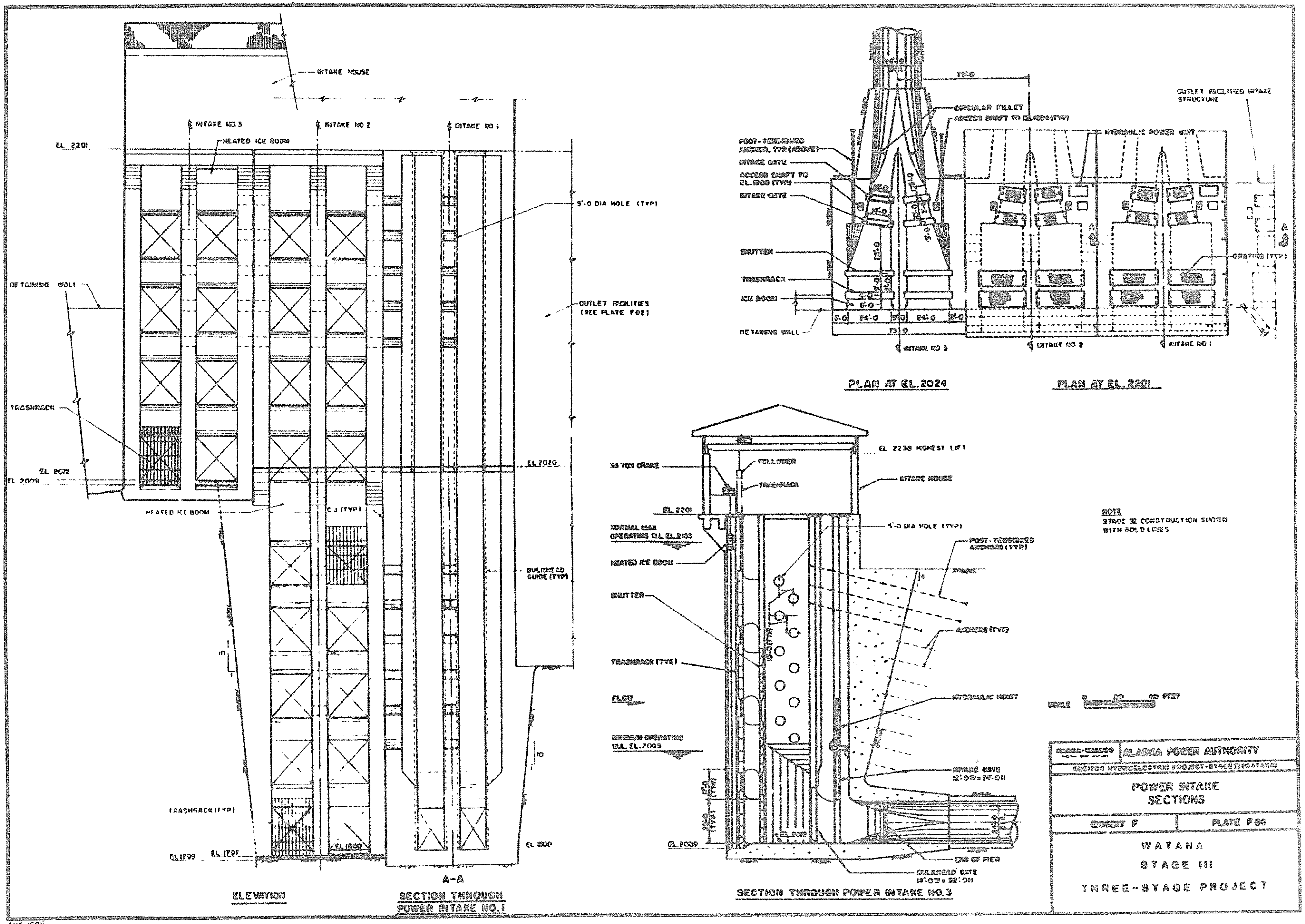
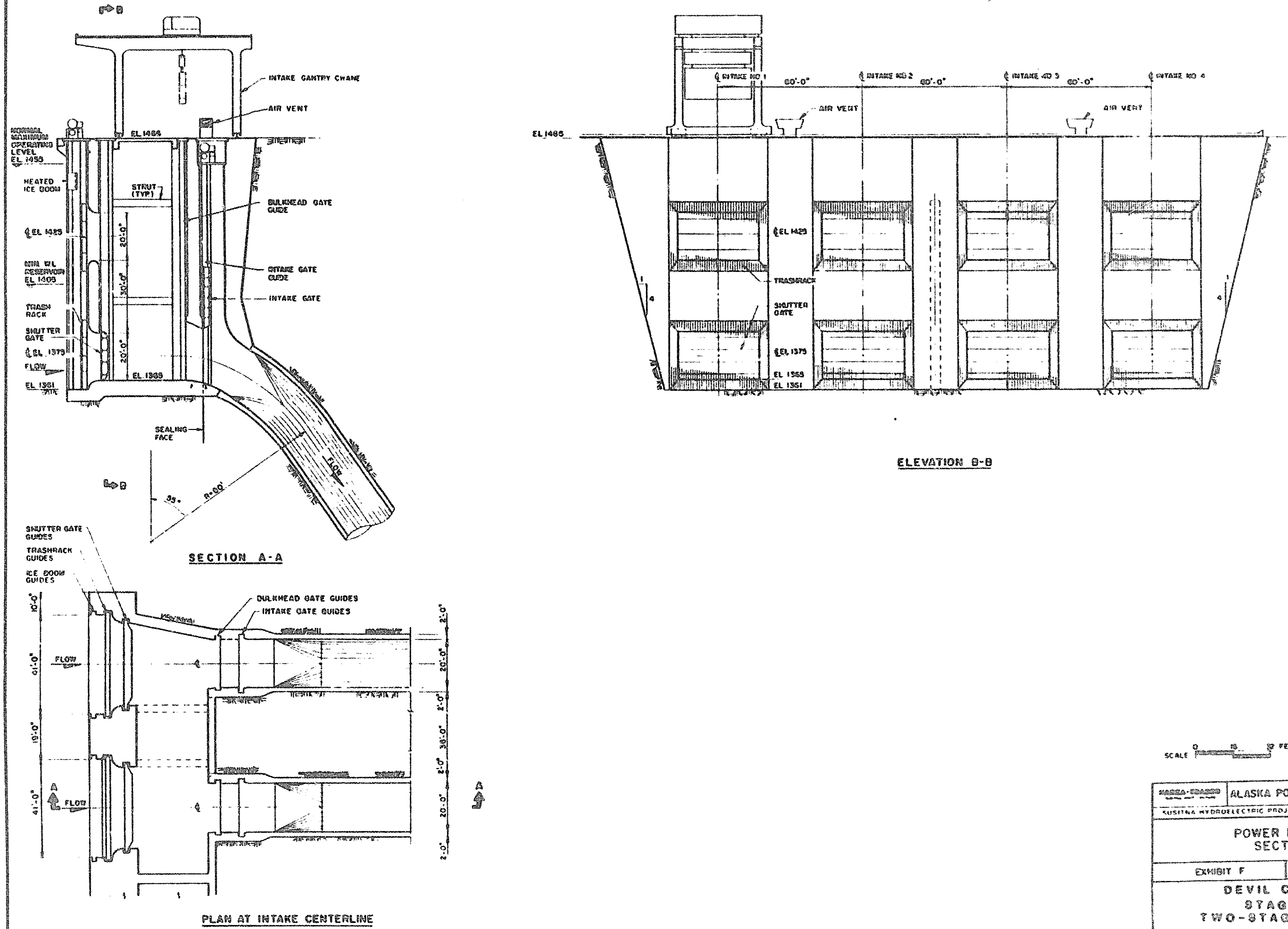

INTAKE HOUSE
INTAKE NO.3
INTAKE NO 2
INTAKE NO 1
HEATED ICE BOOM
EL 2201
5'-0 DIA HOLE (TYP)
RETAINING WALL
OUTLET FACILITIES (SEE PLATE F02)
TRASHRACK
EL 2072
EL 2009
EL 2020
C J (TYP)
BULKHEAD GUIDE (TYP)
TRASHRACK (TYP)
EL 1799
EL 1797
EL 1800
A-A
ELEVATION
SECTION THROUGH POWER INTAKE NO.1
CIRCULAR FILLET
OUTLET FACILITIES INTAKE STRUCTURE
HYDRAULIC POWER UNIT
INTAKE GATE
SHUTTER
TRASHRACK
ICE BOOM
RETAINING WALL
GRATING (TYP)
INTAKE NO 3
INTAKE NO 2
INTAKE NO 1
PLAN AT EL.2024
PLAN AT EL.2201
EL 2238 HIGHEST LIFT
35 TON CRANE
FOLLOWER
TRASHRACK
INTAKE HOUSE
EL 2201
NORMAL MAX OPERATING W.L. EL.2185
5'-0 DIA HOLE (TYP)
POST-TENSIONED ANCHORS (TYP)
HEATED ICE BOOM
SHUTTER
ANCHORS (TYP)
TRASHRACK (TYP)
FLOW
HYDRAULIC HOIST
MINIMUM OPERATING W.L. EL.2065
INTAKE GATE
END OF PIER
EL 2009
SECTION THROUGH POWER INTAKE NO.3
NOTE
STAGE III CONSTRUCTION SHOWN WITH BOLD LINES
SCALE 0 30 60 FEET
ALASKA POWER AUTHORITY
POWER INTAKE SECTIONS
EXHIBIT F
PLATE F 86
WATANA
STAGE III
THREE-STAGE PROJECT

FIGURE 6(b)



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT STAGE II (DEVIL CANYON)

POWER INTAKE SECTIONS

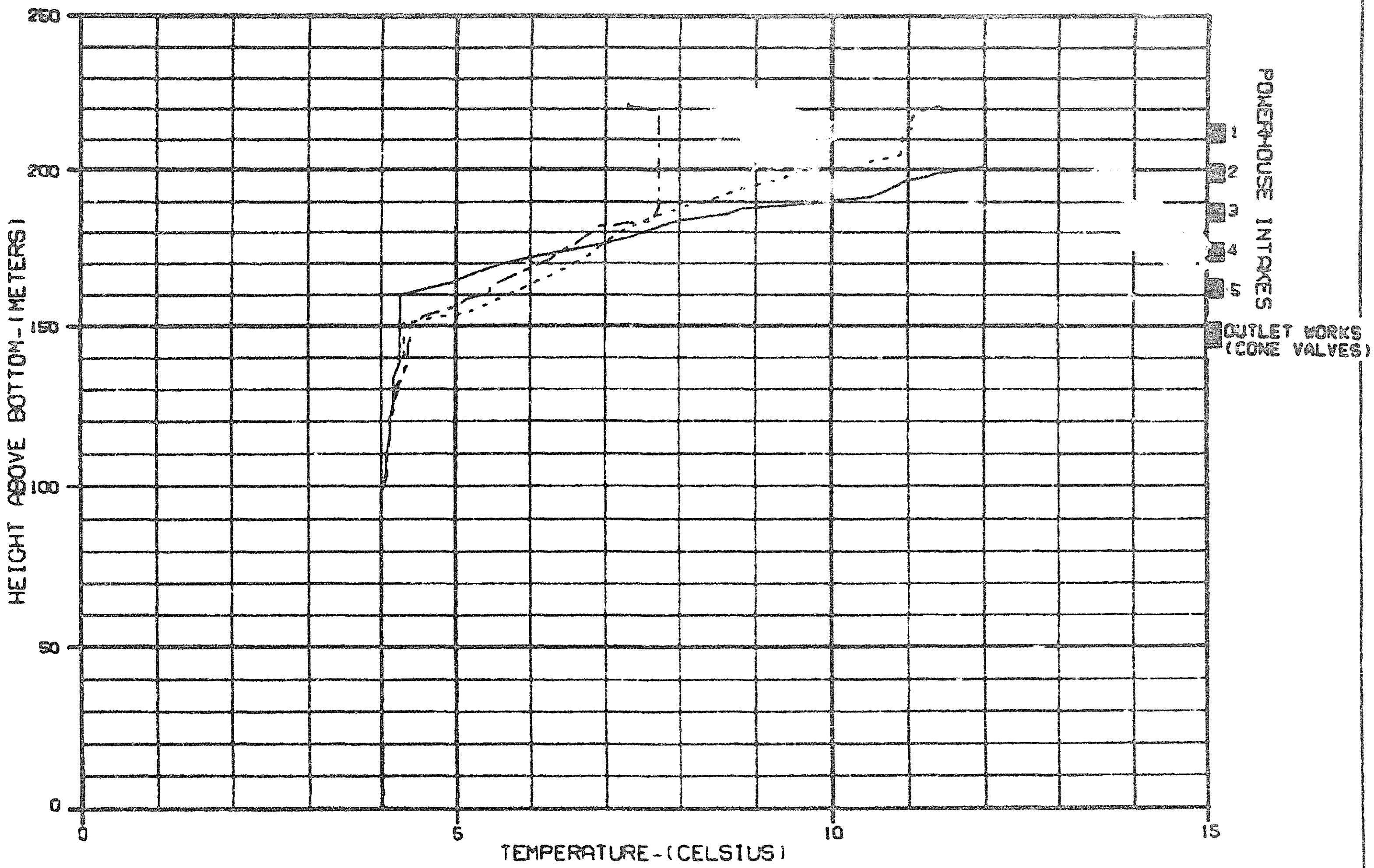
EXHIBIT F | PLATE F 62

DEVIL CANYON
STAGE II
TWO-STAGE PROJECT

STAGE II AND STAGE III
THREE-STAGE PROJECT

FIGURE 7

AUG 1985



CASE: ** WA8120E - WATANA OPERATION W/DEVIL CANYON IN 2020 (CASE E-6) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

———— 1 AUGUST 1981
· · · · · · · · 1 SEPTEMBER 1981
— · — · — 1 OCTOBER 1981

ALASKA POWER AUTHORITY

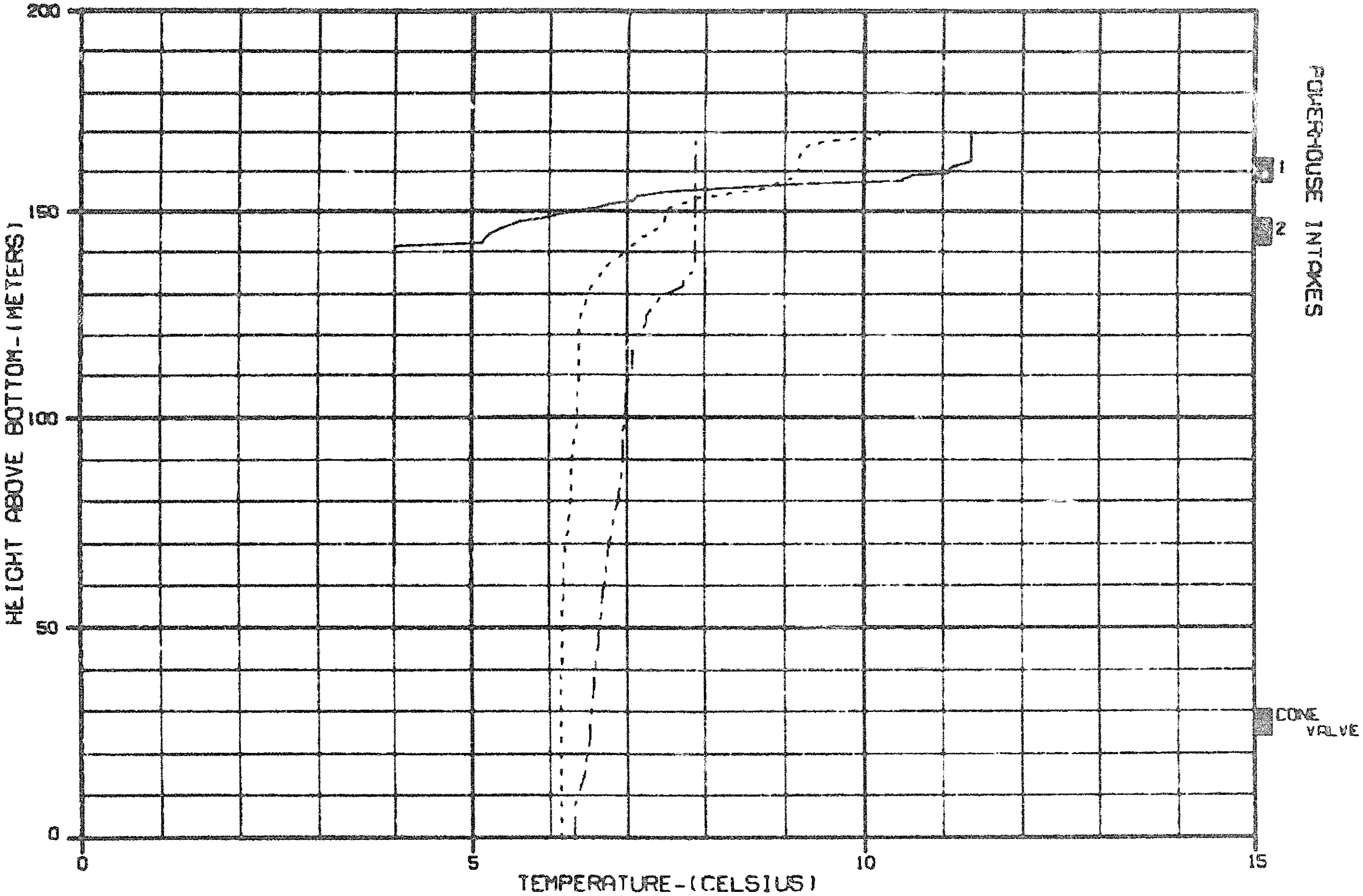
SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

42-010-04

FIGURE 8



CASE: ** DC8120E - DEVIL CANYON OPERATION W/WATANA IN 2020 (CASE E-6) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 AUGUST	1981
········	1 SEPTEMBER	1981
— - — -	1 OCTOBER	1981

ALASKA POWER AUTHORITY

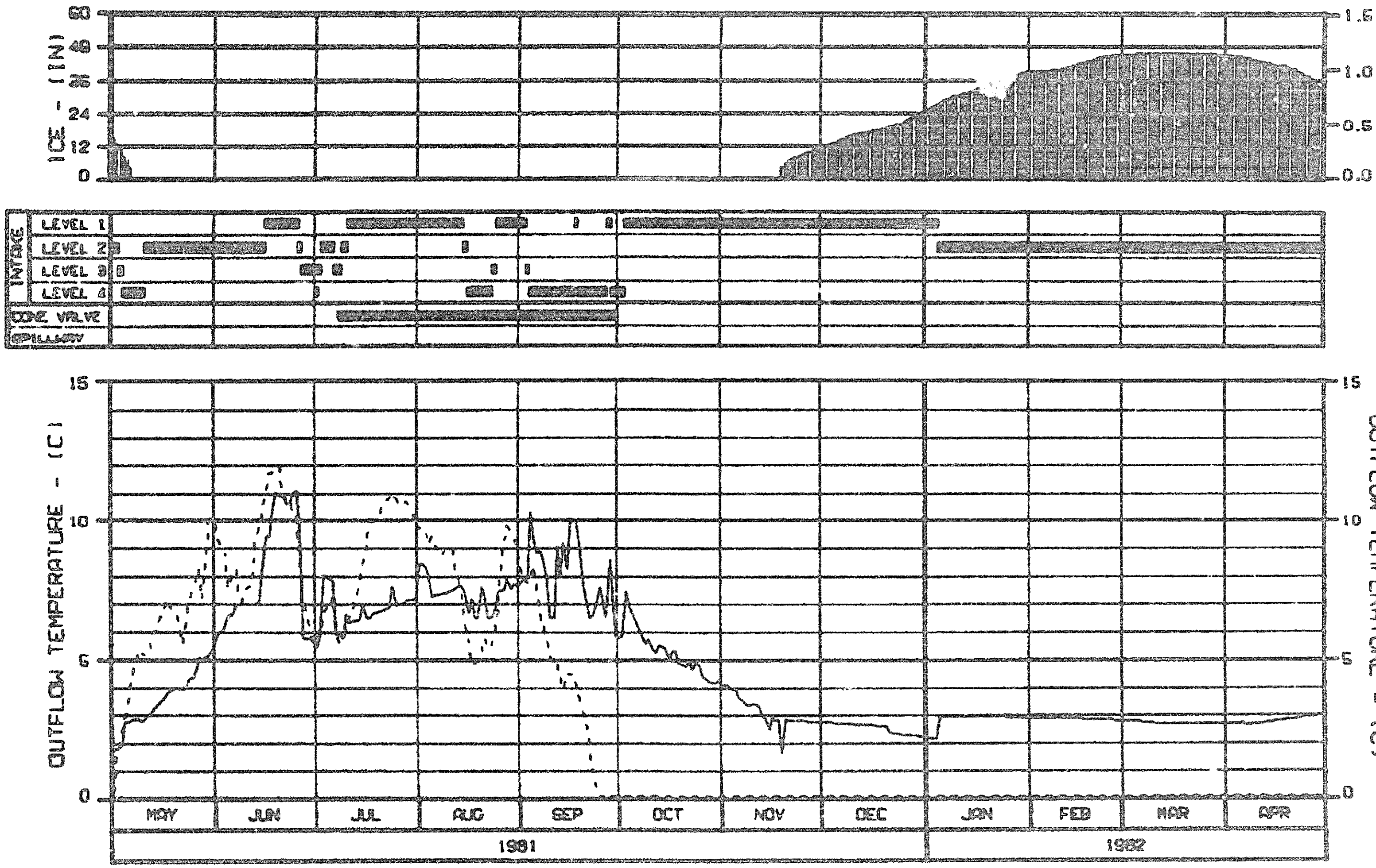
SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHECKED. ALL PAGES | 20 APR 83 | 42-010-04

FIGURE 9



LEGEND: CASE: ** WA8102J - WATANA OPERATION W/DEVIL CANYON IN 2002 ** (E-VI)
INFLOW TEMPERATURE MATCHING; STAGE II, TWO-STAGE PROJECT

——— PREDICTED OUTFLOW TEMPERATURE

- - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 2151 FT (655.6 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE AT ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

ALASKA POWER AUTHORITY

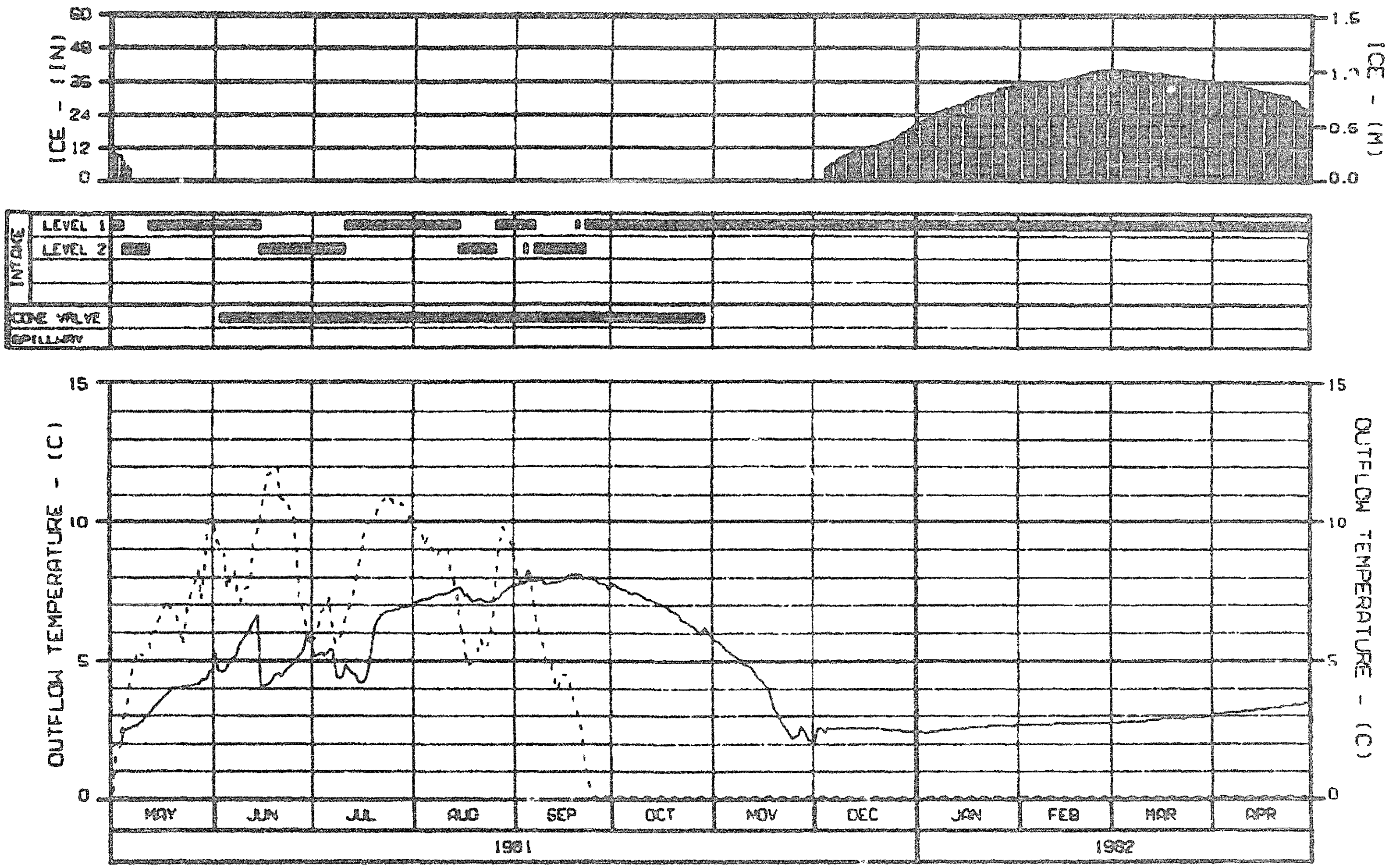
SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

42-810-04

FIGURE 10



LEGEND: CASE: DC8102J - DEVIL CANYON OPERATION W/WATANA IN 2002 (E-VI)
INFLOW TEMPERATURE MATCHING; STAGE II, TWO-STAGE PROJECT

——— PREDICTED OUTFLOW TEMPERATURE
- - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 1425 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1375 FT (419.10 M)
3. CONE VALVE AT ELEVATION 990 FT (301.75 M)
4. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)

ALASKA POWER AUTHORITY

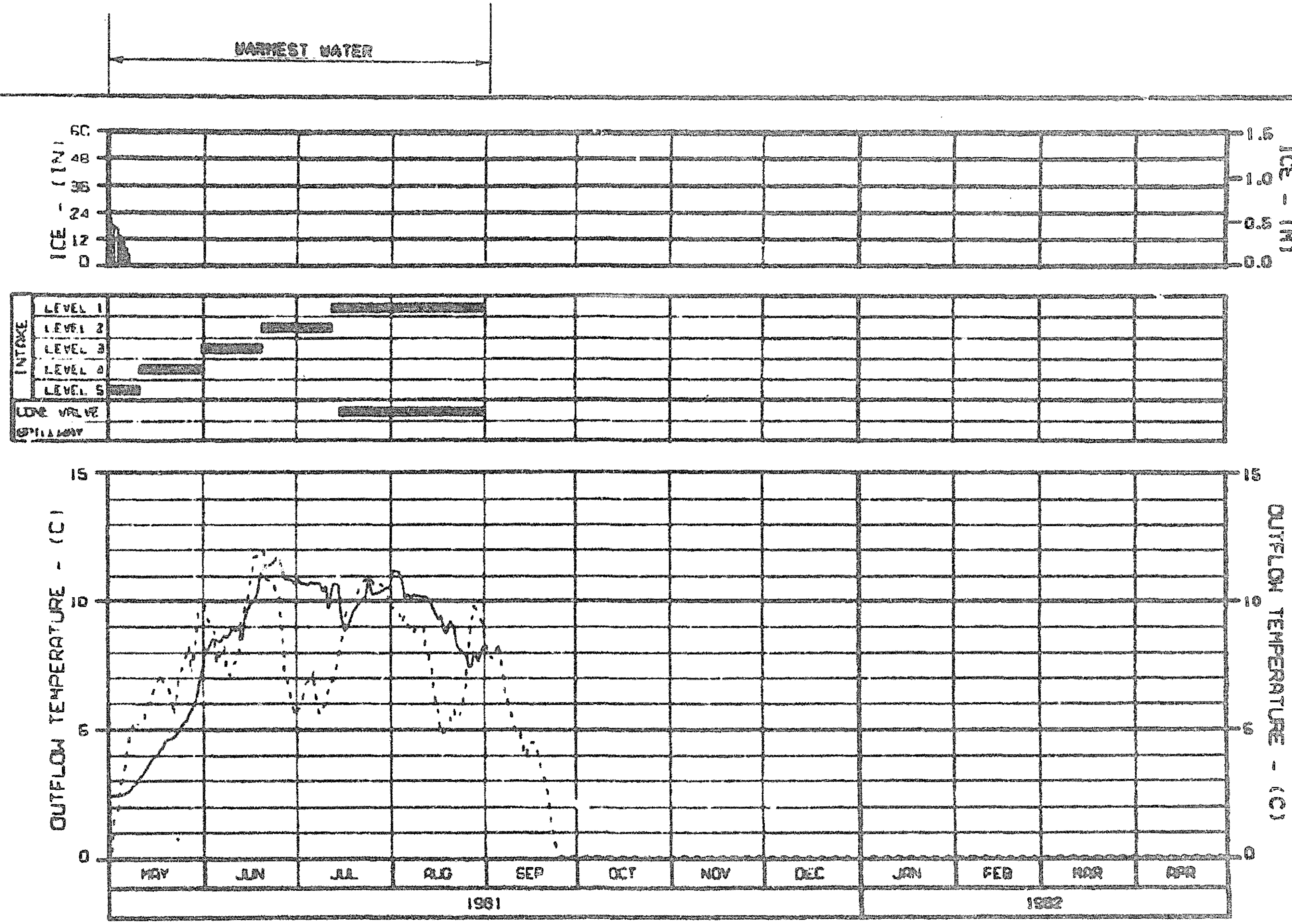
SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 25 JAN 85 | 42-010-04

FIGURE 11



LEGEND: CASE:WA8102V WATANA IN 2002 STAGE 2 1NOV80-30APR81:MATCH INFLOW TEMP
CASE E-VI DRAWDOWN AT DC = 50 FT 1MAY81-31AUG81:WARMEST WATER
———— PREDICTED OUTFLOW TEMPERATURE STAGE II, THREE-STAGE PROJECT
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT EL. 1964.4 FT. (598.8 M)
2. INTAKE PORT LEVEL 2 AT EL. 1926.4 FT. (587.2 M)
3. INTAKE PORT LEVEL 3 AT EL. 1888.4 FT. (575.6 M)
4. INTAKE PORT LEVEL 4 AT EL. 1850.4 FT. (564.0 M)
5. INTAKE PORT LEVEL 5 AT EL. 1812.4 FT. (552.4 M)
6. CONE VALVE AT ELEVATION 1929 FT (588.0 M)
7. SPILLWAY CREST AT ELEVATION 2125 FT (650.7 M)

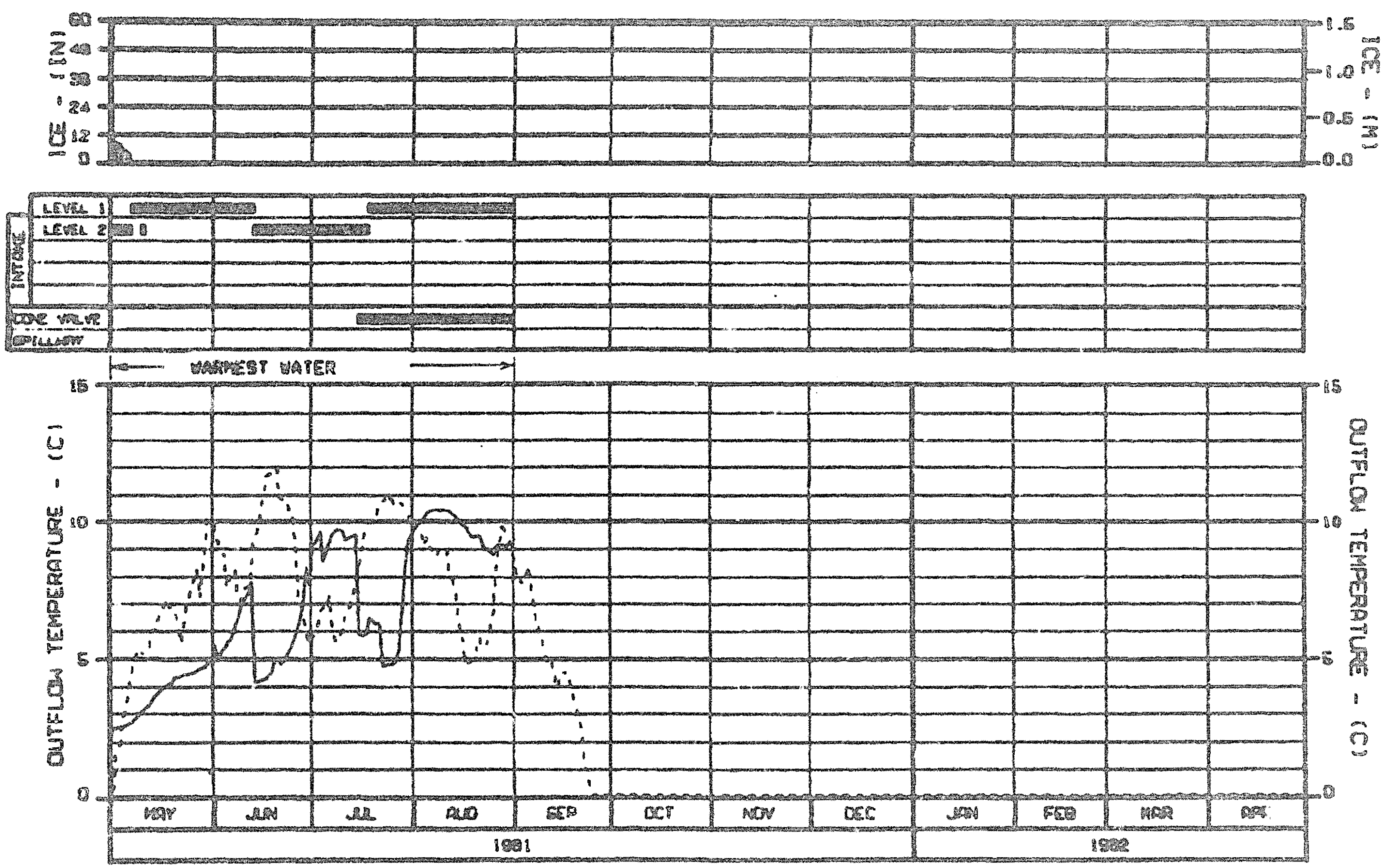
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

FIGURE 12



LEGEND: CASE: DC8102V DEVIL CANYON IN 2002 (NOV80-30APR81: MATCH INFLOW TEMP
CASE E-VI 50 FT DRAWDOWN AT DC STAGE 2 (MAY81-31AUG81: WARMEST WATER
——————— PREDICTED OUTFLOW TEMPERATURE STAGE II, THREE-STAGE PROJECT
- - - - - - - INFLOW TEMPERATURE

NOTES: 1. INTAKE PORT LEVEL 1 AT ELEVATION 1425 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1375 FT (419.10 M)
3. CONE VALVE AT ELEVATION 990 FT (301.75 M)
4. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)

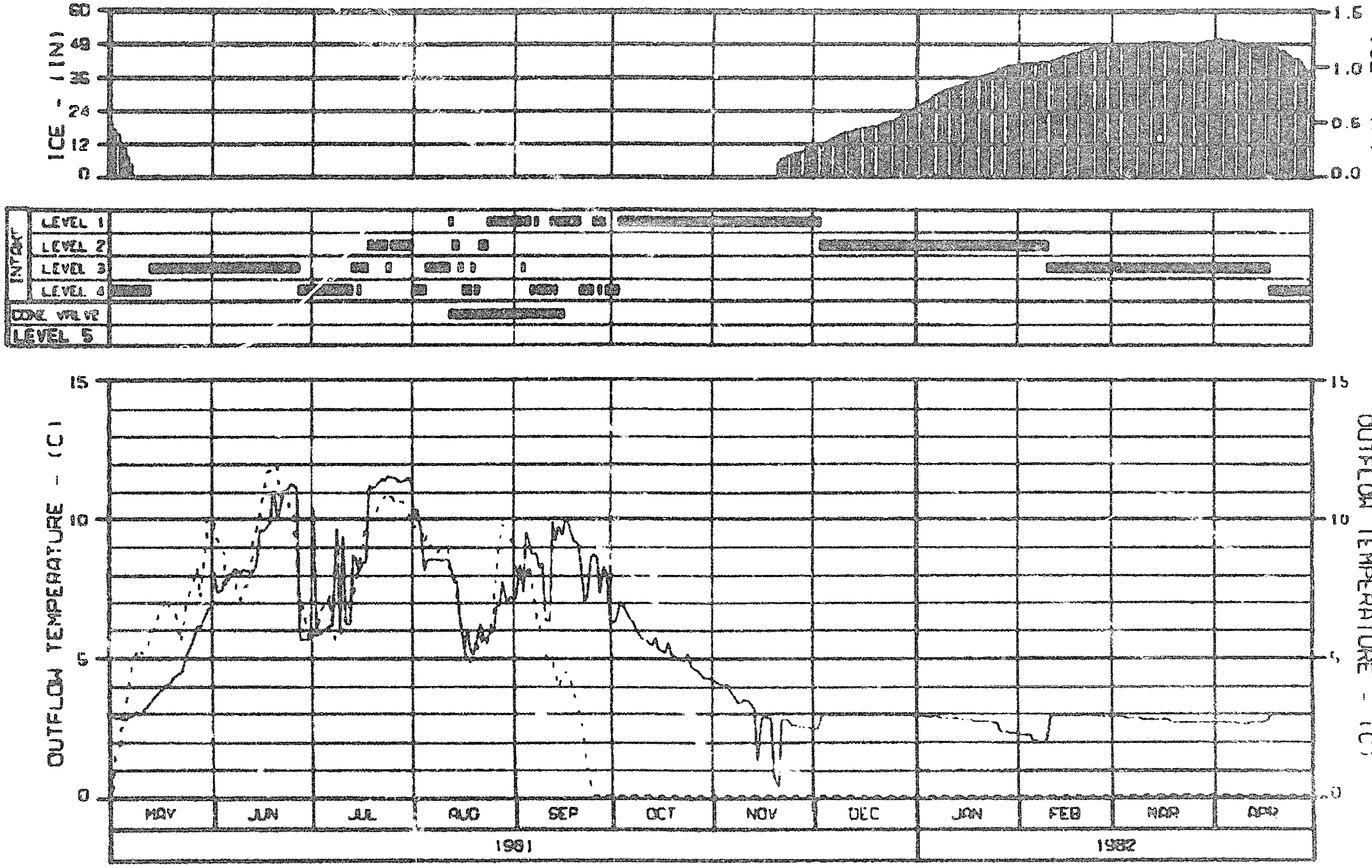
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

FIGURE 13



LEGEND- CASE: WA8120E - WATANA OPERATION W/DEVIL CANYON IN 2020 (CASE E-6)
STAGE III, THREE-STAGE PROJECT

——— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 2193 FT (666.4 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2108 FT (642.7 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2066 FT (629.9 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2024 FT (617.1 M)
5. CONE VALVE AT ELEVATION 1929 FT (588.0 M)
6. SPILLWAY CREST AT ELEVATION 2297 FT (700.0 M)

ALASKA POWER AUTHORITY

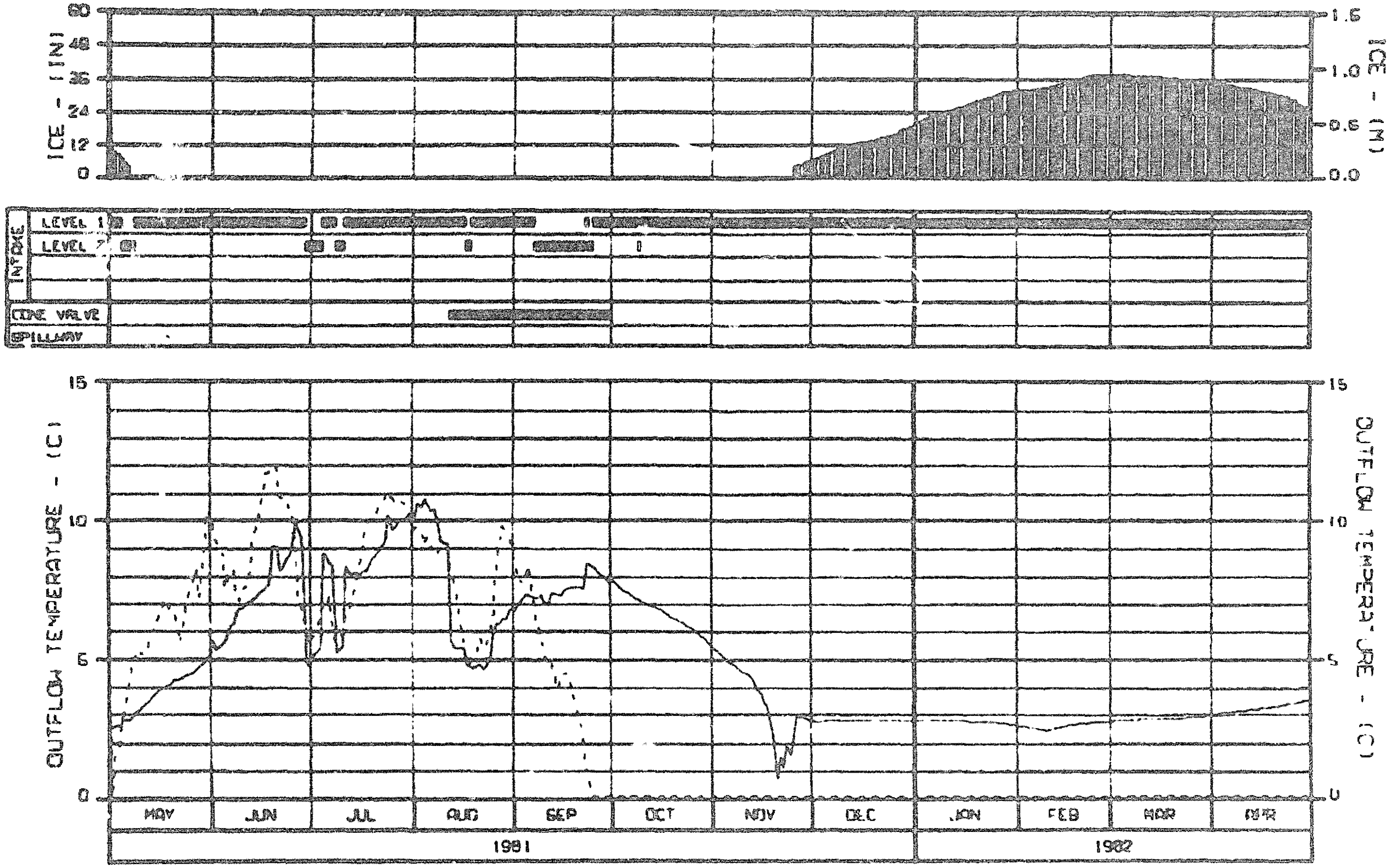
SUSITNA PROJECT | DYRESN MODEL

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | [illegible] | 82.010.04

FIGURE 14



LEGEND: CASE: DCB120E - DEVIL CANYON OPERATION W/WATANA IN 2020 (CASE E-6)
STAGE III, THREE-STAGE PROJECT

———— PREDICTED OUTFLOW TEMPERATURE
- - - - - - INFLOW TEMPERATURE

NOTES: 1. INTAKE PORT LEVEL 1 AT ELEVATION 1426 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1375 FT (419.10 M)
3. CONE VALVE AT ELEVATION 990 FT (301.75 M)
4. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)

ALASKA POWER AUTHORITY

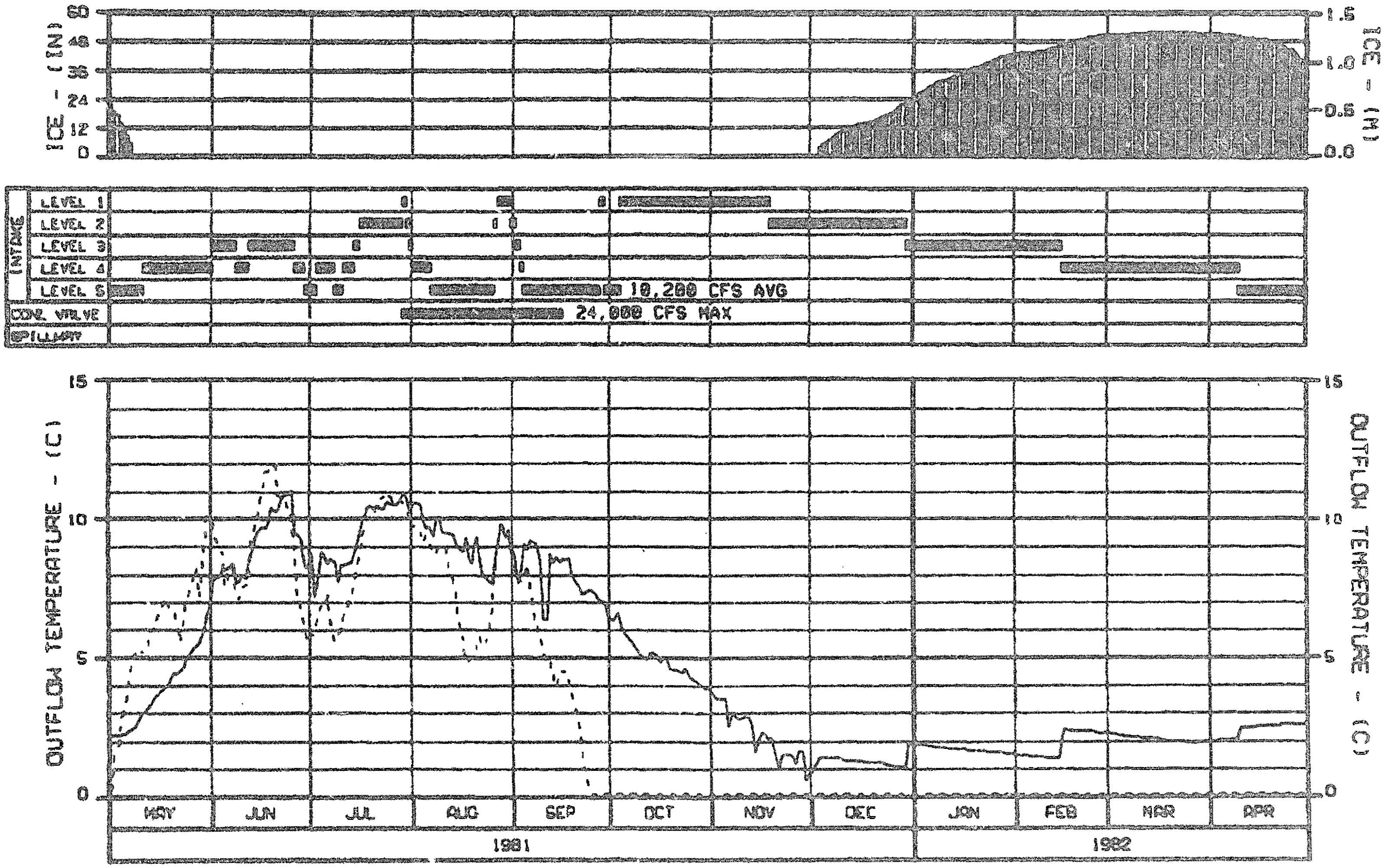
SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 28 MAR 85 | 42.012.04

FIGURE 15



LEGEND: CASE: ** WA81010 - WATANA OPERATION ALONE IN 2001 (E-6 S1) **
INFLOW TEMPERATURE MATCHING: STAGE I, THREE-STAGE PROJECT

———— PREDICTED OUTFLOW TEMPERATURE
- - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT EL. 1964 FT. (598.8 M)
2. INTAKE PORT LEVEL 2 AT EL. 1926 FT. (587.2 M)
3. INTAKE PORT LEVEL 3 AT EL. 1888 FT. (575.6 M)
4. INTAKE PORT LEVEL 4 AT EL. 1850 FT. (564.0 M)
5. INTAKE PORT LEVEL 5 AT EL. 1812 FT. (552.4 M)
6. CONE VALVE AT ELEVATION 1929 FT (588.0 M)
7. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

ALASKA POWER AUTHORITY

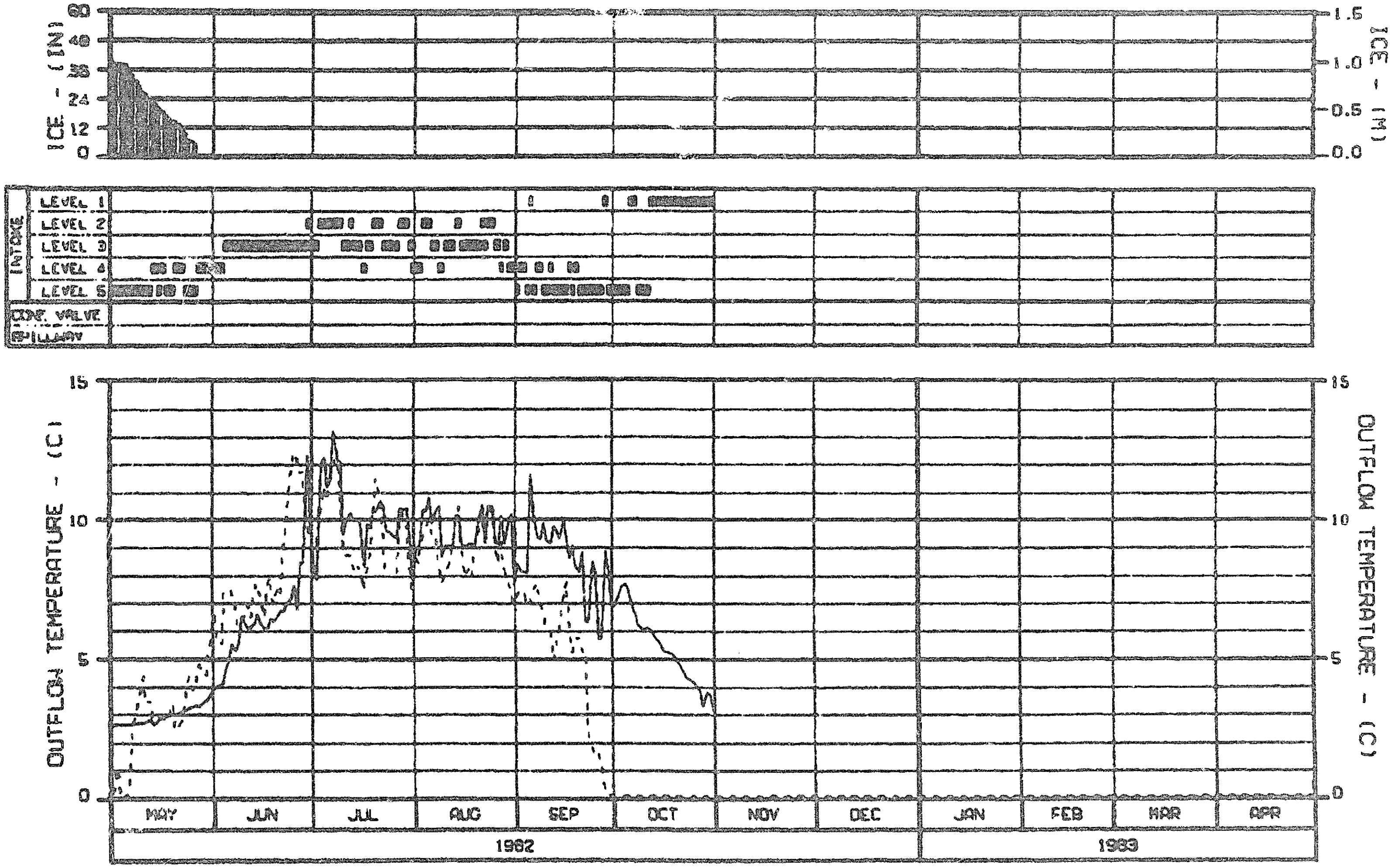
SUSITNA PROJECT	DYRESM MODEL

WATANA RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS	18 JUN 85	42-010-04

FIGURE 16



LEGEND: CASE: ** WA81010 - WATANA OPERATION ALONE IN 2001 (E-G 61) **
INFLOW TEMPERATURE MATCHING; STAGE 1, THREE-STAGE PROJECT

———— PREDICTED OUTFLOW TEMPERATURE
- - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT EL. 1964 FT. (598.8 M)
2. INTAKE PORT LEVEL 2 AT EL. 1926 FT. (587.2 M)
3. INTAKE PORT LEVEL 3 AT EL. 1888 FT. (575.6 M)
4. INTAKE PORT LEVEL 4 AT EL. 1850 FT. (564.0 M)
5. INTAKE PORT LEVEL 5 AT EL. 1812 FT. (552.4 M)
6. CONE VALVE AT ELEVATION 1829 FT (558.0 M)
7. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

ALASKA POWER AUTHORITY

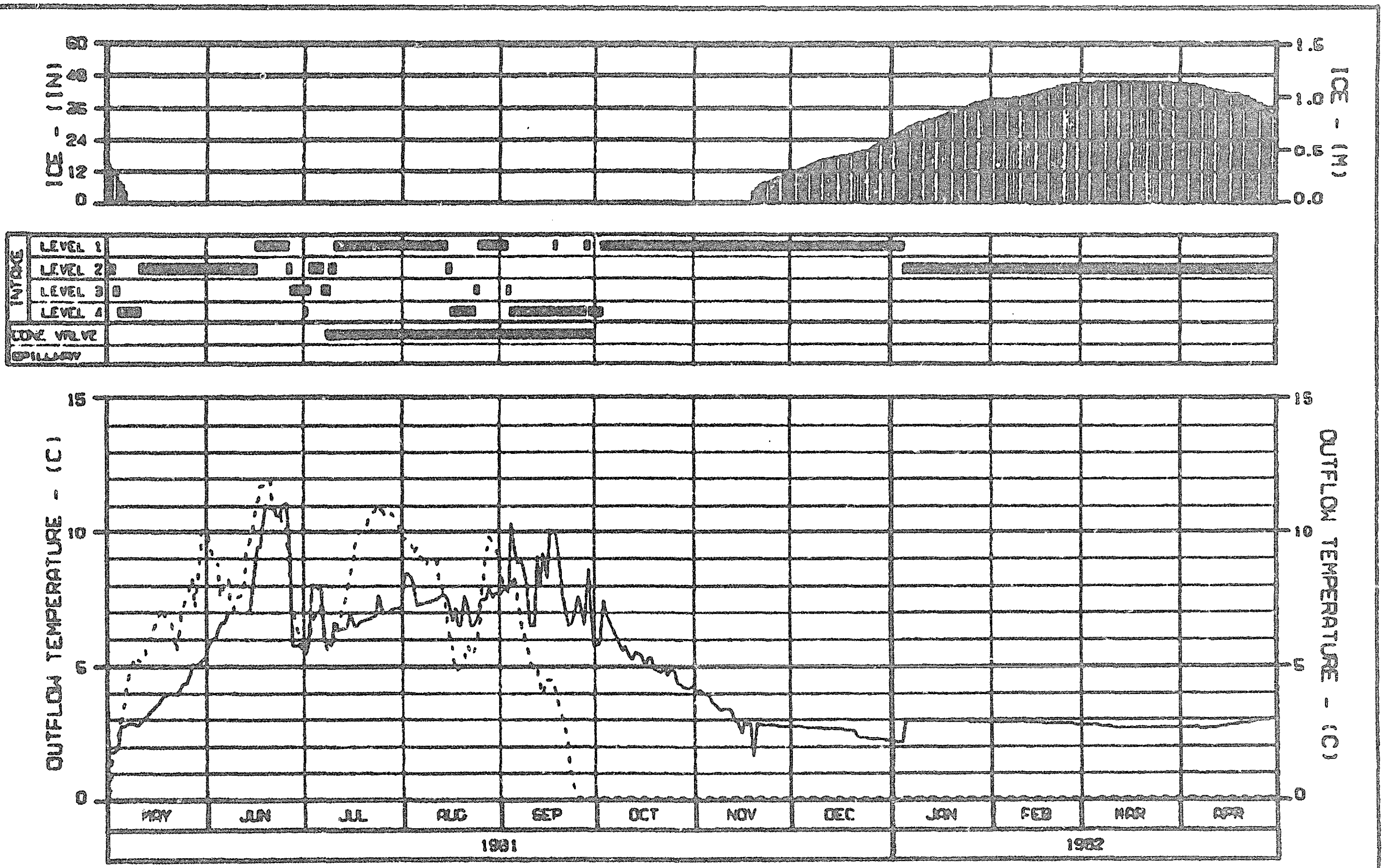
SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 18 JUN 85 | 42-010-04

FIGURE 17



LEGEND: CASE: ** WA8102J - WATANA OPERATION W/DEVIL CANYON IN 2002 ** (E-VI)
INFLOW TEMPERATURE MATCHING; STAGE II, TWO-STAGE PROJECT

———— PREDICTED OUTFLOW TEMPERATURE

- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 2151 FT (655.6 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE AT ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST AT ELEVATION 2140 FT (654.7 M)

ALASKA POWER AUTHORITY

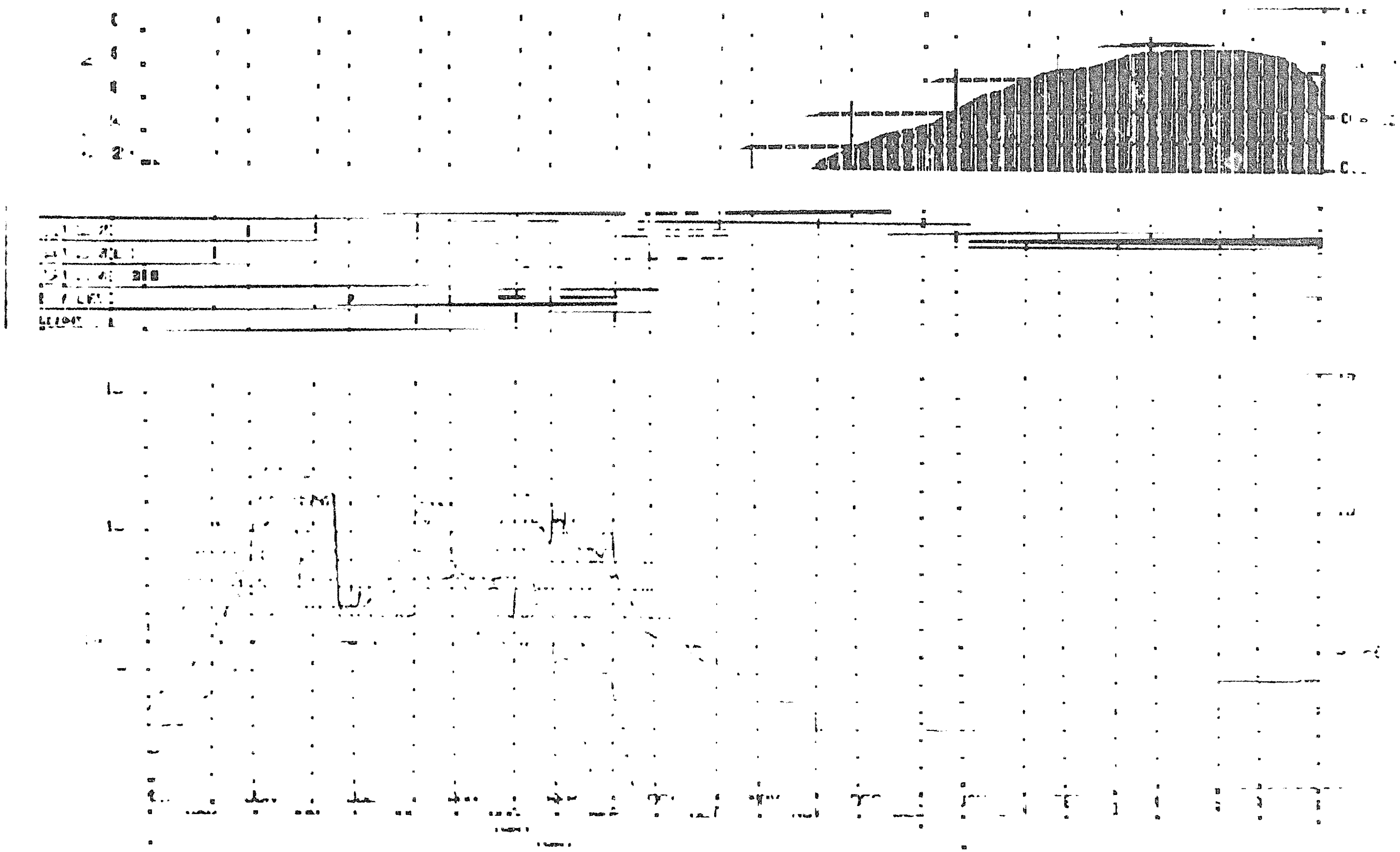
SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

42-010-04

FIGURE 18



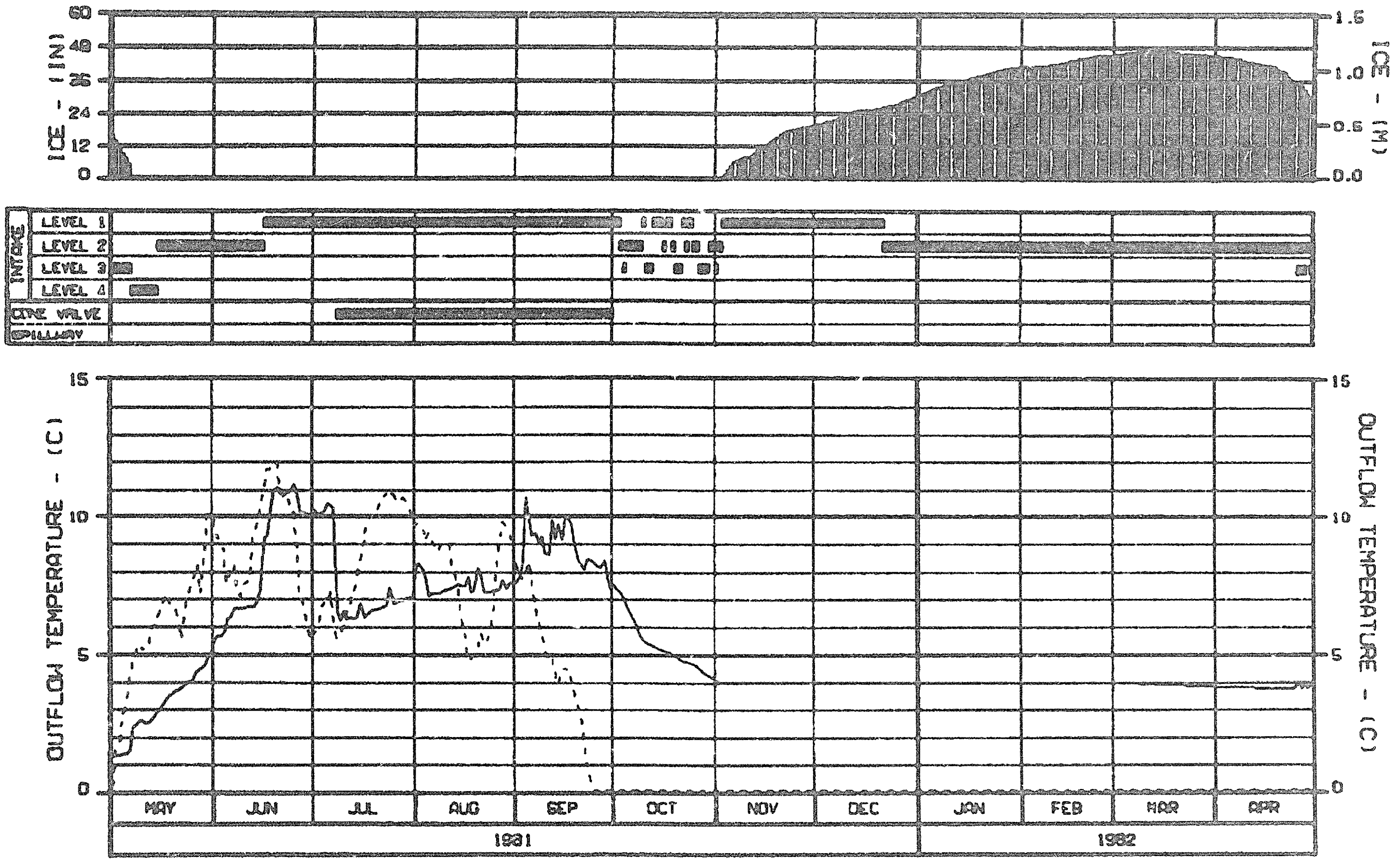
[illegible] AMBIENT WATER [illegible]

[illegible] TEMPERATURE

[illegible]

[illegible] AT ELEVATION 2146 FT ([illegible] M)

[illegible]



LEGEND: CASE: WAB102K - WATANA OPERATION W/DEVIL CANYON IN 2002 (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR) STAGE II, TWO-STAGE PROJECT
———— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 2151 FT (655.6 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE AT ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

42-010-04

FIGURE 19

K+E SEMI-LOGARITHMIC 5 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 6212

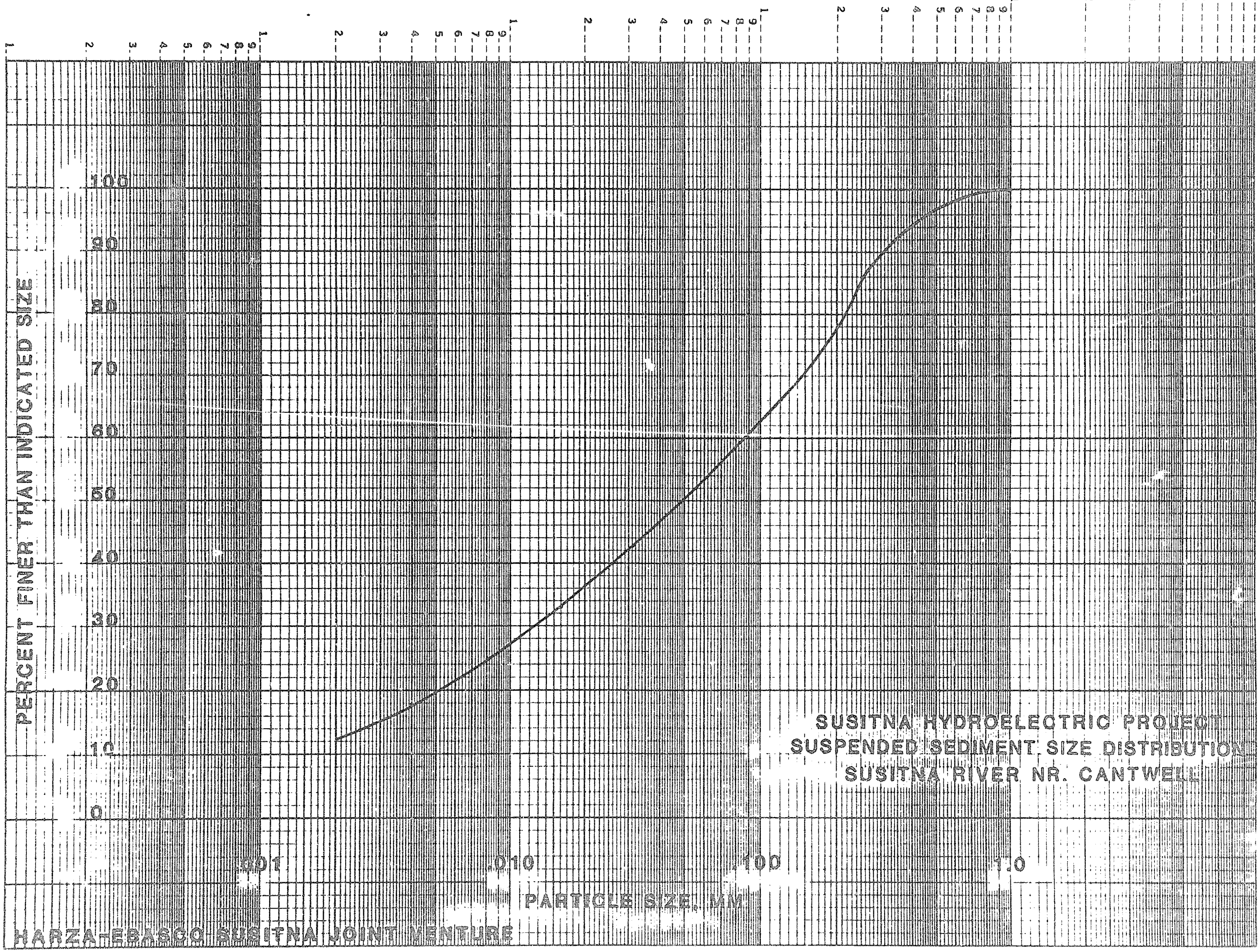
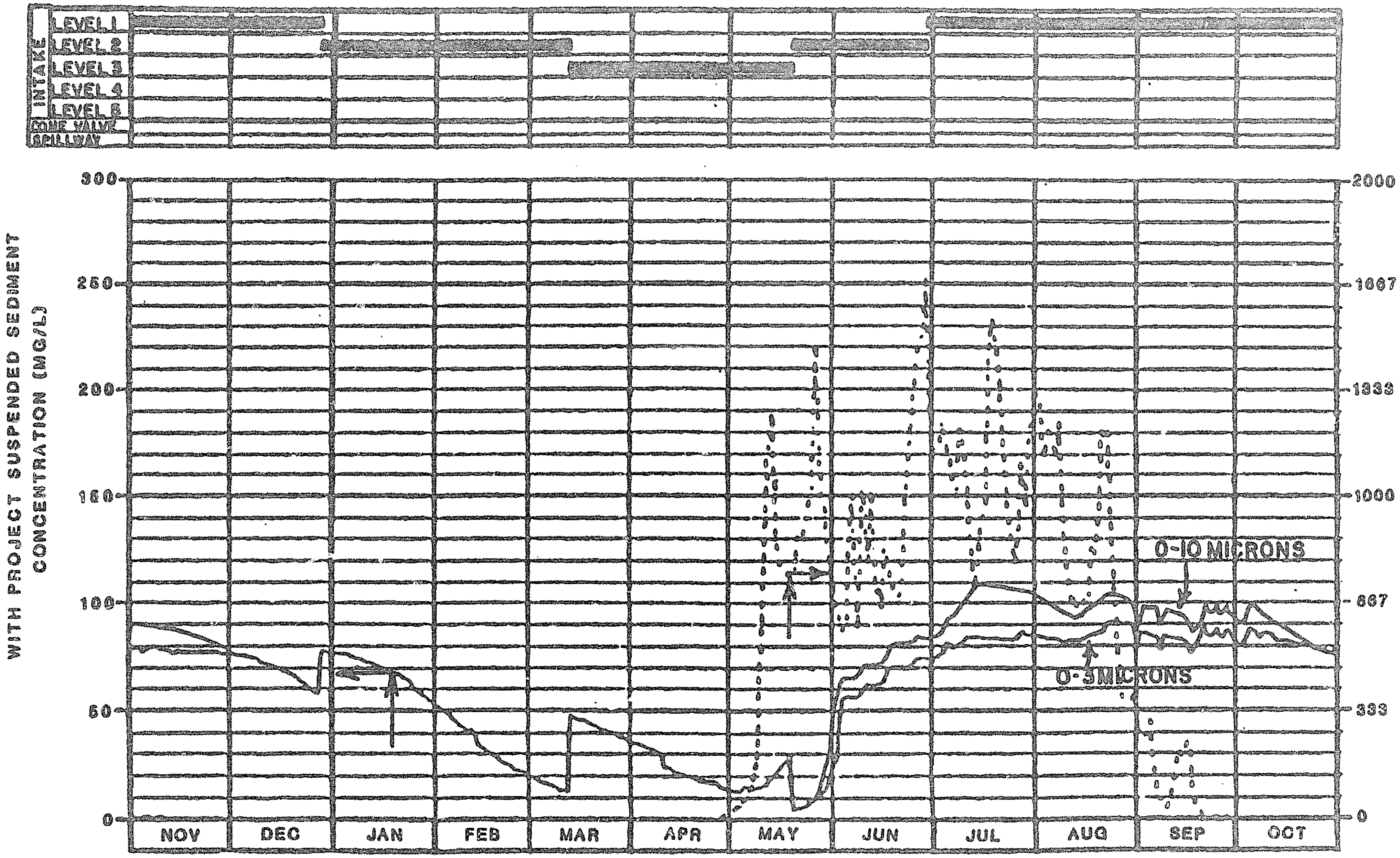


FIGURE 20



LEGEND

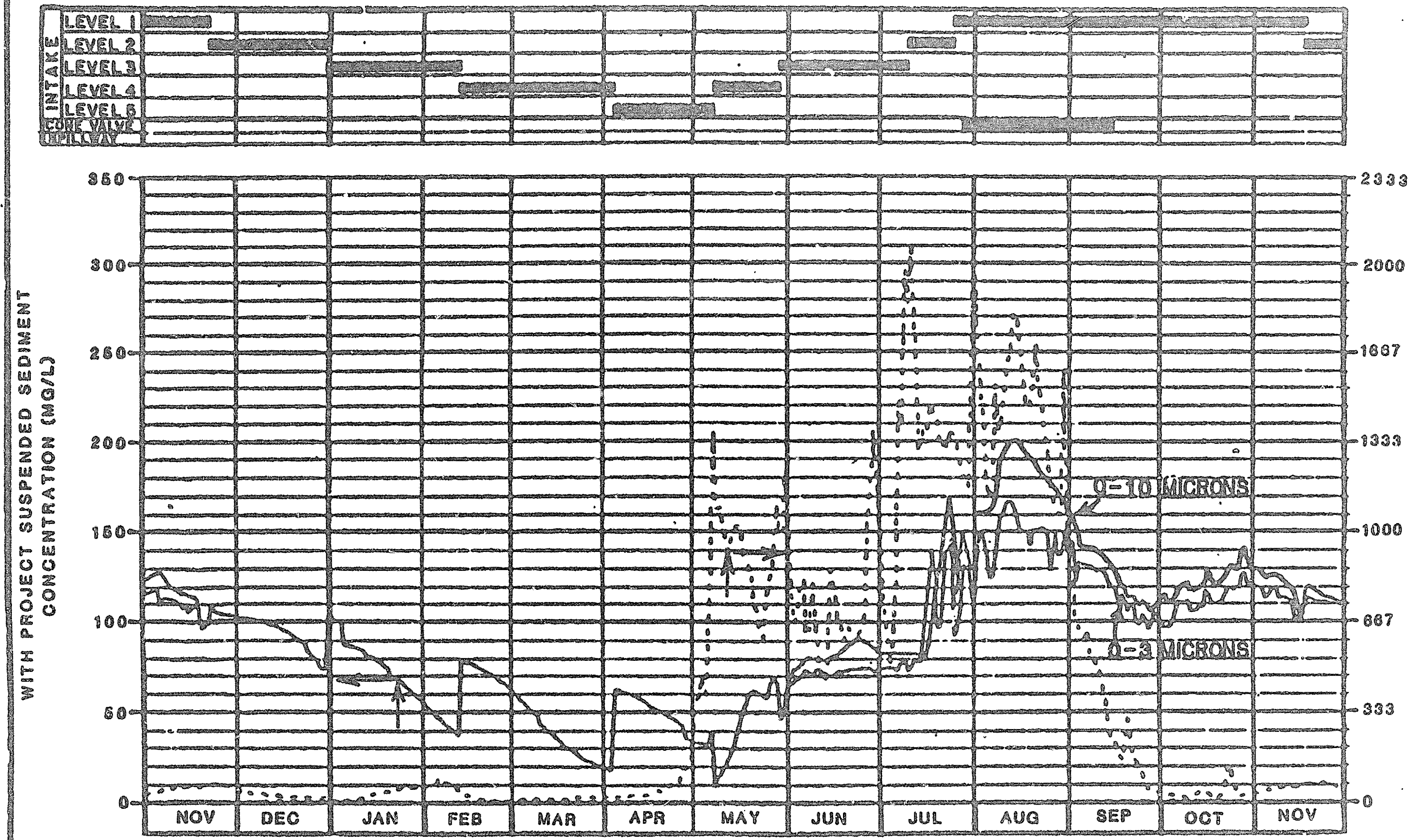
PREDICTED OUTFLOW SUSP. SED. CONCENTRATION (MG/L), STAGE I

INFLOW SUSP. SED. CONCENTRATION (MG/L)

WATANA RESERVOIR OUTFLOW SUSPENDED SOLIDS LOW INFLOW YEAR, STAGE I

HARZA-EBASCO SUSITNA JOINT VENTURE

FIGURE 21



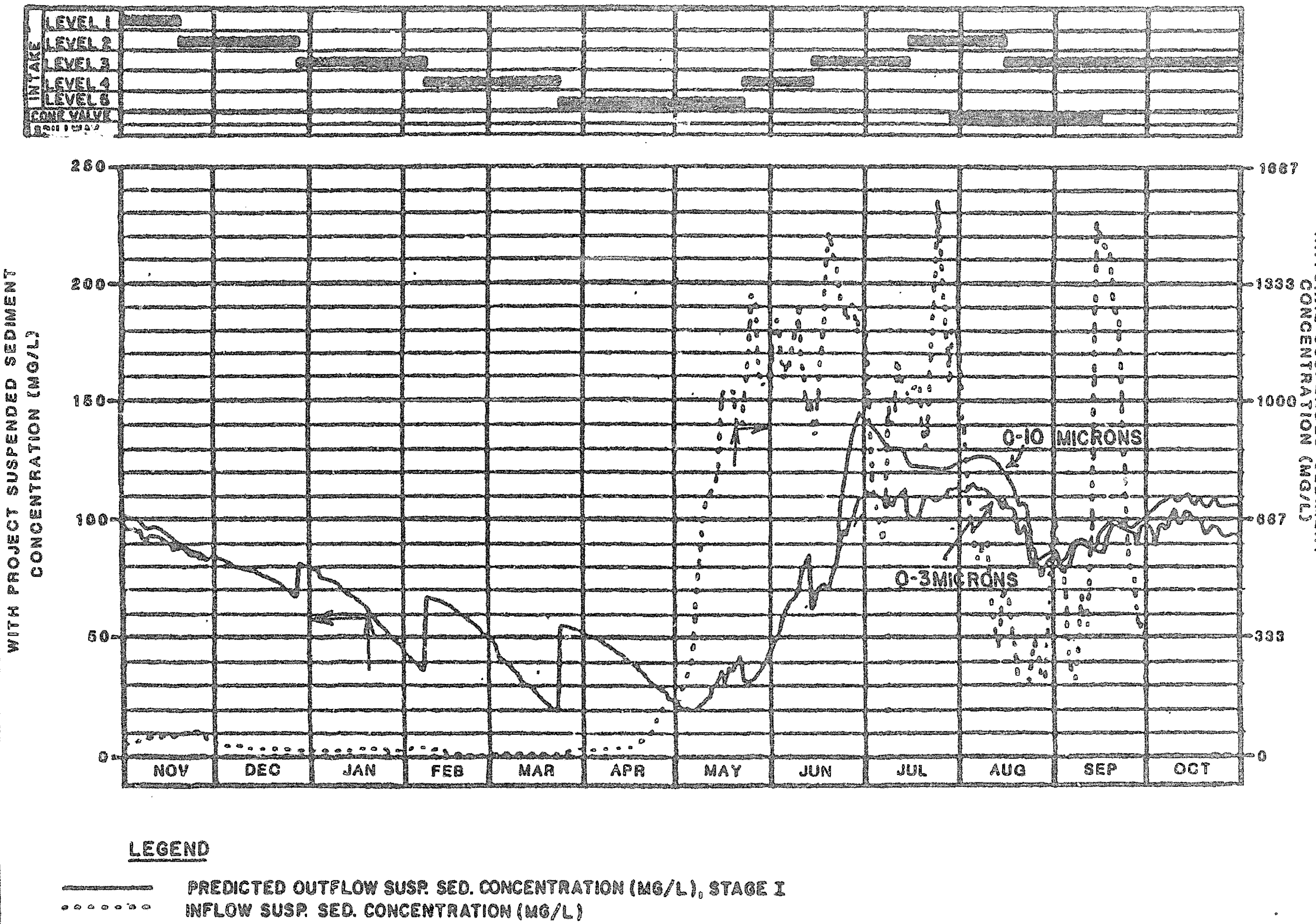
LEGEND

PREDICTED OUTFLOW SUSP. SED. CONCENTRATION (MG/L), STAGE I
INFLOW SUSP. SED. CONCENTRATION (MG/L)

WATANA RESERVOIR OUTFLOW SUSPENDED SOLIDS HIGH INFLOW YEAR, STAGE I

HARZA-EBASCO SUSITNA JOINT VENTURE

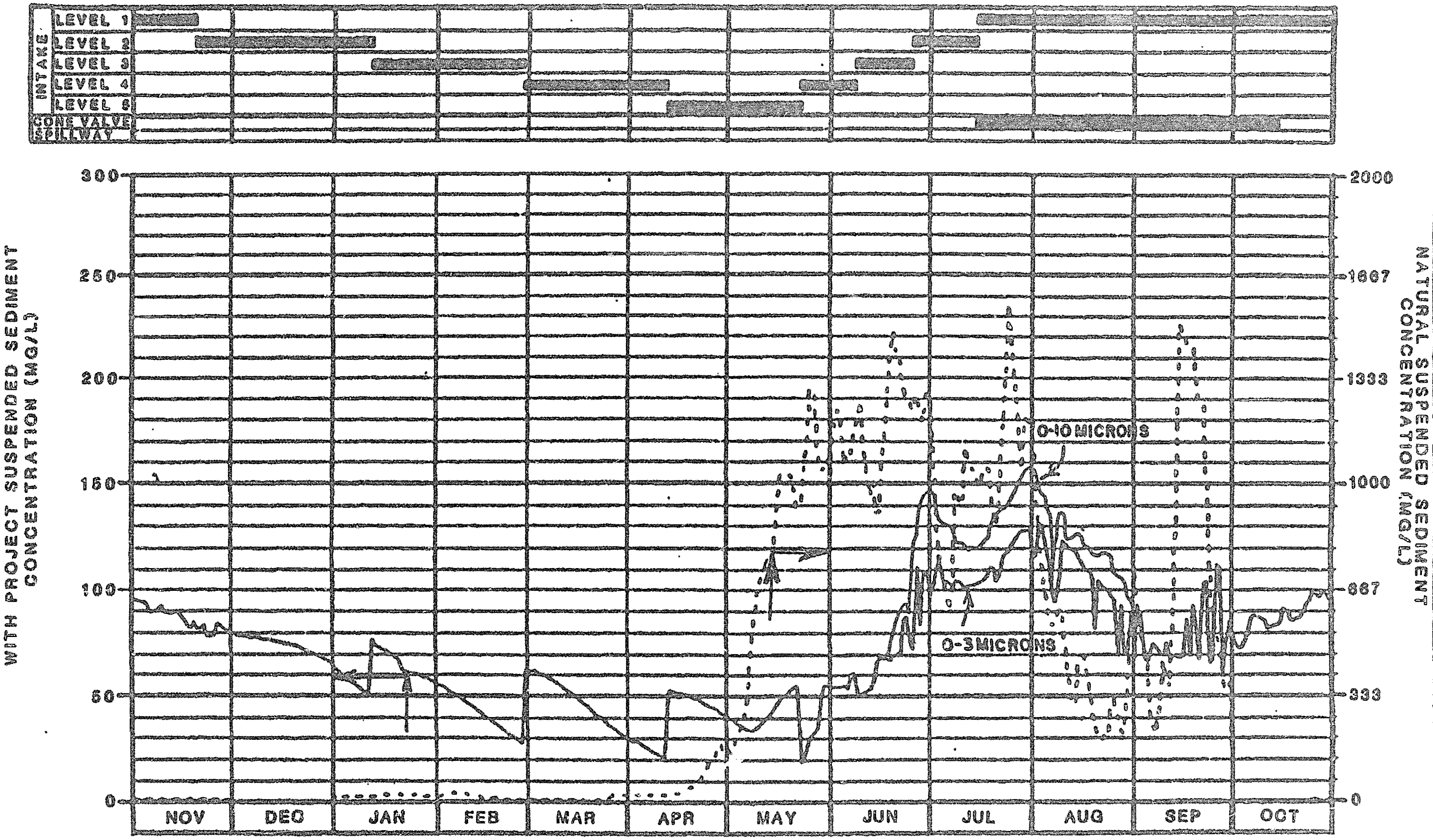
FIGURE 22



WATANA RESERVOIR OUTFLOW
SUSPENDED SOLIDS AVERAGE
INFLOW YEAR, STAGE I

HARZA-EBASCO SUSITNA JOINT VENTURE

FIGURE 23



LEGEND

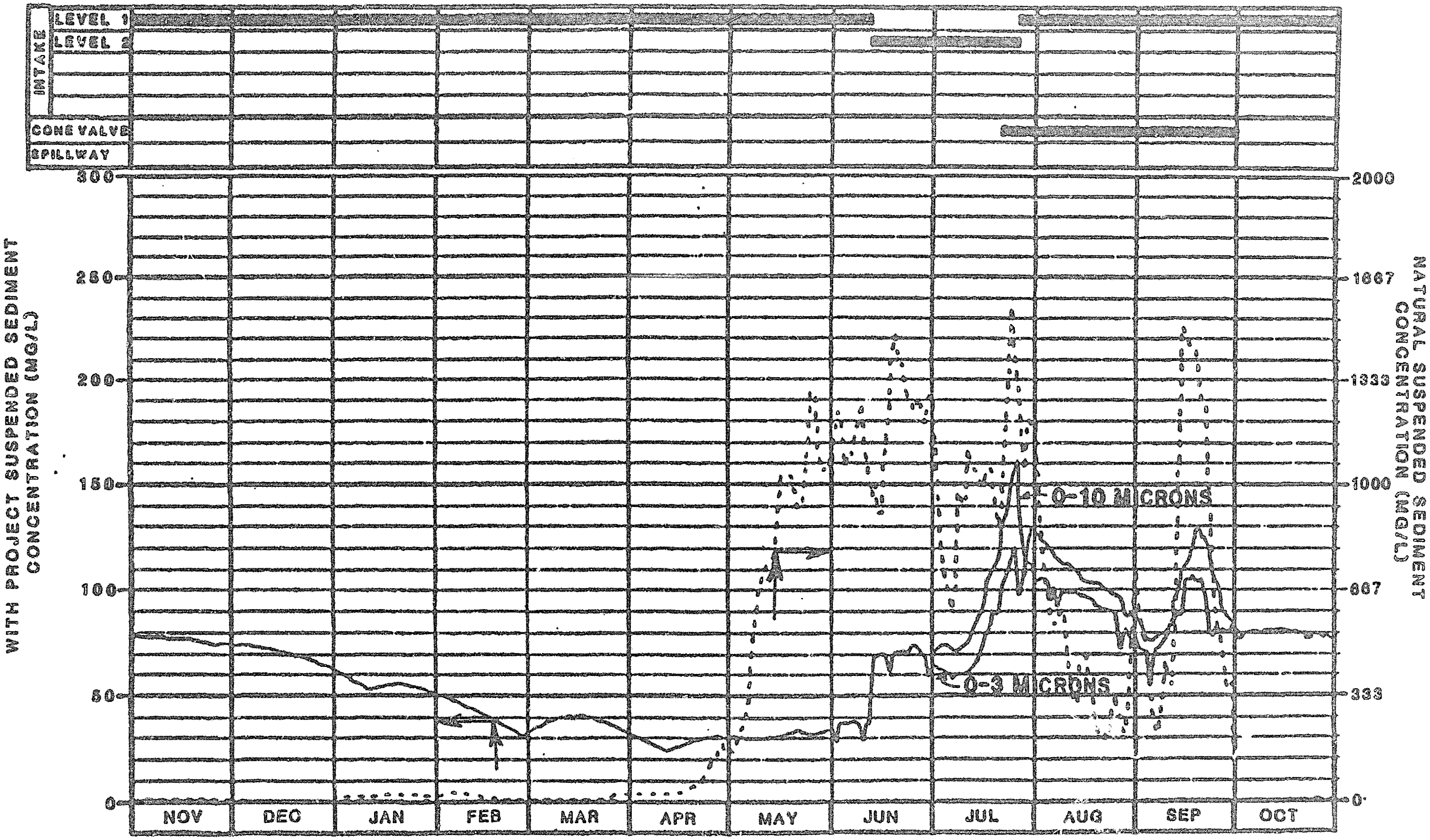
——— PREDICTED OUTFLOW SUSP. SED. CONCENTRATION (MG/L), STAGE II

• • • • • • INFLOW SUSP. SED. CONCENTRATION (MG/L)

WATANA RESERVOIR OUTFLOW SUSPENDED SOLIDS STAGE II AVERAGE YEAR

HARZA-EBASCO SUSITNA JOINT VENTURE

FIGURE 24



LEGEND

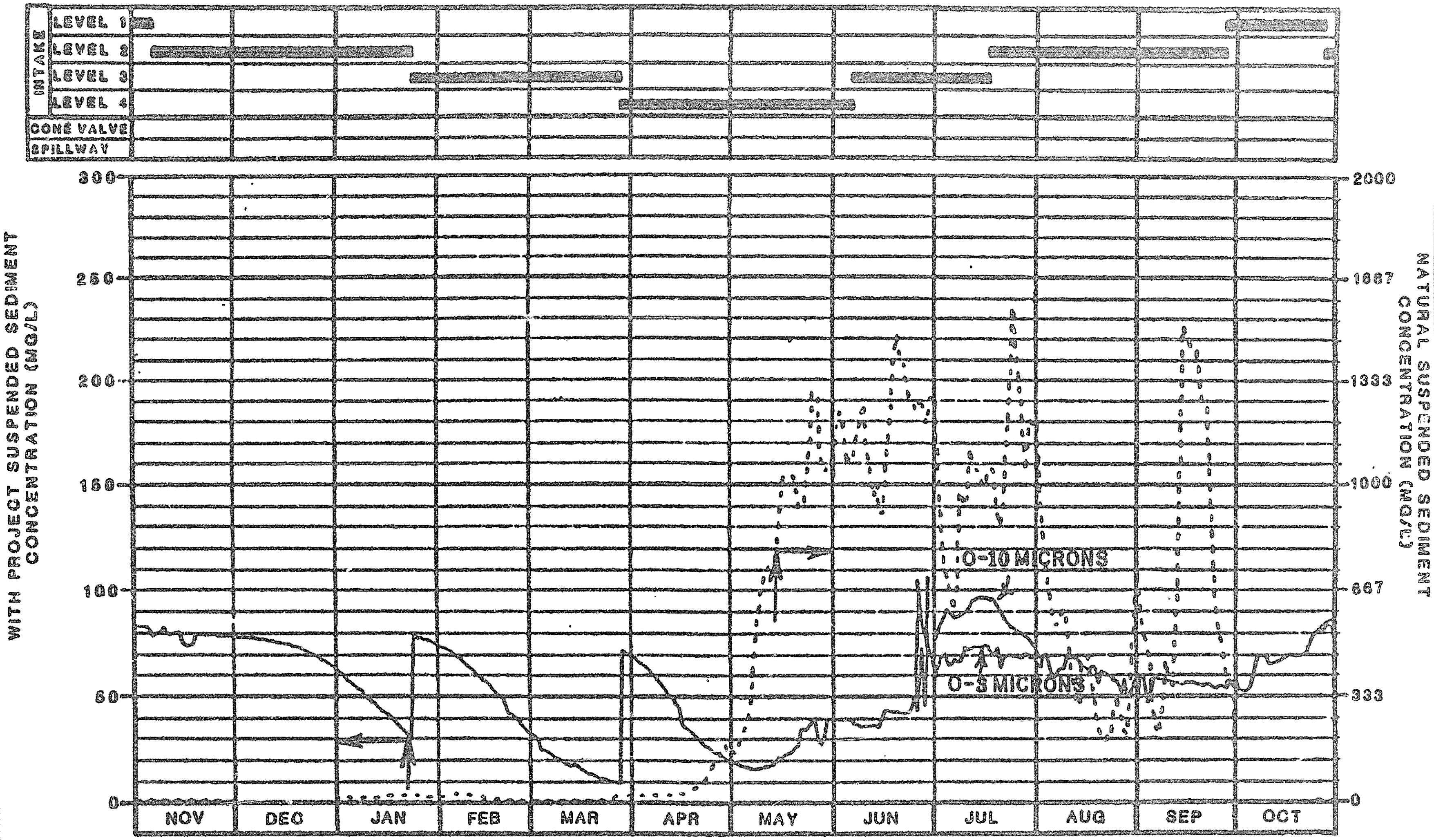
PREDICTED OUTFLOW SUSP. SED. CONCENTRATION (MG/L), STAGE II

INFLOW SUSP. SED. CONCENTRATION AT WATANA (MG/L)

DEVIL CANYON OUTFLOW
SUSPENDED SOLIDS STAGE II
AVERAGE YEAR

HARZA-EBASCO SUSITNA JOINT VENTURE

FIGURE 25



LEGEND

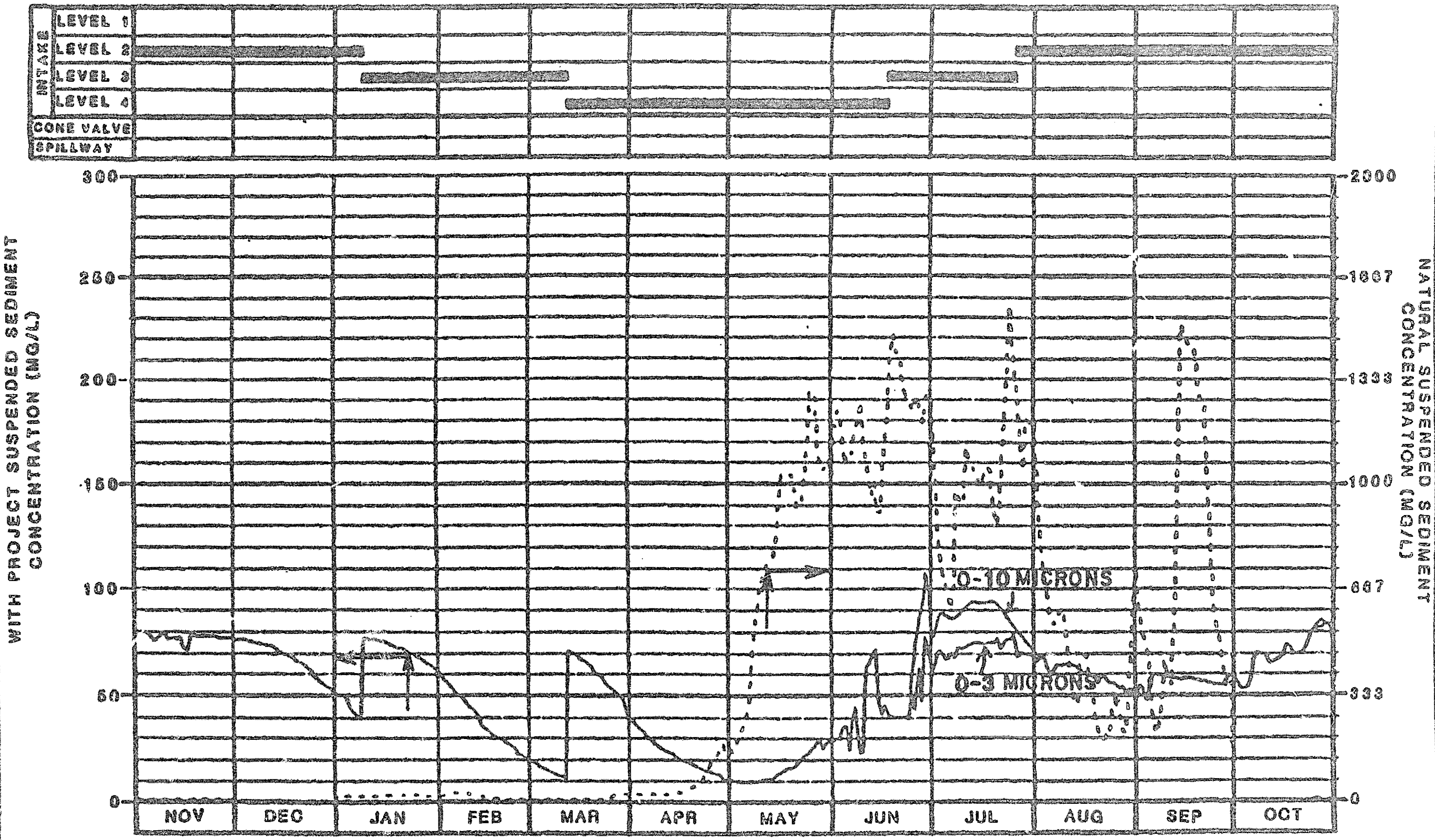
——— PREDICTED OUTFLOW SUSP. SED. CONCENTRATION (MG/L), STAGE III

• • • • • • INFLOW SUSP. SED. CONCENTRATION (MG/L)

STAGE III WATANA OUTFLOW
SUSPENDED SOLIDS
AVERAGE YEAR

HARZA-EBASCO SUSITNA JOINT VENTURE

FIGURE 26(a)



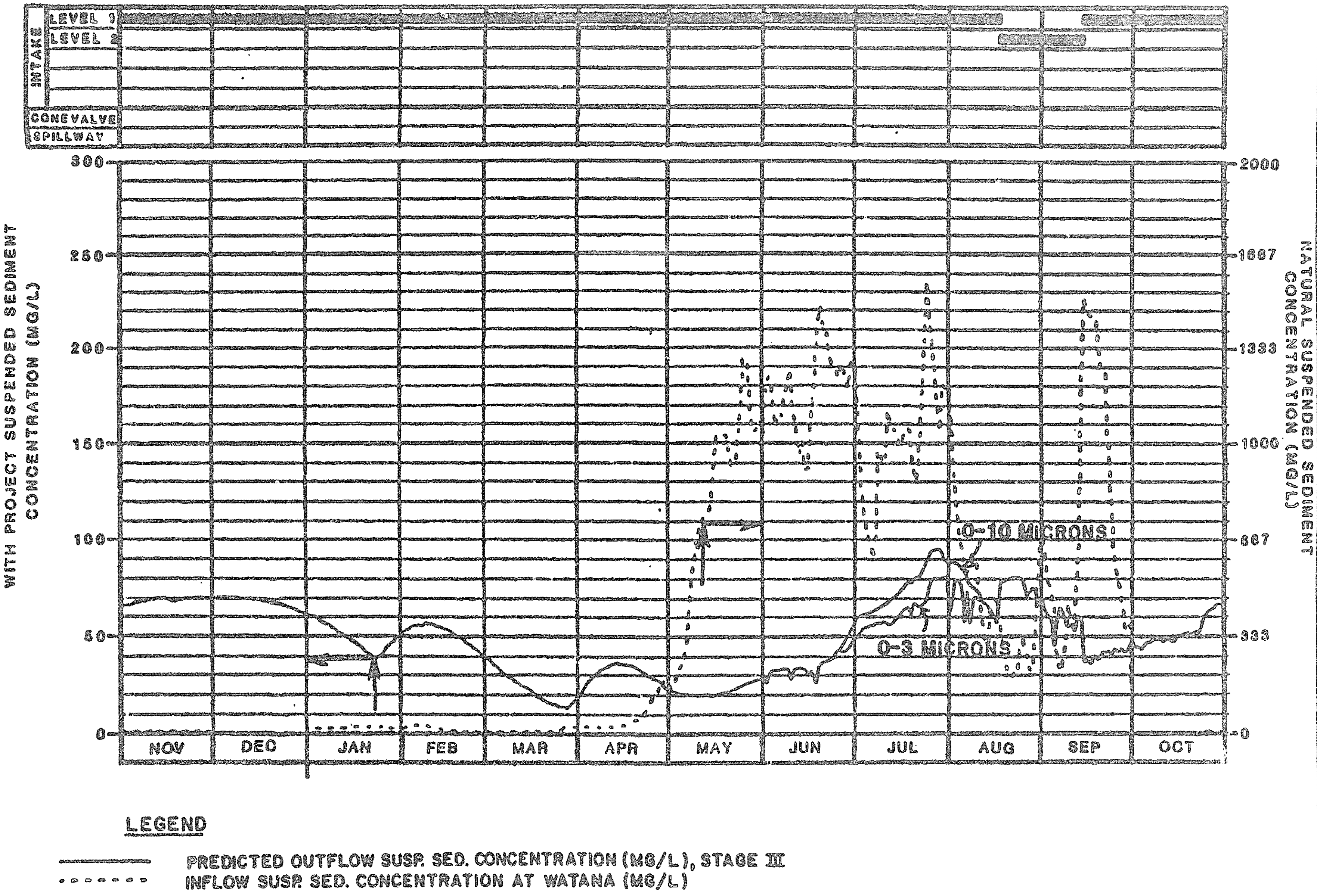
LEGEND

PREDICTED OUTFLOW SUSP. SED. CONCENTRATION (MG/L), STAGE III
INFLOW SUSP. SED. CONCENTRATION (MG/L)

STAGE III WATANA OUTFLOW
SUSPENDED SOLIDS
AVERAGE YEAR

HARZA-EBASCO SUSITNA JOINT VENTURE

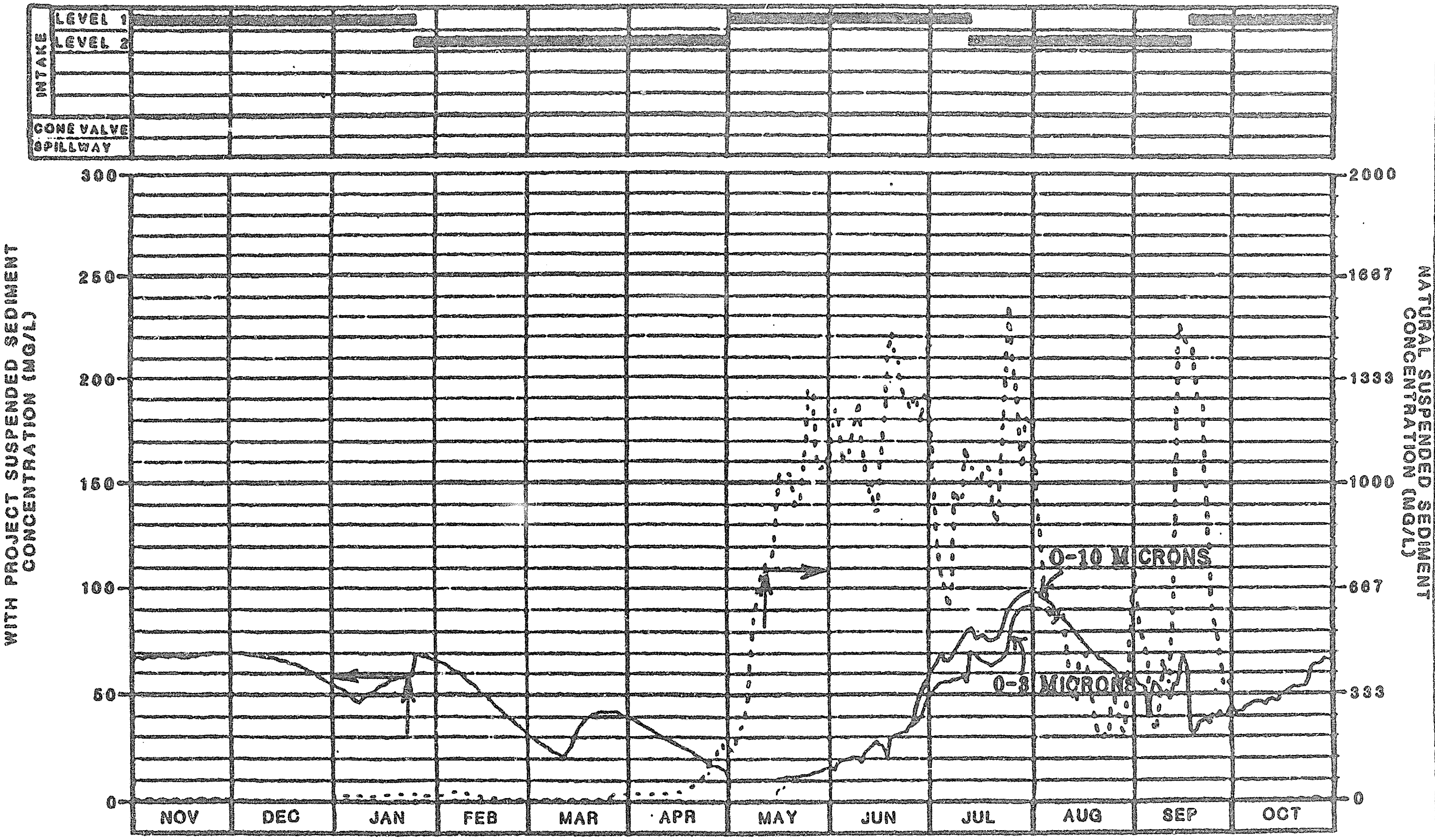
FIGURE 26(b)



HARZA-EBASCO SUSITNA JOINT VENTURE

STAGE III DEVIL CANYON
OUTFLOW SUSPENDED SOLIDS
AVERAGE YEAR

FIGURE 27(a)



LEGEND

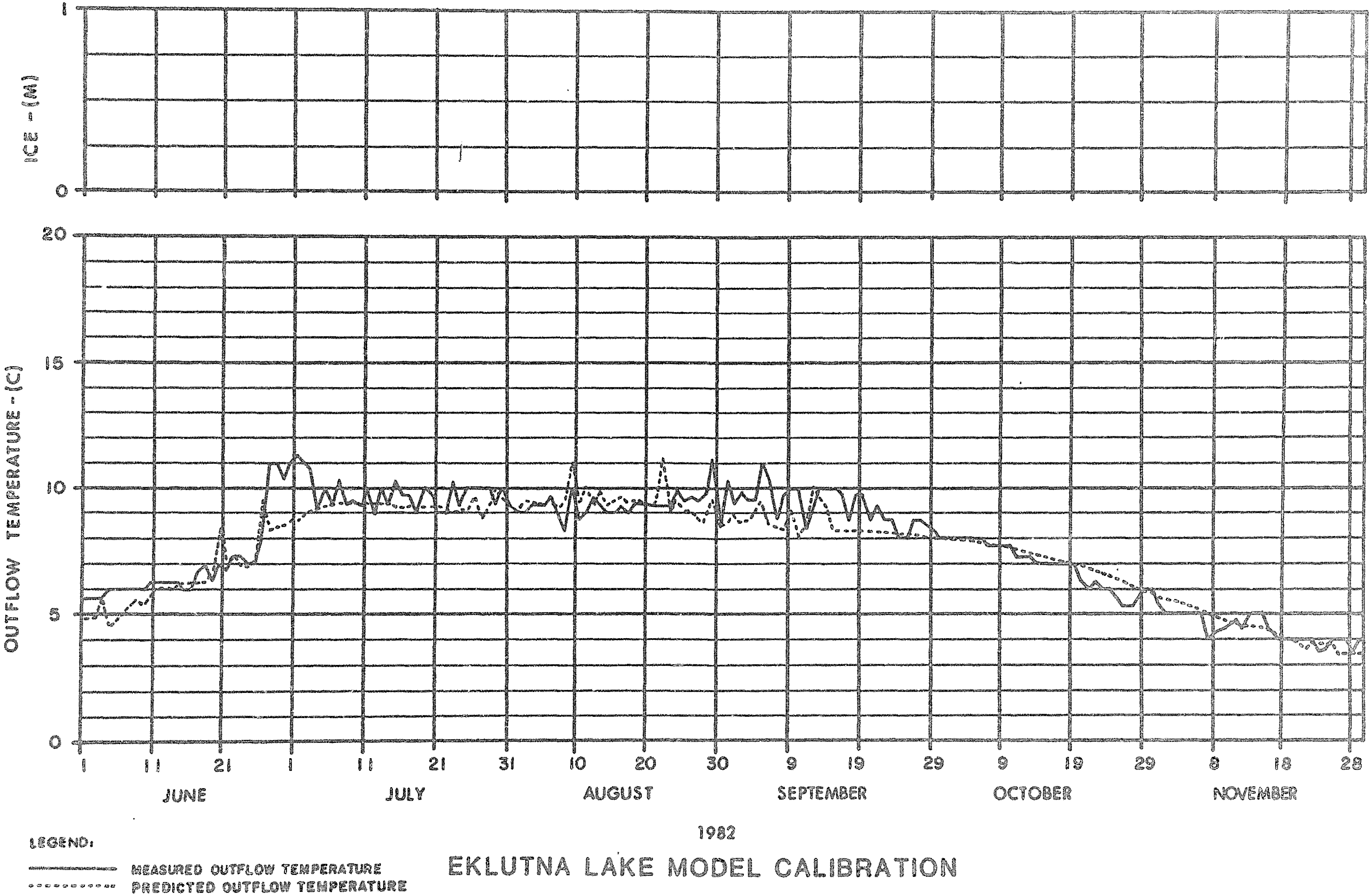
——— PREDICTED OUTFLOW SUSP. SED. CONCENTRATION (MG/L), STAGE III

· · · · · · · INFLOW SUSP. SED. CONCENTRATION AT WATANA (MG/L)

STAGE III DEVIL CANYON
OUTFLOW SUSPENDED SOLIDS
AVERAGE YEAR

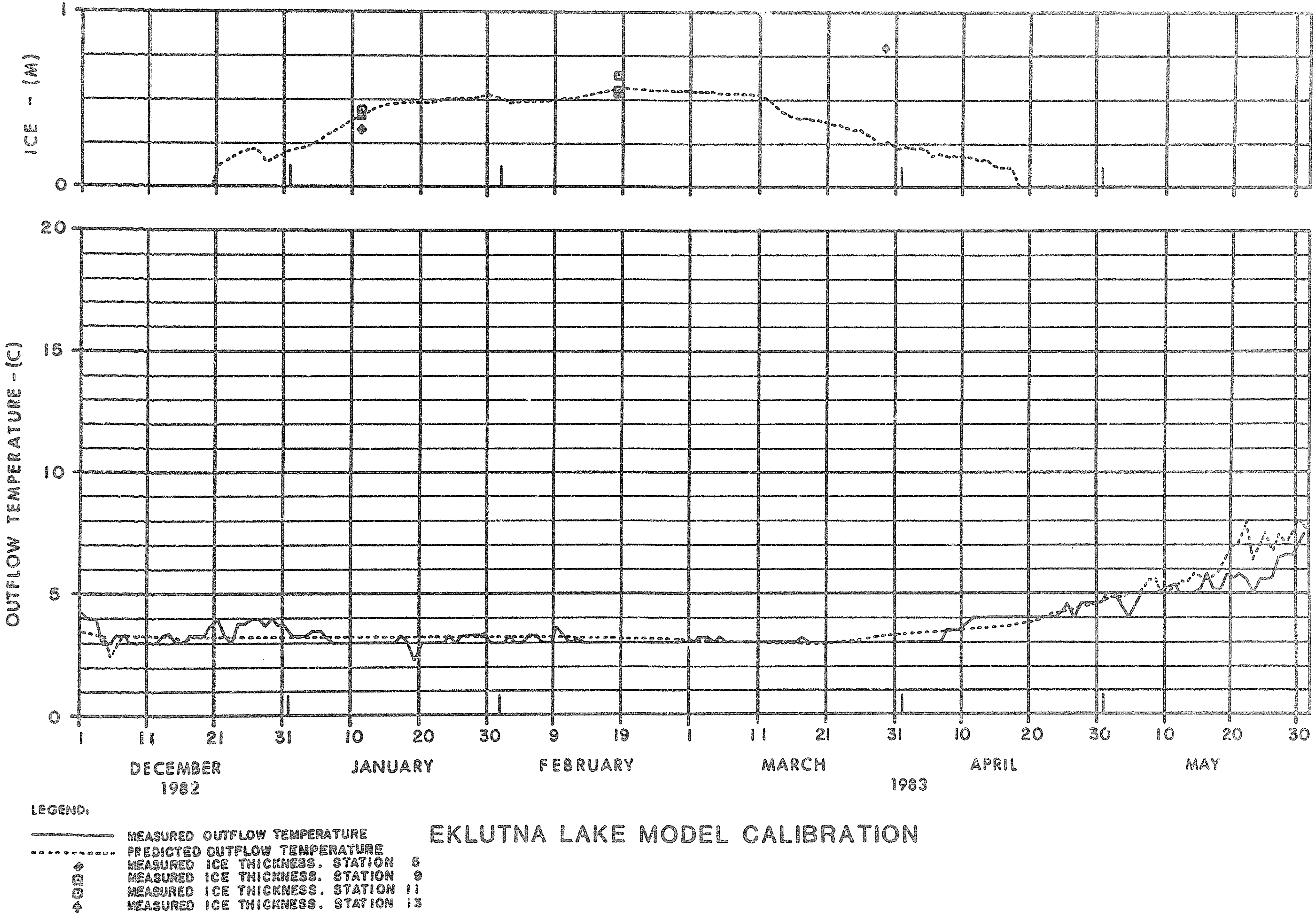
HARZA-EBASCO SUSITNA JOINT VENTURE

FIGURE 27(b)



EKLUTNA LAKE MODEL CALIBRATION

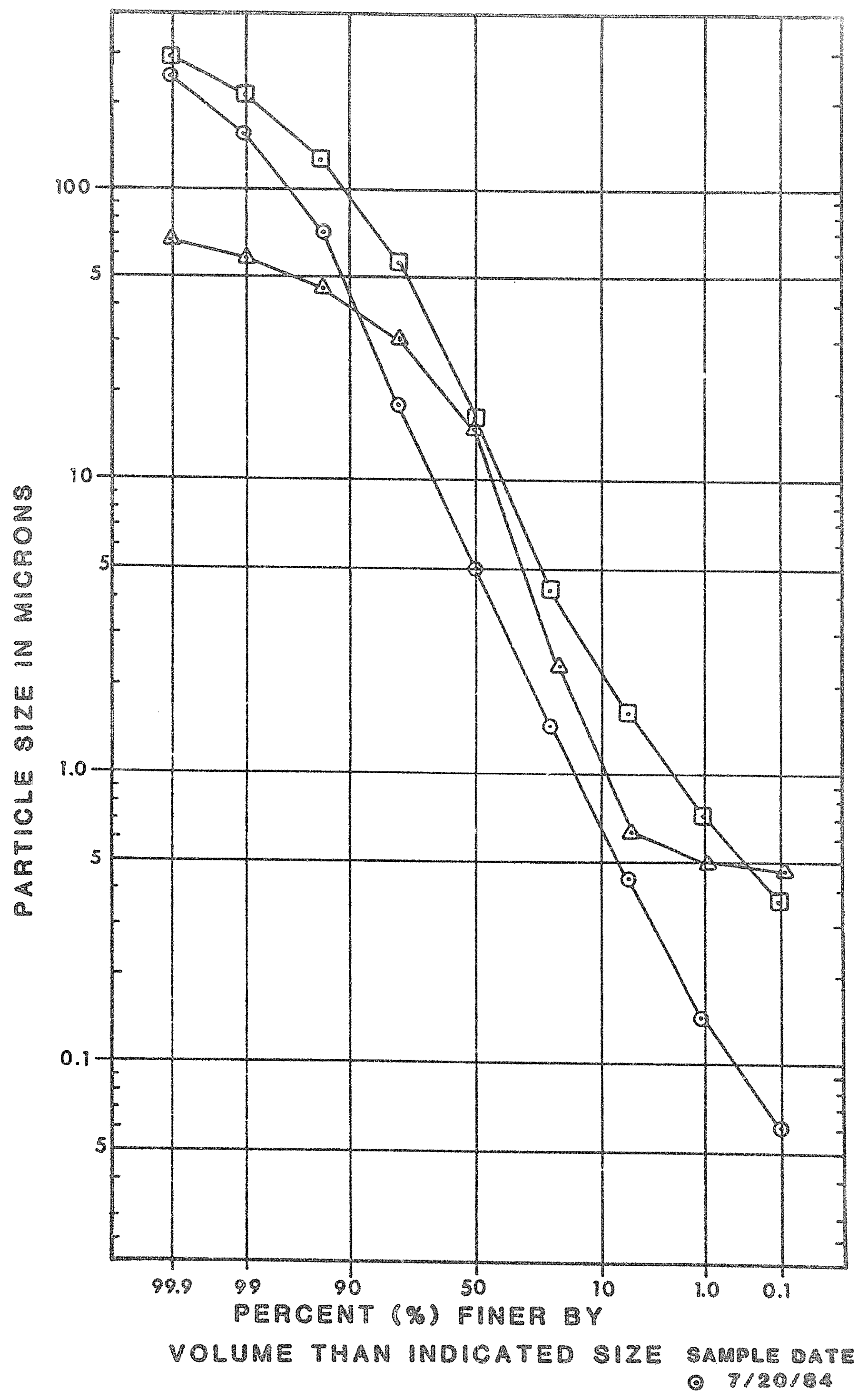
FIGURE 28(a)



EKLUTNA LAKE MODEL CALIBRATION

FIGURE 28(b)

FIGURE 29

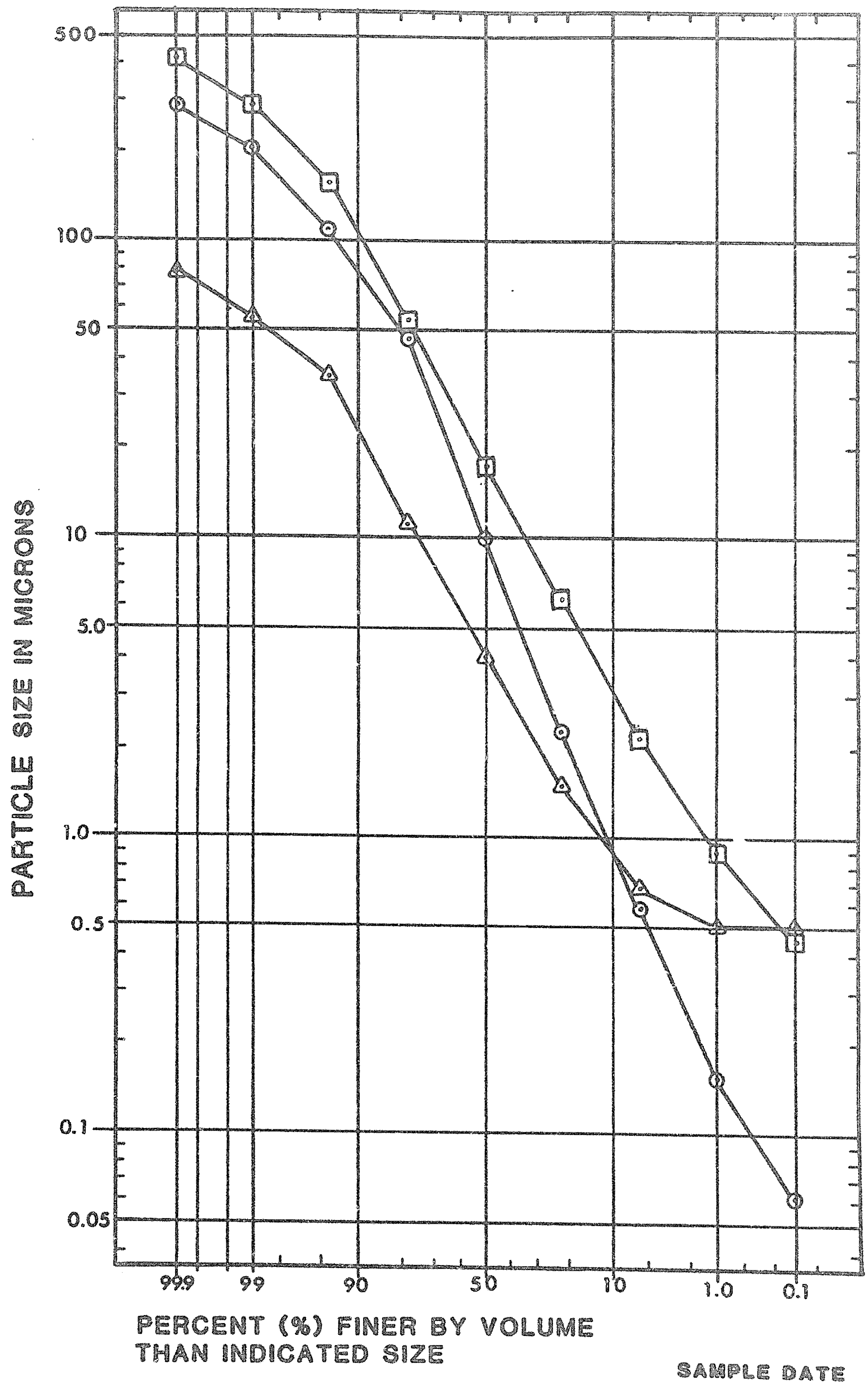


EAST FORK EKLUTNA CREEK

SUSPENDED SEDIMENT PARTICLE SIZE DISTRIBUTION

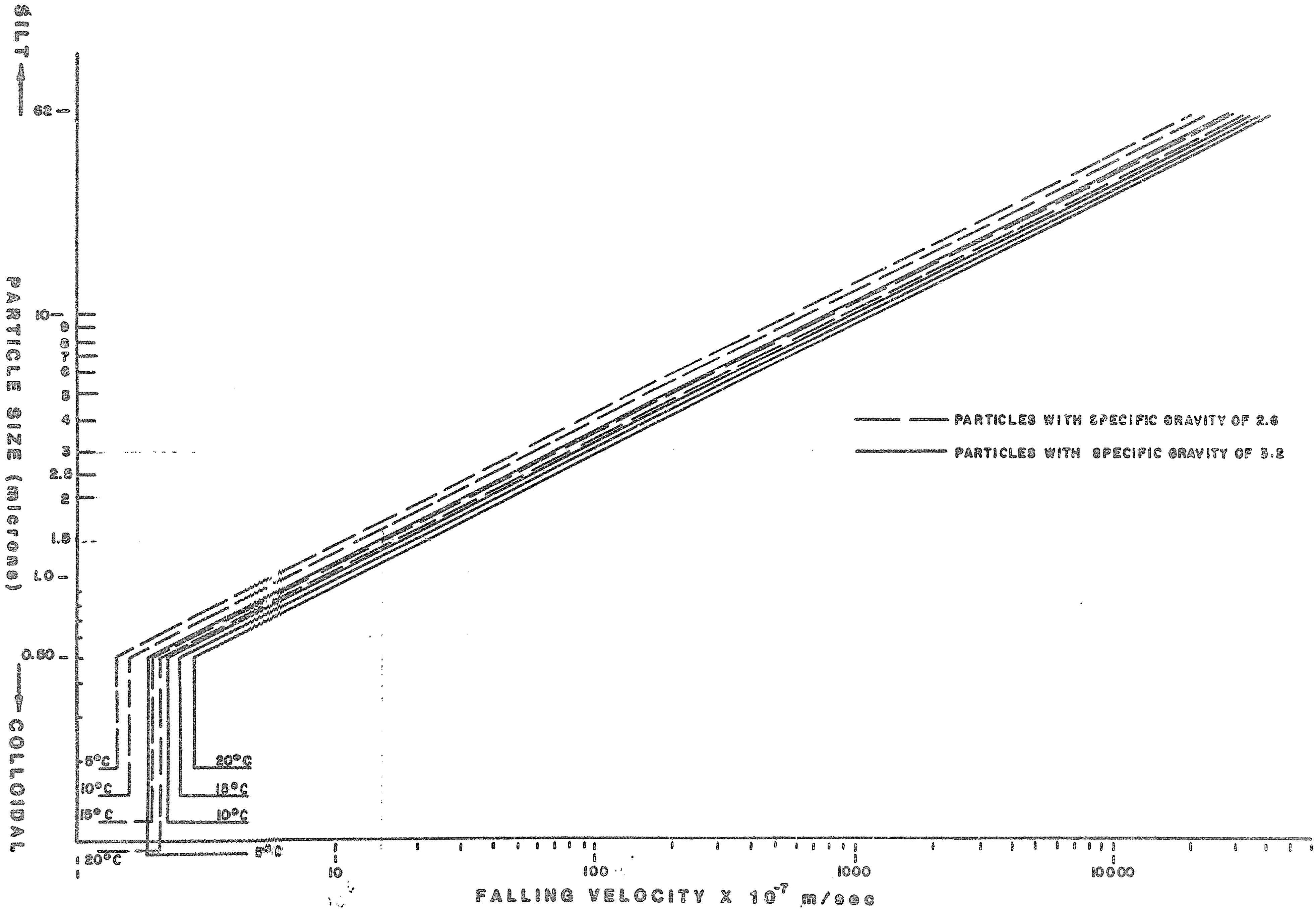
SOURCE: R & M 1985 f

FIGURE 30



SOURCE: R&M 1985f

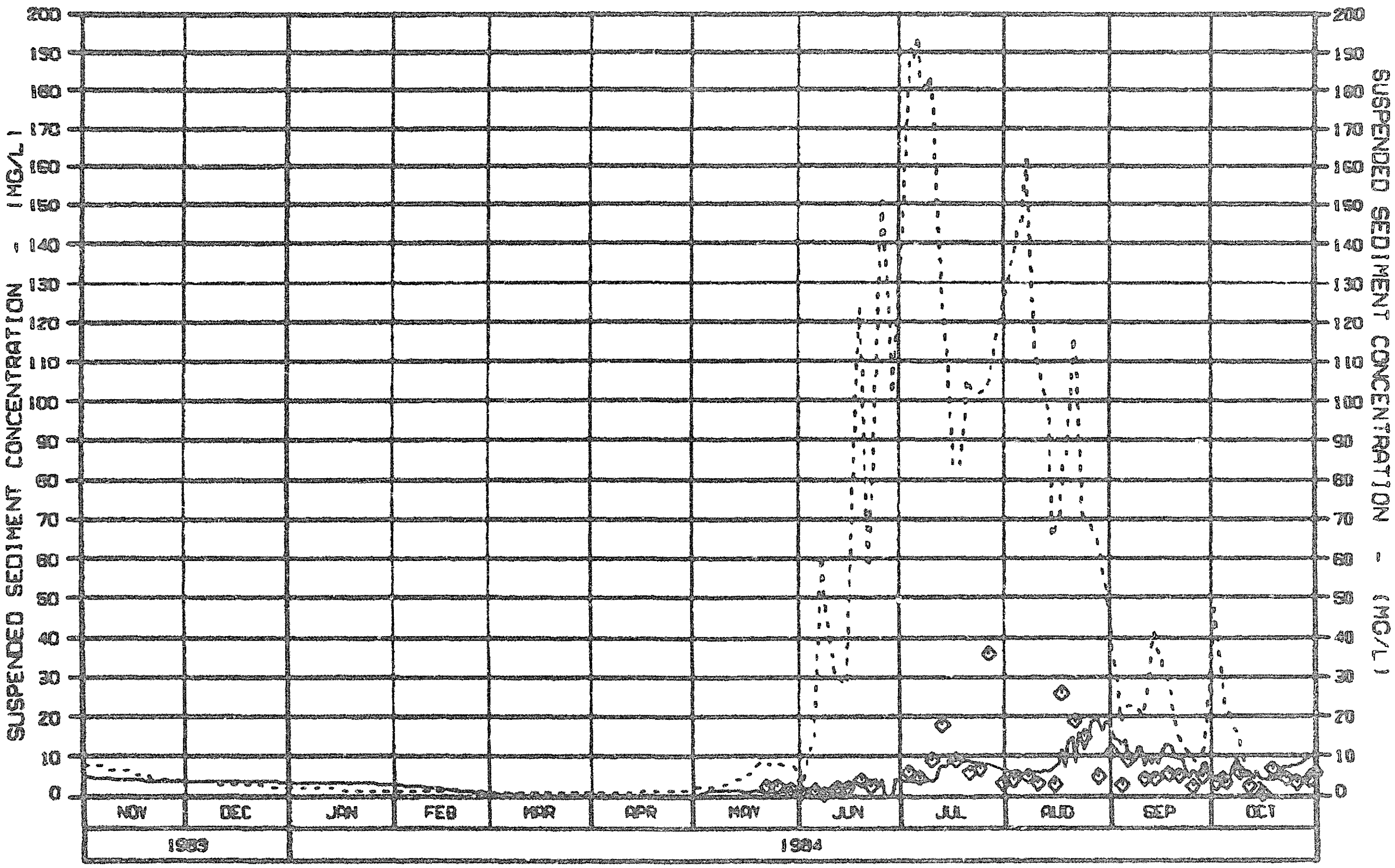
GLACIER FORK EKLUTNA CREEK
SUSPENDED SEDIMENT PARTICLE SIZE DISTRIBUTION FIGURE



STOKES LAW FOR FALL VELOCITIES VARIATIONS WITH RESPECT TO TEMPERATURE AND PARTICLE DENSITY

SOURCE: R&M 1985f

FIGURE 31



LEGEND: EK84HH 0-10 MICRON SUSPENDED SEDIMENT SIMULATION
0-3 MICRON AND 3-10 MICRON RUNS COMBINED (EK84HH03+EK84HH10)
——— PREDICTED OUTFLOW SUSPENDED SEDIMENT CONCENTRATION (MG/L)
- - - - INFLOW SUSPENDED SEDIMENT CONCENTRATION (MG/L)
◇ OBSERVED OUTFLOW SUSPENDED SEDIMENT CONCENTRATION (MG/L)

NOTES:
1. INFLOW SUSP. SED. CONC. IS BASED ON 7/20 8/28 10/23 (1984) PARTICLE SIZE DISTRIBUTIONS
2. SSC INFLOW VALUES REPRESENT THE 0-10 MICRON RANGE AND ARE 51.8% OF TSS EXCEPT DURING 7/20/84-10/23/84. DURING THIS PERIOD, SSC PERCENTAGES (OF TSS) ARE LINEARLY INTERPOLATED BETWEEN THE FOLLOWING VALUES:
55.5% ON 7/20/84 35.7% ON 8/28/84 51.8% ON 10/23/84

ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

EKLUTNA LAKE
OUTFLOW (0-10 MICRON)
SUSPENDED SEDIMENT

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | [illegible] | 42-010-38

FIGURE 32

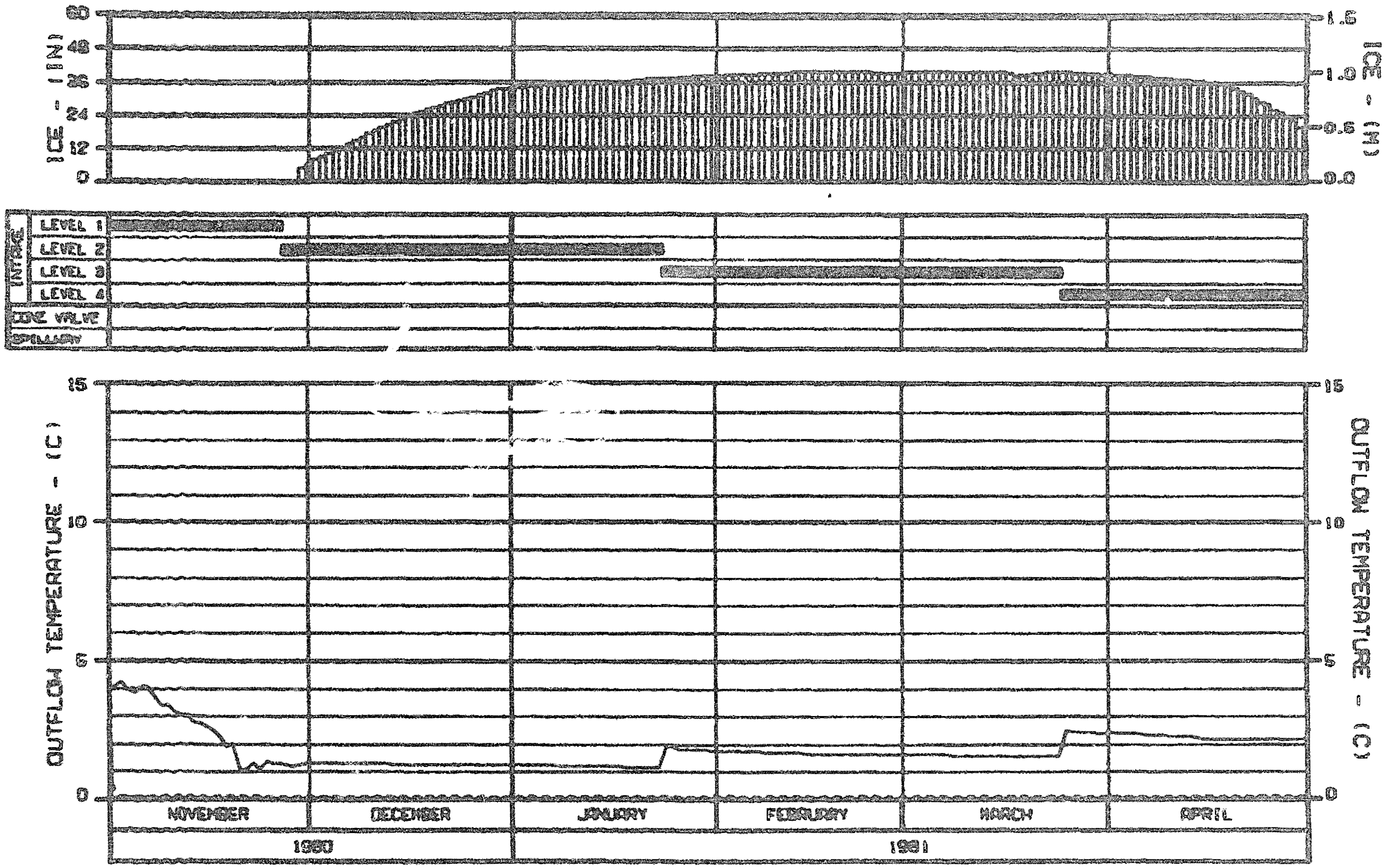
EXHIBITS

SIMULATED RESERVOIR TEMPERATURE PROFILE
AND OUTFLOW TEMPERATURES

* Reservoir temperature profiles not included

EXHIBIT A

CASE E-VI
STAGE I
TWO-STAGE PROJECT
INFLOW TEMPERATURE MATCHING



LEGEND: CASE: ** WA81011 - WATANA OPERATION ALONE IN 2001 ** (E-VI)

——— PREDICTED OUTFLOW TEMPERATURE
- - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 2151 FT (655.6 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE AT ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

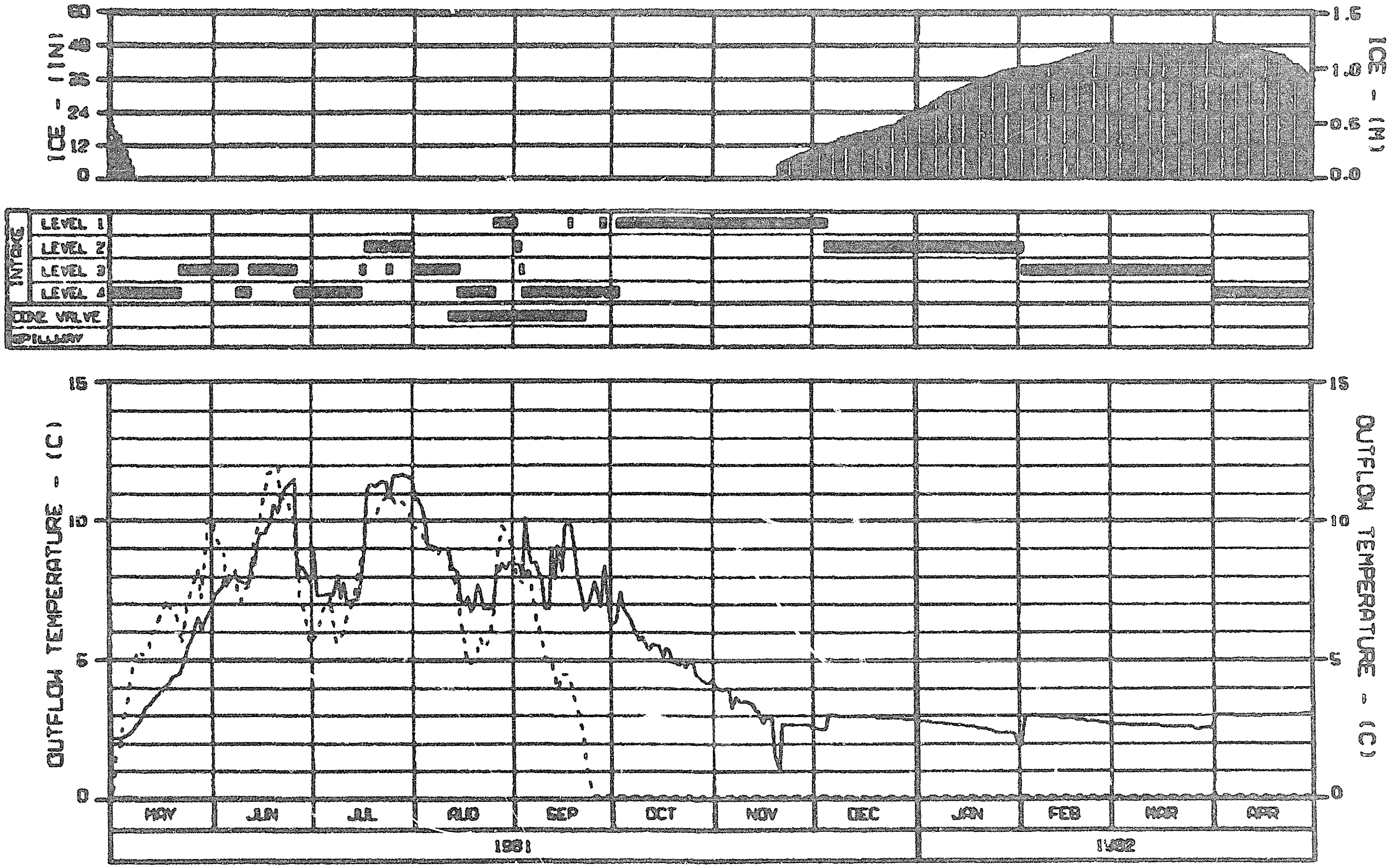
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | [illegible] | 42-010-84

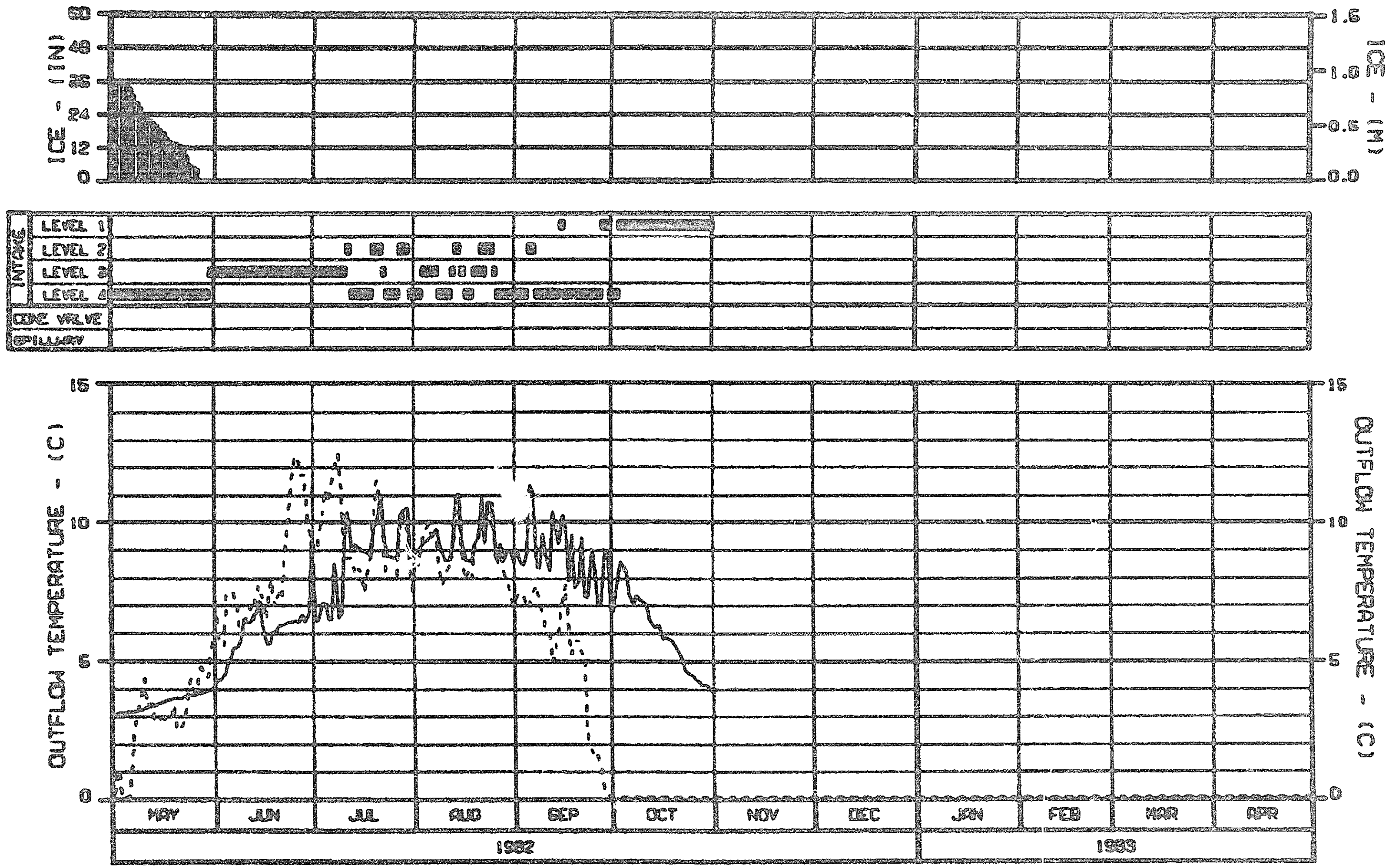


LEGEND: CASE: WA81011 - WATANA OPERATION ALONE IN 2001 (E-VI)

——— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 2151 FT (655.6 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE AT ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
WATANA RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH	
HARZA-EBASCO JOINT VENTURE	
[illegible]	42-010-04



LEGEND: CASE: ** WAB1011 - WATANA OPERATION ALONE IN 2001 ** (E-VI)

——————— PREDICTED OUTFLOW TEMPERATURE
· · · · · · · INFLOW TEMPERATURE

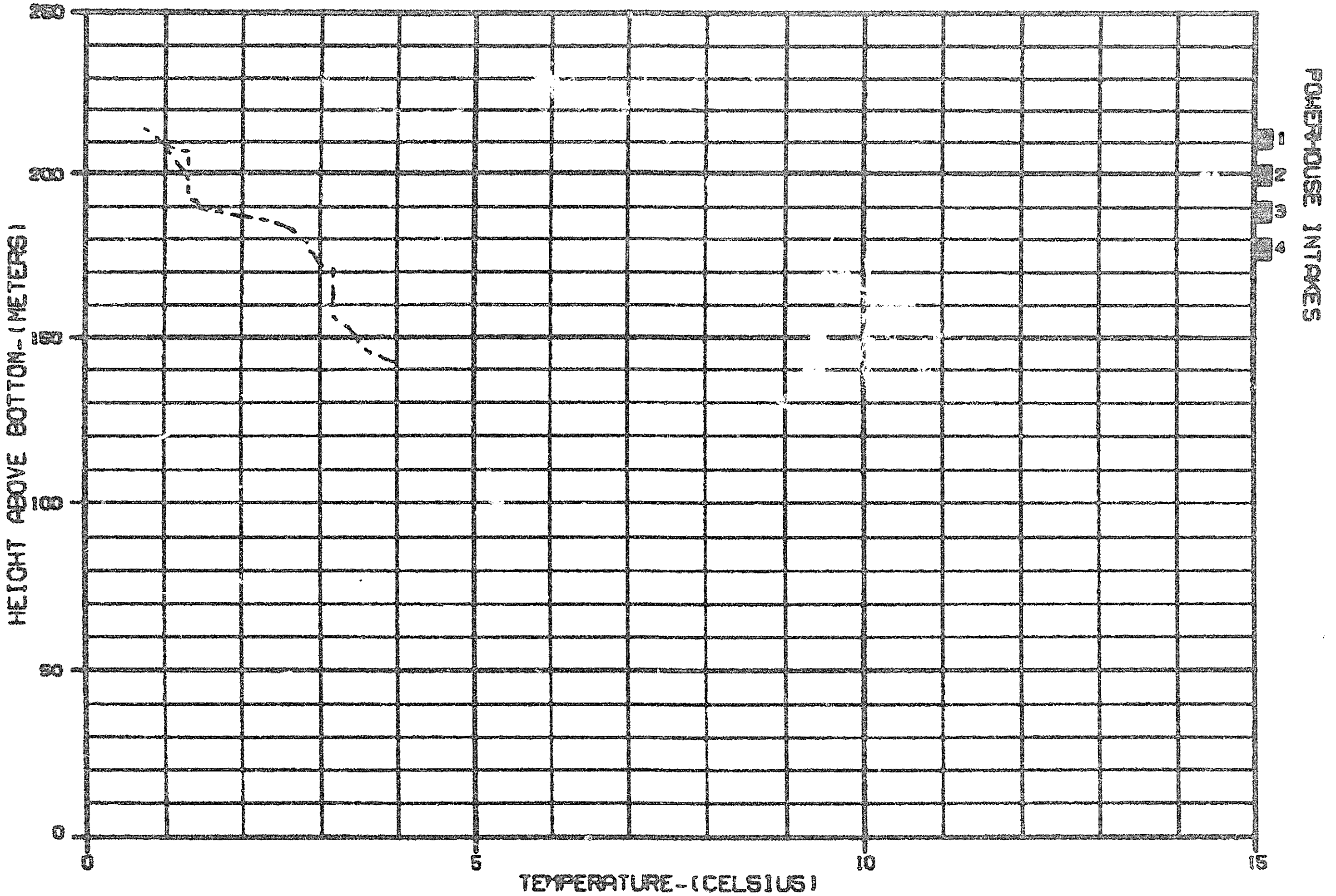
NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 2151 FT (655.6 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE AT ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

ALASKA POWER AUTHORITY

SUSITNA PROJECT

WAT4NA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE



CASE: ** WAB1011 - WATANA OPERATION ALONE IN 2001 ** (E-VI)

LEGEND:

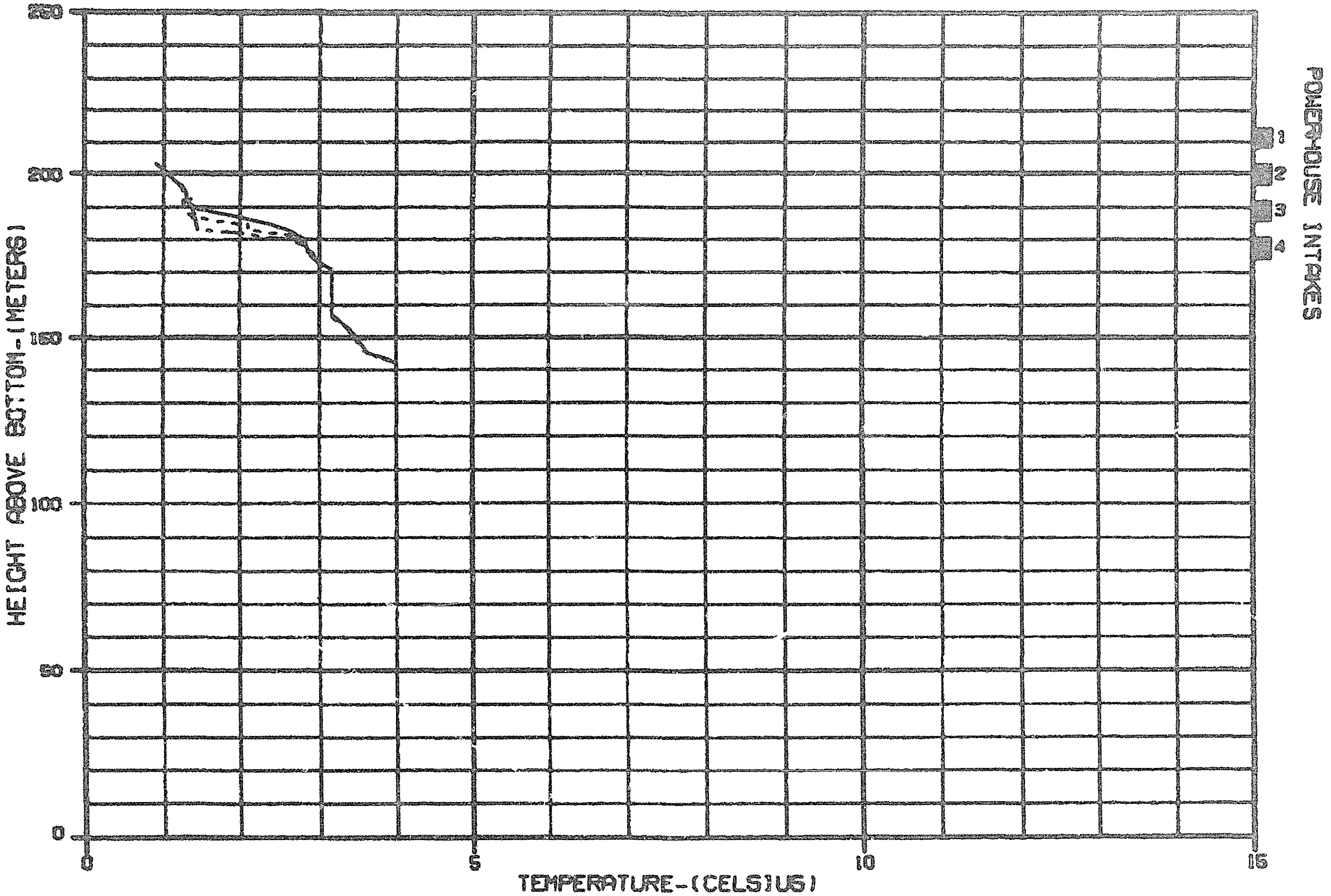
PREDICTED TEMPERATURE PROFILES:

——————— 1 NOVEMBER 1980

- - - - - - - 1 DECEMBER 1980

— - — - — 1 JANUARY 1981

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
WATANA RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
[illegible]	18 JAN 83	42-010-04



CASE: ** WA81011 - WATANA OPERATION ALONE IN 2001 ** (E-VI)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————————	1 FEBRUARY	1981
- - - - - - - -	1 MARCH	1981
— - — - —	1 APRIL	1981

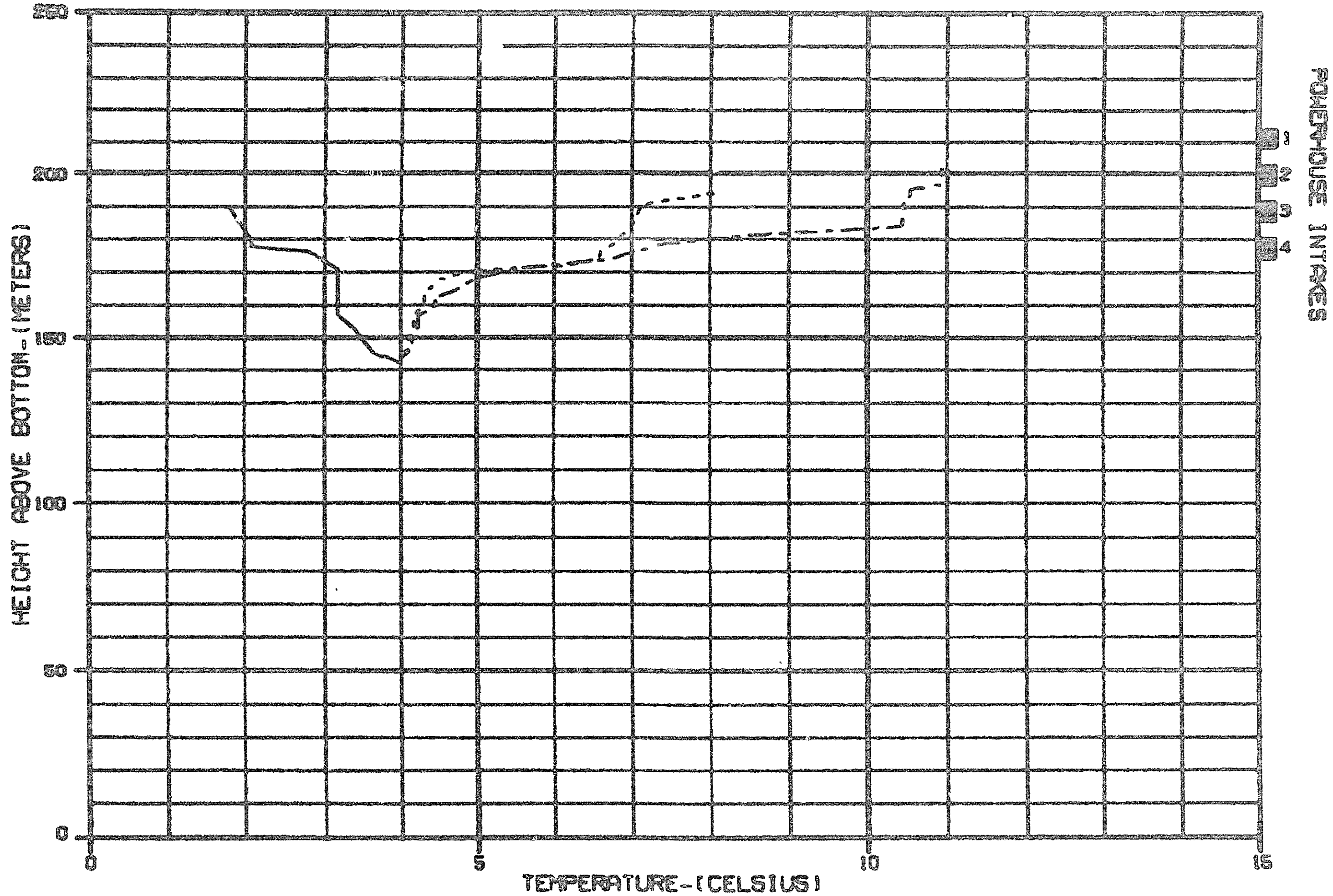
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

[illegible] | [illegible] | 42-010-04



CASE: ** WAB101I - WATANA OPERATION ALONE IN 2001 ** (E-VI)

LEGEND:

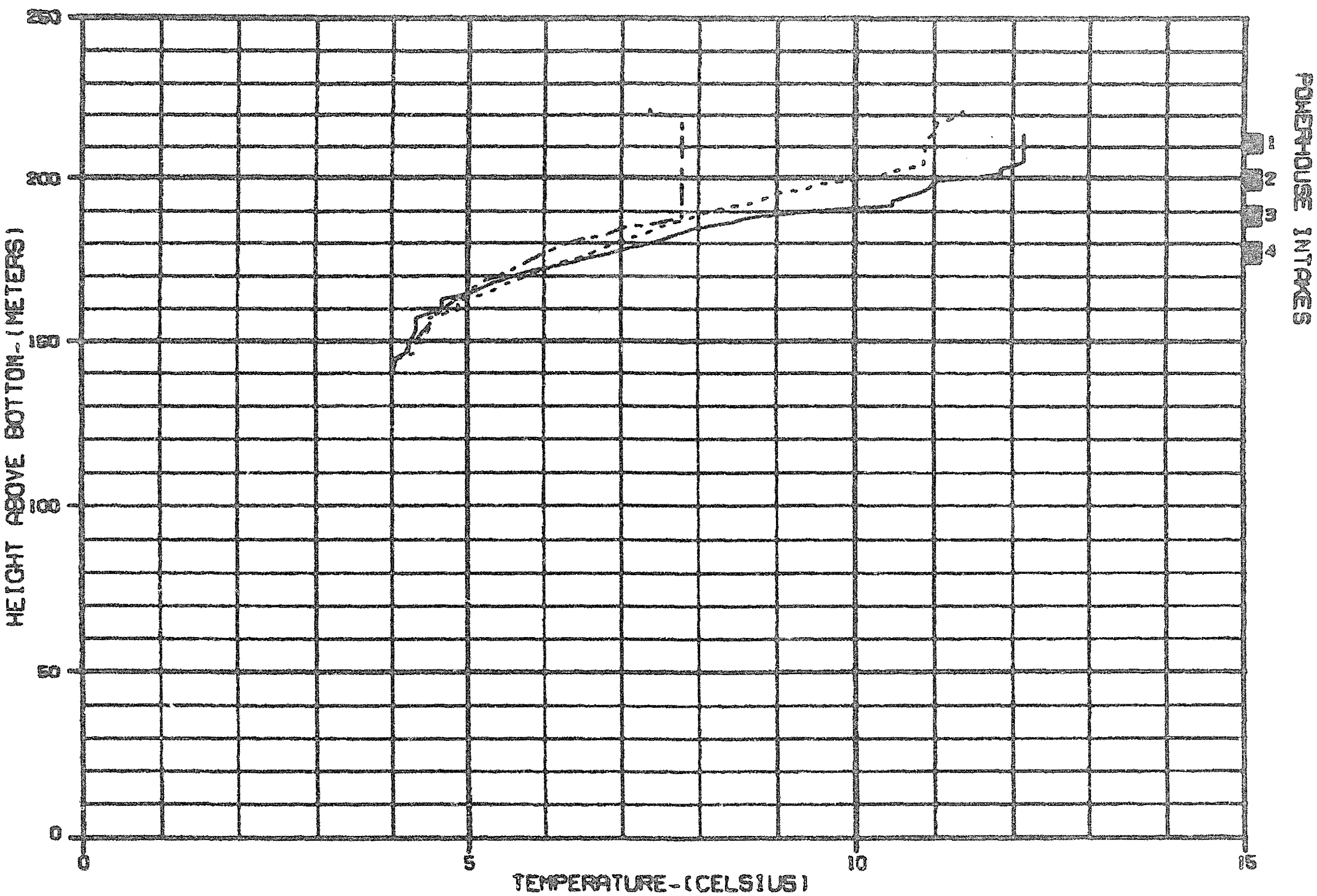
PREDICTED TEMPERATURE PROFILES:

———— 1 MAY 1981

········ 1 JUNE 1981

—·—·— 1 JULY 1981

ALASKA POWER AUTHORITY		
SUSITNA PROJECT	DYRESM MODEL	
WATANA RESERVOIR TEMPERATURE PROFILES		
HARZA-EBASCO JOINT VENTURE		
[illegible]	[illegible]	42-010-04



CASE: ** WAB1011 - WATANA OPERATION ALONE IN 2001 ** (E-VI)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————————	1 AUGUST	1981
- - - - - - - -	1 SEPTEMBER	1981
— - — - —	1 OCTOBER	1981

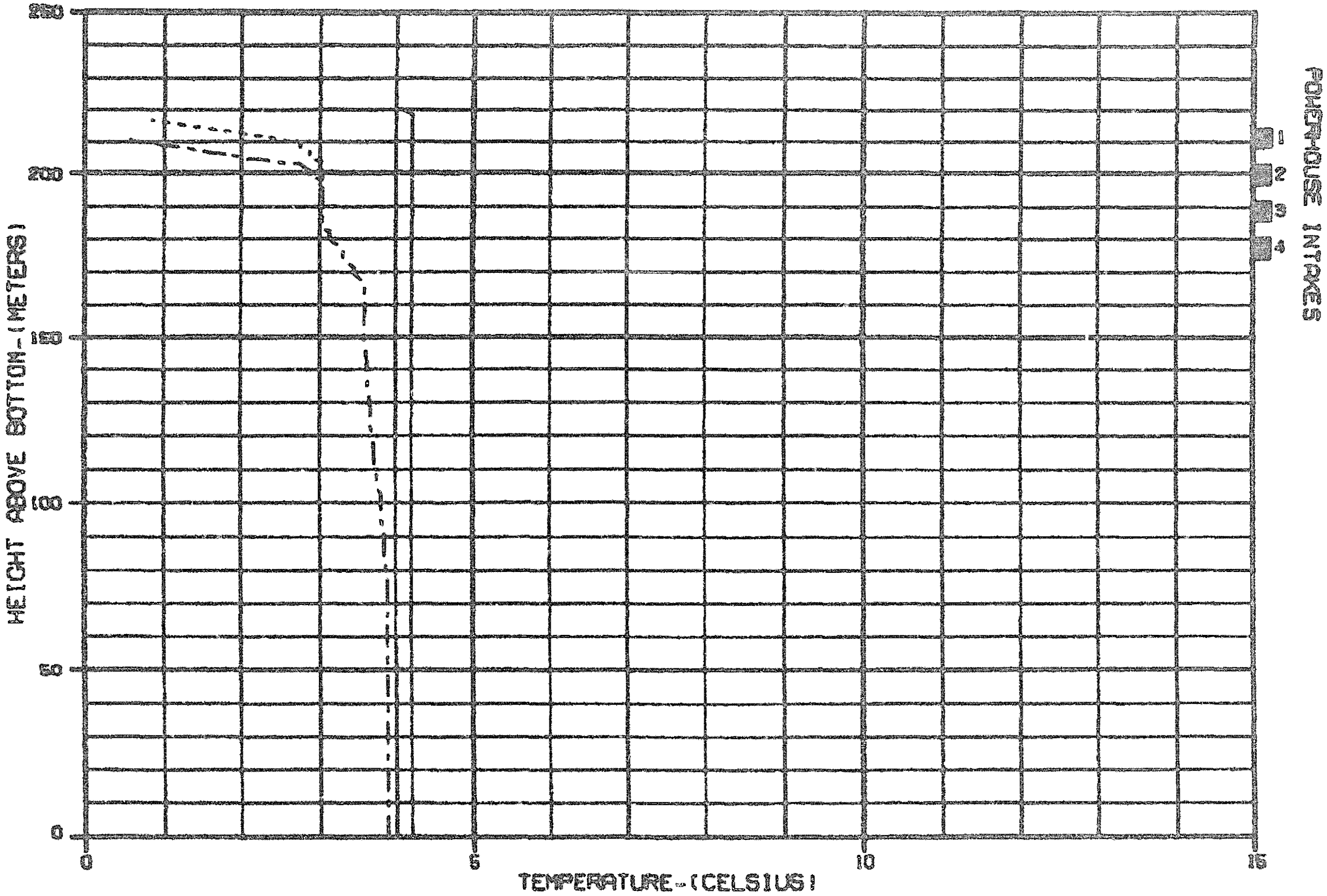
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

[illegible] | [illegible] | 42-010-04



CASE: ** WA8101I - WATANA OPERATION ALONE IN 2001 ** (E-VI)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

- ———————— 1 NOVEMBER 1981
- - - - - - - - - 1 DECEMBER 1981
- — - — - — 1 JANUARY 1982

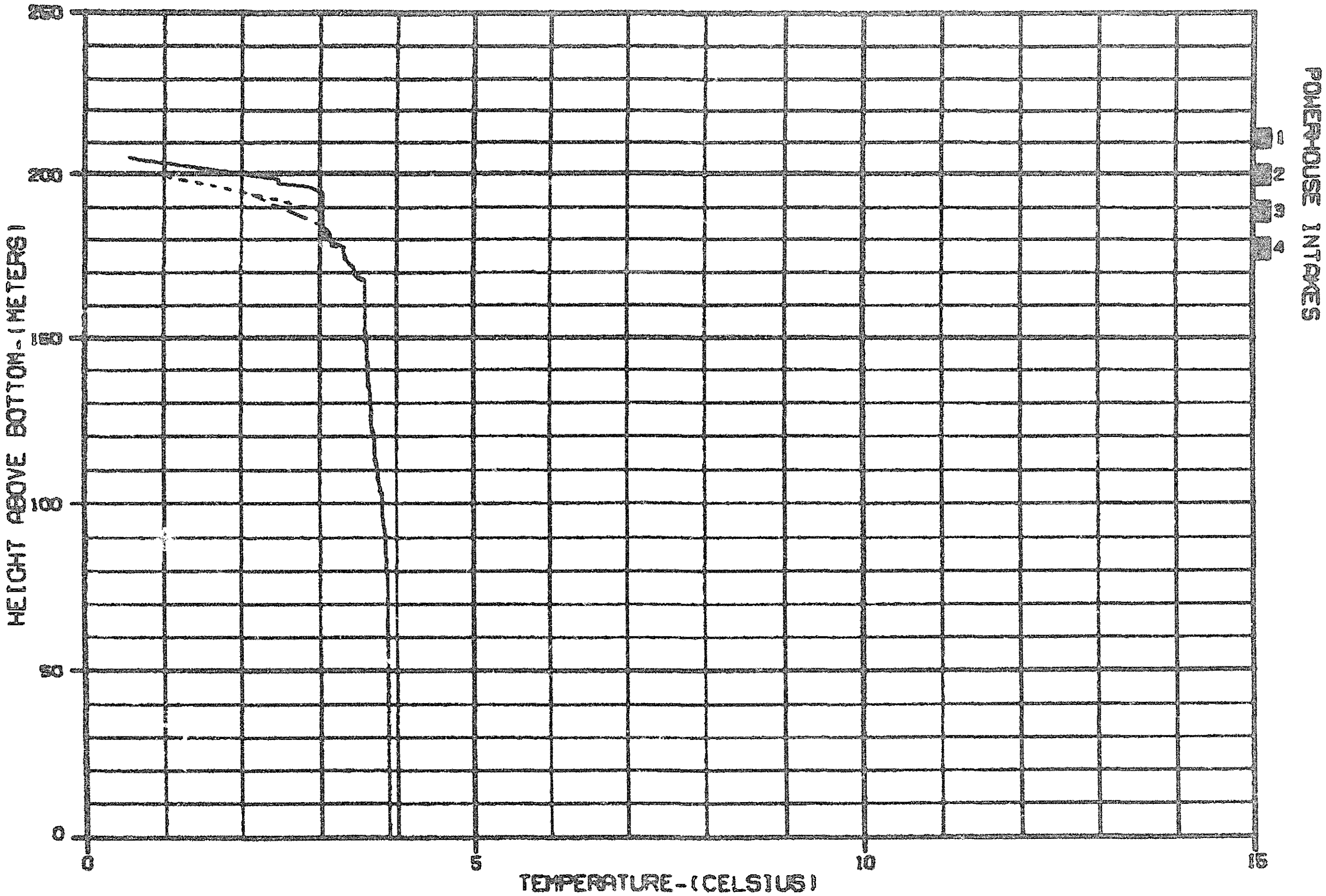
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | [illegible] | 42-010-04



CASE: ** WAB1011 - WATANA OPERATION ALONE IN 2001 ** (E-VI)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

——————— 1 FEBRUARY 1982

- - - - - - - 1 MARCH 1982

— - — - — 1 APRIL 1982

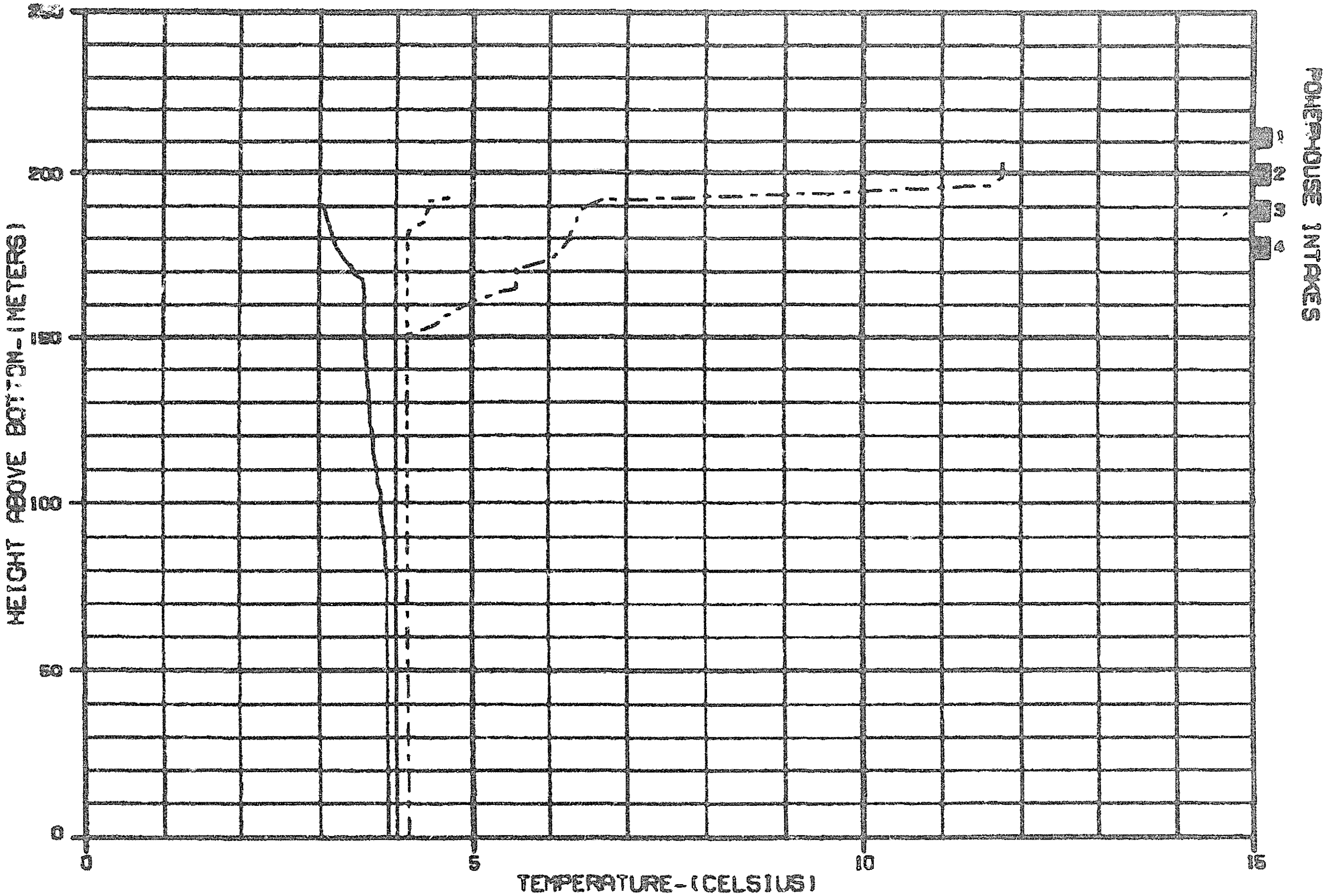
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

42-010-04



CASE: ** WAB1011 - WATANA OPERATION ALONE IN 2001 ** (E-VI)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

- ——————— 1 MAY 1982
- - - - - - - - 1 JUNE 1982
- — · — · — 1 JULY 1982

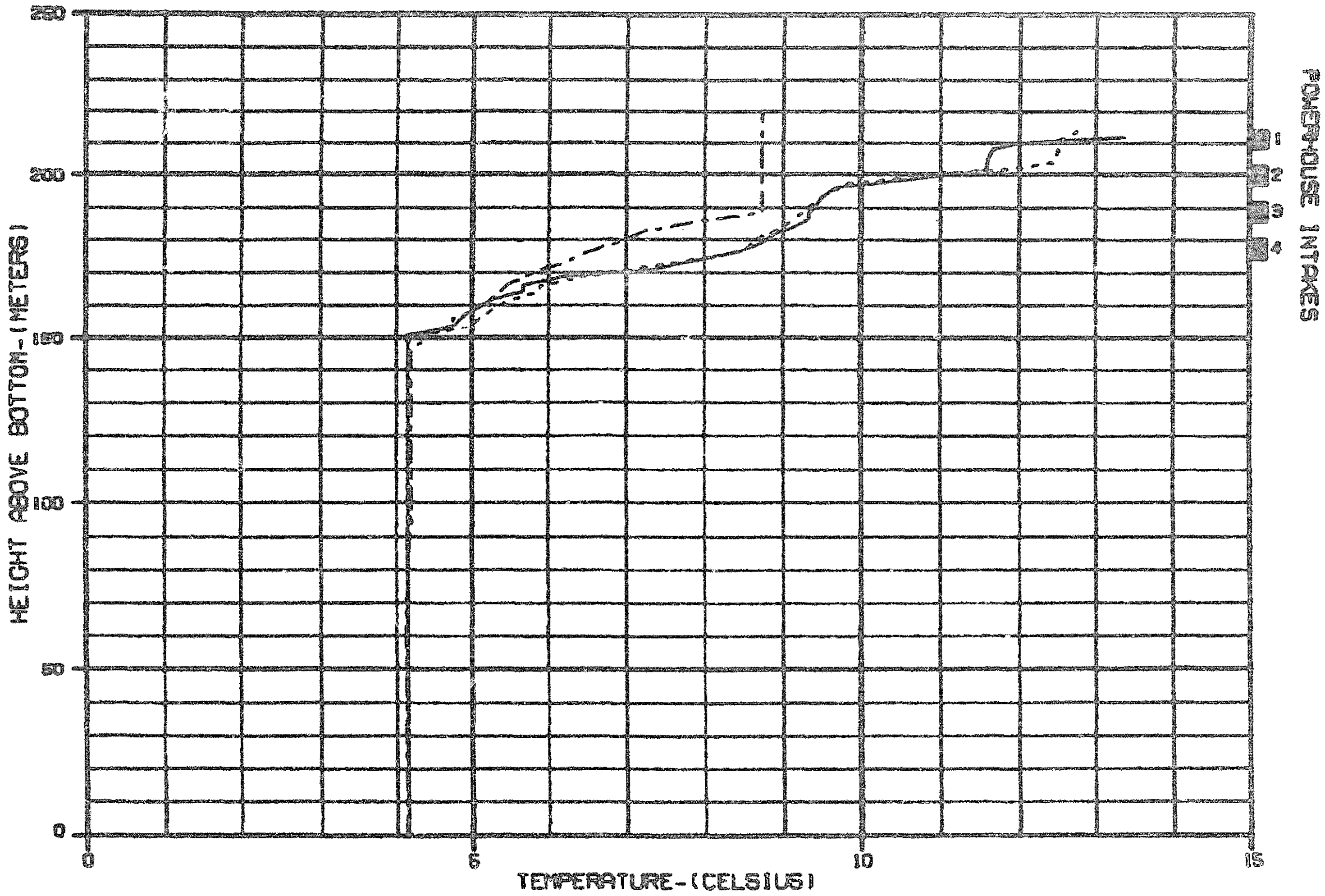
ALASKA POWER AUTHORITY

SUSITNA PROJECT | [illegible]

WATANA RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

[illegible] | [illegible] | [illegible]



CASE: ** WAB1011 - WATANA OPERATION ALONE IN 2001 ** (E-VI)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 AUGUST 1982
- - - - - -	1 SEPTEMBER 1982
— · — · —	1 OCTOBER 1982

ALASKA POWER AUTHORITY

SUSITNA PROJECT | [illegible]

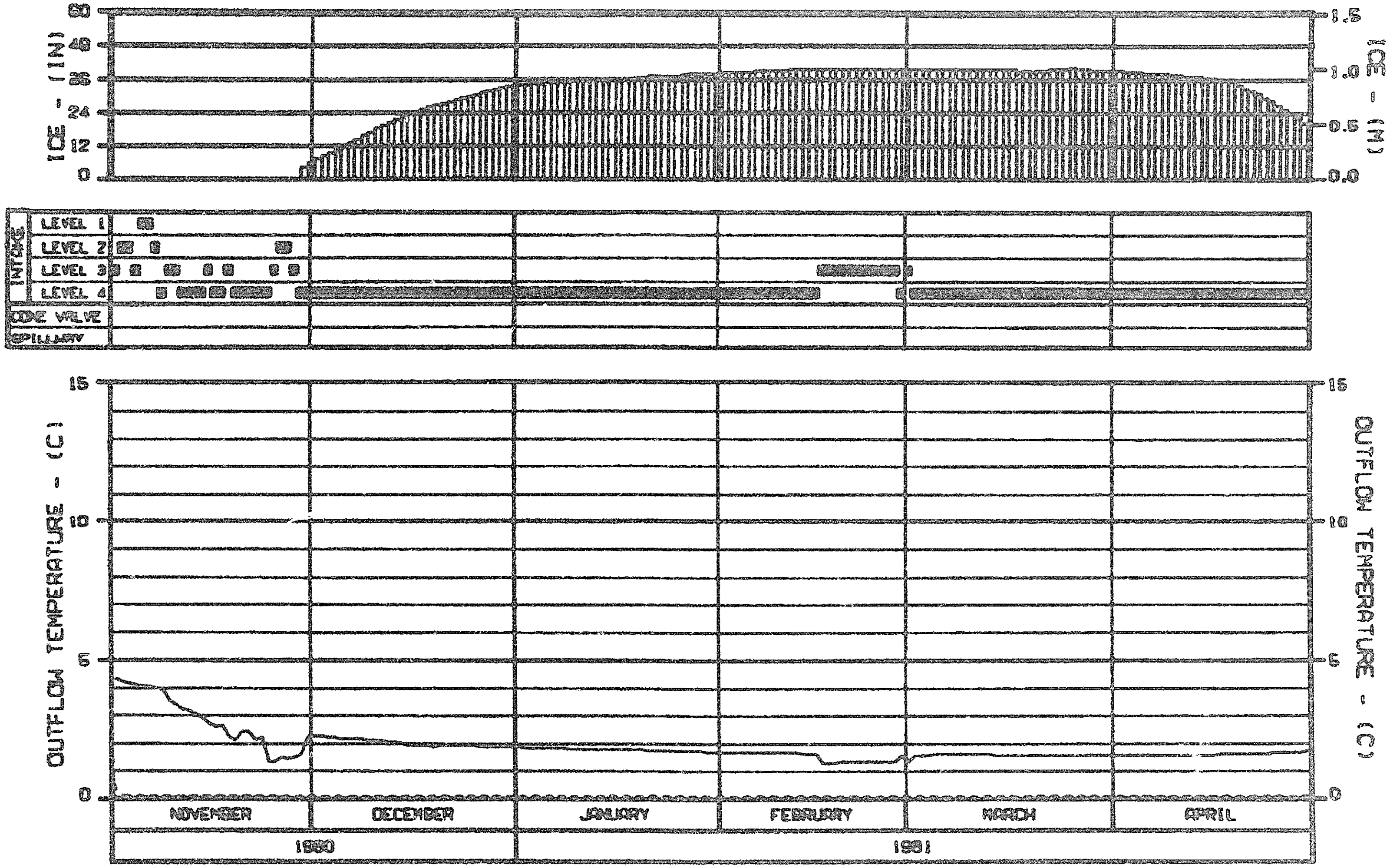
WATANA RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

[illegible] | [illegible] | [illegible]

EXHIBIT B

CASE E-VI
STAGE I
TWO-STAGE PROJECT
WARMEST POSSIBLE OUTFLOW



LEGEND: CASE: WA8101J - WATANA OPERATION ALONE IN 2001 (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)
———— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 2151 FT (655.6 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE AT ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

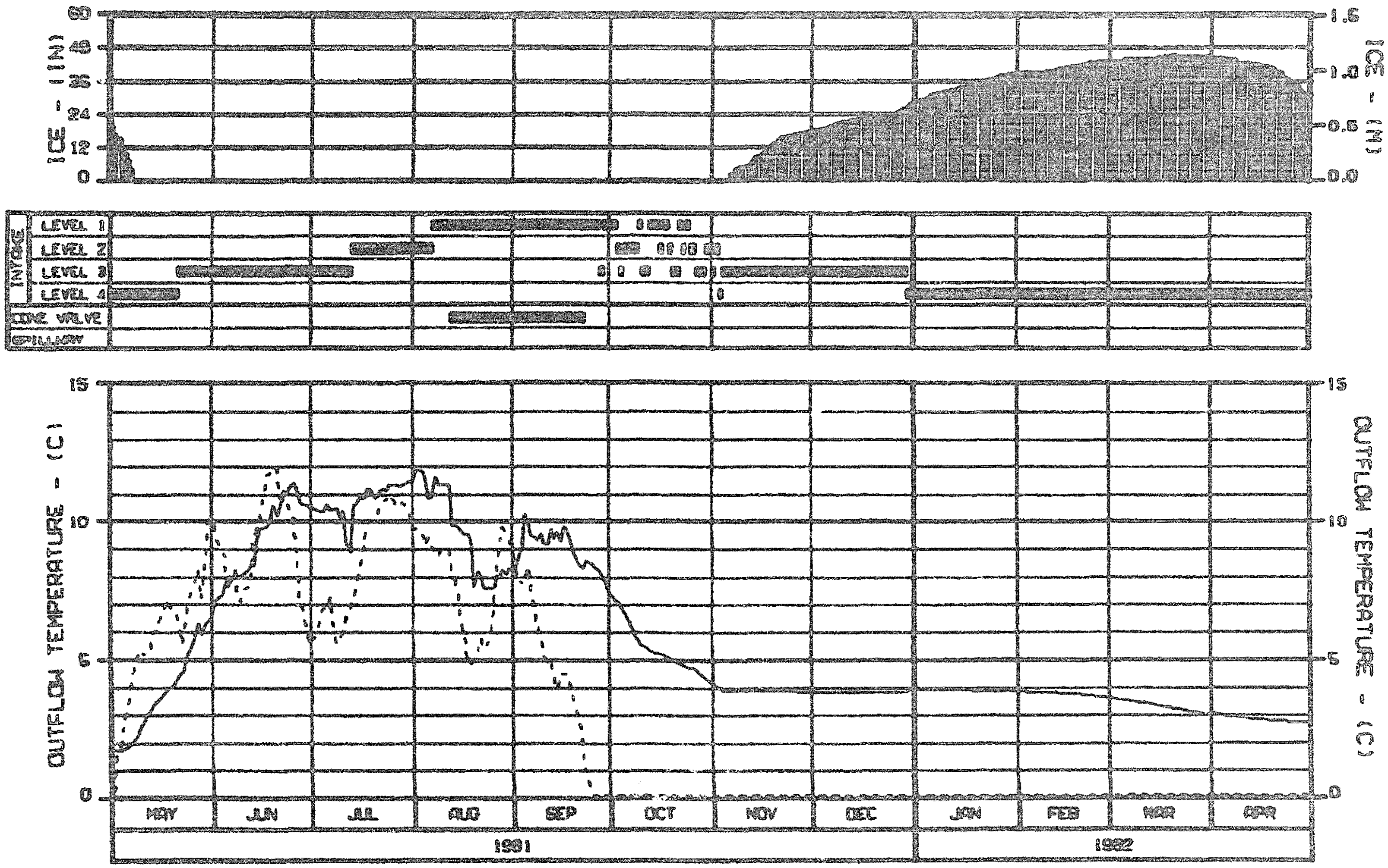
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 18 JAN 85 | 42-010-04



LEGEND: CASE: WA8101J - WATANA OPERATION ALONE IN 2001 (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)

———— PREDICTED OUTFLOW TEMPERATURE

- - - - - - - INFLOW TEMPERATURE

NOTES: 1. INTAKE PORT LEVEL 1 AT ELEVATION 2181 FT (665.6 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE AT ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

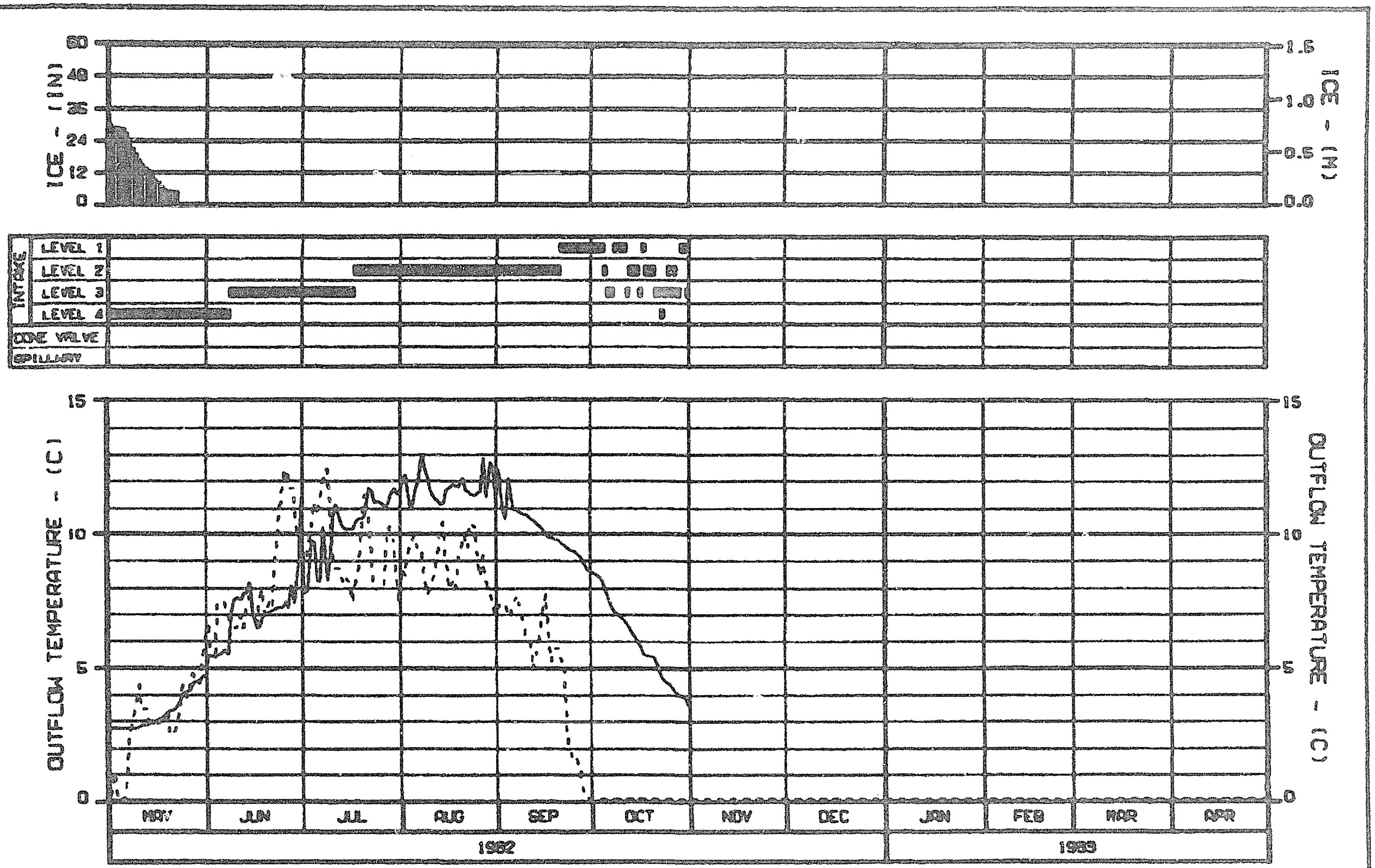
ALASKA POWER AUTHORITY

SUSITNA PROJECT | [illegible]

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

[illegible] | [illegible] | 42-010-04



LEGEND: CASE: ** WAS101J - WATANA OPERATION ALONE IN 2001 ** (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)
———— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 2151 FT (655.6 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE AT ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

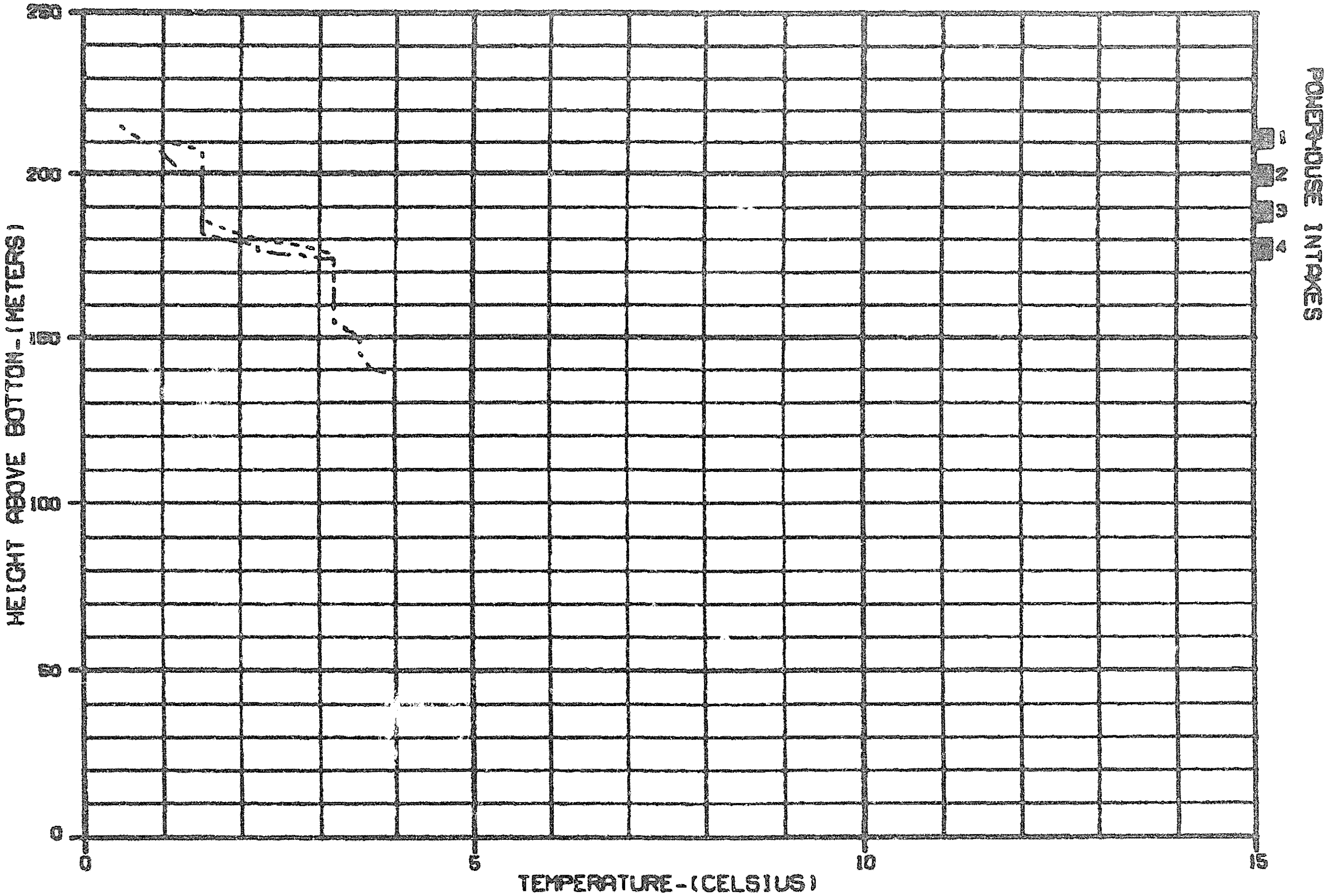
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 18 JAN 83 | 42-010-04



CASE: ** WA8101J - WATANA OPERATION ALONE IN 2001 ** (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

———— 1 NOVEMBER 1980
- - - - - - - - 1 DECEMBER 1980
—·—·— 1 JANUARY 1981

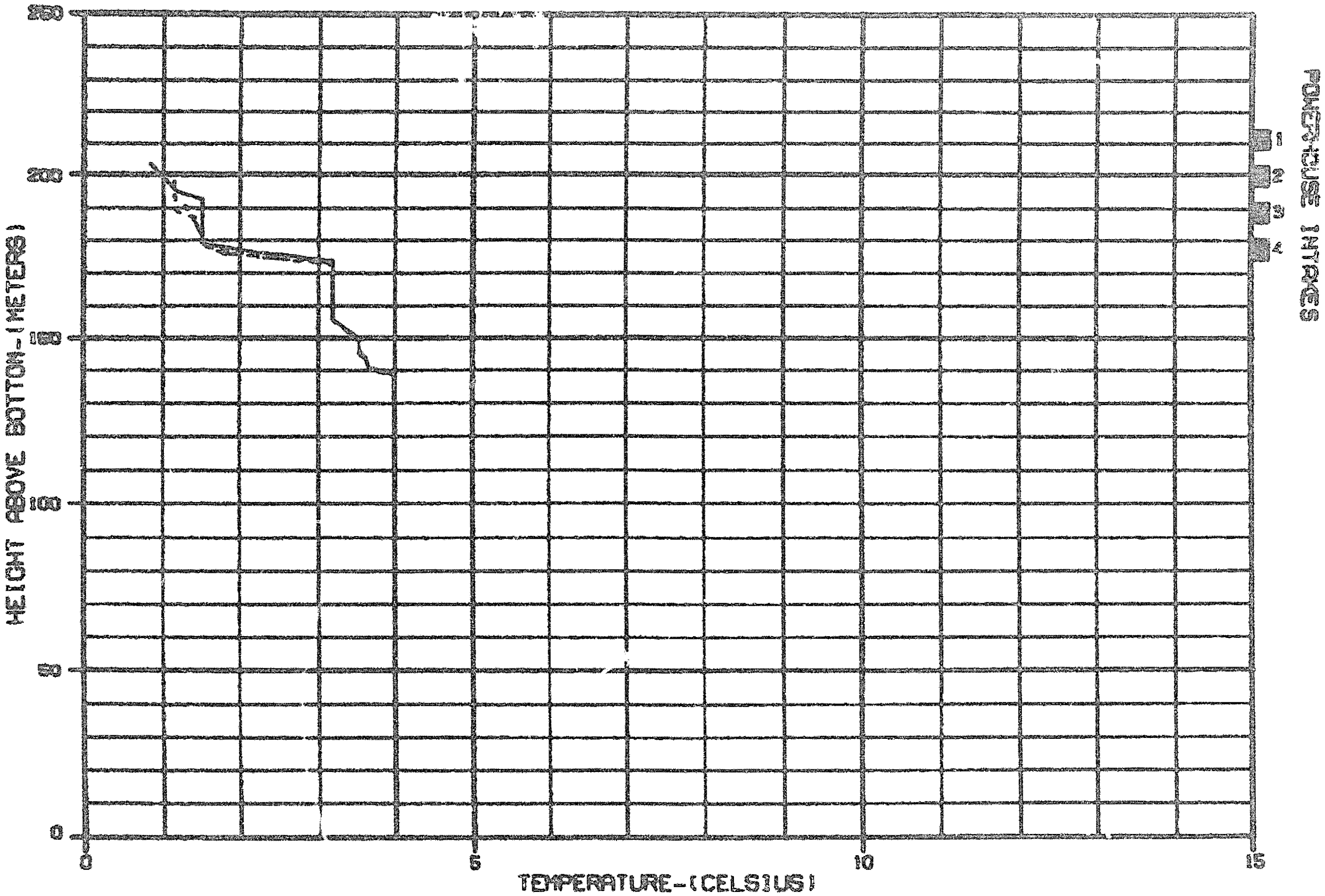
ALASKA POWER AUTHORITY

SUSITNA PROJECT | [illegible]

WATANA RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

[illegible] | [illegible] | [illegible]-010-04



CASE: WA8101J - WATANA OPERATION ALONE IN 2001 (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

- ———— 1 FEBRUARY 1981
- - - - - - 1 MARCH 1981
- — - — - 1 APRIL 1981

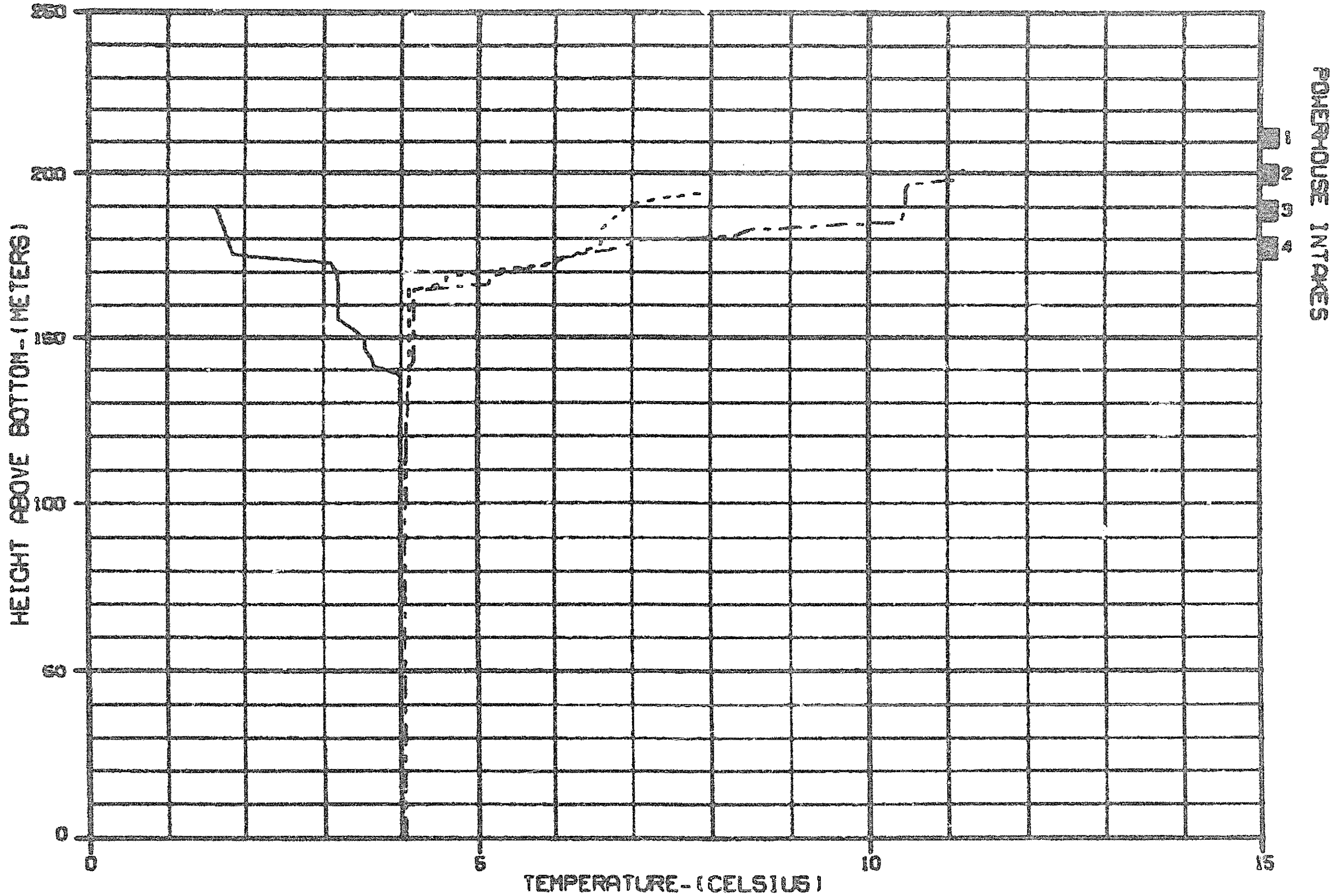
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

[illegible] | [illegible] | 42-010-04



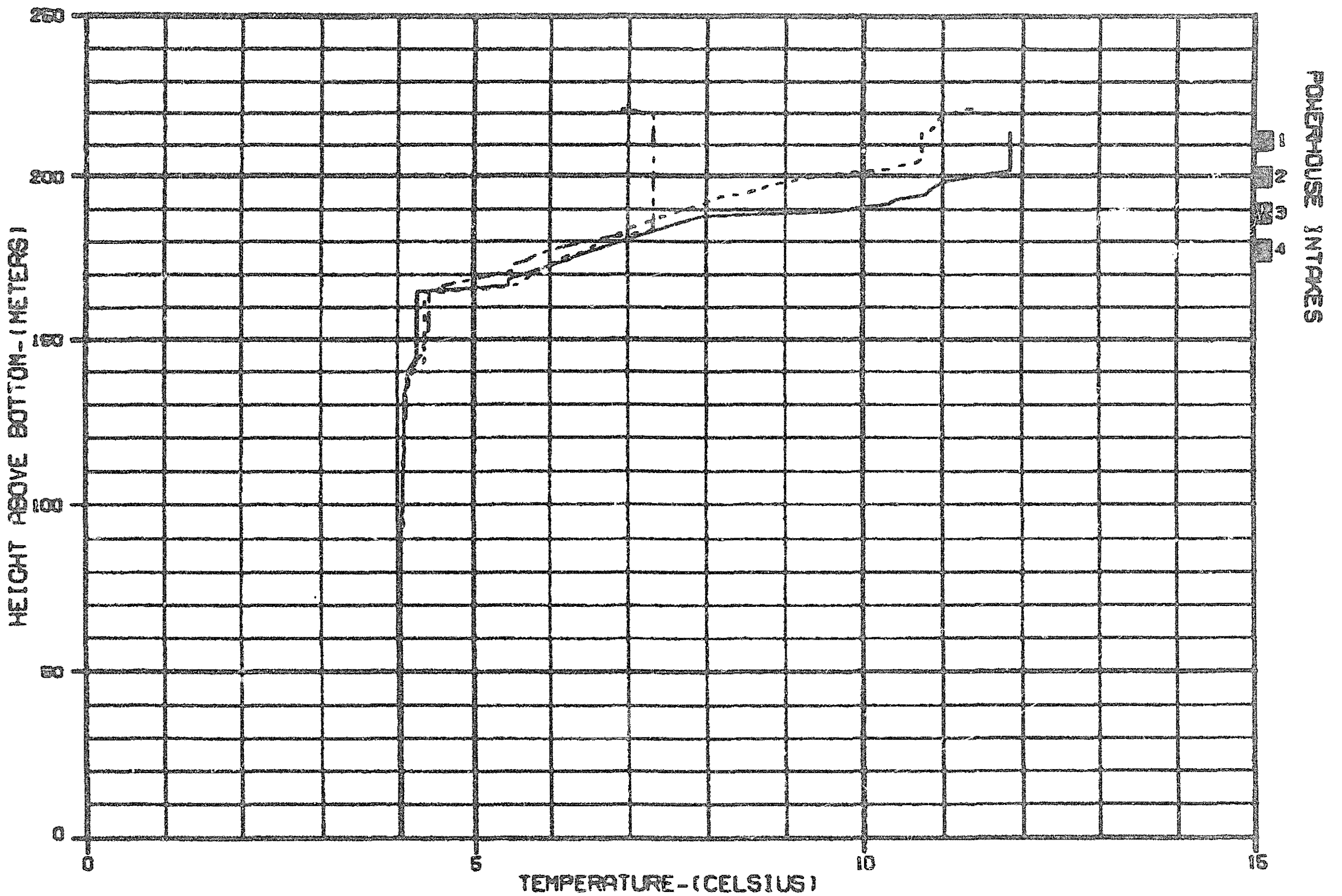
CASE: ** WA8101J - WATANA OPERATION ALONE IN 2001 ** (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

———— 1 MAY 1981
-------- 1 JUNE 1981
—-—-— 1 JULY 1981

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
WATANA RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
[illegible]	42-010-04



CASE: ** WA8101J - WATANA OPERATION ALONE IN 2001 ** (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————————	1 AUGUST	1981
- - - - - - - -	1 SEPTEMBER	1981
— - — - —	1 OCTOBER	1981

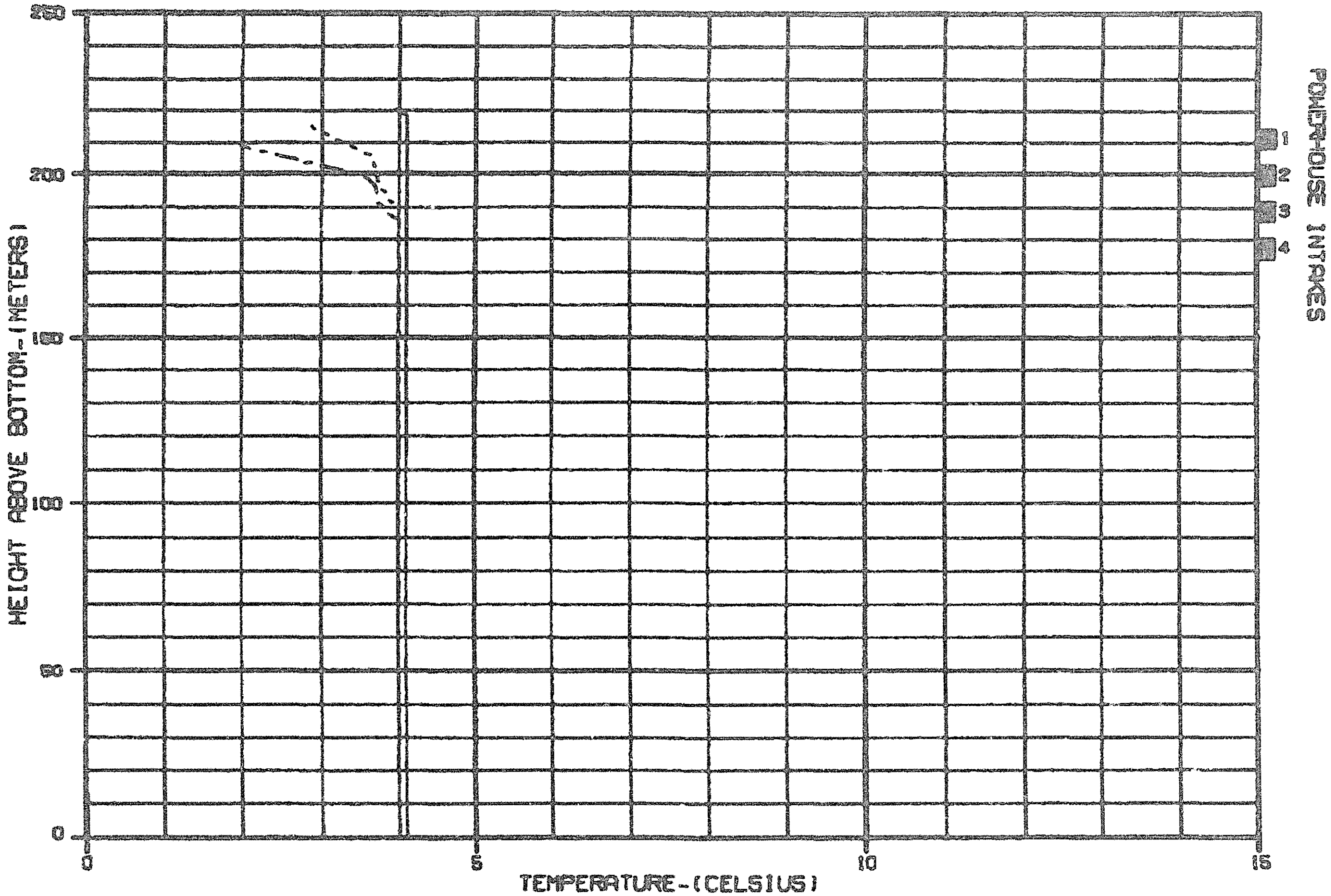
ALASKA POWER AUTHORITY

SUSITNA PROJECT | [illegible]

WATANA RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

[illegible] | [illegible] | 42-010-04



CASE: ** WAB101J - WATANA OPERATION ALONE IN 2001 ** (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

———— 1 NOVEMBER 1981
- - - - - - - 1 DECEMBER 1981
— - — - — 1 JANUARY 1982

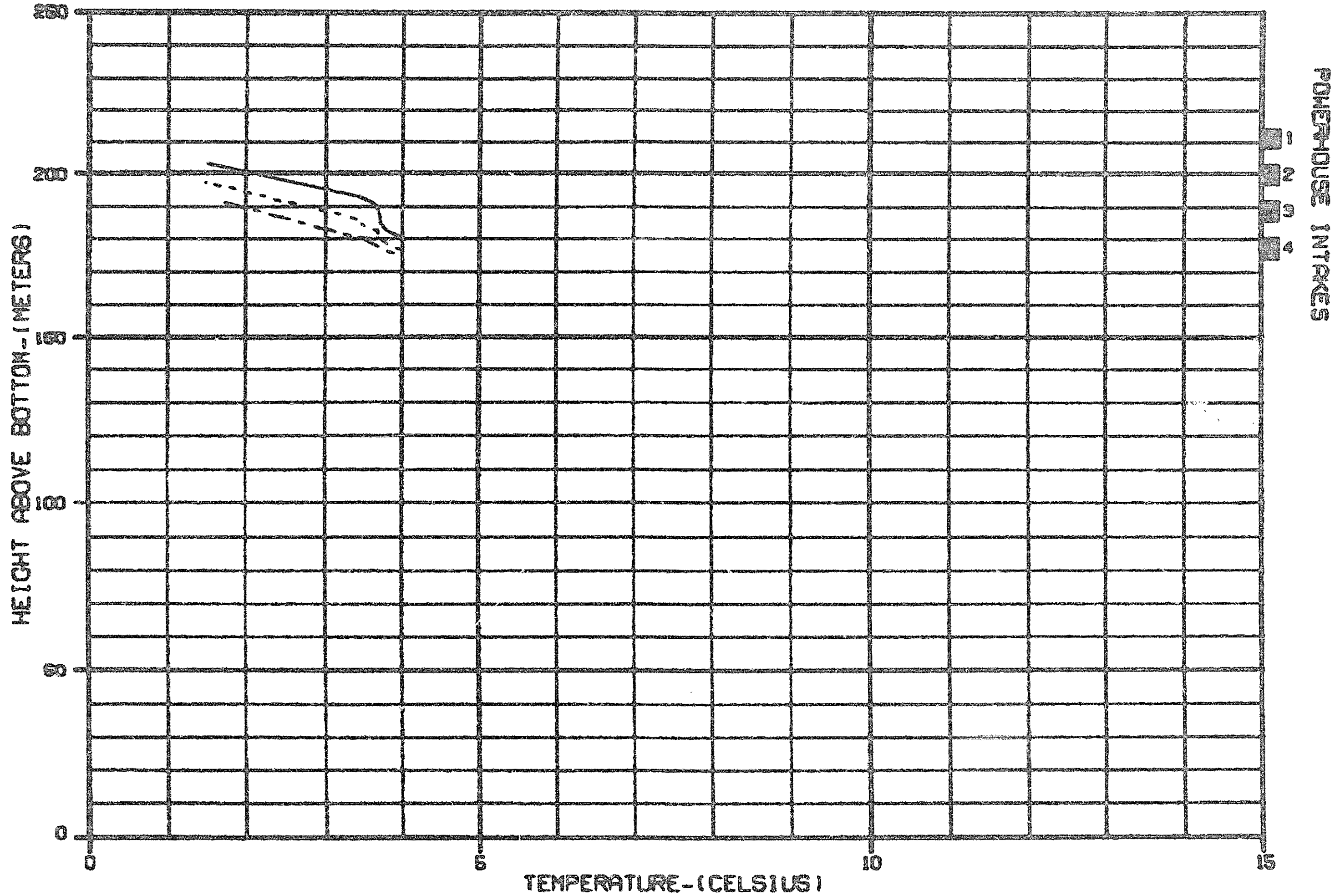
ALASKA POWER AUTHORITY

SUSITNA PROJECT | OXYGEN MODEL

WATANA RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 18 JAN 83 | 42-010-04



CASE: ** WA8101J - WATANA OPERATION ALONE IN 2001 ** (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

———— 1 FEBRUARY 1982
- - - - - - 1 MARCH 1982
— - — - — 1 APRIL 1982

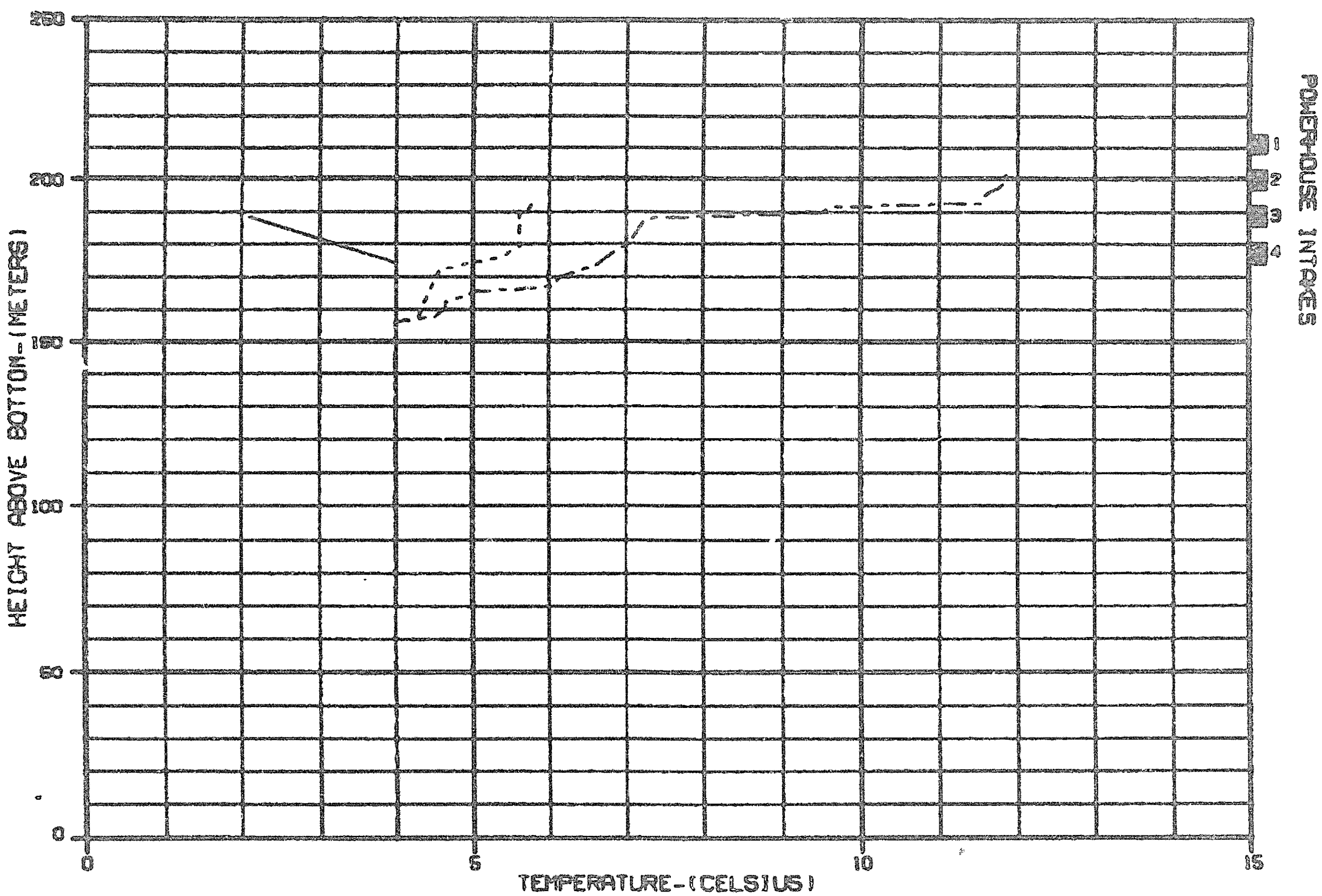
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

42-010-04



CASE: ** WA8101J - WATANA OPERATION ALONE IN 2001 ** (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

———————	1 MAY 1982
- - - - - - -	1 JUNE 1982
— - — - —	1 JULY 1982

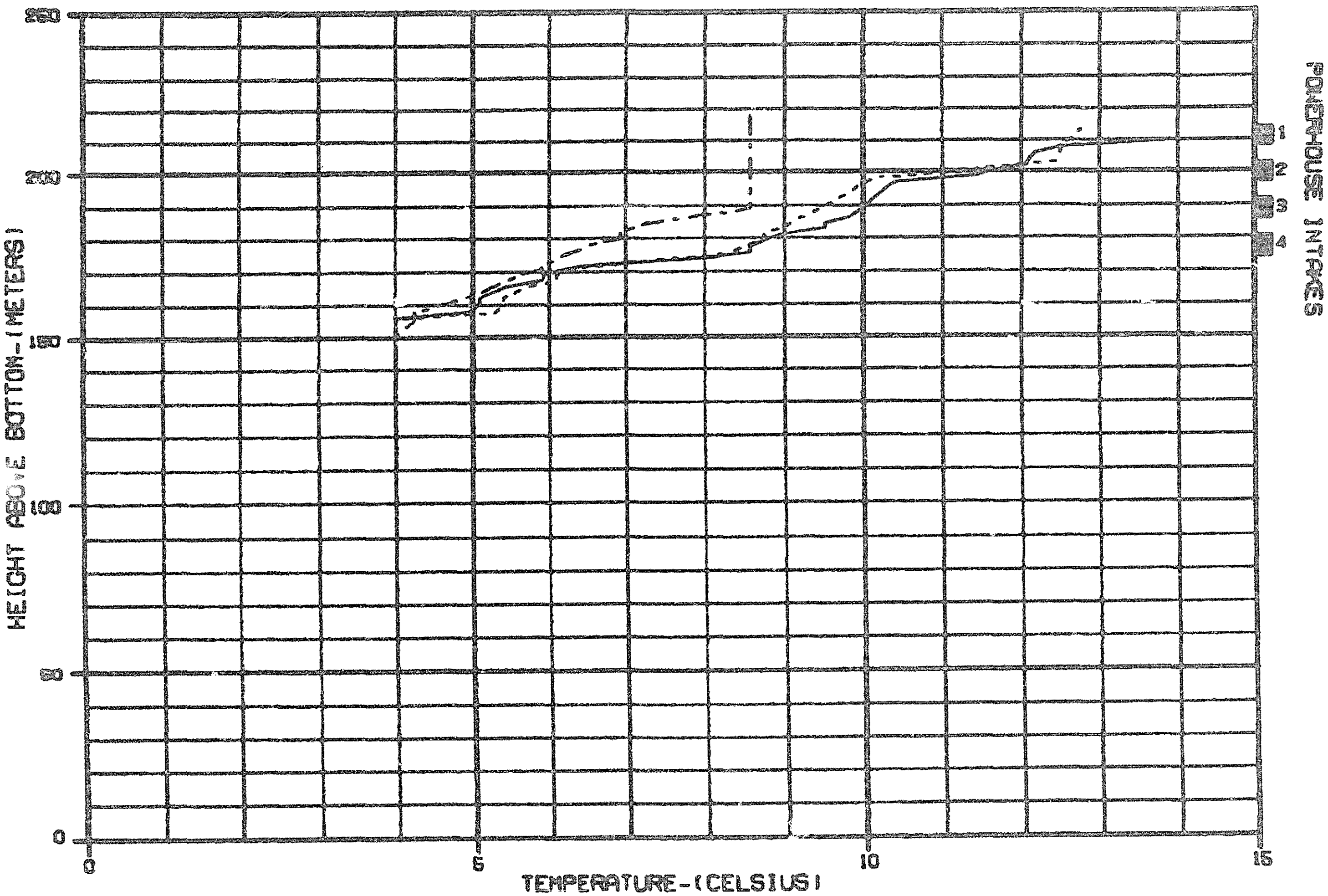
ALASKA POWER AUTHORITY

SUSITNA PROJECT | [illegible]

WATANA RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

[illegible] | [illegible] | [illegible]



CASE: ** WA8101J - WATANA OPERATION ALONE IN 2001 ** (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)

LEGEND:

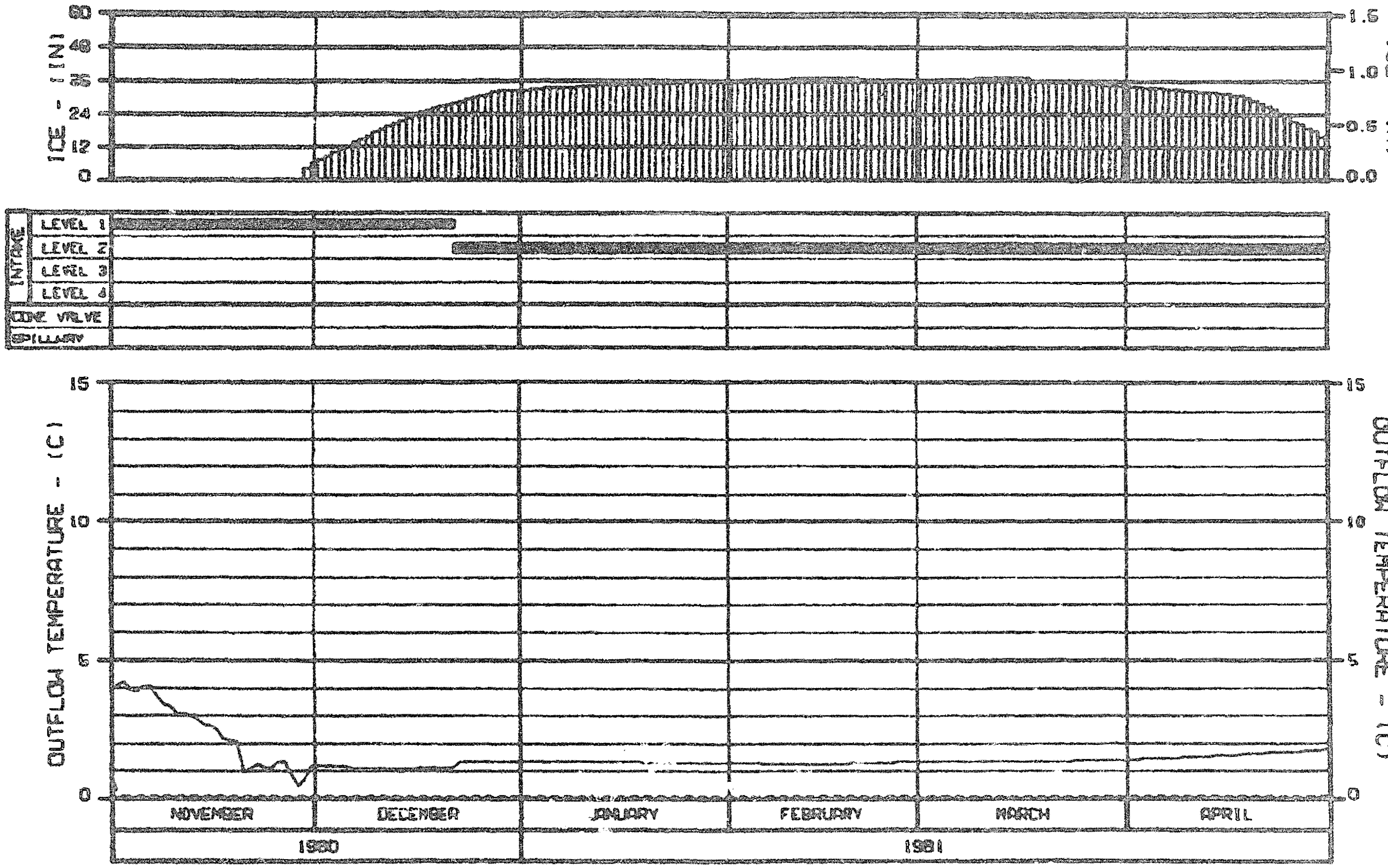
PREDICTED TEMPERATURE PROFILES:

- ———— 1 AUGUST 1982
- - - - - - 1 SEPTEMBER 1982
- —·—·— 1 OCTOBER 1982

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
WATANA RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
[illegible]	[illegible]

EXHIBIT C

CASE E-VI
STAGE II
TWO-STAGE PROJECT
INFLOW TEMPERATURE MATCHING



LEGEND: CASE: WAB102J - WATANA OPERATION W/DEVIL CANYON IN 2002 (E-VI)

——————— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 2181 FT (665.6 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2114 FT (644.2 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE AT ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

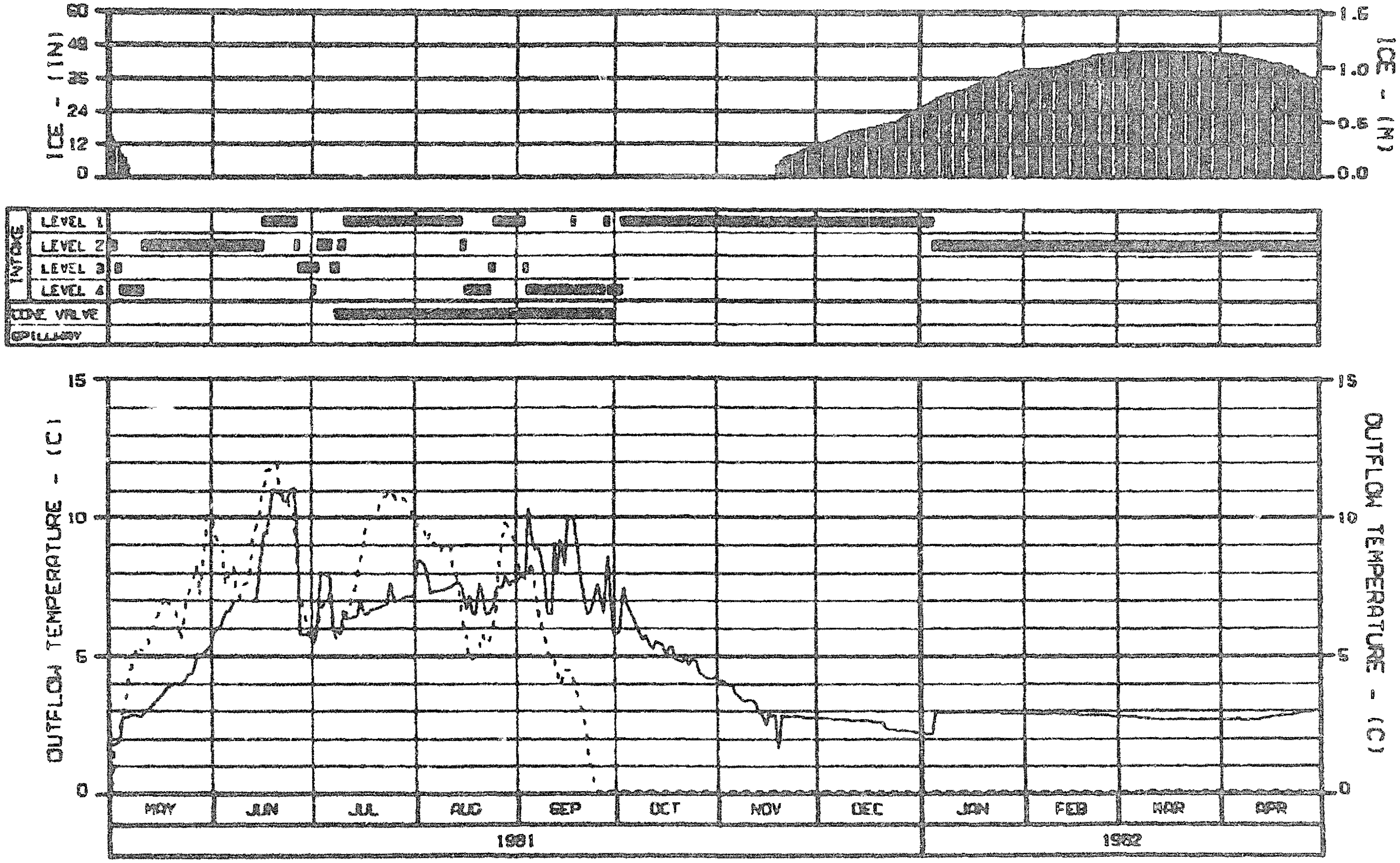
ALASKA POWER AUTHORITY

SUSITNA PROJECT | STREAM MODEL

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

42-010-04

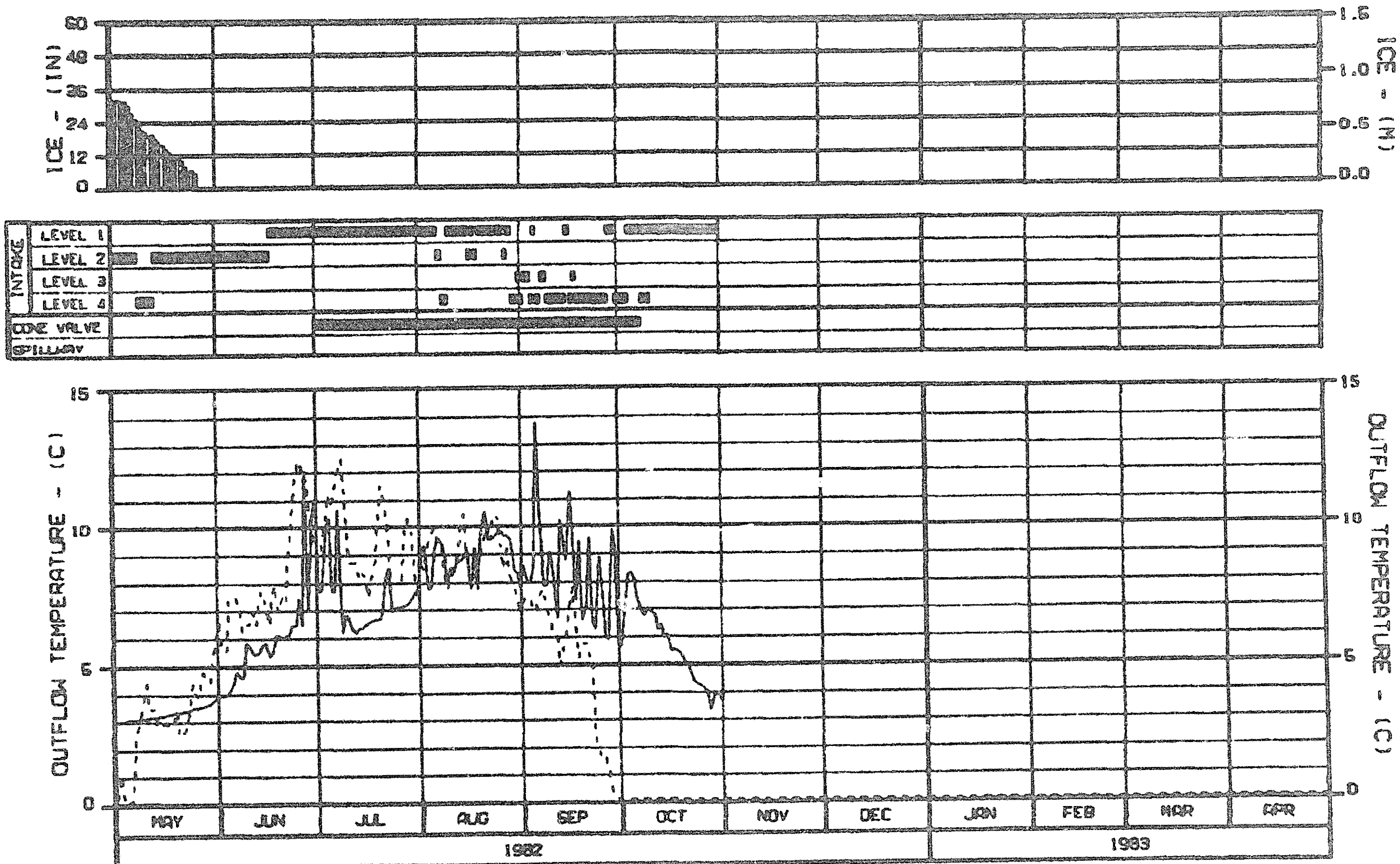


LEGEND: CASE: ** WA8102J - WATANA OPERATION W/DEVIL CANYON IN 2002 ** (E-VI)

———— PREDICTED OUTFLOW TEMPERATURE
- - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 2161 FT (665.6 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE AT ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
WATANA RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH	
HARZA-EBASCO JOINT VENTURE	
CHECKED: ALL PORTS / 03 JAN 85	42-010-04



LEGEND: CASE: ** WAB102J - WATANA OPERATION W/DEVIL CANYON IN 2002 ** (E-VI)

———— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 2161 FT (658.6 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE AT ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

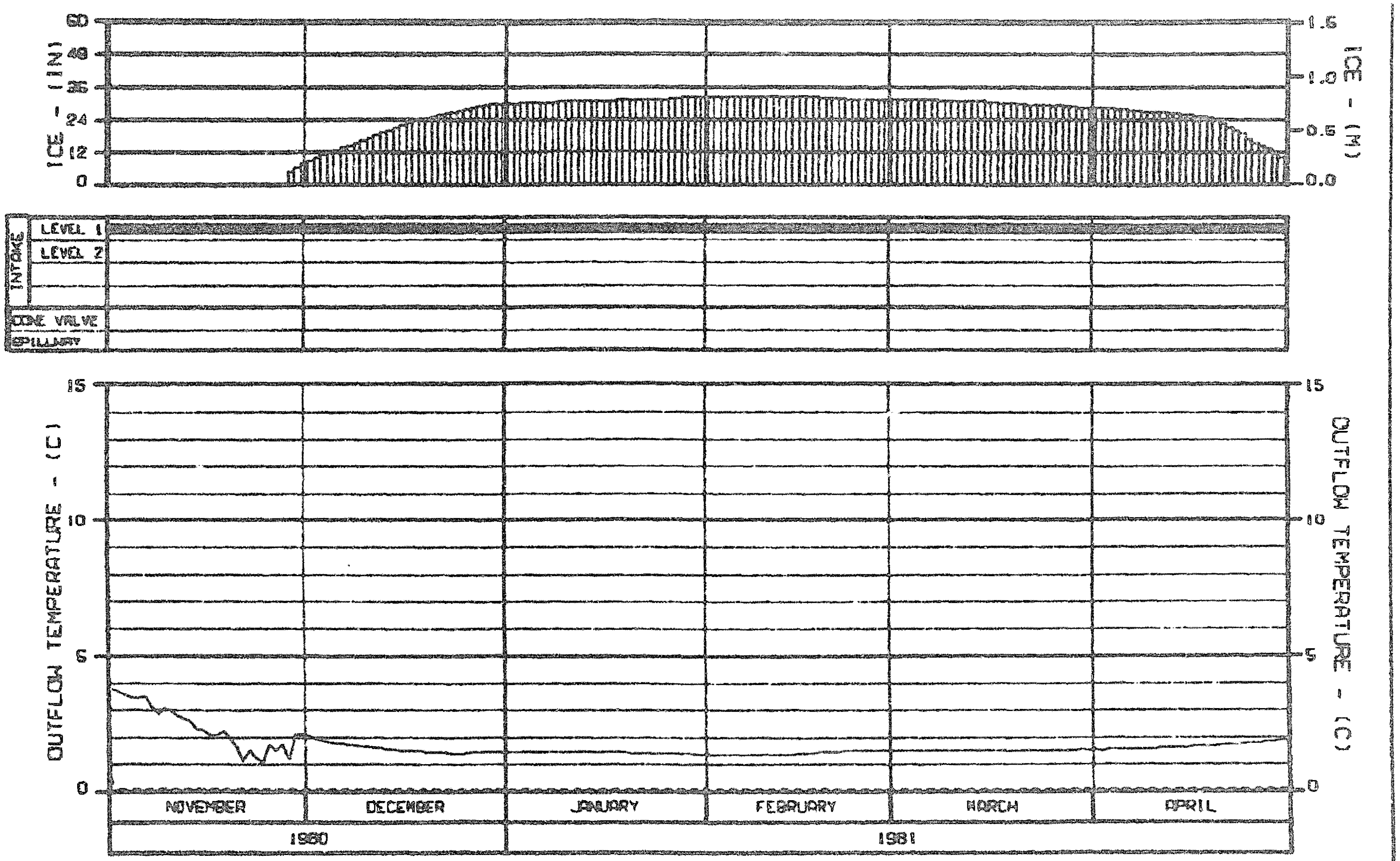
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

CHECKED. ALPOTO | 18 JUN 85 | 42-010-04

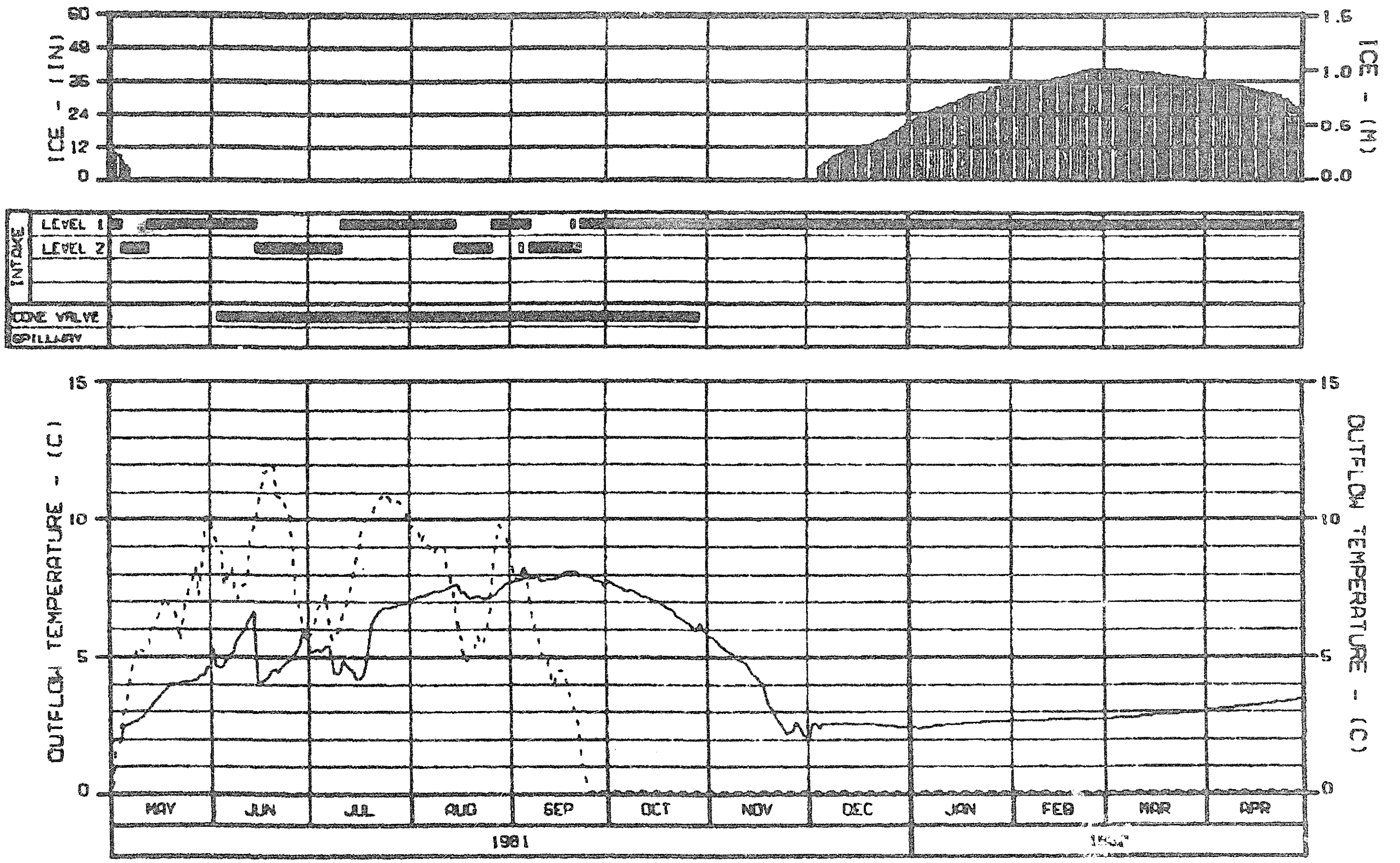


LEGEND: CASE: ** DC8102J - DEVIL CANYON OPERATION W/WATANA IN 2002 ** (E-VI)

——————— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES: 1. INTAKE PORT LEVEL 1 AT ELEVATION 1425 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1375 FT (419.10 M)
3. CONE VALVE AT ELEVATION 990 FT (301.75 M)
4. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
DEVIL CANYON RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH	
HARZA-EBASCO JOINT VENTURE	
CHICAGO, ILLINOIS 20 JAN 83	42-510-04



LEGEND: CASE: DC8102J - DEVIL CANYON OPERATION W/WATANA IN 2002 (E-VI)

———— PREDICTED OUTFLOW TEMPERATURE *Inflow Temp Matching*
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 1425 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1376 FT (419.10 M)
3. CONE VALVE AT ELEVATION 990 FT (301.75 M)
4. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)

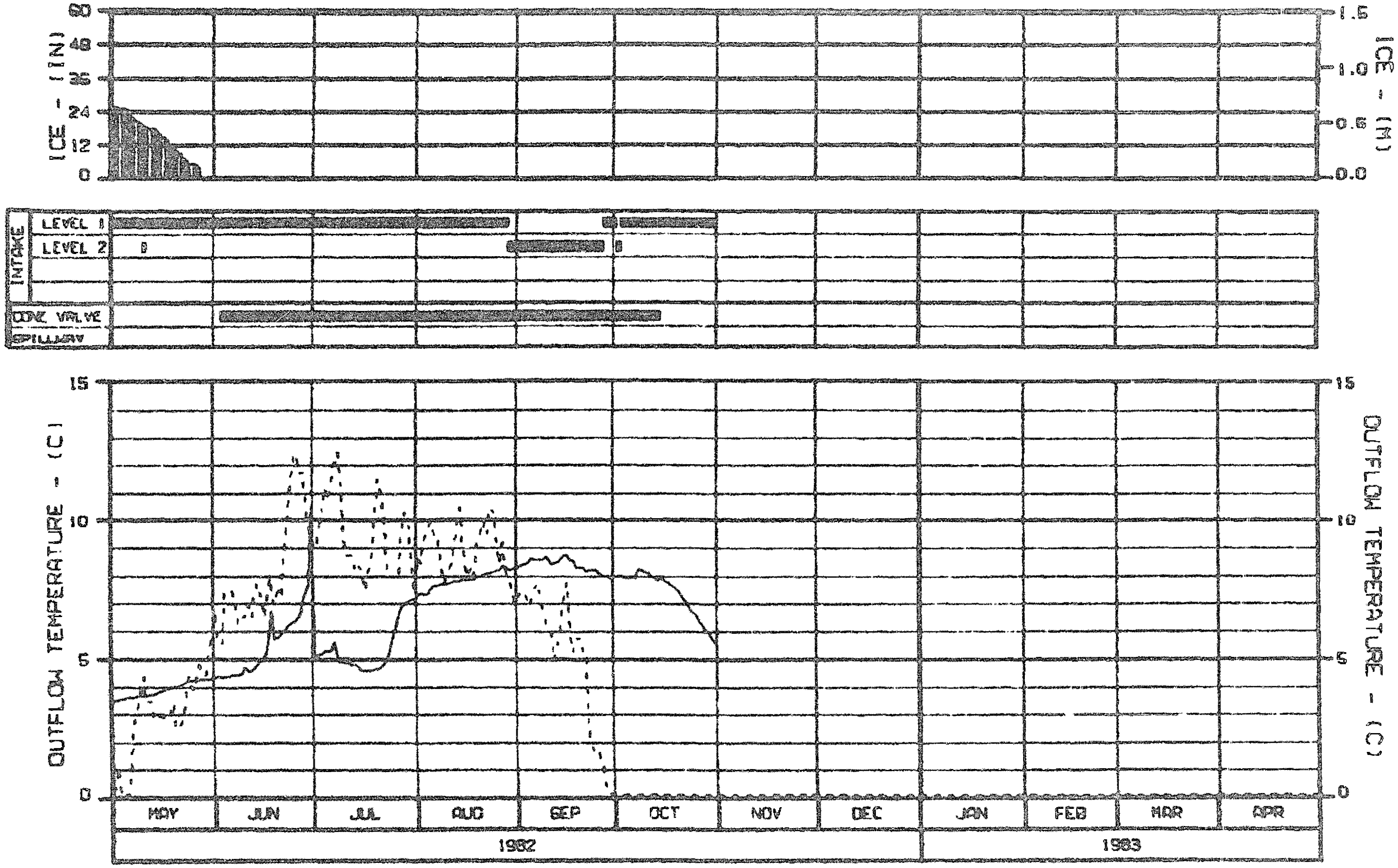
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 20 JAN 83 | 42-010-04



LEGEND: CASE: ** DC8102J - DEVIL CANYON OPERATION W/WATANA IN 2002 ** (E-VI)

———— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES: 1. INTAKE PORT LEVEL 1 AT ELEVATION 1425 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1376 FT (419.10 M)
3. CONE VALVE AT ELEVATION 990 FT (301.75 M)
4. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)

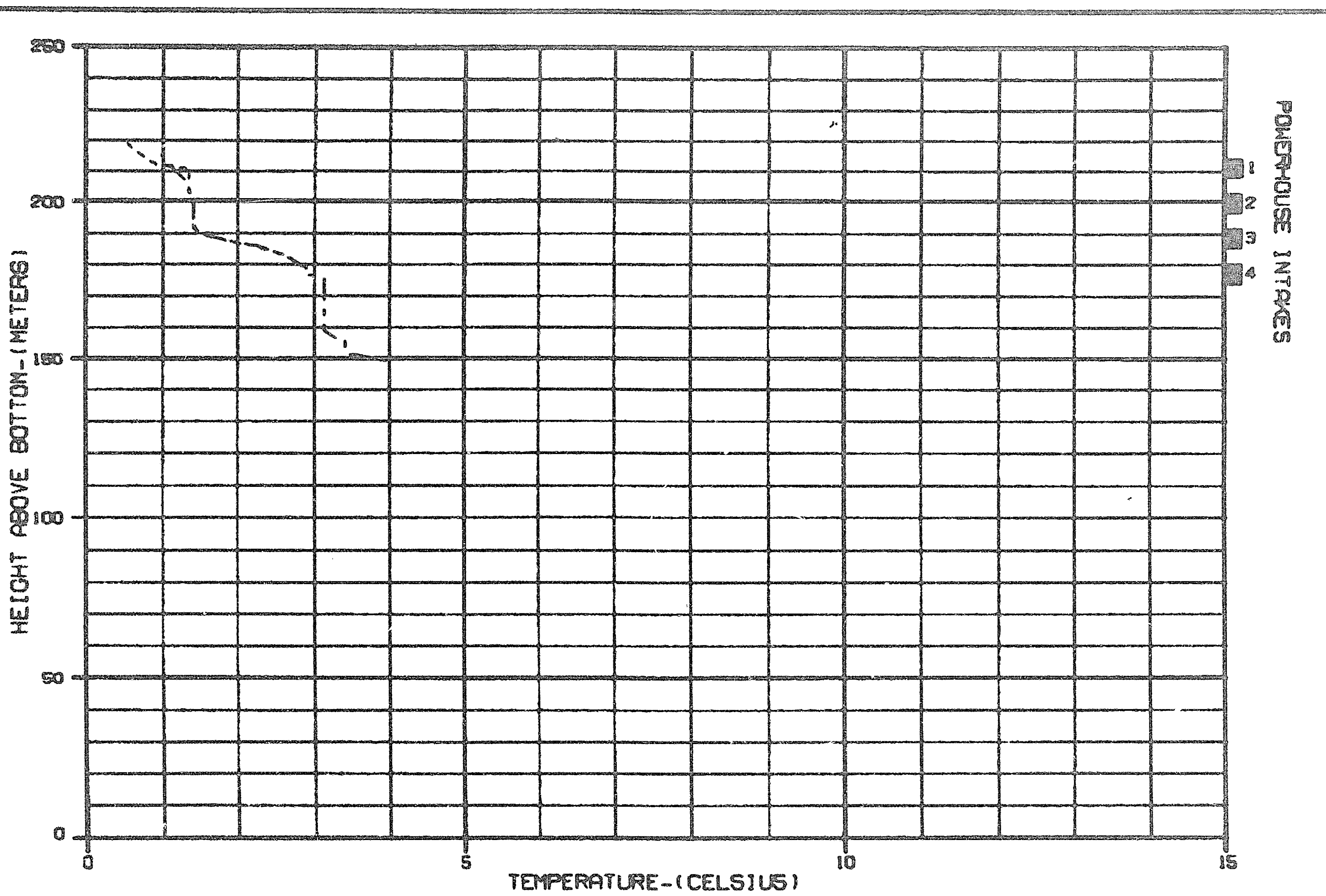
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 30 JAN 85 | 42-010-04



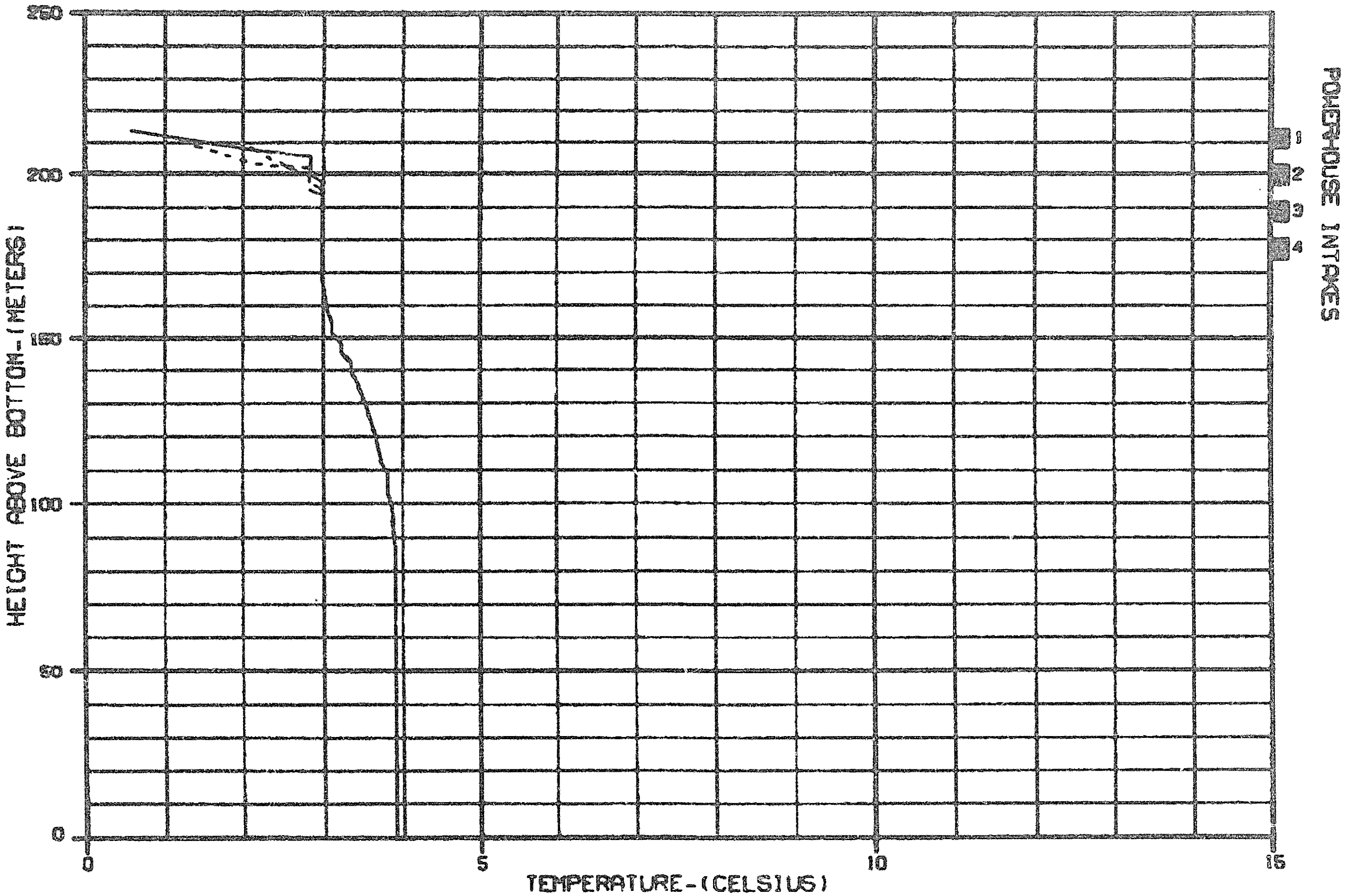
CASE: ** WA8102J - WATANA OPERATION W/DEVIL CANYON IN 2002 ** (E-VI)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

- ———— 1 NOVEMBER 1980
- - - - - 1 DECEMBER 1980
- — - — 1 JANUARY 1981

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
WATANA RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
CHICAGO, ILLINOIS 20 JAN 83	42-010-04



CASE: ** WA8102J - WATANA OPERATION W/DEVIL CANYON IN 2002 ** (E-VI)

LEGEND:

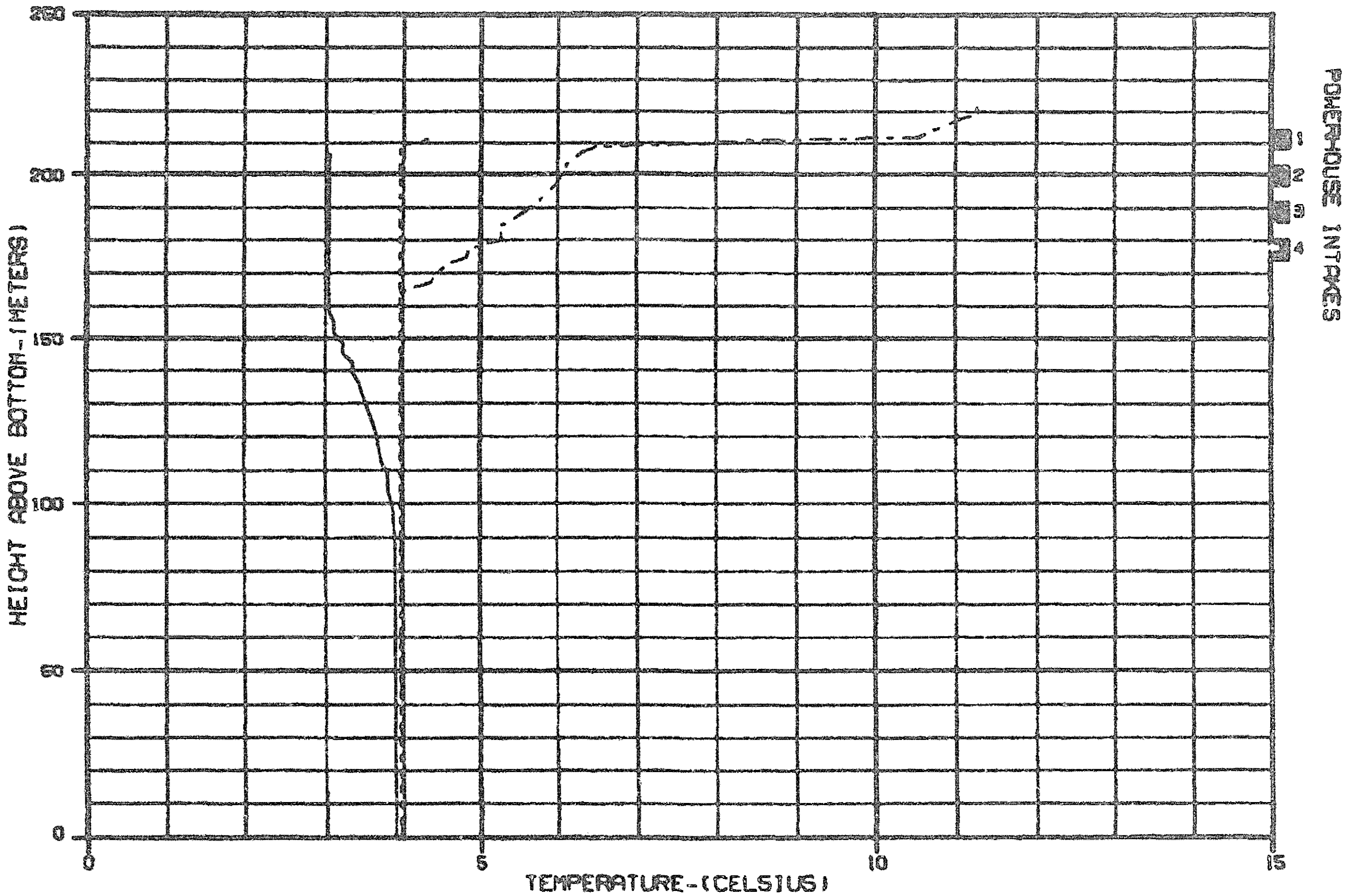
PREDICTED TEMPERATURE PROFILES:

————————	1 FEBRUARY	1982
- - - - - - - -	1 MARCH	1982
— - — - —	1 APRIL	1982

ALASKA POWER AUTHORITY

WATANA RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE



CASE: ** WA8102J - WATANA OPERATION W/DEVIL CANYON IN 2002 ** (E-VI)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

1 MAY 1982

1 JUNE 1982

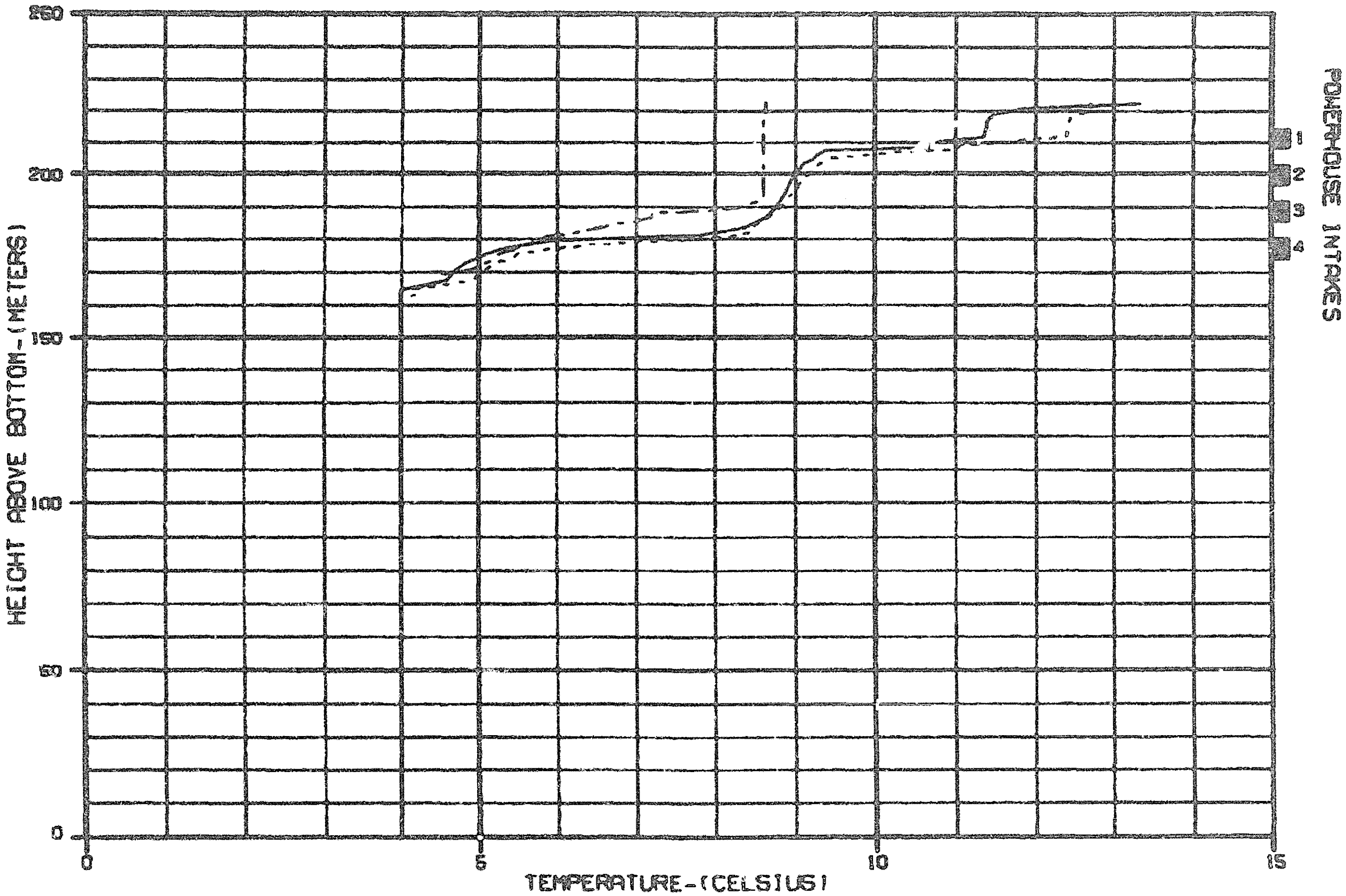
1 JULY 1982

ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE



CASE: ** WA8102J - WATANA OPERATION W/DEVIL CANYON IN 2002 ** (E-VI)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

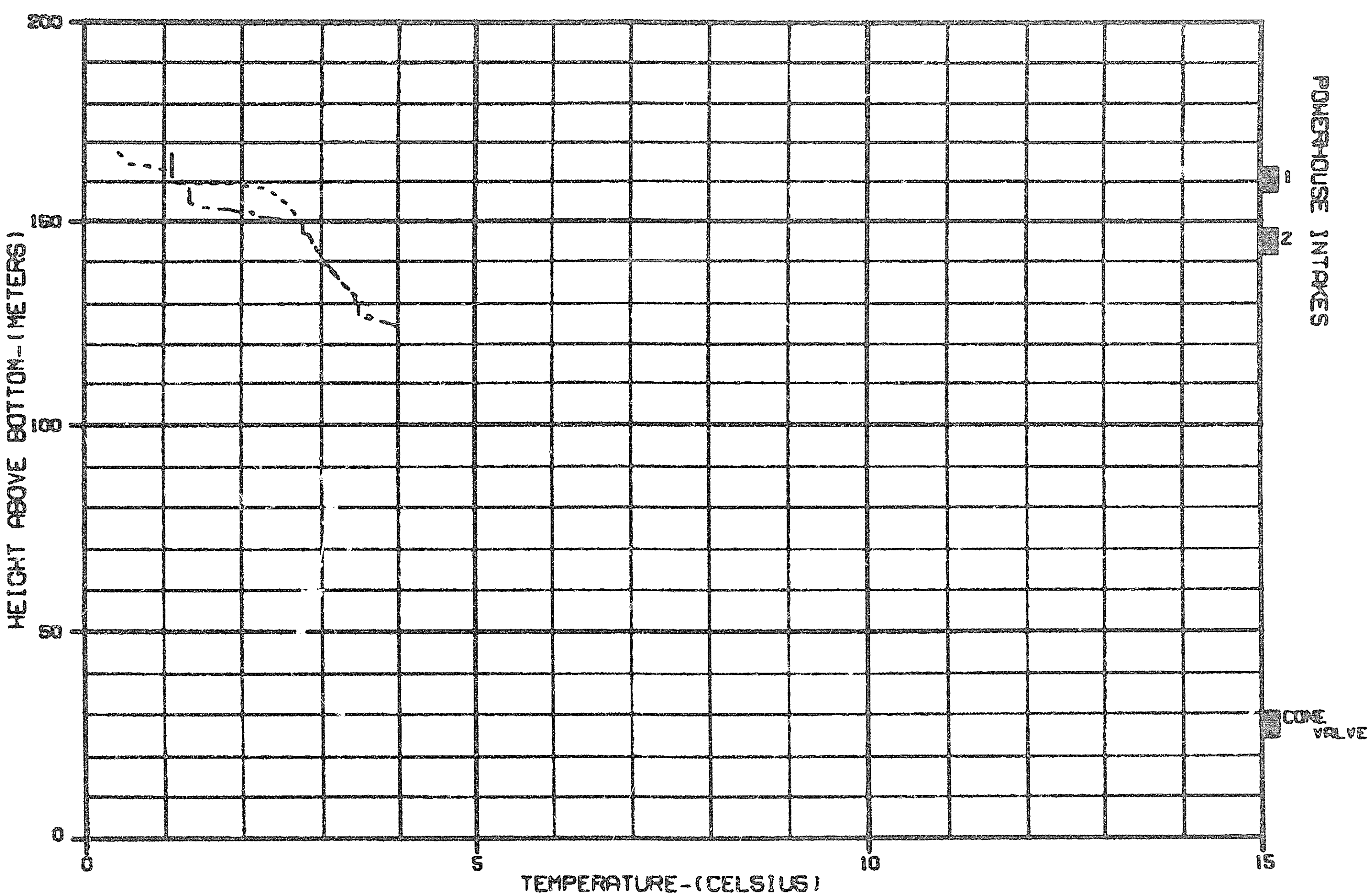
————	1 AUGUST	1982
- - - - - - - -	1 SEPTEMBER	1982
— - — - —	1 OCTOBER	1982

ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE



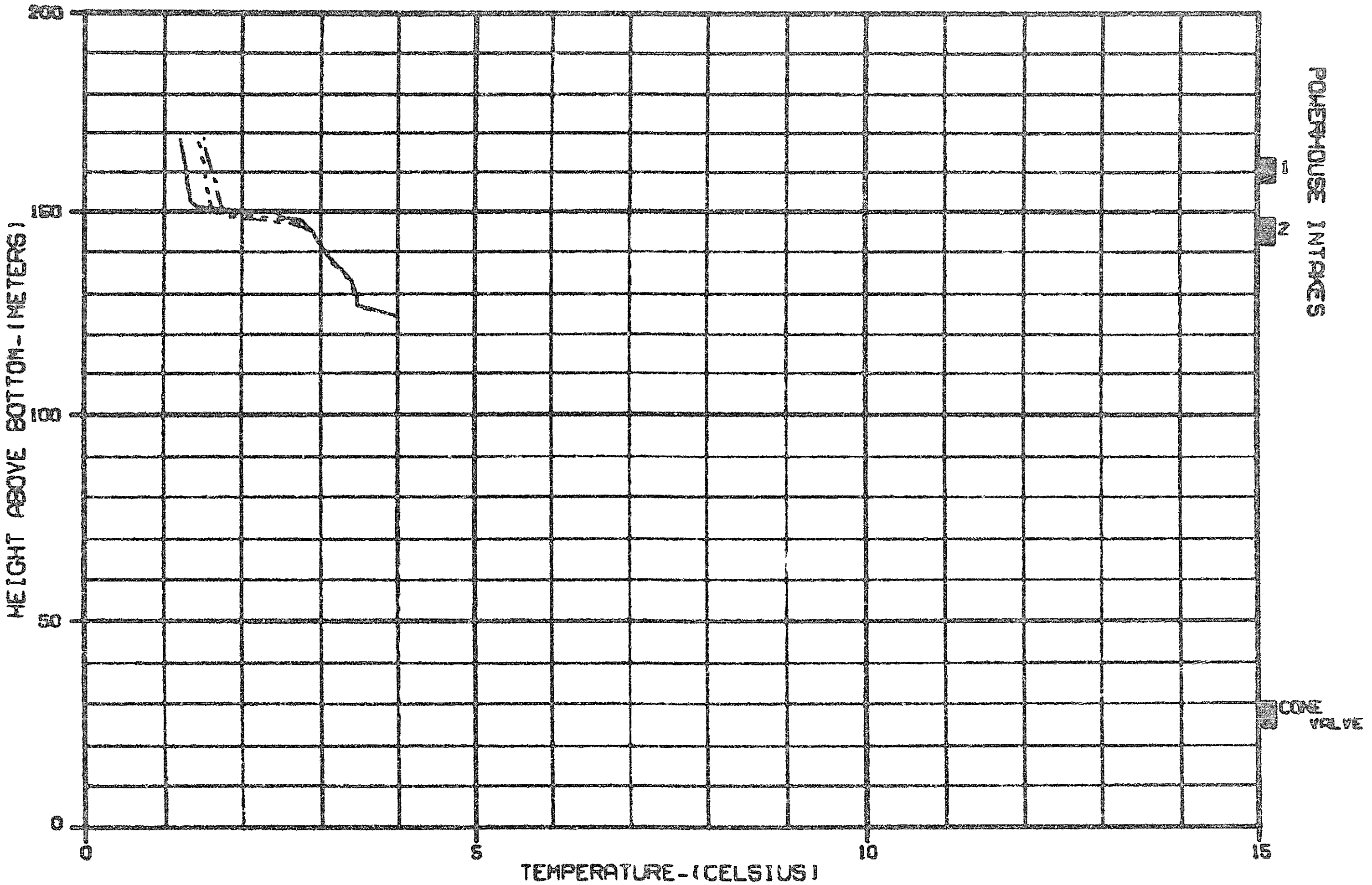
ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
DEVIL CANYON RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	

CASE: ** DC8102J - DEVIL CANYON OPERATION W/WATANA IN 2002 ** (E-VI)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

——— 1 NOVEMBER 1980
- - - - 1 DECEMBER 1980
— - — 1 JANUARY 1981



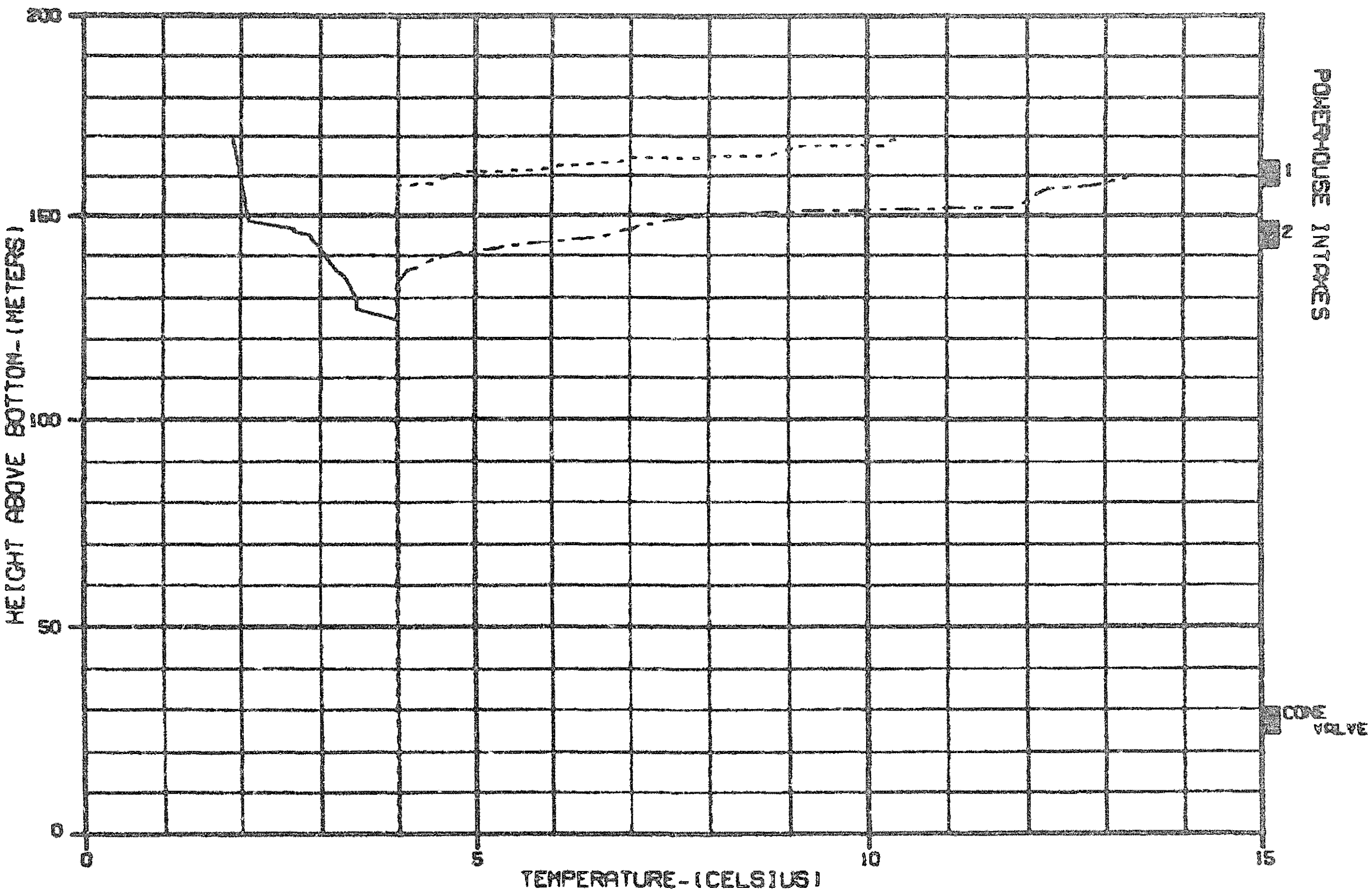
ALASKA POWER AUTHORITY
SUSITNA PROJECT / DYRESM MODEL
DEVIL CANYON RESERVOIR TEMPERATURE PROFILES
HARZA-EBASCO JOINT VENTURE
[illegible] / [illegible] / 42-010-04

CASE: ** DCB102J - DEVIL CANYON OPERATION W/WATANA IN 2002 ** (E-VI)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 FEBRUARY	1981
- - - - - -	1 MARCH	1981
— - — - —	1 APRIL	1981



CASE: ** DC8102J - DEVIL CANYON OPERATION W/WATANA IN 2002 ** (E-VI)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

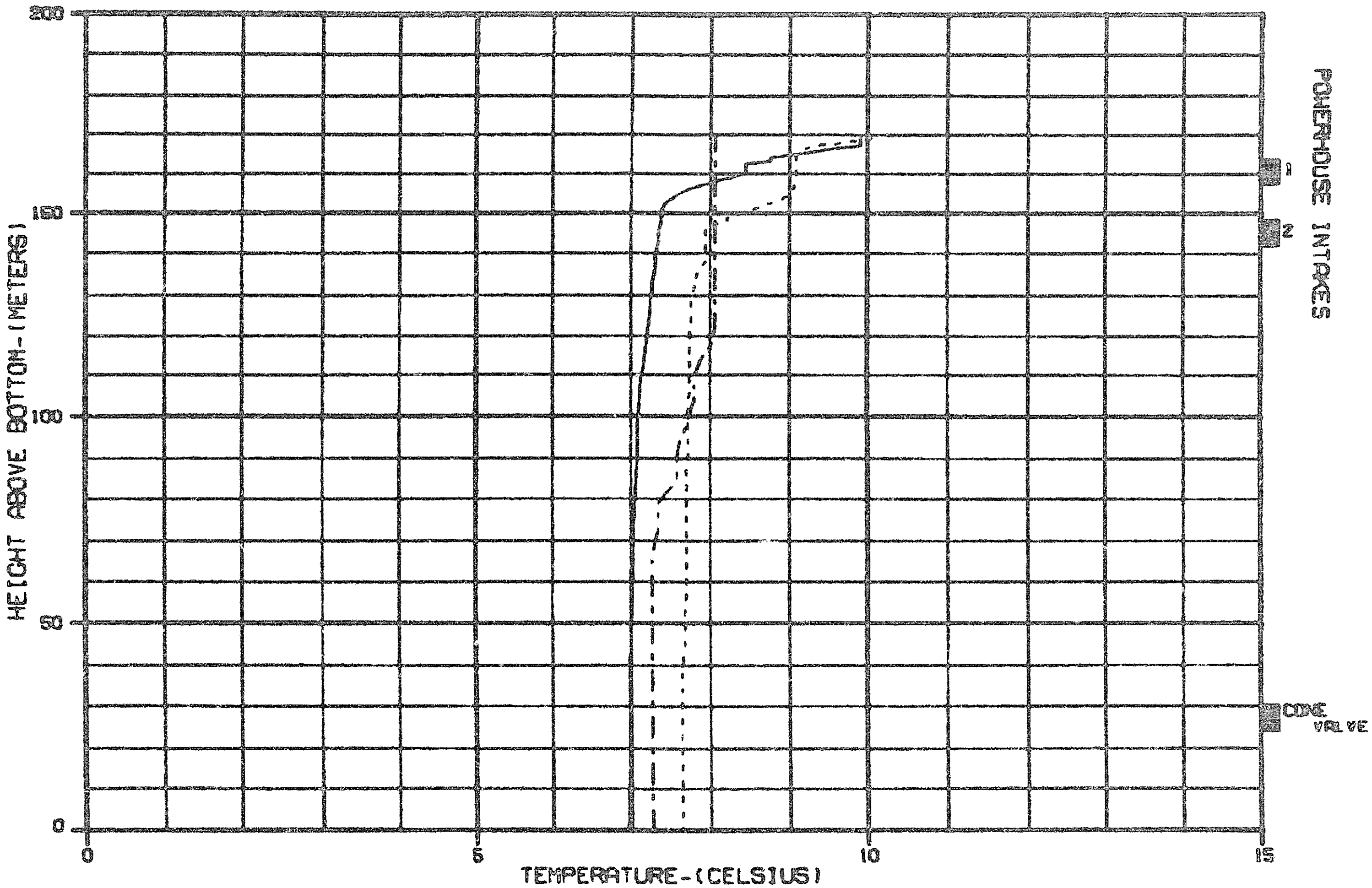
- ———— 1 MAY 1981
- - - - - - 1 JUNE 1981
- —·—·— 1 JULY 1981

ALASKA POWER AUTHORITY

SUSITNA PROJECT

DEVIL CANYON RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE



CASE: ** DCB102J - DEVIL CANYON OPERATION W/WATANA IN 2002 ** (E-VI)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

———— 1 AUGUST 1981
- - - - - 1 SEPTEMBER 1981
—·—·— 1 OCTOBER 1981

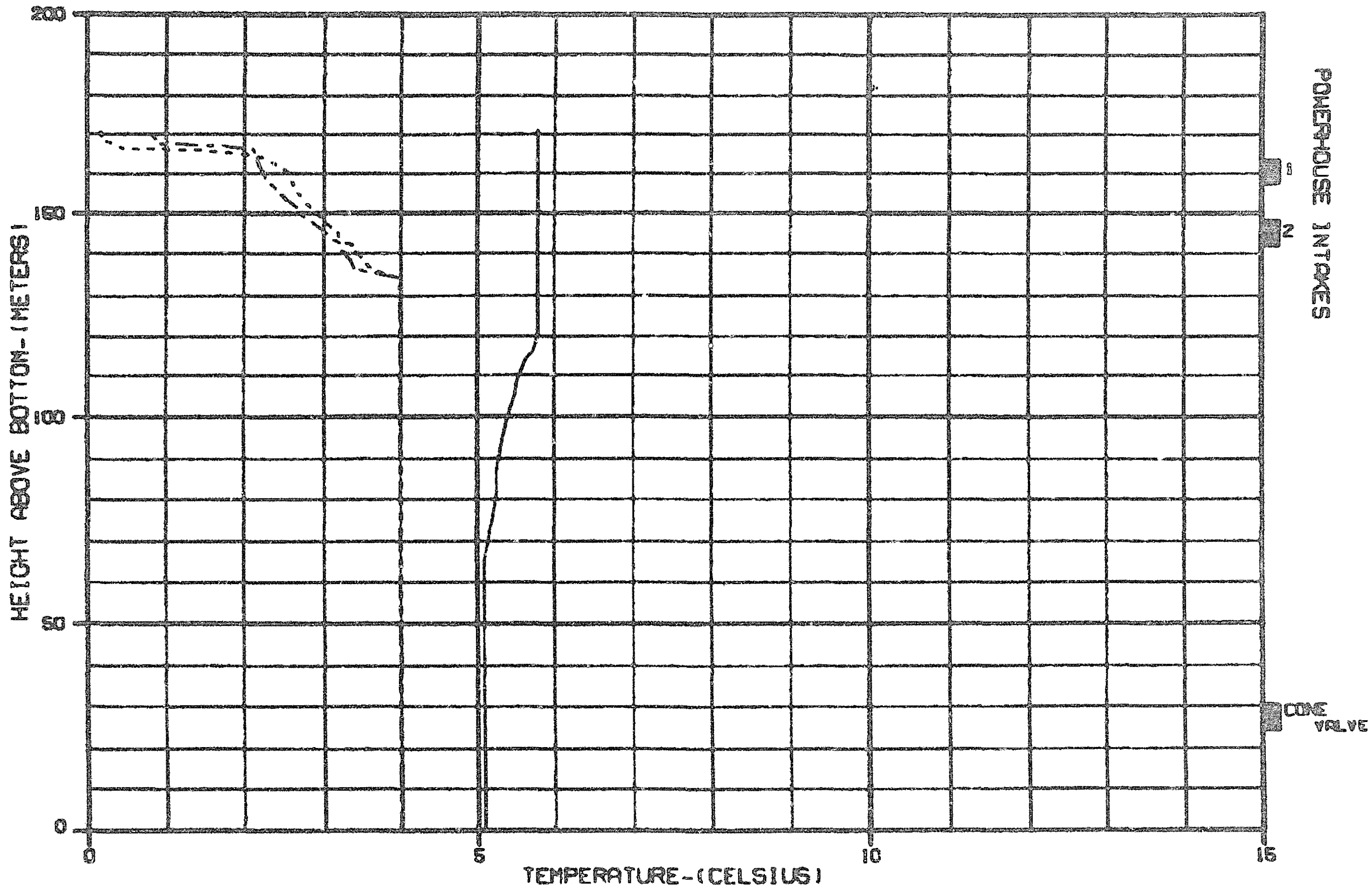
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

42-010-04



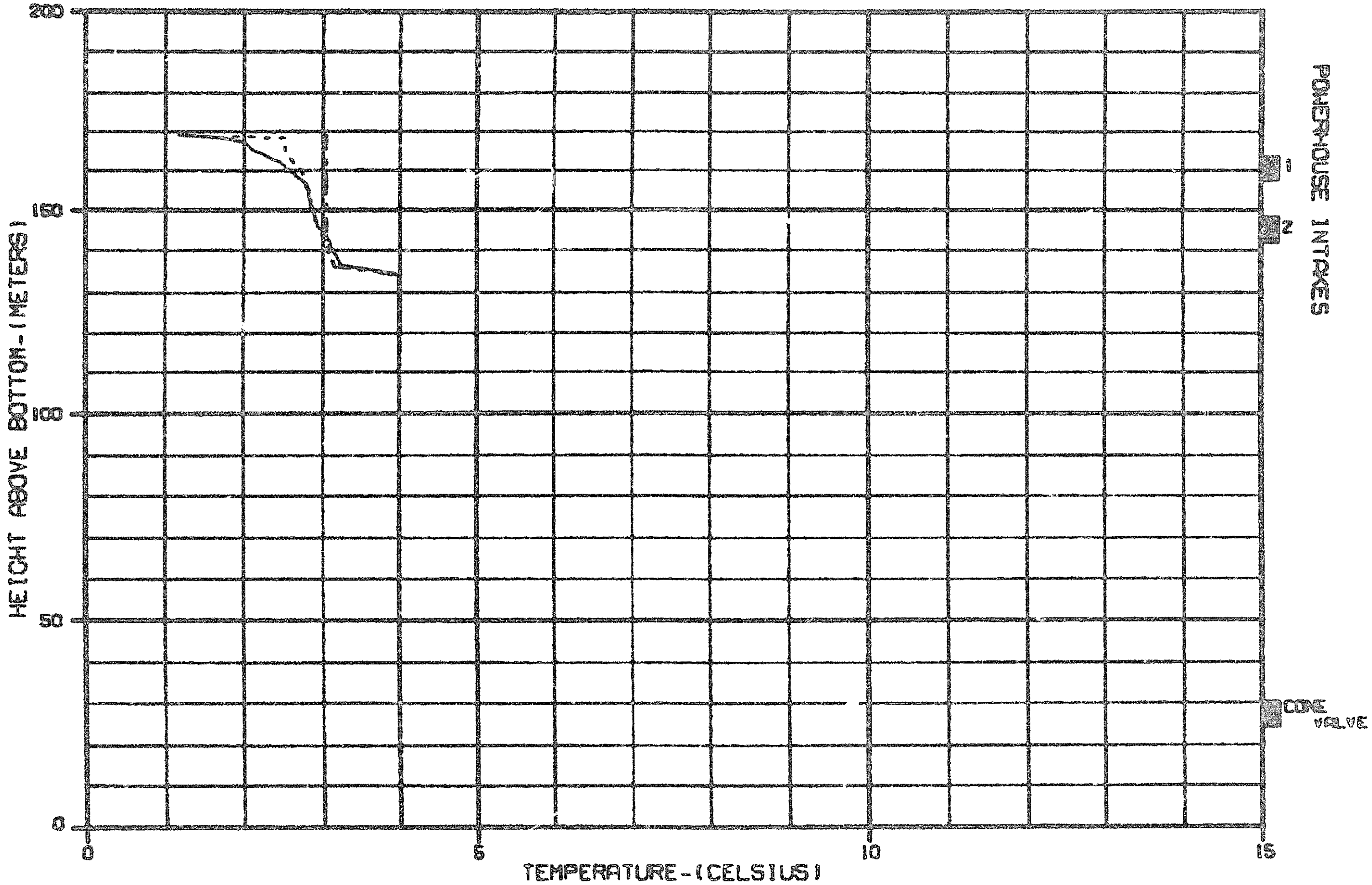
CASE: ** DC8102J - DEVIL CANYON OPERATION W/WATANA IN 2002 ** (E-VI)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 NOVEMBER 1981
- - - - - -	1 DECEMBER 1981
— - — - —	1 JANUARY 1982

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
DEVIL CANYON RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
CHICAGO, ILLINOIS	42-810-04



CASE: ** DCB102J - DEVIL CANYON OPERATION W/WATANA IN 2002 ** (E-VI)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 FEBRUARY	1982
- - - - - -	1 MARCH	1982
— - — - —	1 APRIL	1982

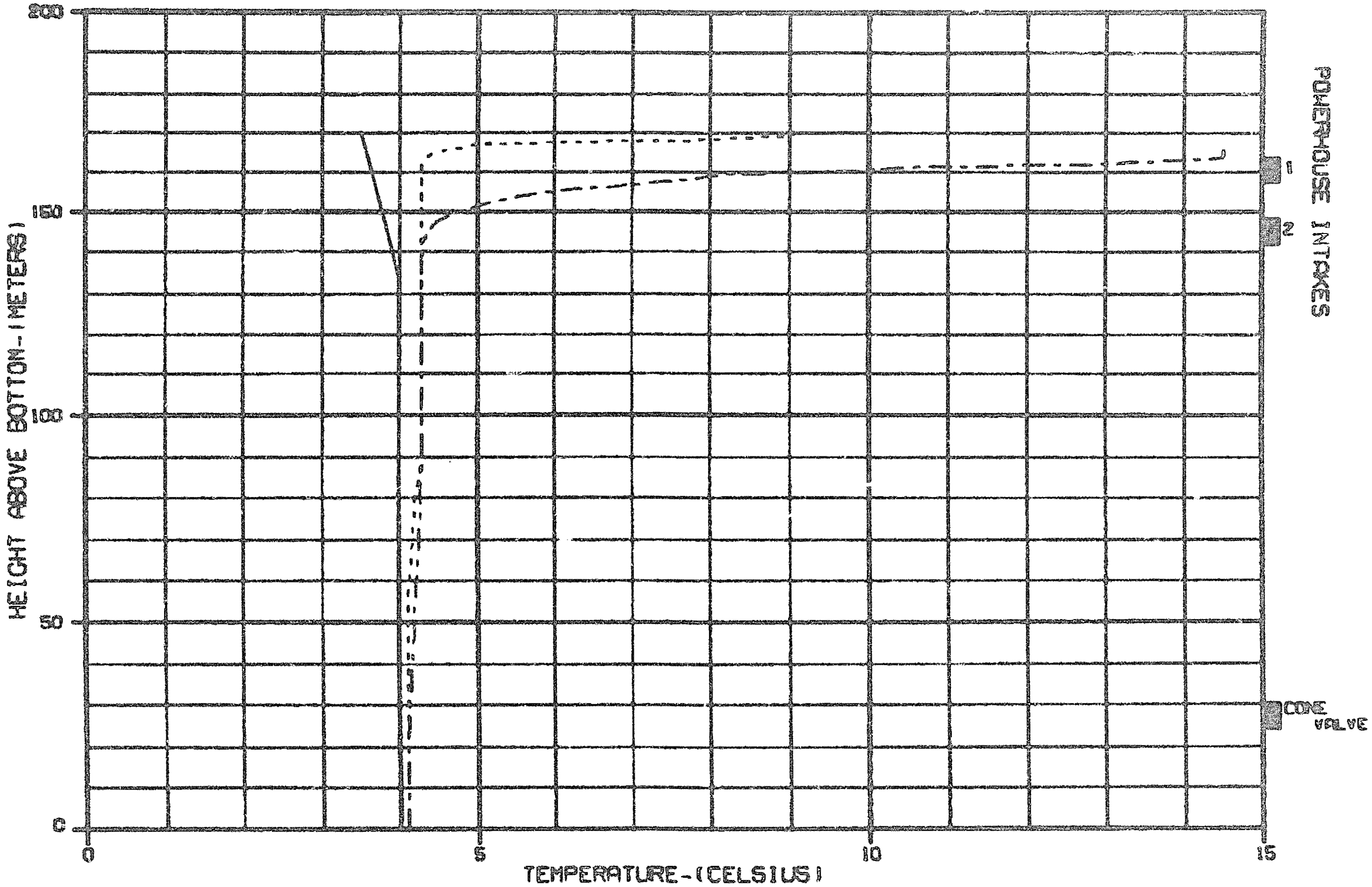
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

42-010-04



CASE: ** DCB102J - DEVIL CANYON OPERATION W/WATANA IN 2002 ** (E-VI)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

- ———— 1 MAY 1982
- · · · · · · 1 JUNE 1982
- — · — · — 1 JULY 1982

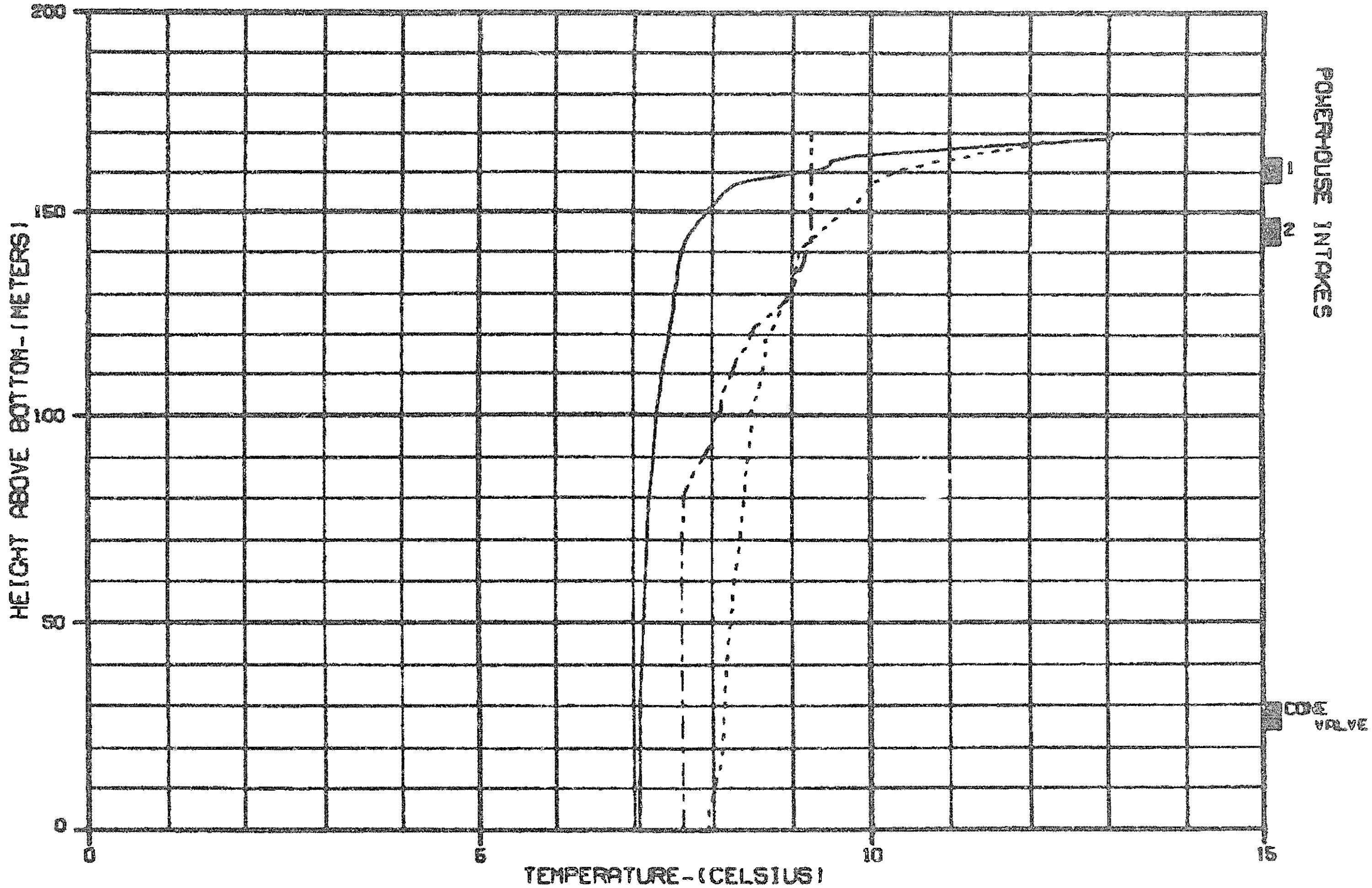
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

42-010-04



CASE: ** DC8102J - DEVIL CANYON OPERATION W/WATANA IN 2002 ** (E-VI)

LEGEND:

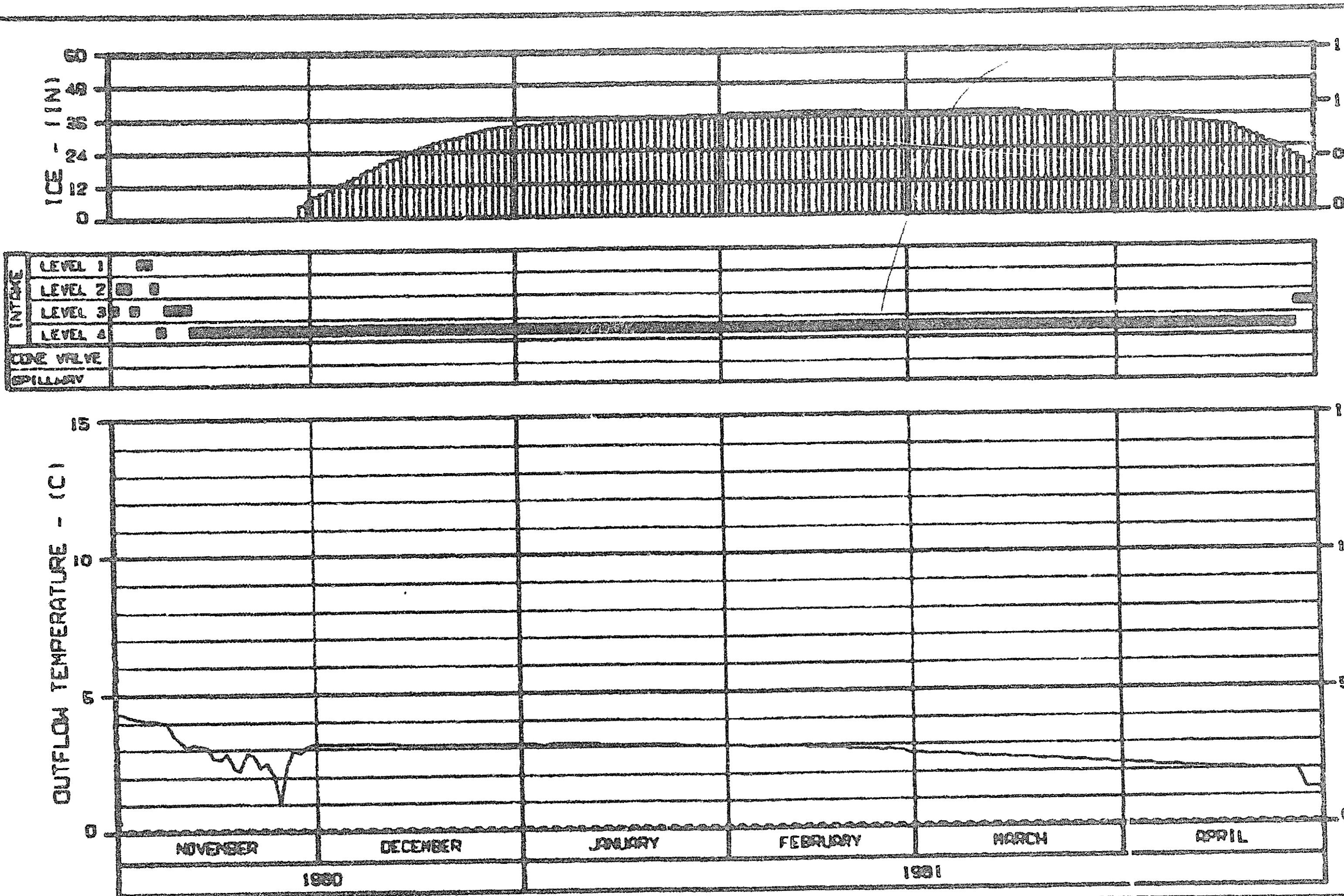
PREDICTED TEMPERATURE PROFILES:

———— (solid)	1 AUGUST	1982
- - - - (dotted)	1 SEPTEMBER	1982
— - — (dash-dot)	1 OCTOBER	1982

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
DEVIL CANYON RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
[illegible] [illegible]	42-010-04

EXHIBIT D

CASE E-VI
STAGE II
TWO-STAGE PROJECT
WARMEST POSSIBLE OUTFLOW



LEGEND: CASE: WAB102K - WATANA OPERATION W/DEVIL CANYON IN 2002 (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)
——— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 2151 FT (655.6 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE AT ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

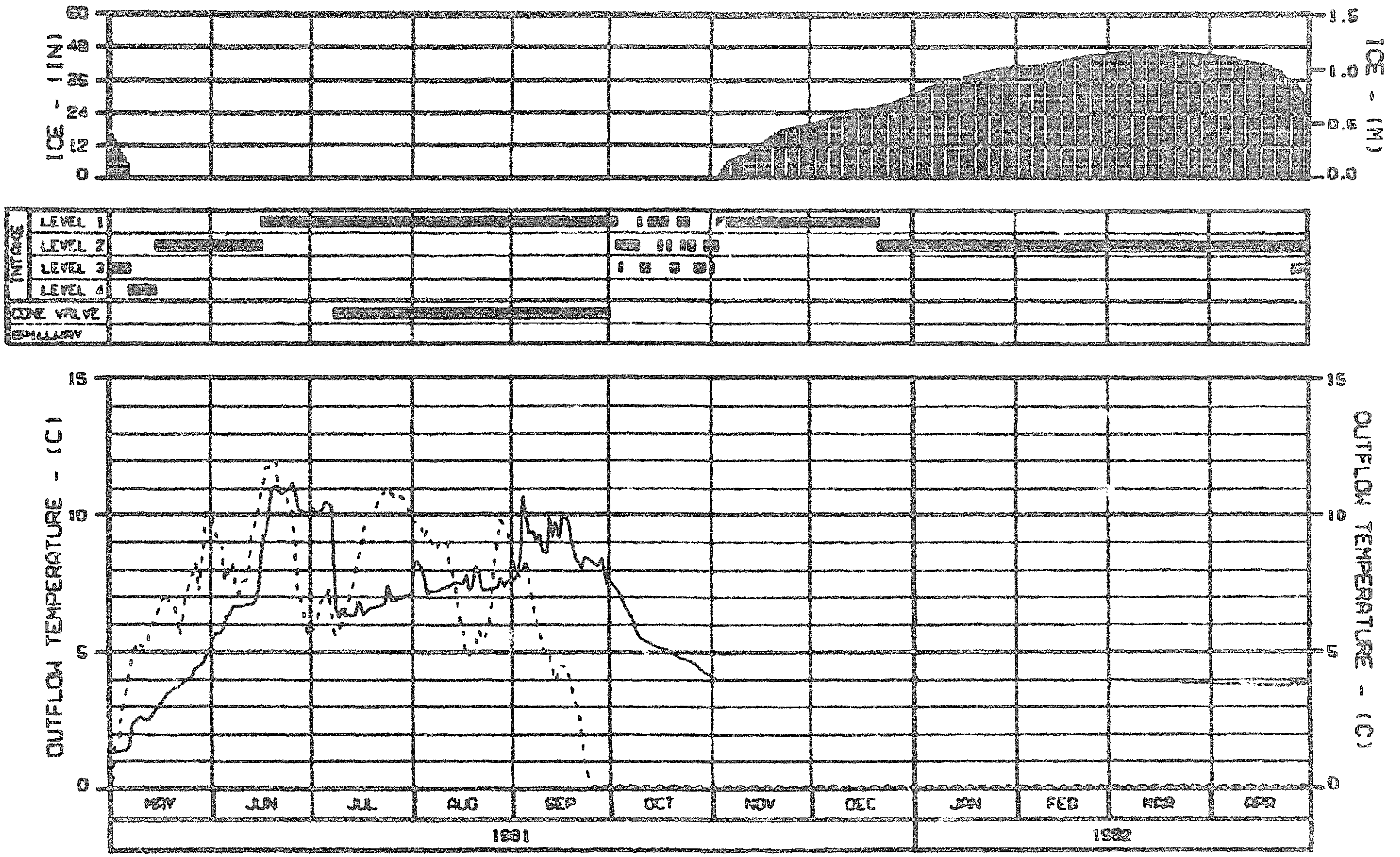
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

42-010-04



LEGEND: CASE: WA8102K - WATANA OPERATION W/DEVIL CANYON IN 2002 (E-VI)
WATANA SIMULATION -- WARMEST WATER (FULL YEAR)
———— PREDICTED OUTFLOW TEMPERATURE
- - - - - - INFLOW TEMPERATURE

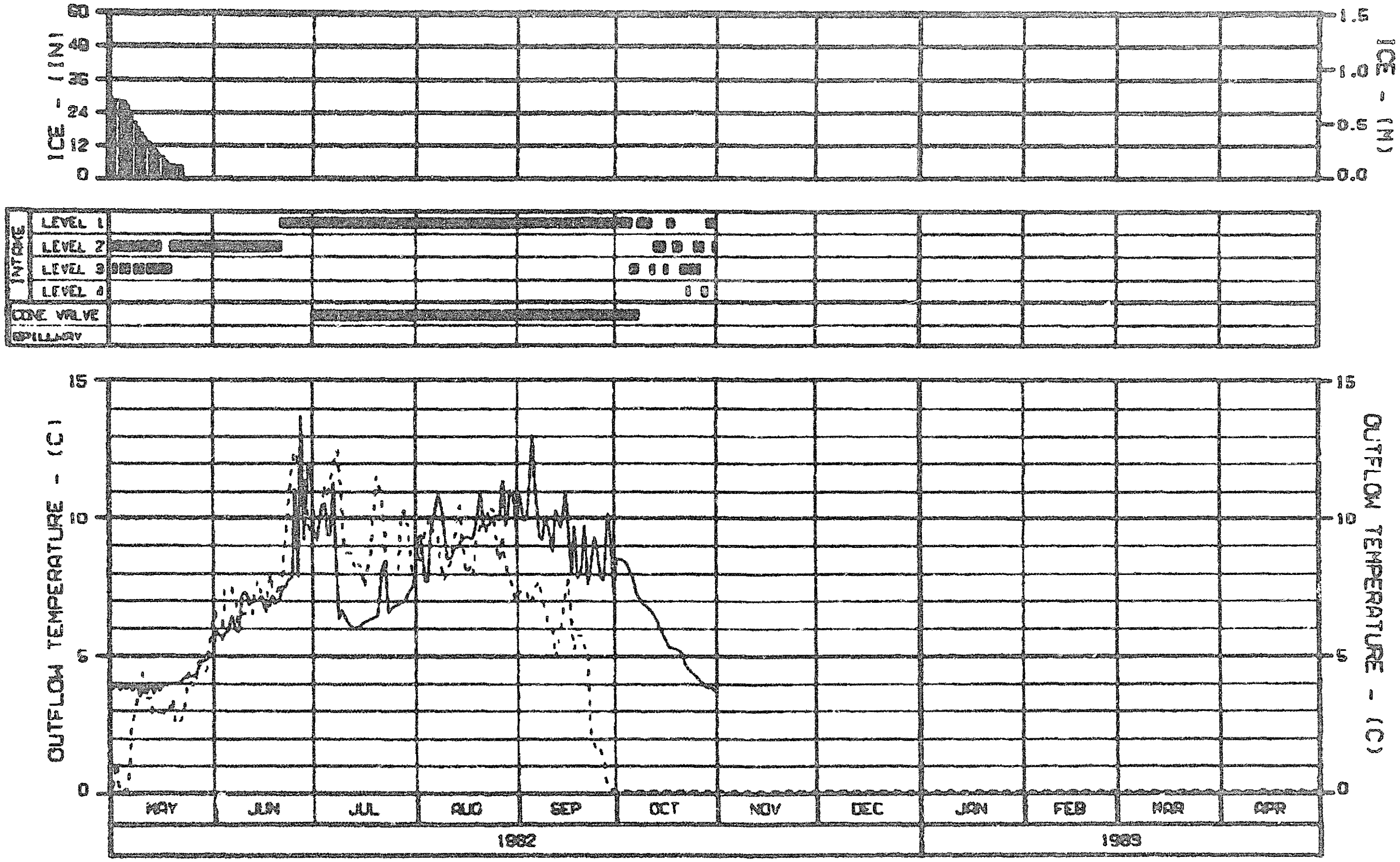
NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 2151 FT (655.6 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE AT ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

ALASKA POWER AUTHORITY

SUSITNA PROJECT

WATANA RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH

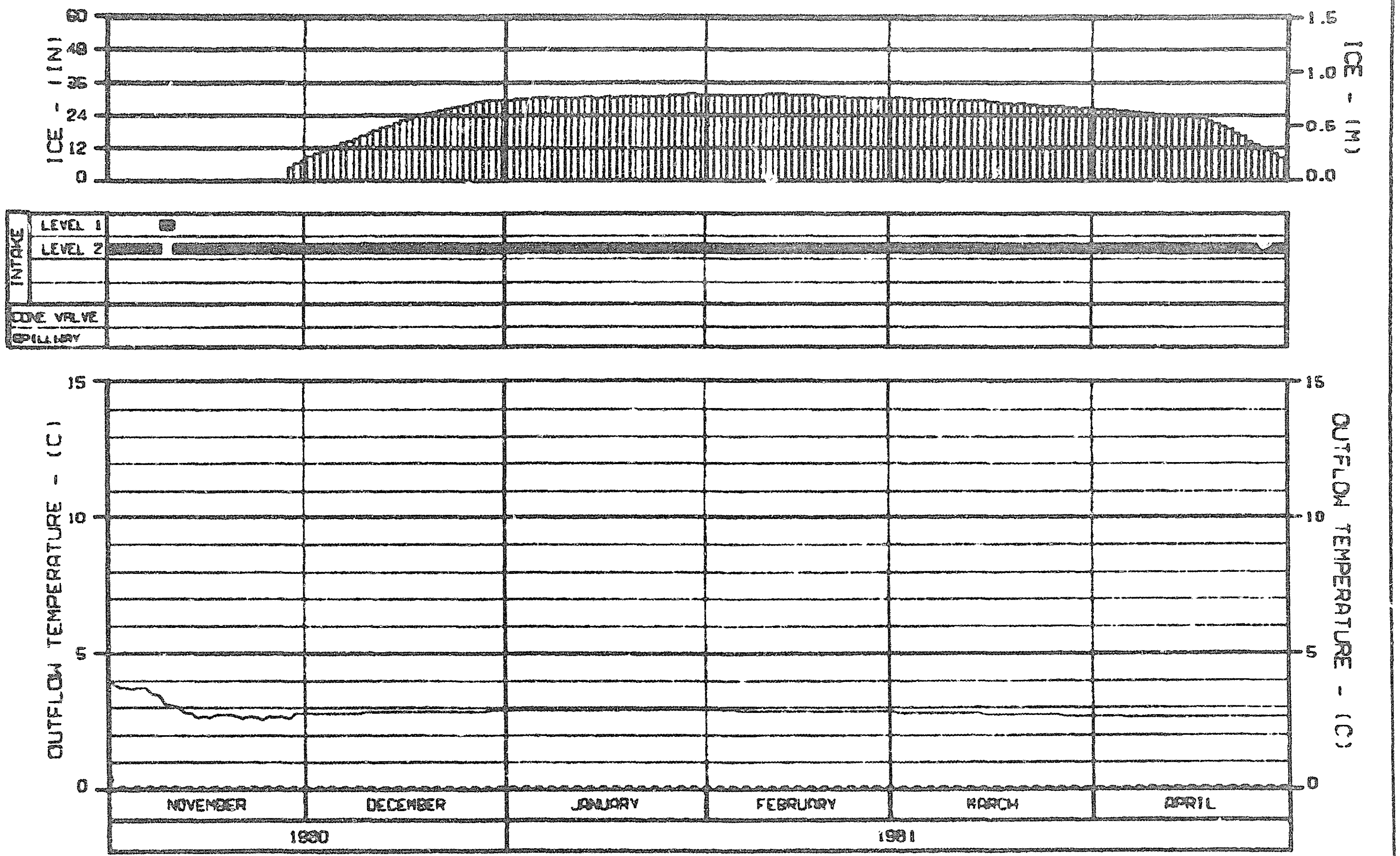
HARZA-EBASCO JOINT VENTURE



LEGEND: CASE: ** WA8102K - WATANA OPERATION W/DEVIL CANYON IN 2002 ** (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)
———————— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 2151 FT (655.6 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE AT ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

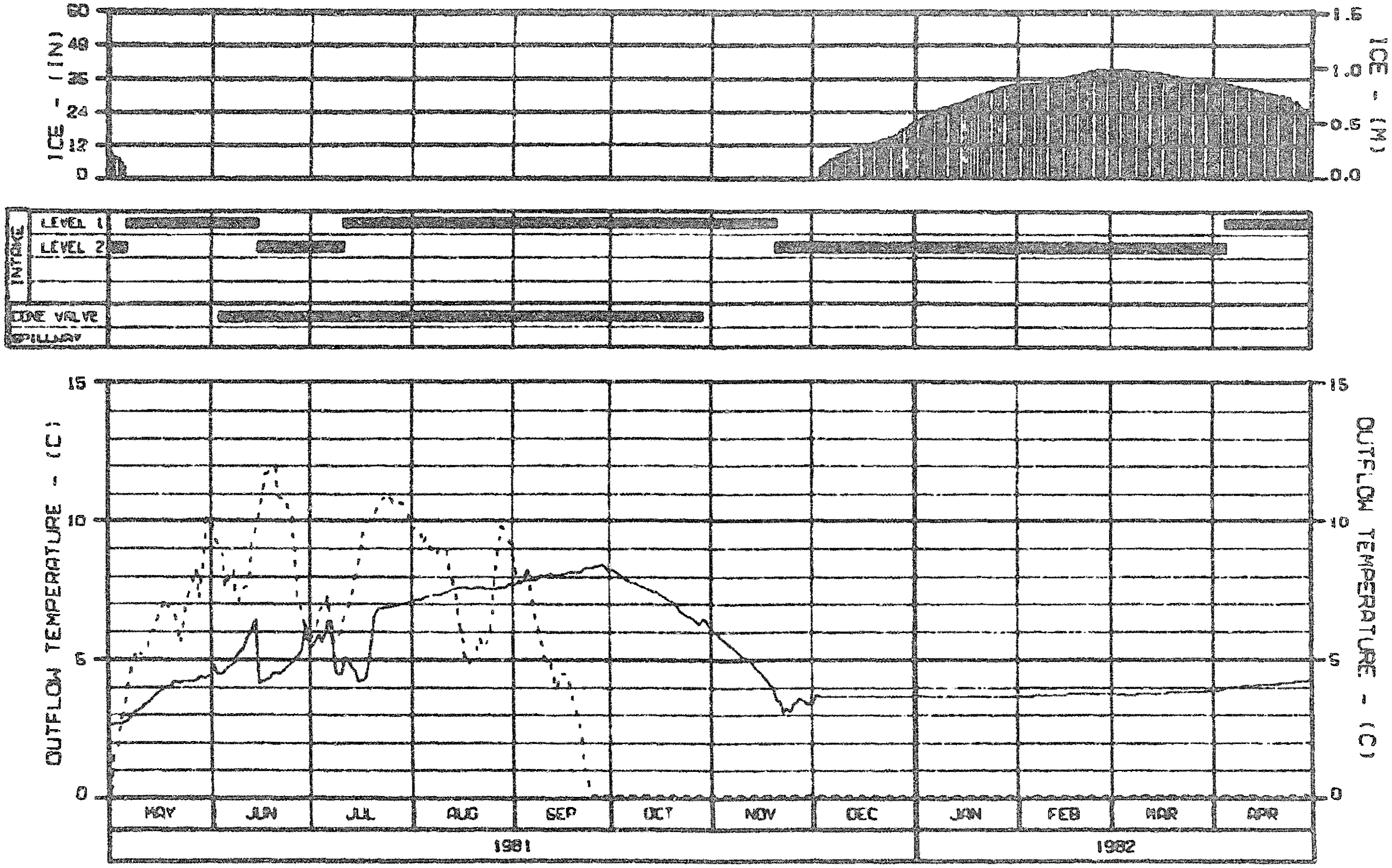
ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
WATANA RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH	
HARZA-EBASCO JOINT VENTURE	
CHICAGO, ILLINOIS [illegible]	42-010-04



LEGEND: CASE: ** DC8102K - DEVIL CANYON OPERATION W/WATANA IN 2002 ** (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)
———— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 1425 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1375 FT (419.10 M)
3. CONE VALVE AT ELEVATION 990 FT (301.75 M)
4. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)

ALASKA POWER AUTHORITY		
SUSITNA PROJECT	DYRESM MODEL	
DEVIL CANYON RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH		
HARZA-EBASCO JOINT VENTURE		
CHICAGO, ILLINOIS	20 JAN 88	42-010-04



LEGEND: CASE: ** DCB102K - DEVIL CANYON OPERATION W/WATANA IN 2002 ** (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)
———— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 1426 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1376 FT (419.10 M)
3. CONE VALVE AT ELEVATION 990 FT (301.75 M)
4. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)

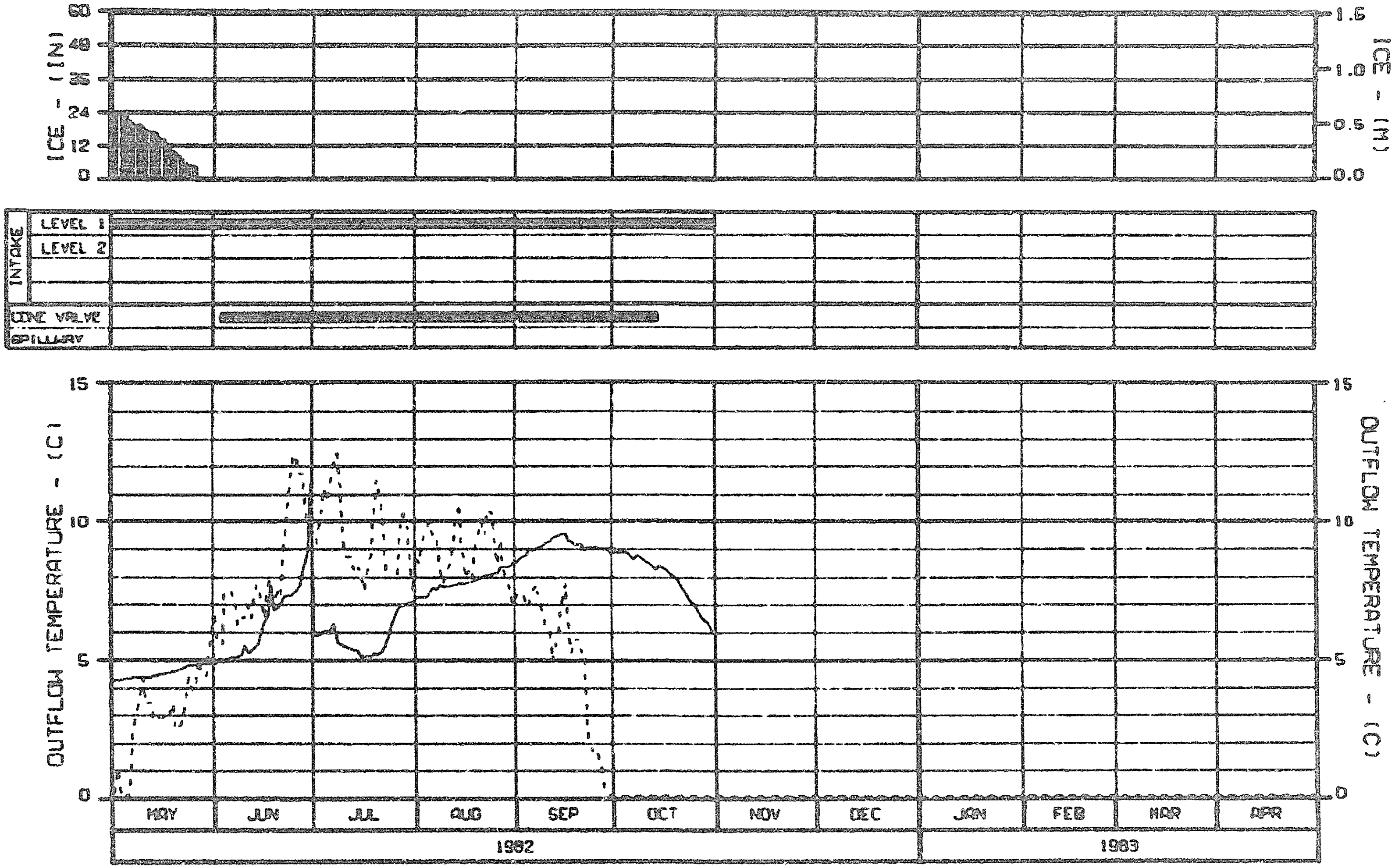
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

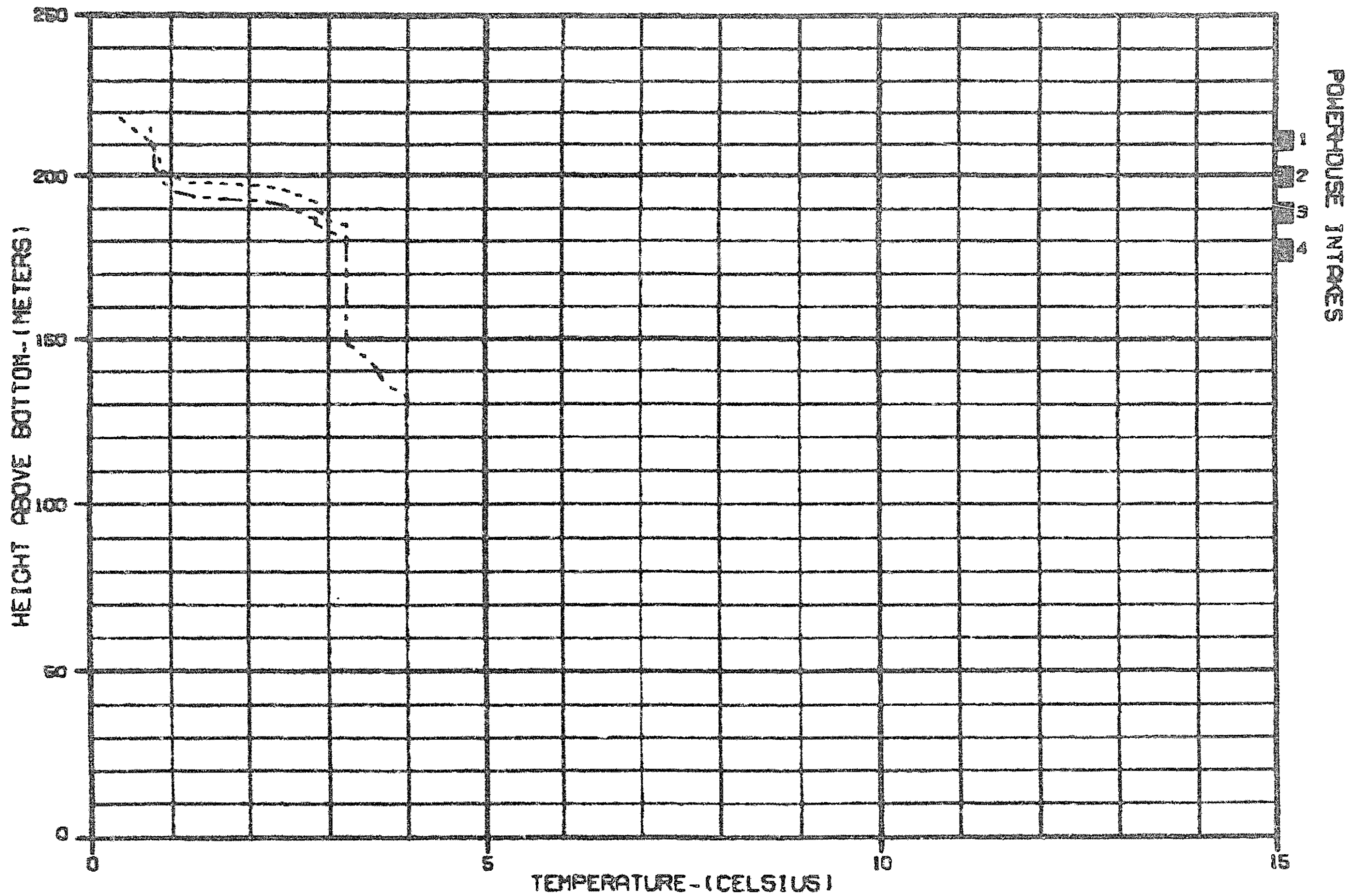
CHICAGO, ILLINOIS | [illegible] | 42-010-04



LEGEND: CASE: == DCB102K - DEVIL CANYON OPERATION W/WATANA IN 2002 == (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)
———— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES: 1. INTAKE PORT LEVEL 1 AT ELEVATION 1425 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1375 FT (419.10 M)
3. CONE VALVE AT ELEVATION 990 FT (301.75 M)
4. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
DEVIL CANYON RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH	
HARZA-EBASCO JOINT VENTURE	
CHICAGO, ILLINOIS / 30 JAN 85	42-010-04



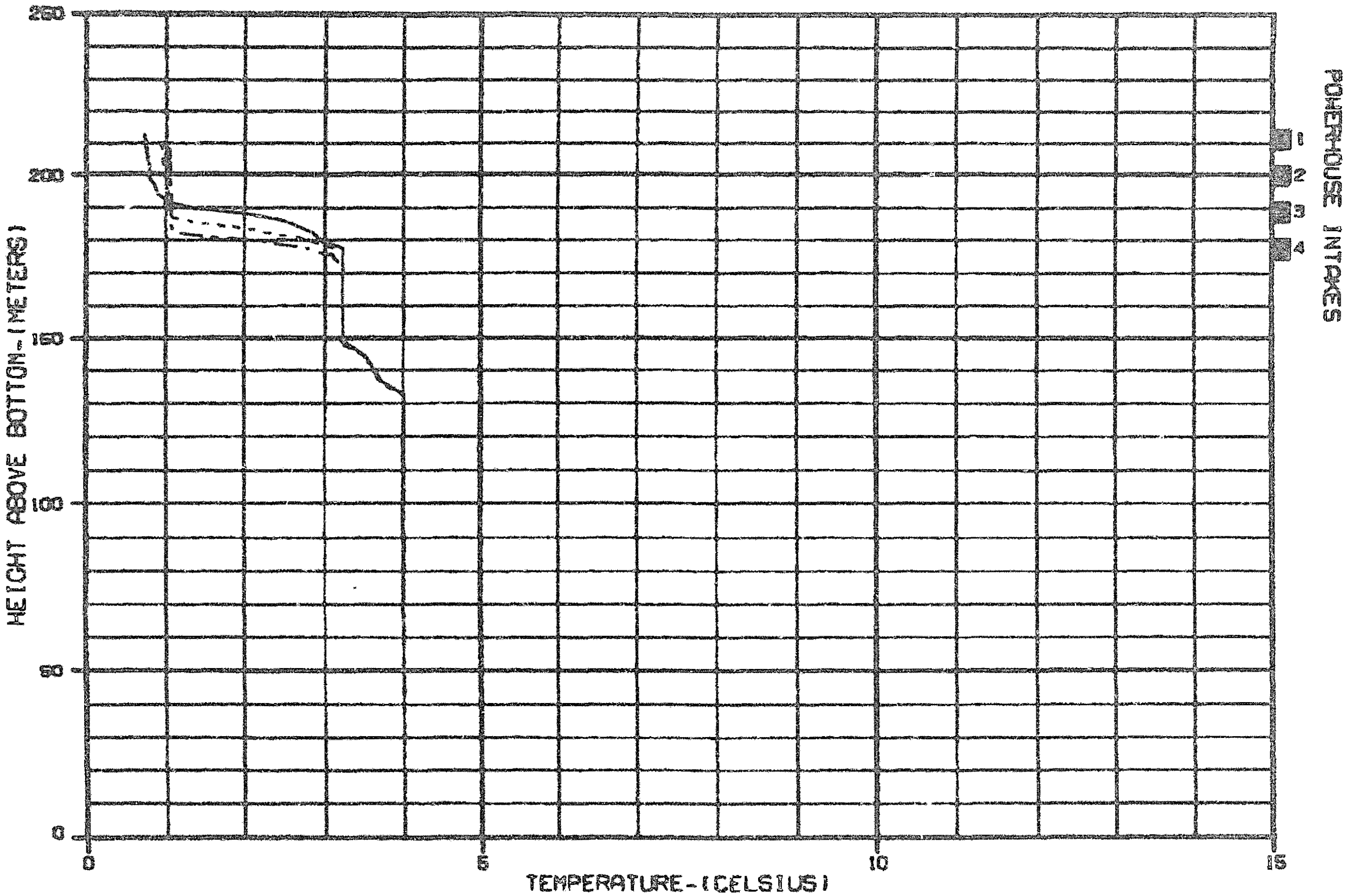
CASE: ** WA8102K - WATANA OPERATION W/DEVIL CANYON IN 2002 ** (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

- 1 NOVEMBER 1980
- 1 DECEMBER 1980
- 1 JANUARY 1981

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	[illegible]
WATANA RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
[illegible]	42-010-04



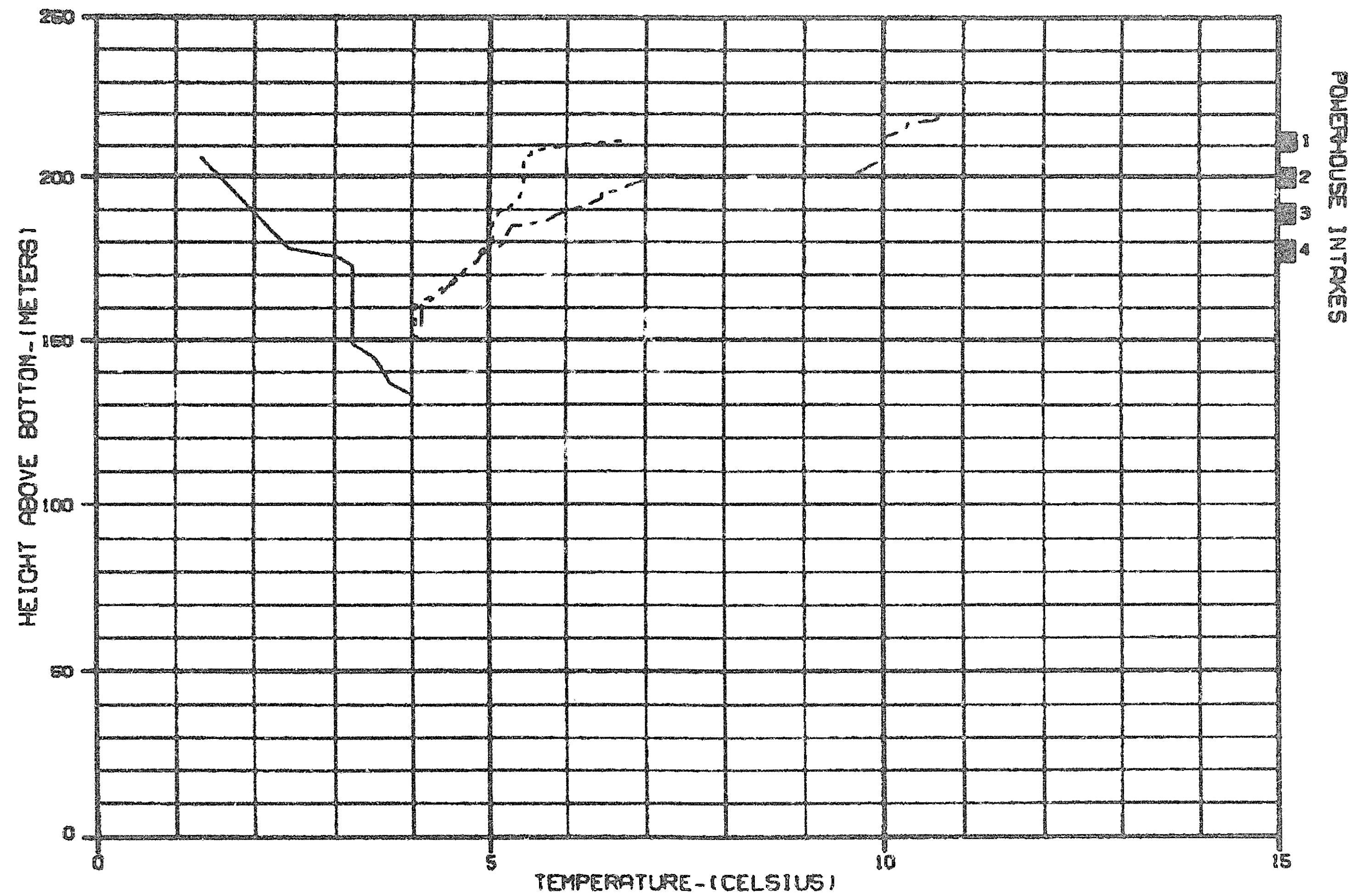
CASE: ** WA8102K - WATANA OPERATION W/DEVIL CANYON IN 2002 ** (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 FEBRUARY	1981
- - - - - -	1 MARCH	1981
— - — - —	1 APRIL	1981

ALASKA POWER AUTHORITY
SUSITNA PROJECT — DYRESM MODEL
WATANA RESERVOIR TEMPERATURE PROFILES
HARZA-EBASCO JOINT VENTURE
42-010-04



CASE: ** WA8102K - WATANA OPERATION W/DEVIL CANYON IN 2002 ** (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

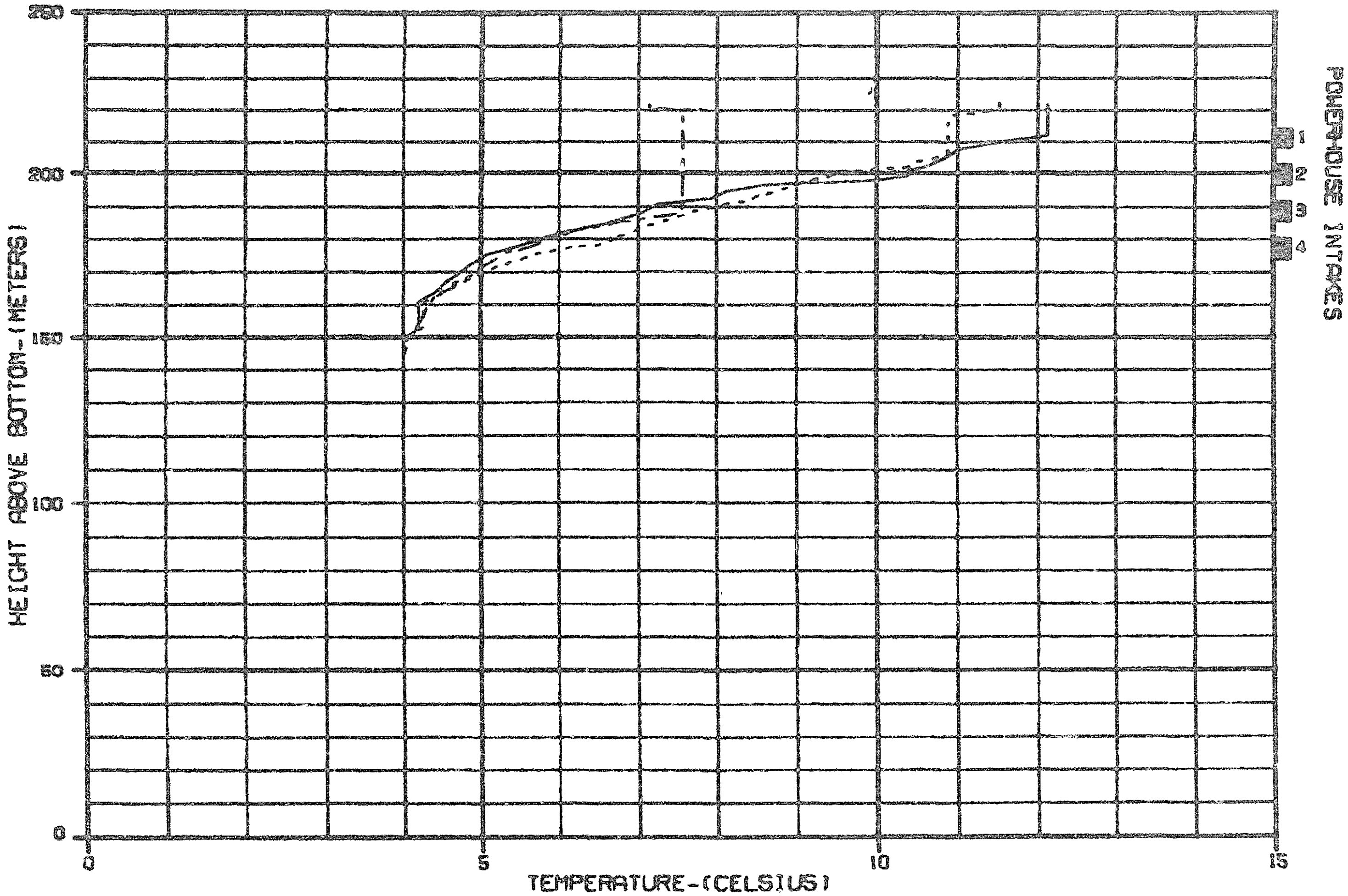
————	1 MAY 1981
- - - - - -	1 JUNE 1981
— - — - —	1 JULY 1981

ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE



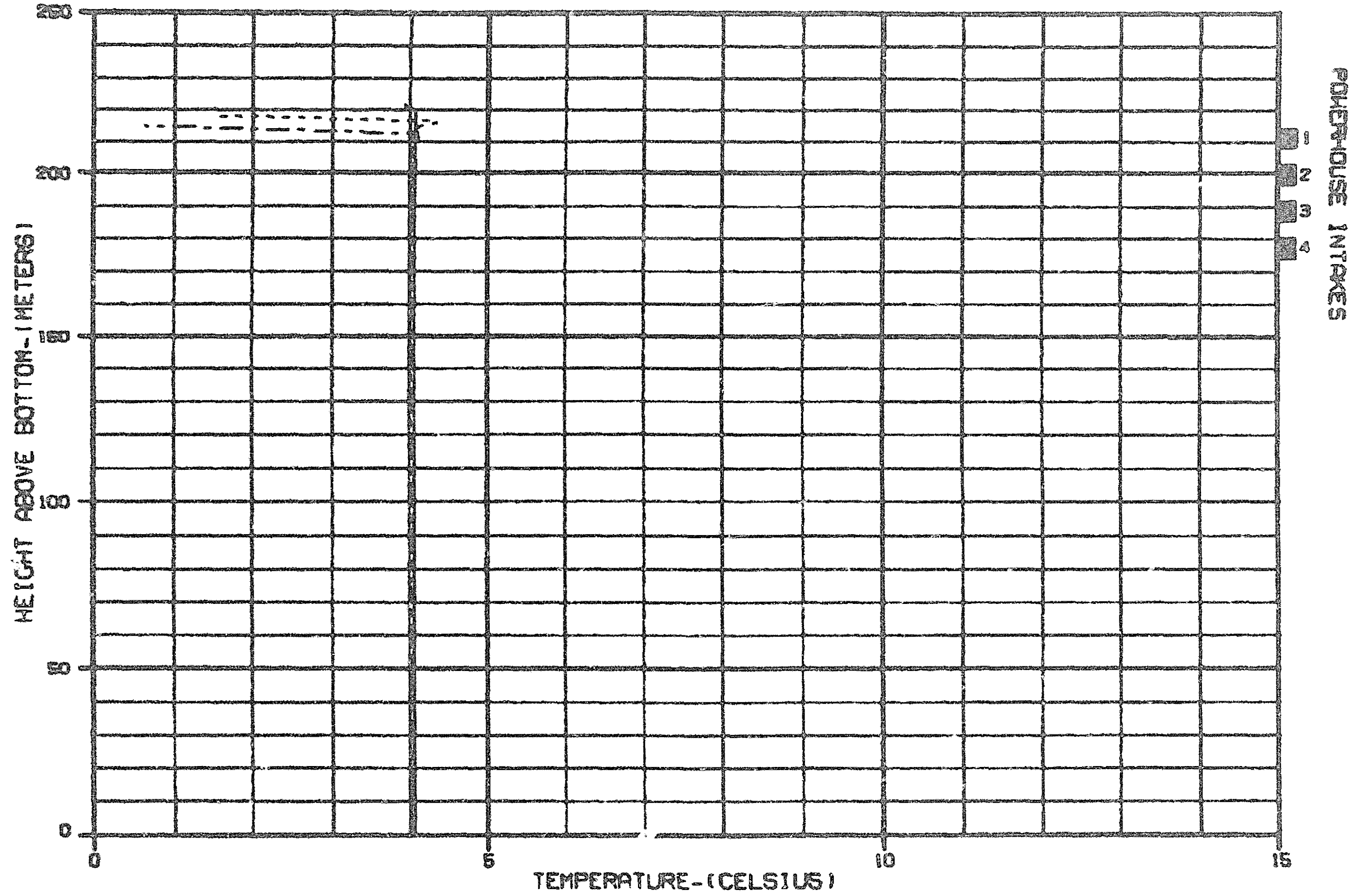
CASE: ** WAB102K - WATANA OPERATION W/DEVIL CANYON IN 2002 ** (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

———— (solid)	1 AUGUST 1981
- - - - (dashed)	1 SEPTEMBER 1981
— - — (dash-dot)	1 OCTOBER 1981

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
WATANA RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
CHICAGO, ILLINOIS	42-010-04



CASE: ** WA8102K - WATANA OPERATION W/DEVIL CANYON IN 2002 ** (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

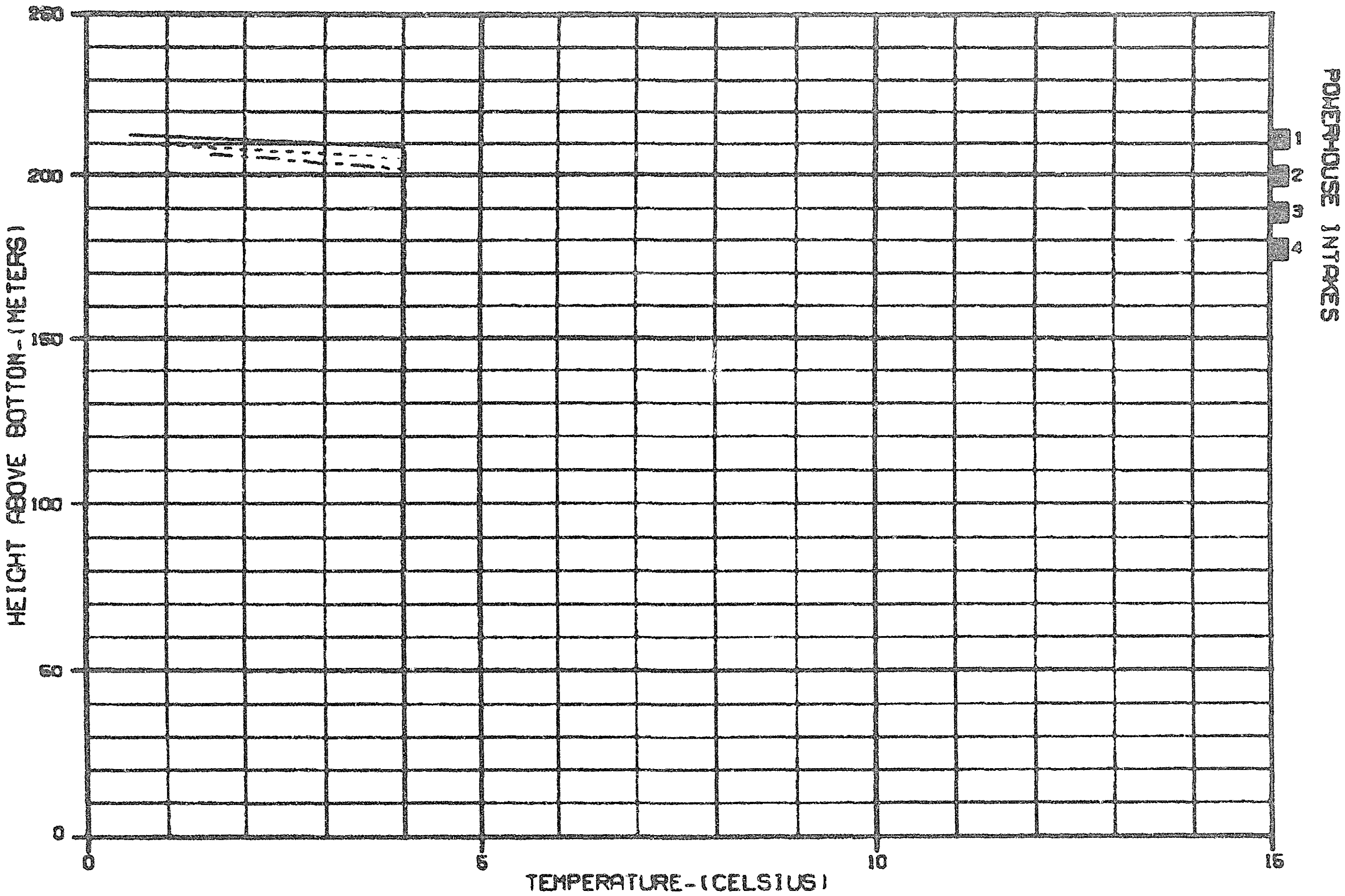
- ———— 1 NOVEMBER 1981
- - - - - - 1 DECEMBER 1981
- —·—·— 1 JANUARY 1982

ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE



CASE: ** WA8102K - WATANA OPERATION W/DEVIL CANYON IN 2002 ** (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————————	1 FEBRUARY 1982
- - - - - - - -	1 MARCH 1982
— - — - — -	1 APRIL 1982

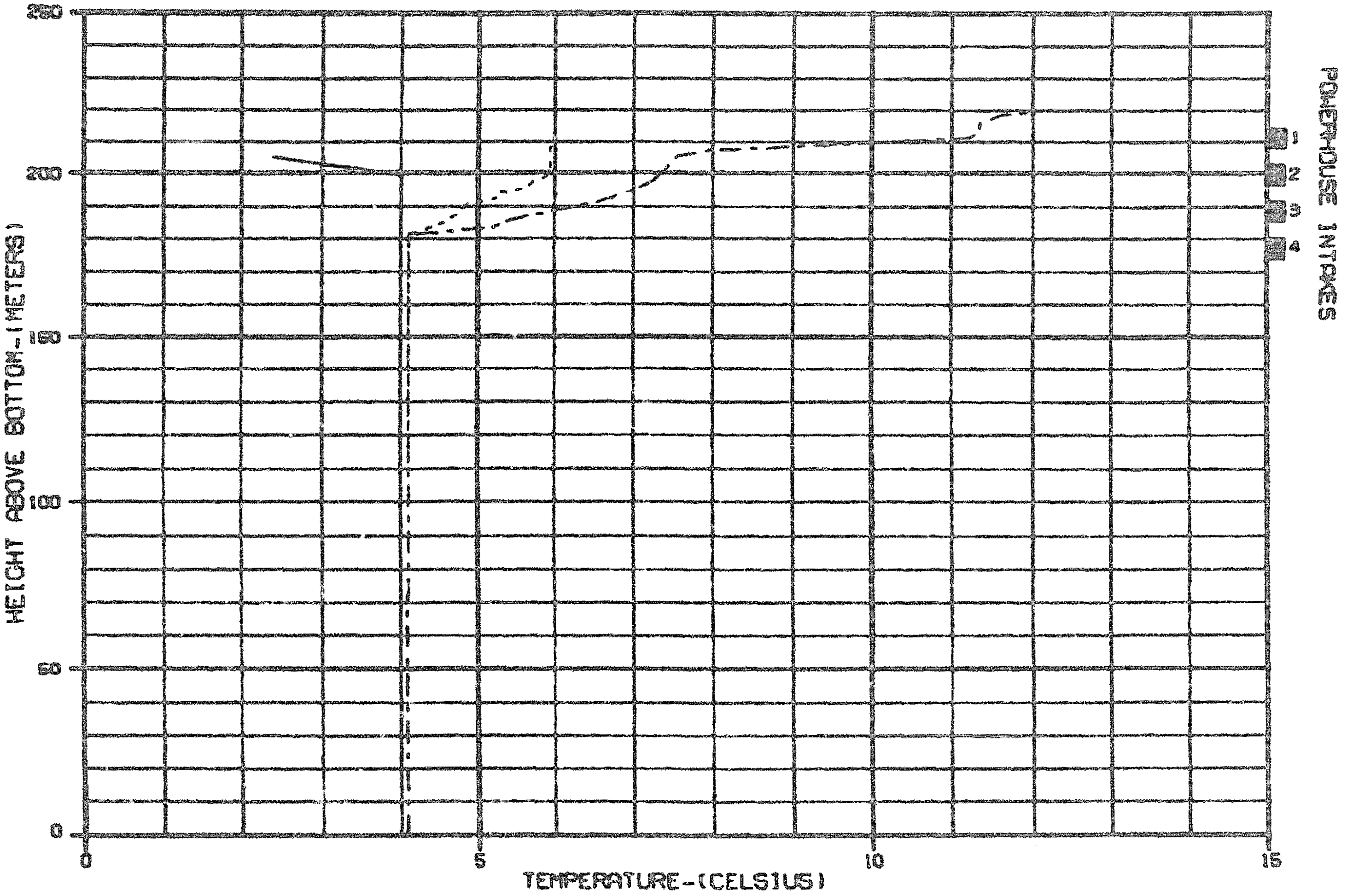
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

42-010-04



CASE: ** WA8102K - WATANA OPERATION W/DEVIL CANYON IN 2002 ** (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

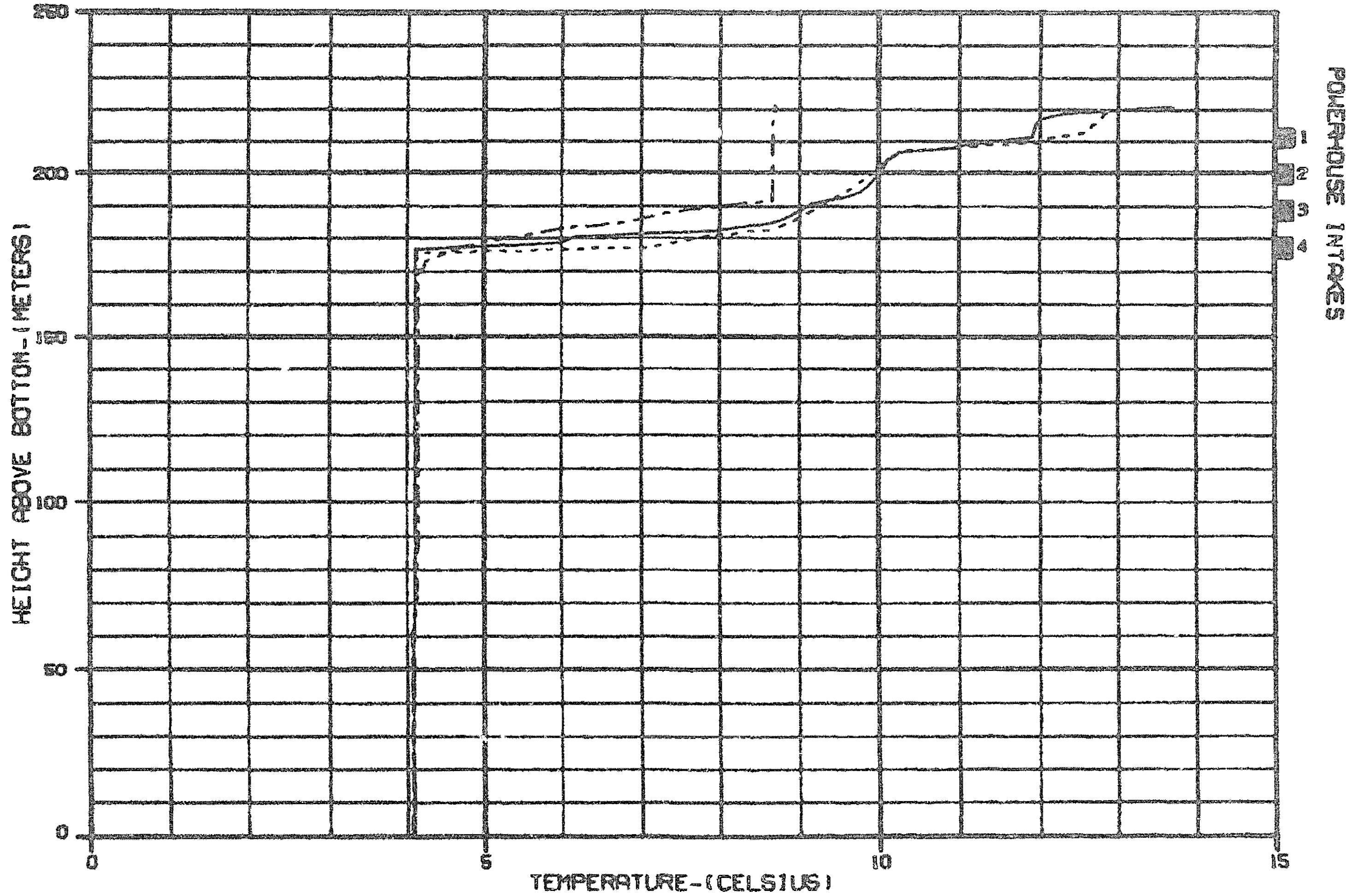
————	1 MAY 1982
- - - - - -	1 JUNE 1982
— - — - —	1 JULY 1982

ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE



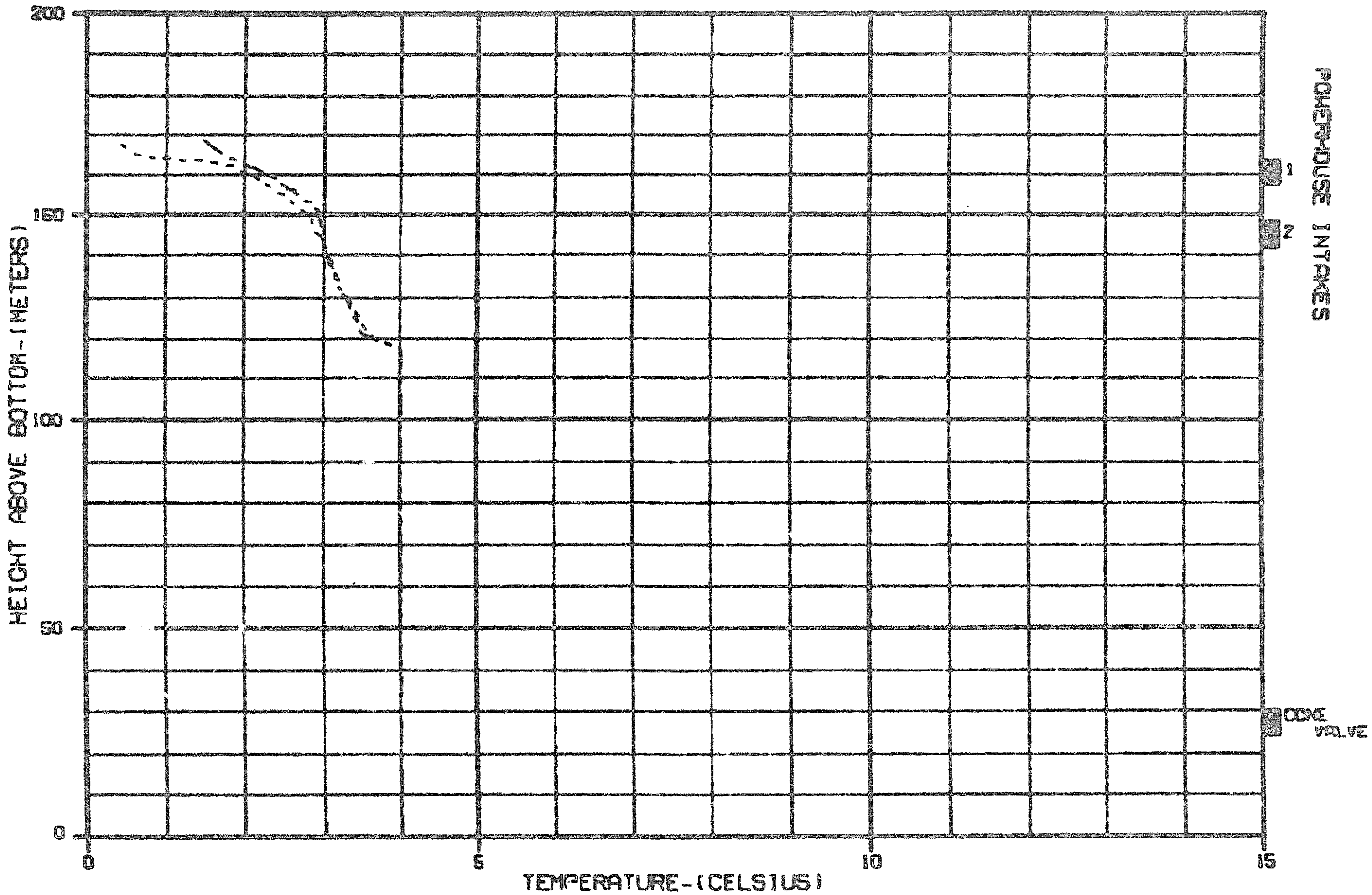
CASE: ** WAB102K - WATANA OPERATION W/DEVIL CANYON IN 2002 ** (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————————	1 AUGUST	1982
- - - - - - - -	1 SEPTEMBER	1982
— - — - —	1 OCTOBER	1982

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
WATANA RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
CHICAGO, ILLINOIS [illegible]	42-010-04



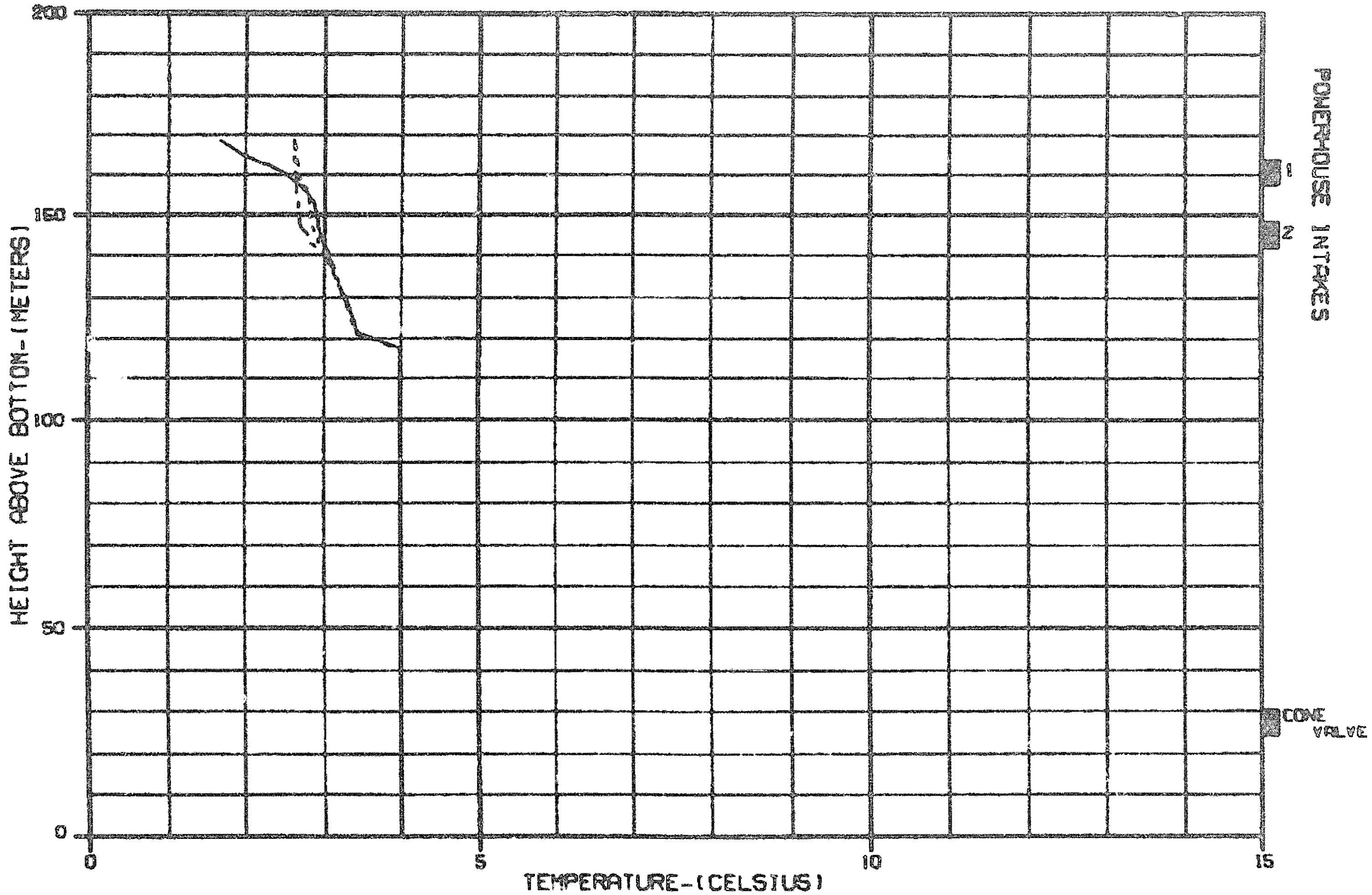
CASE: ** DC8102K - DEVIL CANYON OPERATION W/WATANA IN 2002 ** (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

- ———— 1 NOVEMBER 1980
- - - - - - 1 DECEMBER 1980
- —-—-— 1 JANUARY 1981

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
DEVIL CANYON RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
CHICAGO, ILLINOIS [illegible]	42-C10-04



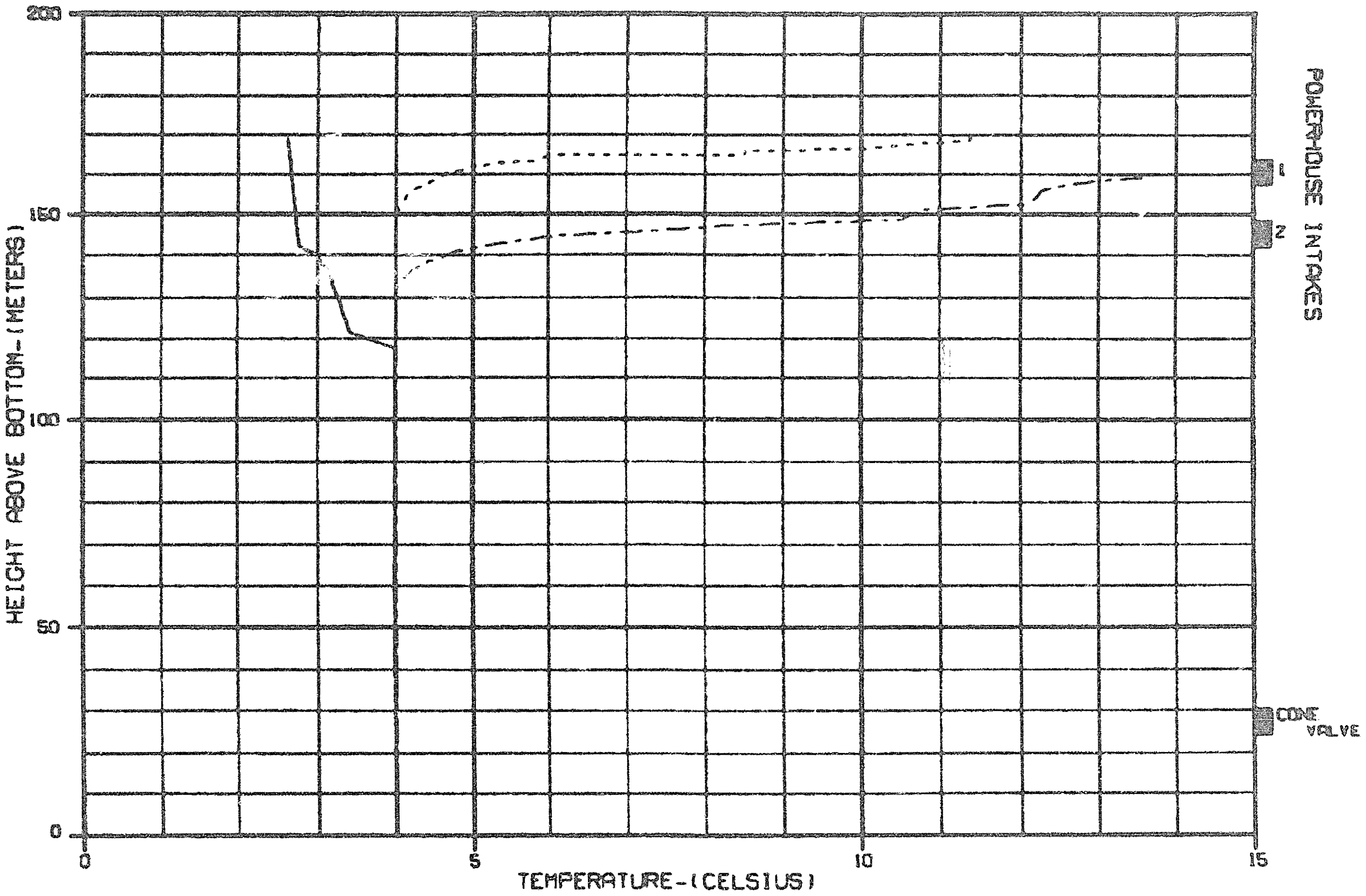
CASE: ** DC8102K - DEVIL CANYON OPERATION W/WATANA IN 2002 ** (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

1 FEBRUARY 1981 (solid line)
1 MARCH 1981 (dotted line)
1 APRIL 1981 (dash-dot line)

ALASKA POWER AUTHORITY		
SUSITNA PROJECT	DYRESM MODEL	
DEVIL CANYON RESERVOIR TEMPERATURE PROFILES		
HARZA-EBASCO JOINT VENTURE		
CHICAGO, ILLINOIS	[illegible]	E-010-04



CASE: ** DC8102K - DEVIL CANYON OPERATION W/WATANA IN 2002 ** (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)

LEGEND:

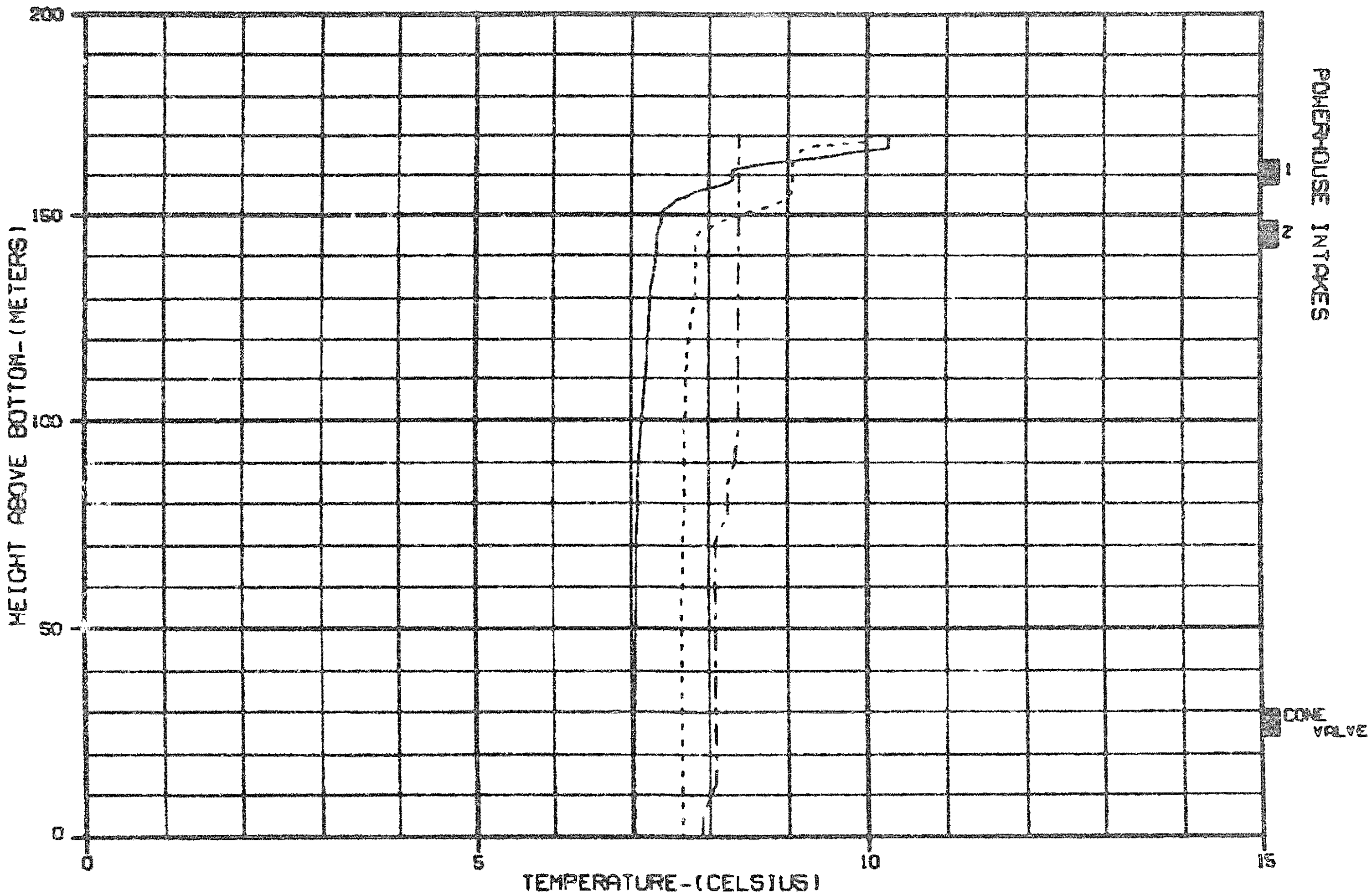
PREDICTED TEMPERATURE PROFILES:

———— 1 MAY 1981

- - - - 1 JUNE 1981

—·—·— 1 JULY 1981

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
DEVIL CANYON RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
[illegible]	42-010-04



CASE: ** DC8102K - DEVIL CANYON OPERATION W/WATANA IN 2002 ** (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

- ———— 1 AUGUST 1981
- - - - - - 1 SEPTEMBER 1981
- —·—·— 1 OCTOBER 1981

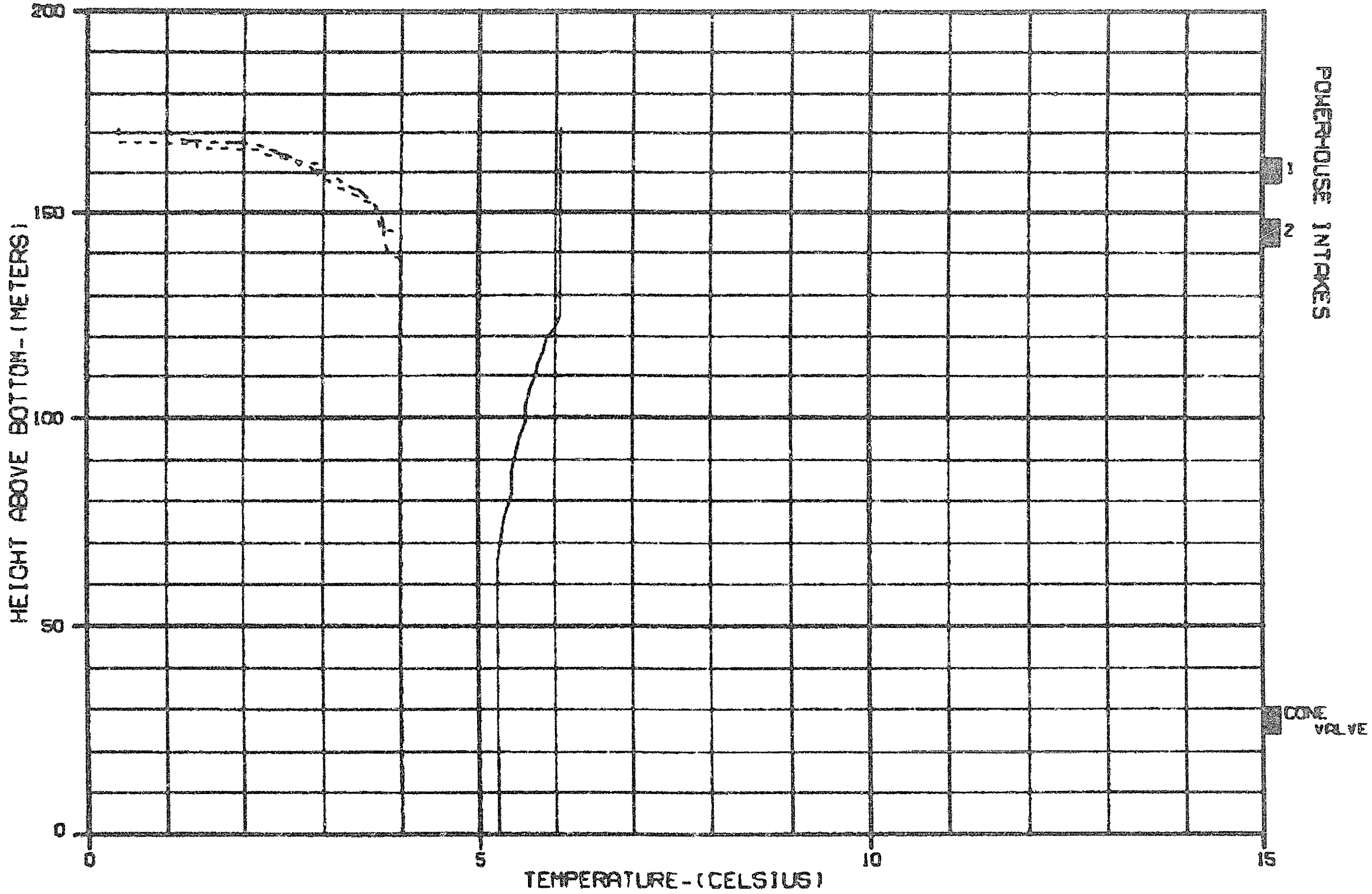
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

42-010-04



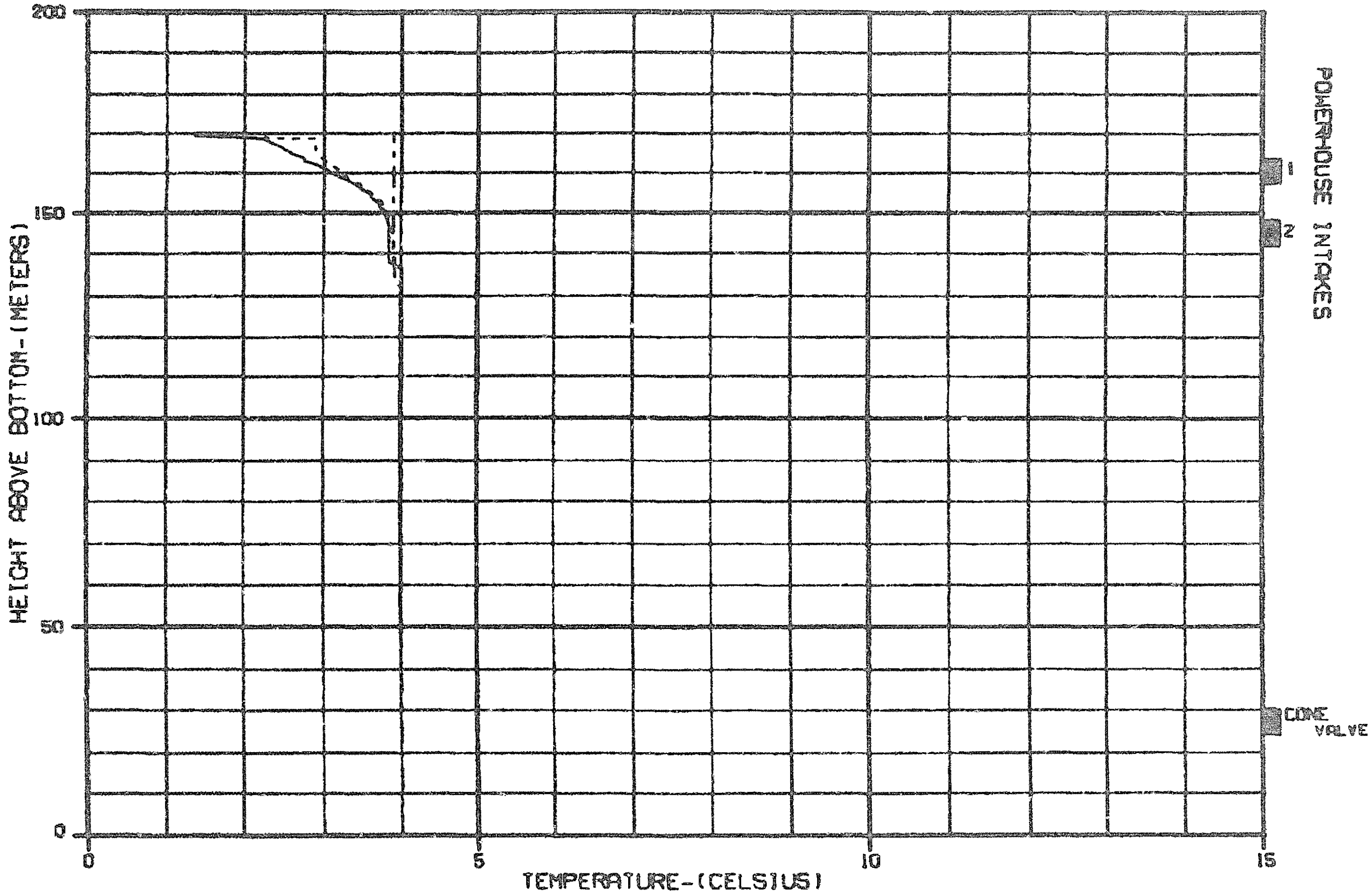
CASE: ** DCB102K - DEVIL CANYON OPERATION W/WATANA IN 2002 ** (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 NOVEMBER 1981
- - - - - - - -	1 DECEMBER 1981
—·—·—	1 JANUARY 1982

ALASKA POWER AUTHORITY		
SUSITNA PROJECT	DYRESM MODEL	
DEVIL CANYON RESERVOIR TEMPERATURE PROFILES		
HARZA-EBASCO JOINT VENTURE		
CHICAGO, ILLINOIS	20 JAN 83	42-010-04



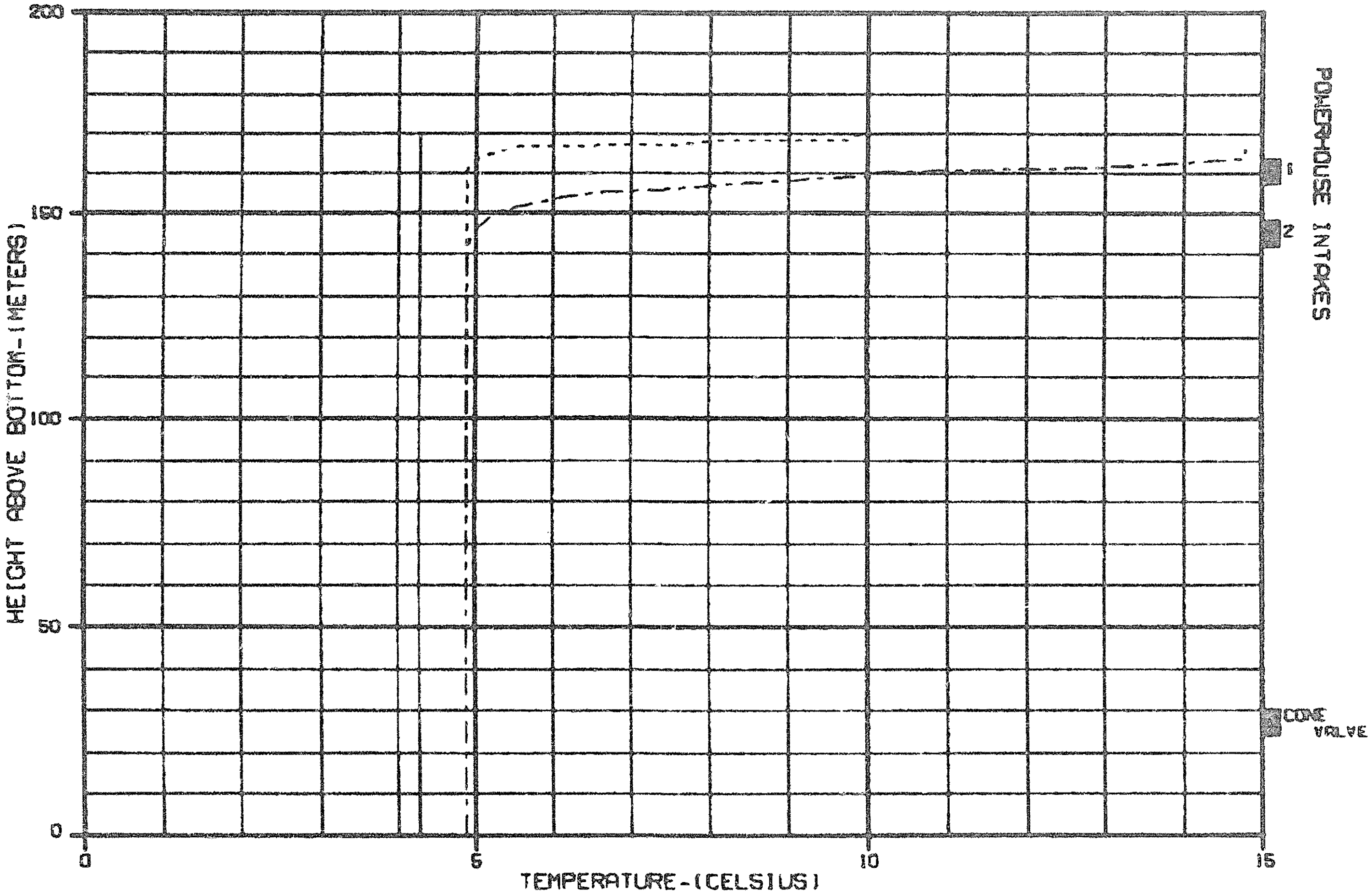
CASE: ** DC8102K - DEVIL CANYON OPERATION W/WATANA IN 2002 ** (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 FEBRUARY	1982
- - - - - -	1 MARCH	1982
— - — - —	1 APRIL	1982

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
DEVIL CANYON RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
CHICAGO, ILLINOIS	42-010-04



CASE: ** DC8102K - DEVIL CANYON OPERATION W/WATANA IN 2002 ** (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)

LEGEND:
PREDICTED TEMPERATURE PROFILES:
———— 1 MAY 1982
- - - - - 1 JUNE 1982
—·—·— 1 JULY 1982

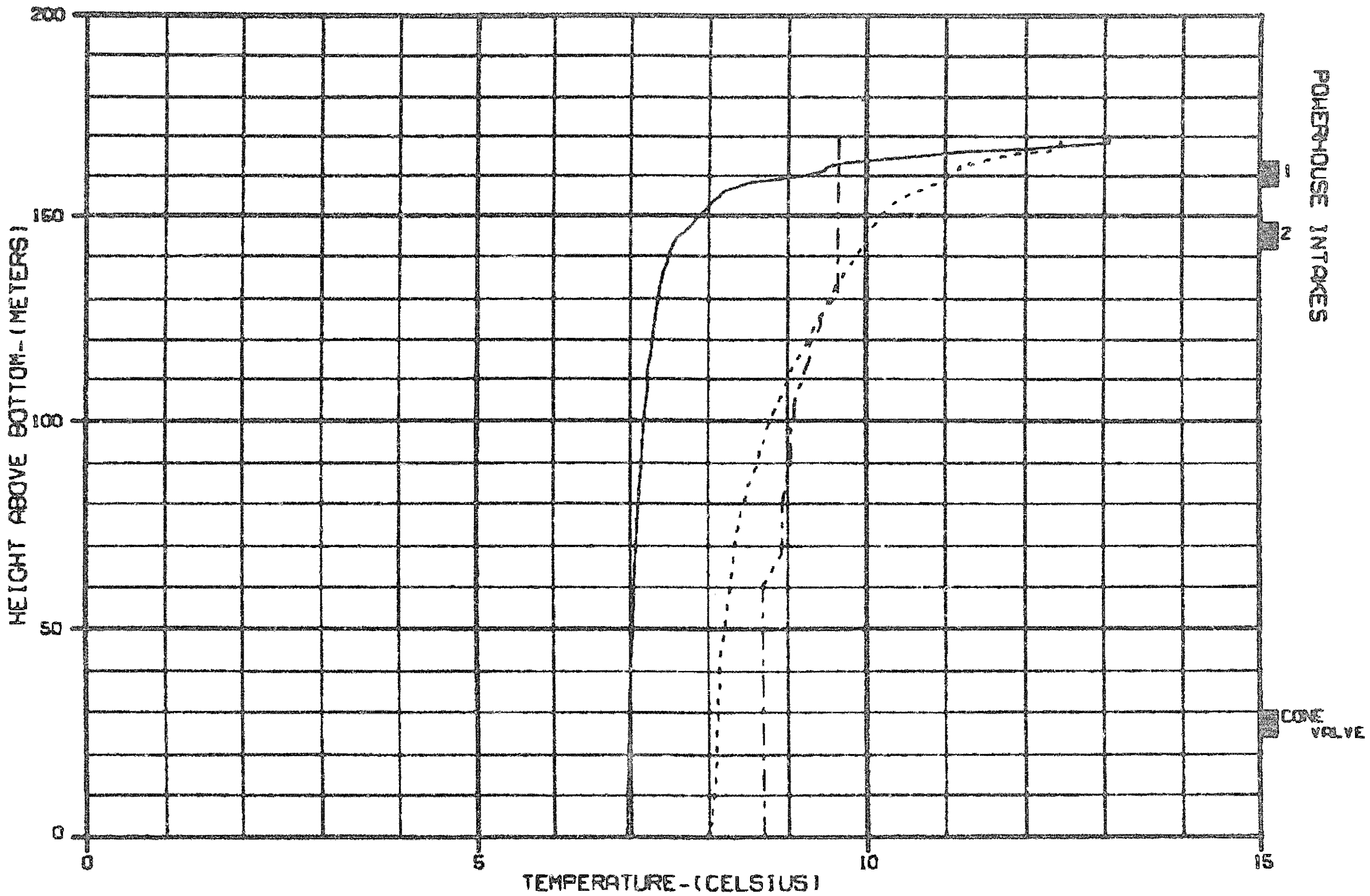
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 42-010-04



CASE: ** DC8102K - DEVIL CANYON OPERATION W/WATANA IN 2002 ** (E-VI)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)

LEGEND:

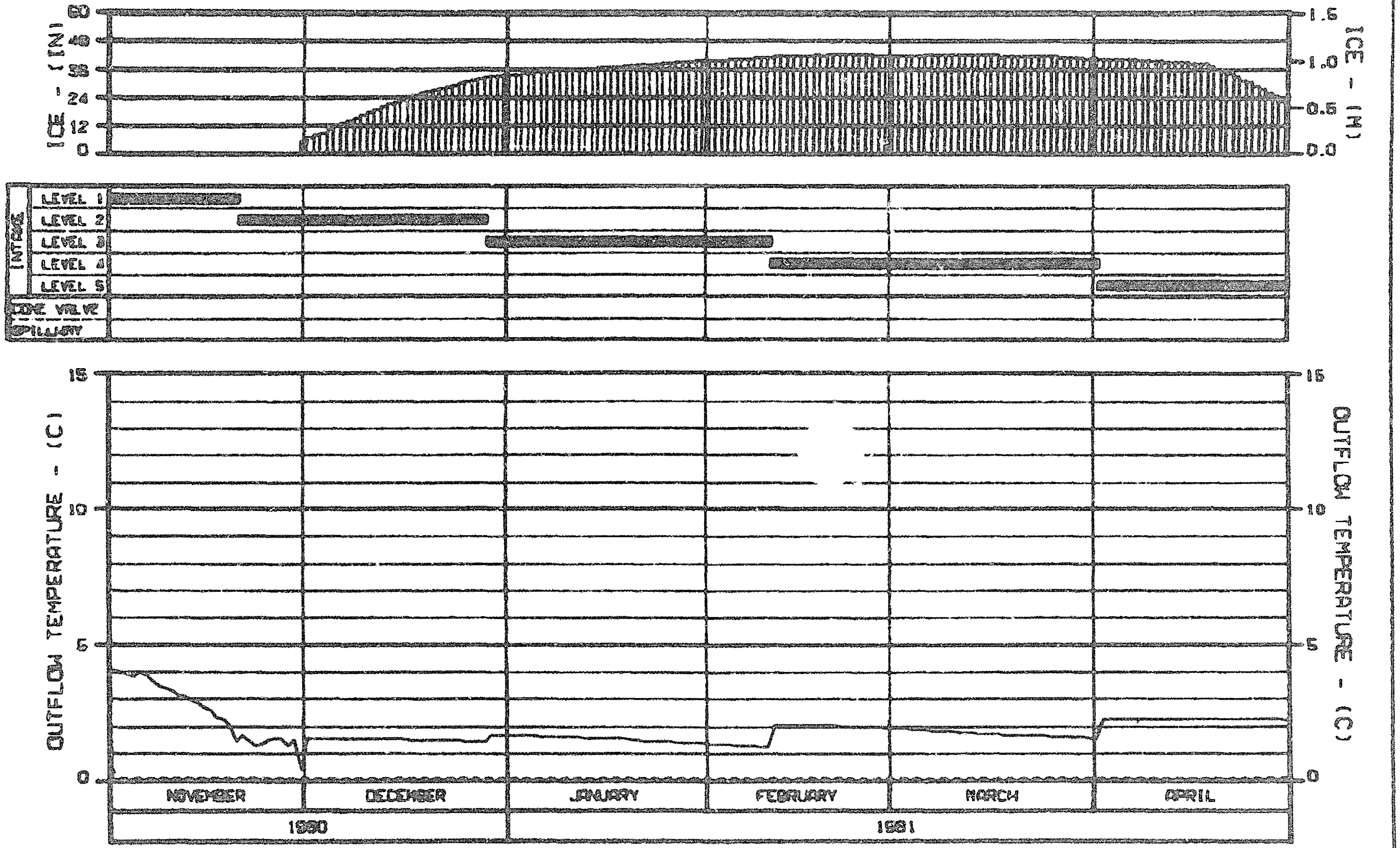
PREDICTED TEMPERATURE PROFILES:

- ———— 1 AUGUST 1982
- - - - - - 1 SEPTEMBER 1982
- — - — - 1 OCTOBER 1982

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
DEVIL CANYON RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
EVANSTON, ILLINOIS	42-010-04

EXHIBIT E

CASE E-VI
STAGE I
THREE-STAGE PROJECT
INFLOW TEMPERATURE MATCHING



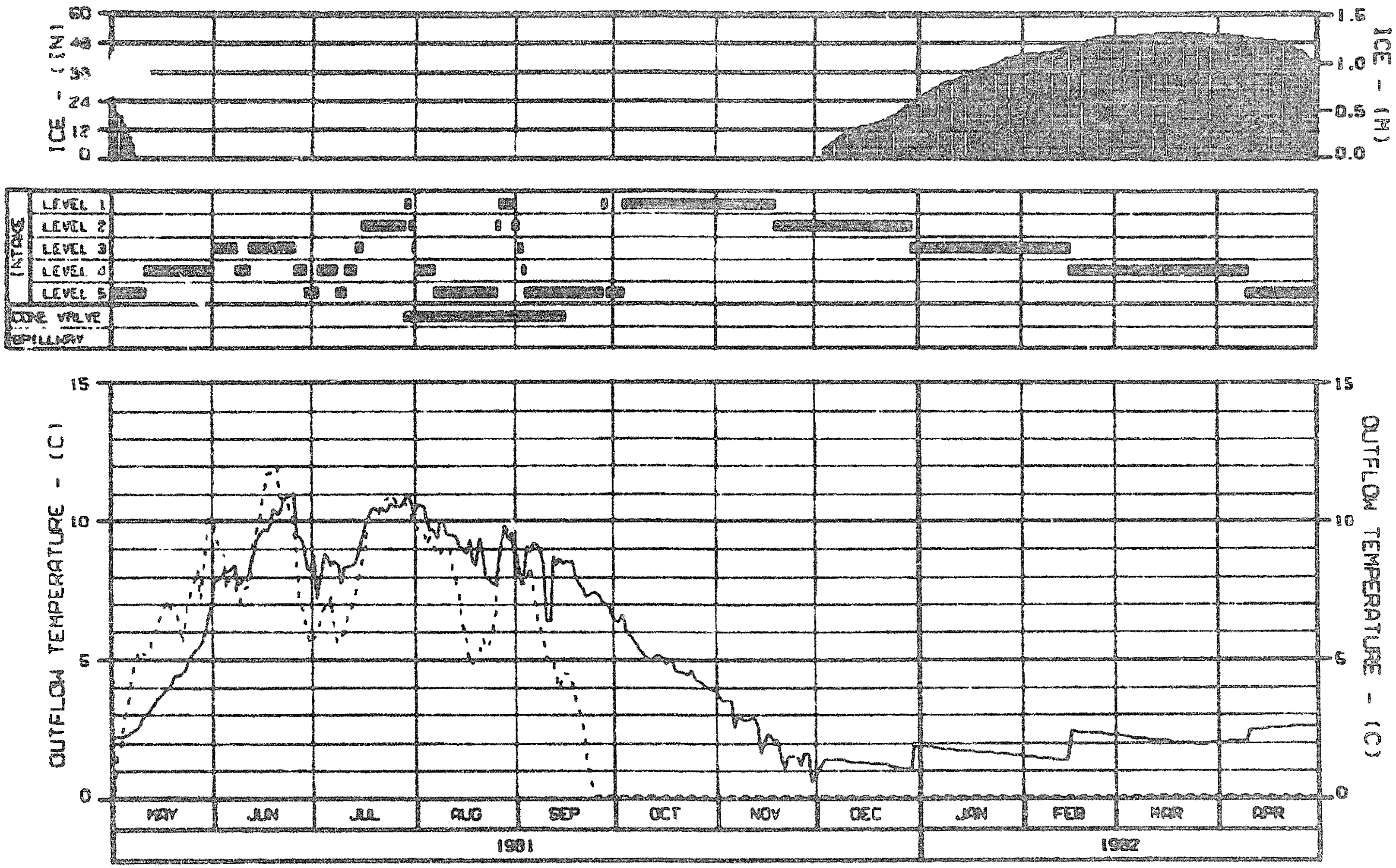
LEGEND: CASE: WA81010 - WATANA OPERATION ALONE IN 2001 (CASE E-6 STAGE 1)

———— PREDICTED OUTFLOW TEMPERATURE
- - - - - - INFLOW TEMPERATURE

Inflow Temp. Matching

NOTES:
1. INTAKE PORT LEVEL 1 AT EL. 1964.6 FT. (598.8 M)
2. INTAKE PORT LEVEL 2 AT EL. 1926.6 FT. (587.4 M)
3. INTAKE PORT LEVEL 3 AT EL. 1889.5 FT. (575.8 M)
4. INTAKE PORT LEVEL 4 AT EL. 1850.5 FT. (564.2 M)
5. INTAKE PORT LEVEL 5 AT EL. 1812.5 FT. (552.6 M)
6. CONE VALVE AT ELEVATION 1929 FT (588.0 M)
7. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

ALASKA POWER AUTHORITY		
SUSITNA PROJECT	DYRESM MODEL	
WATANA RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH		
HARZA-EBASCO JOINT VENTURE		
CHICAGO, ILLINOIS	[illegible]	42-010-04



LEGEND: CASE: WA81010 - WATANA OPERATION ALONE IN 2001 (CASE E-6 STAGE I)

——————— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

Inflow Temp. Matching

NOTES:
1. INTAKE PORT LEVEL 1 AT EL. 1964.5 FT. (598.9 M)
2. INTAKE PORT LEVEL 2 AT EL. 1926.5 FT. (587.4 M)
3. INTAKE PORT LEVEL 3 AT EL. 1888.5 FT. (575.8 M)
4. INTAKE PORT LEVEL 4 AT EL. 1850.5 FT. (564.2 M)
5. INTAKE PORT LEVEL 5 AT EL. 1812.5 FT. (552.6 M)
6. CONE VALVE AT ELEVATION 1929 FT (588.0 M)
7. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

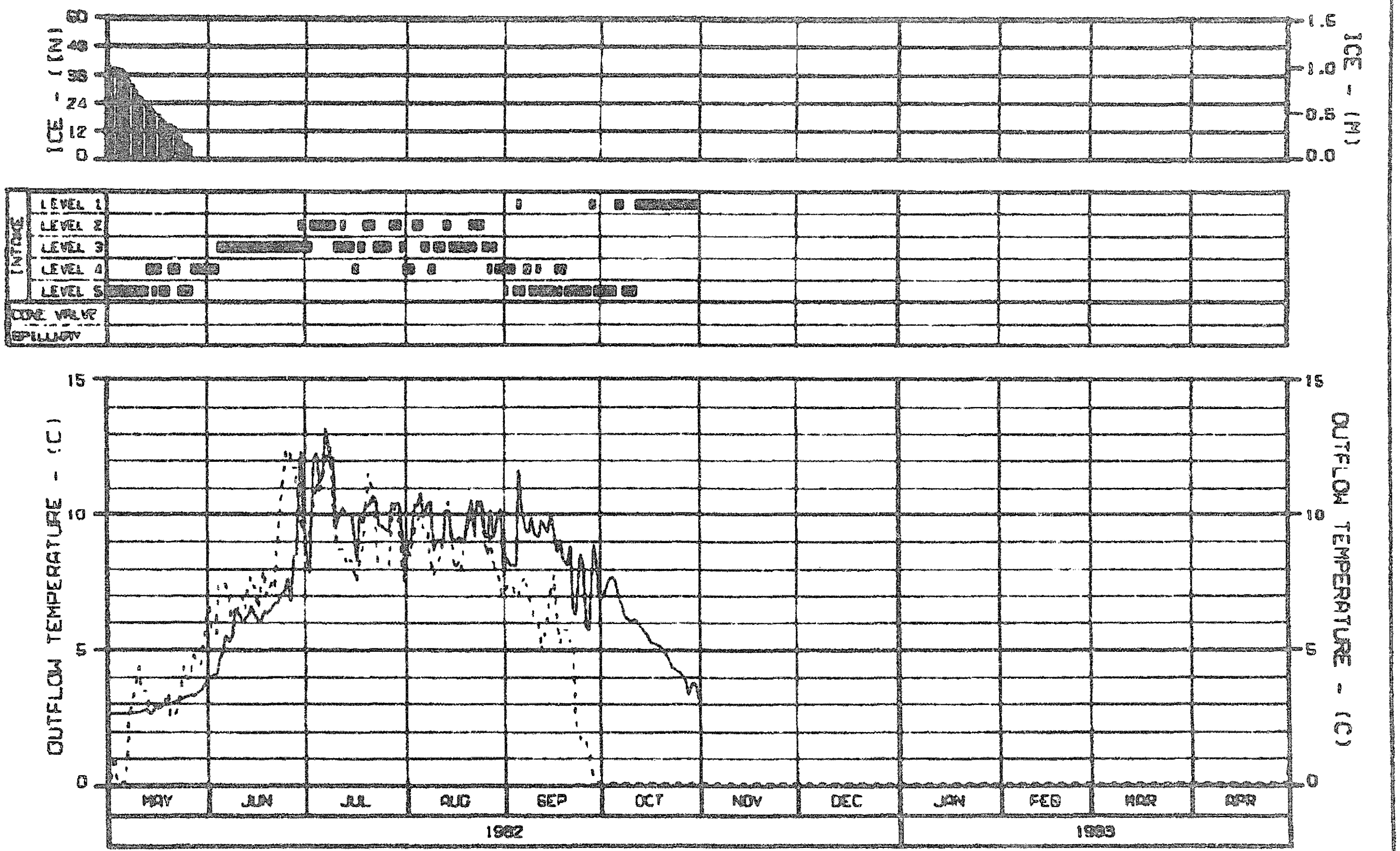
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 4 JUN 85 | 42-010-04



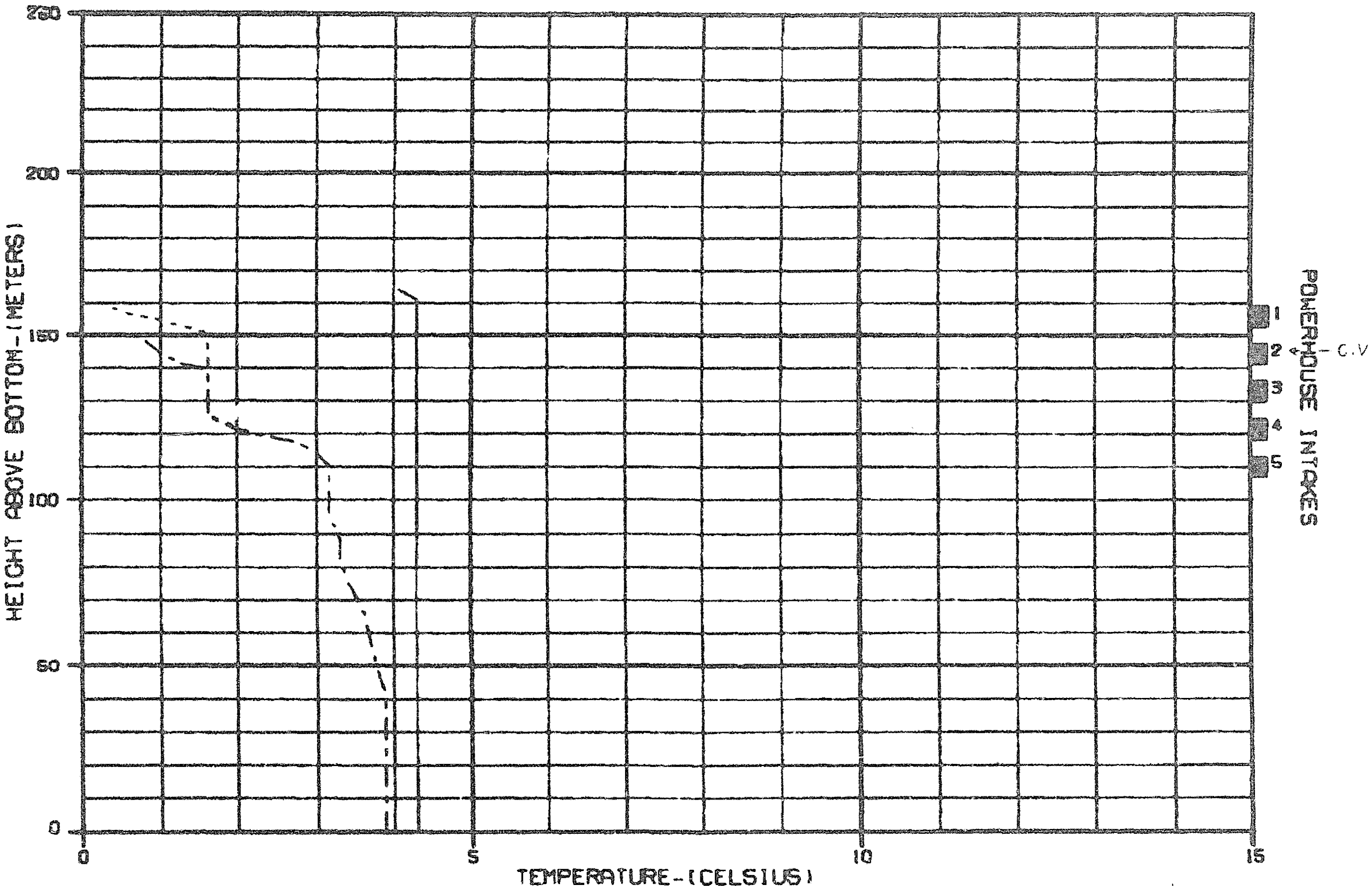
LEGEND: CASE: ** WAS1010 - WATANA OPERATION ALONE IN 2001 (CASE E-6 STAGE 1) *

——————— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

Inflowing Temp. Matching

NOTES:
1. INTAKE PORT LEVEL 1 AT EL. 1964.5 FT. (598.9 M)
2. INTAKE PORT LEVEL 2 AT EL. 1926.5 FT. (587.4 M)
3. INTAKE PORT LEVEL 3 AT EL. 1888.5 FT. (575.8 M)
4. INTAKE PORT LEVEL 4 AT EL. 1850.5 FT. (564.2 M)
5. INTAKE PORT LEVEL 5 AT EL. 1812.5 FT. (552.6 M)
6. CONE VALVE AT ELEVATION 1929 FT (588.0 M)
7. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

ALASKA POWER AUTHORITY		
SUSITNA PROJECT	DYRESM MODEL	
WATANA RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH		
HARZA-EBASCO JOINT VENTURE		
CHICAGO, ILLINOIS	[illegible]	[illegible]



CASE: ** WA81010 - WATANA OPERATION ALONE IN 2001 (CASE E-6 STAGE I) **

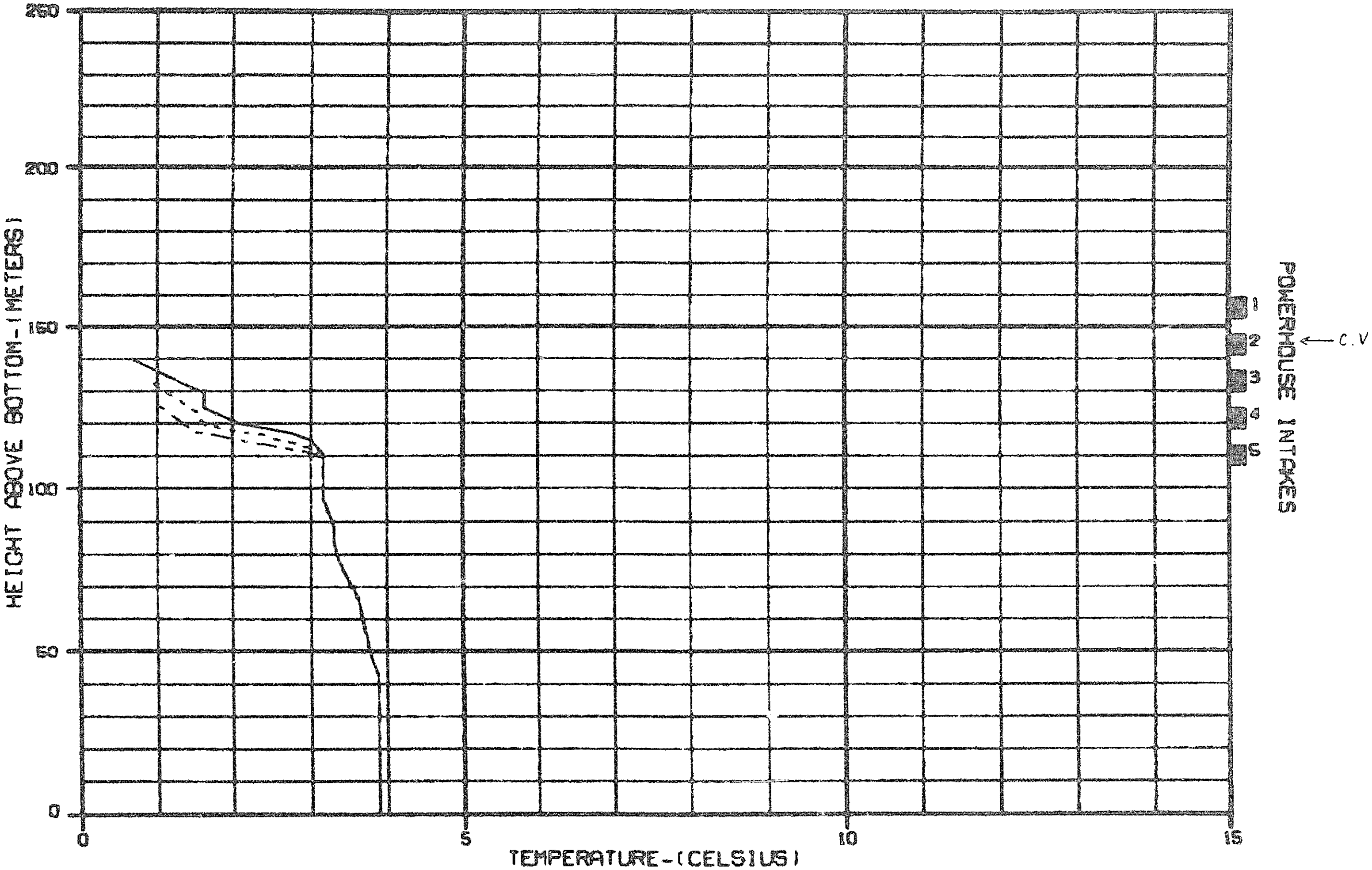
Inflowing Temp. Matching

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 NOVEMBER 1980
- - - - - - -	1 DECEMBER 1980
— - — - —	1 JANUARY 1981

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
WATANA RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
CHICAGO, ILLINOIS · 4 JUN 83	42-010-04



CASE: ** WAB1010 - WATANA OPERATION ALONE IN 2001 (CASE E-6 STAGE 1) **

Inflow Temp. Matching

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 FEBRUARY	1981
- - - - - - -	1 MARCH	1981
— - — - —	1 APRIL	1981

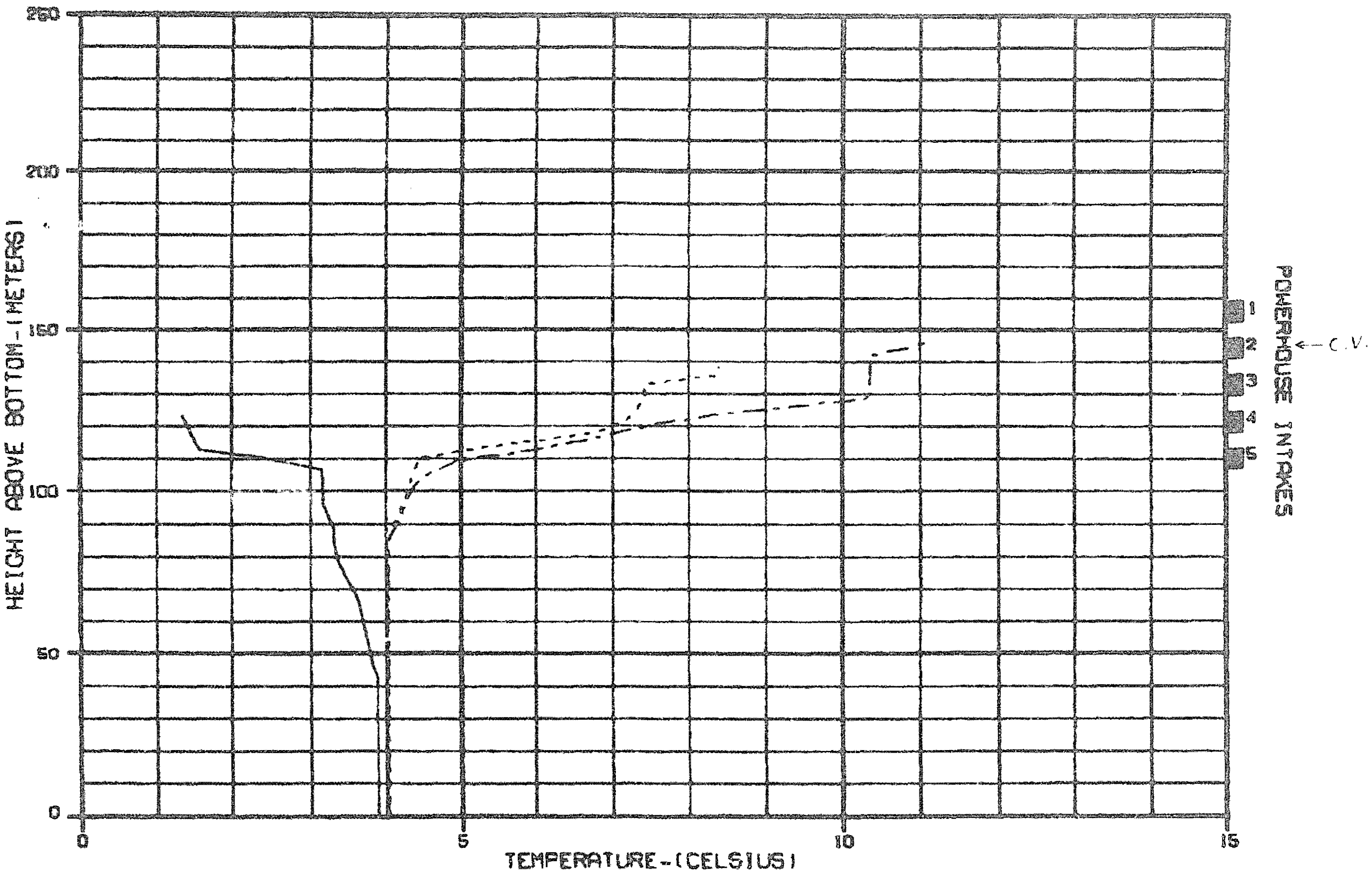
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 4 JUN [illegible] | 42-010-04



CASE: ** WA81010 - WATANA OPERATION ALONE IN 2001 (CASE E-6 STAGE 1) **

Inflow Temp. Matching

LEGEND:

PREDICTED TEMPERATURE PROFILES:

———— (solid)	1 MAY 1981
- - - - - (dashed)	1 JUNE 1981
—·—·— (dash-dot)	1 JULY 1981

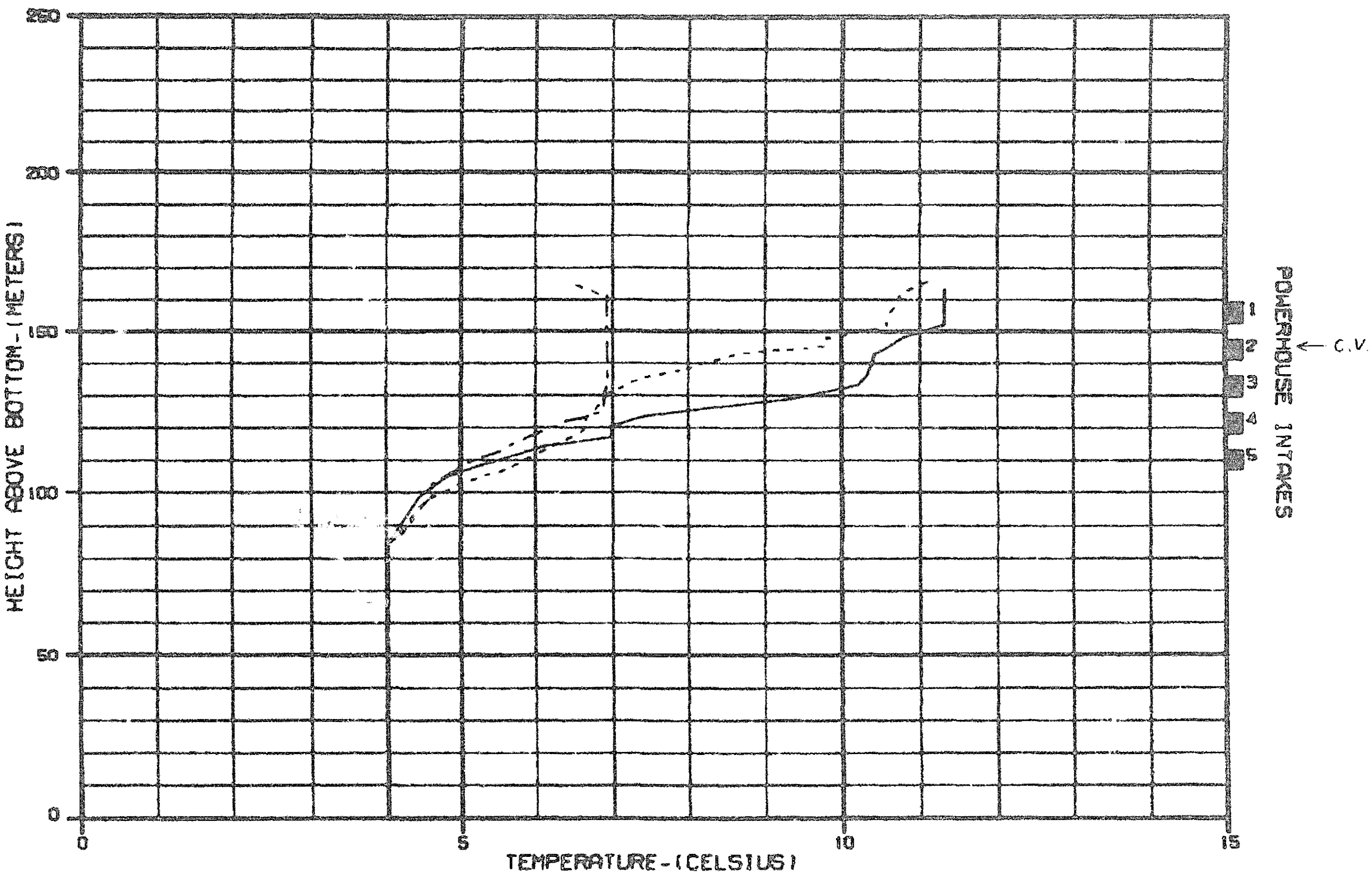
ALASKA POWER AUTHORITY

SUSITNA PROJECT

WATANA RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

42-010-04



CASE: ** WAB1010 - WATANA OPERATION ALONE IN 2001 (CASE E-6 STAGE 1) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

——— 1 AUGUST 1981
- - - - - 1 SEPTEMBER 1981
— - — - 1 OCTOBER 1981

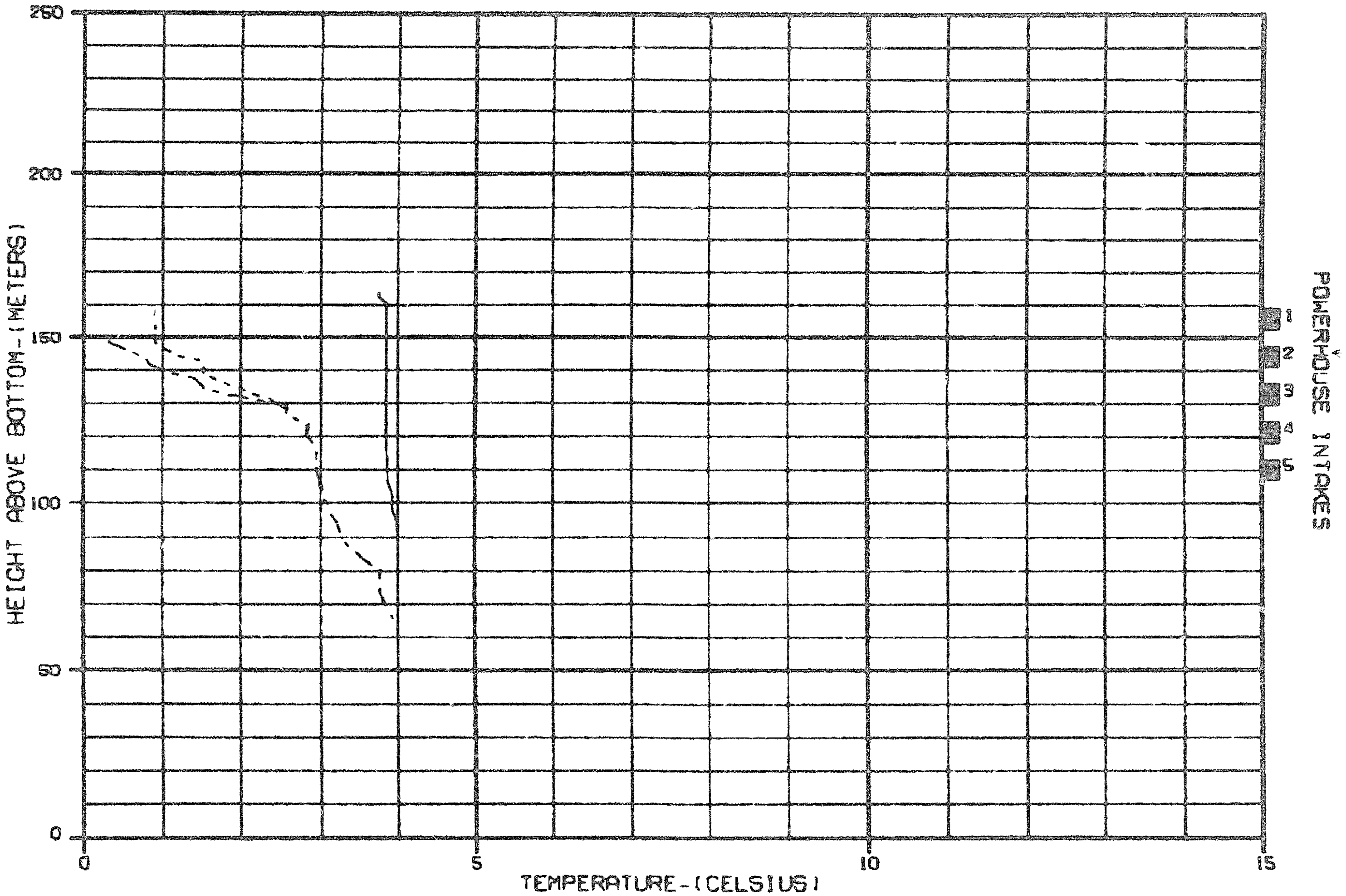
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

42-010-04



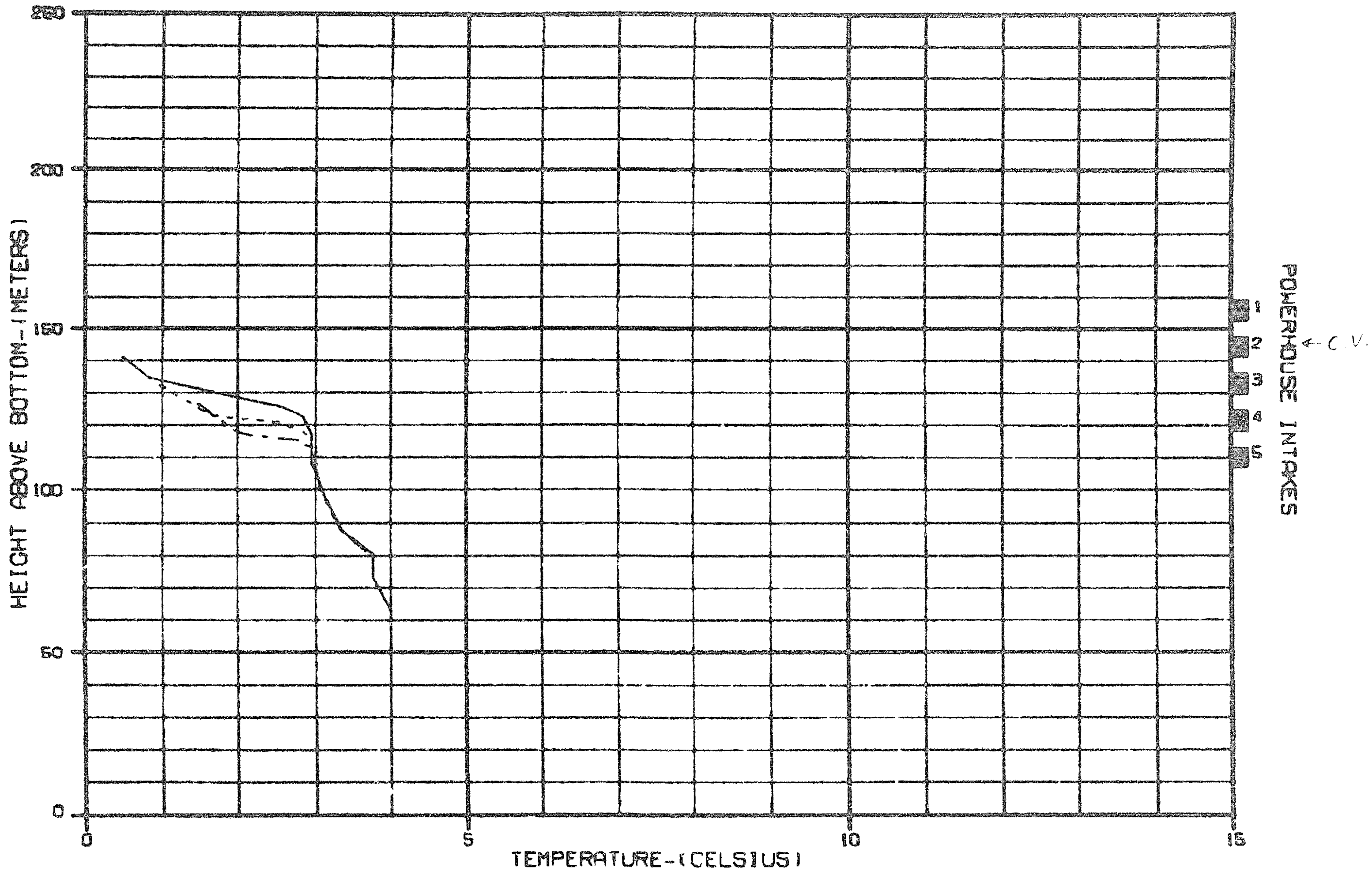
CASE: ** WA81010 - WATANA OPERATION ALONE IN 2001 (CASE E-6 STAGE 1) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

———— 1 NOVEMBER 1981
- - - - 1 DECEMBER 1981
— - — - 1 JANUARY 1982

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
WATANA RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
CHECKED: ILL 0/0/0 · 4 JUN 85	42-010-04



CASE: ** WAB1010 - WATANA OPERATION ALONE IN 2001 (CASE E-6 STAGE I) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 FEBRUARY	1982
- - - - -	1 MARCH	1982
— - — -	1 APRIL	1982

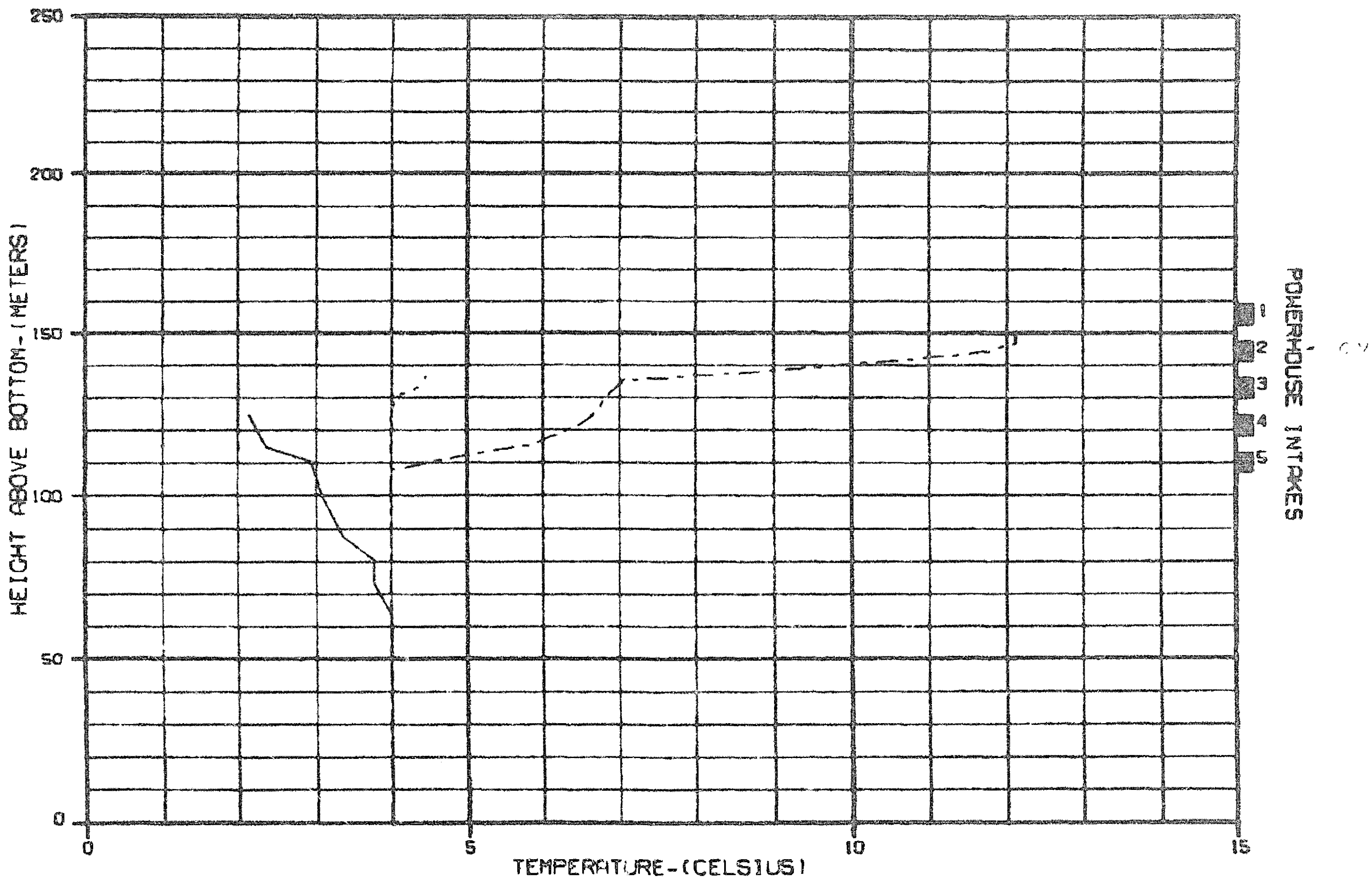
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR TEMPERATURE PROFILES

HAR... JOINT VENTURE

42-010-04



CASE: ** WA81010 - WATANA OPERATION ALONE IN 2001 (CASE E-6 STAGE I) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 MAY 1982
- - - - - - - -	1 JUNE 1982
— - — - —	1 JULY 1982

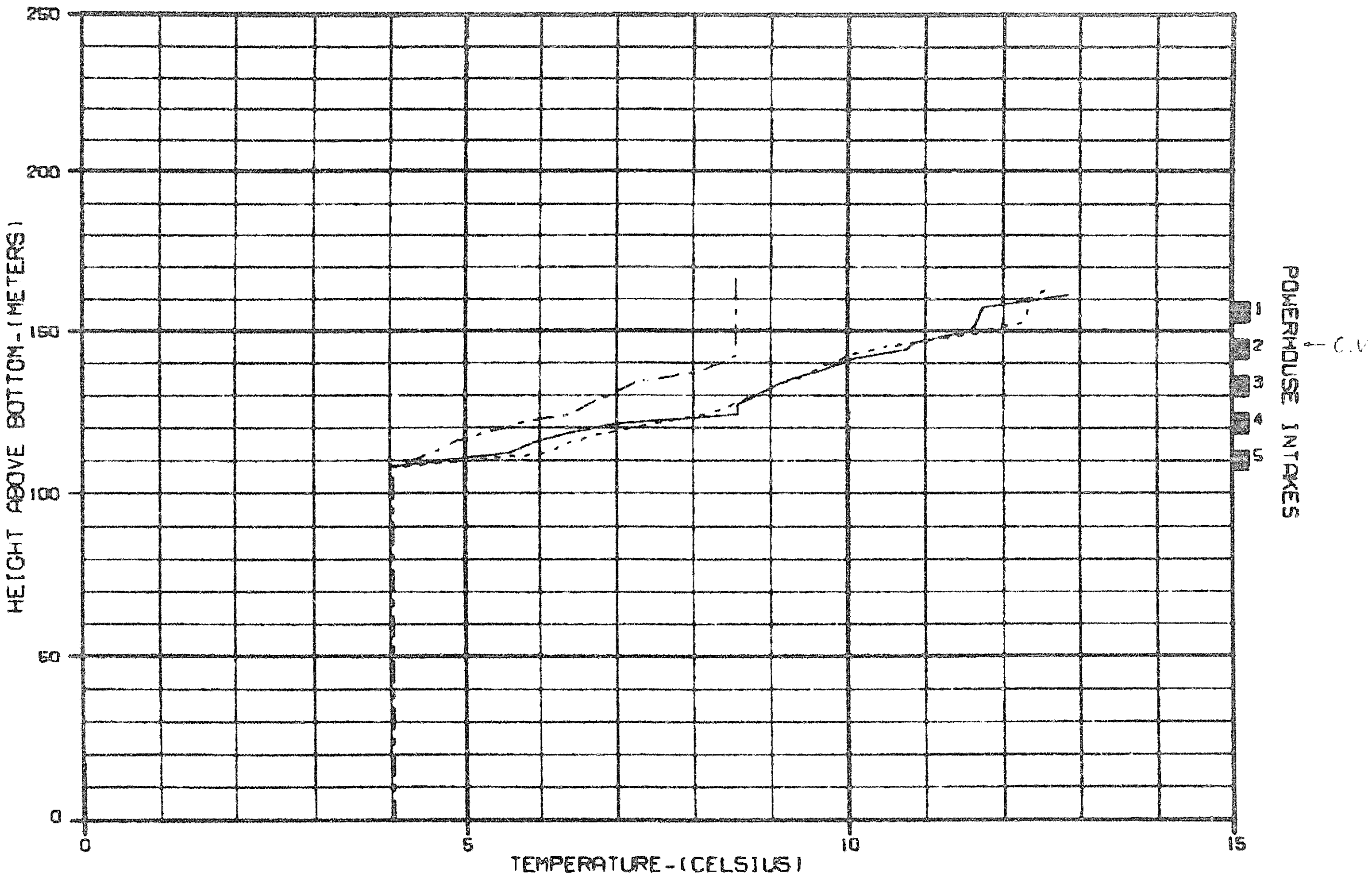
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 4 JAN 83 | 42-010-04



CASE: ** WA81010 - WATANA OPERATION ALONE IN 2001 (CASE E-6 STAGE I) **

LEGEND:

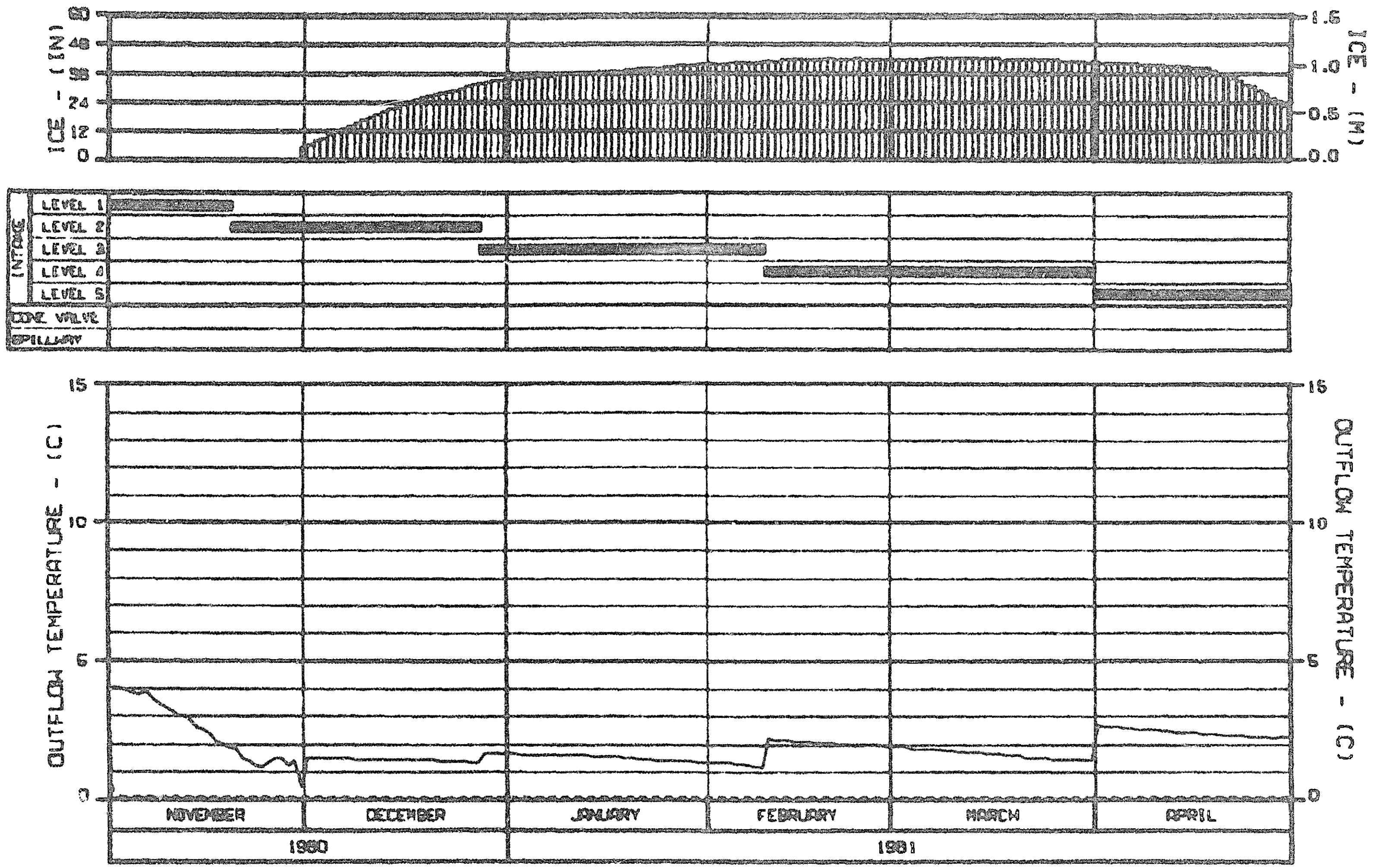
PREDICTED TEMPERATURE PROFILES:

————	1 AUGUST	1982
- - - - - -	1 SEPTEMBER	1982
— - — - —	1 OCTOBER	1982

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
WATANA RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
CHECKED. ILL PHOTO 4 JAN 85	42-010-04

EXHIBIT F

CASE E-VI
STAGE I
THREE-STAGE PROJECT
INFLOW TEMPERATURE MATCHING
AND LEVEL-5 ONLY



LEGEND: CASE: ** WA8101L - WATANA OPERATION ALONE IN 2001 **
CASE E-VI61. NATURAL CONDITIONS AND LOWEST LEVEL
——— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

winter 81-82

NOTES:
1. INTAKE PORT LEVEL 1 AT EL. 1964.5 FT. (598.8 M)
2. INTAKE PORT LEVEL 2 AT EL. 1926.5 FT. (587.4 M)
3. INTAKE PORT LEVEL 3 AT EL. 1888.5 FT. (575.6 M)
4. INTAKE PORT LEVEL 4 AT EL. 1850.5 FT. (564.2 M)
5. INTAKE PORT LEVEL 5 AT EL. 1812.5 FT. (552.6 M)
6. CONE VALVE AT ELEVATION 1791 FT (546.0 M)
7. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

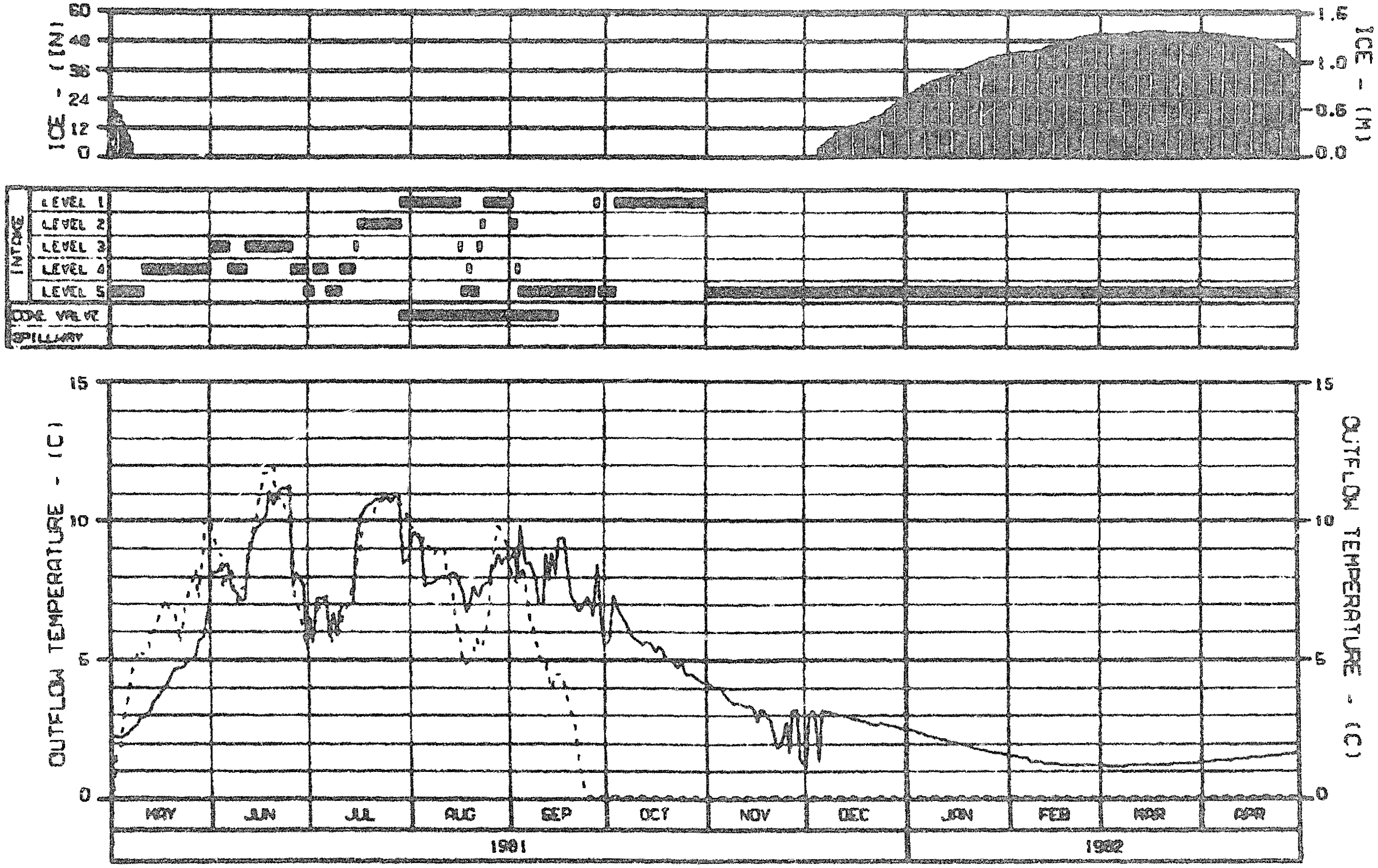
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | [illegible] | 42-010-04



LEGEND: CASE: WAS101L - WATANA OPERATION ALONE IN 2001
CASE E-VI51. NATURAL CONDITIONS AND LOWEST LEVEL
———— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT EL. 1964.5 FT. (598.8 M)
2. INTAKE PORT LEVEL 2 AT EL. 1926.5 FT. (587.4 M)
3. INTAKE PORT LEVEL 3 AT EL. 1888.5 FT. (575.8 M)
4. INTAKE PORT LEVEL 4 AT EL. 1850.5 FT. (564.2 M)
5. INTAKE PORT LEVEL 5 AT EL. 1812.5 FT. (552.6 M)
6. CONE VALVE AT ELEVATION 1791 FT (546.0 M)
7. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

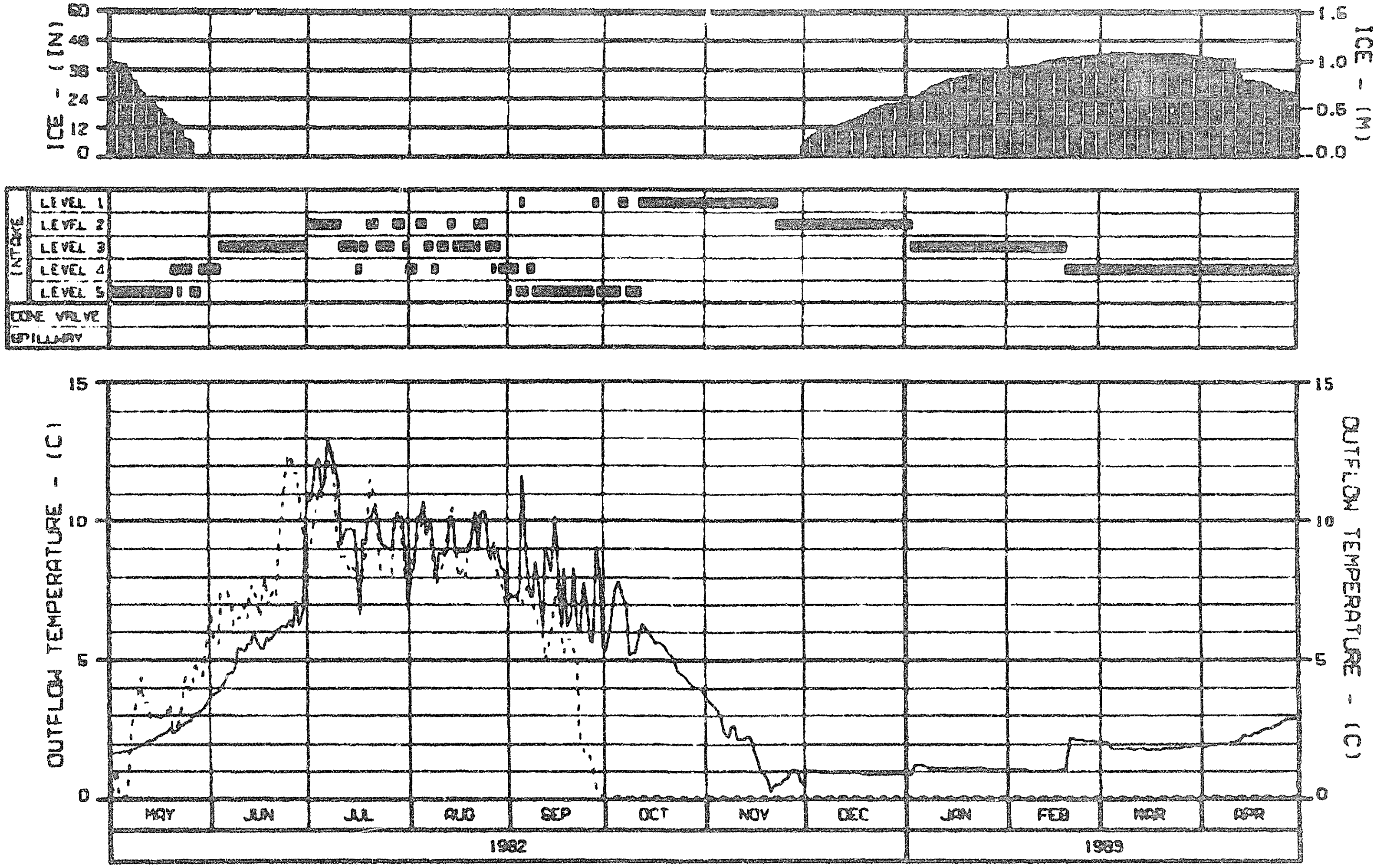
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | [illegible] | 42-010-04



LEGEND: CASE: WA8101L - WATANA OPERATION ALONE IN 2001
CASE E-VI61. NATURAL CONDITIONS AND LOWEST LEVEL
——————— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT EL. 1964.5 FT. (598.9 M)
2. INTAKE PORT LEVEL 2 AT EL. 1926.5 FT. (587.4 M)
3. INTAKE PORT LEVEL 3 AT EL. 1888.5 FT. (575.8 M)
4. INTAKE PORT LEVEL 4 AT EL. 1850.5 FT. (564.2 M)
5. INTAKE PORT LEVEL 5 AT EL. 1812.5 FT. (552.6 M)
6. CONE VALVE AT ELEVATION 1791 FT (546.0 M)
7. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

ALASKA POWER AUTHORITY

SUSITNA PROJECT	DYRESM MODEL

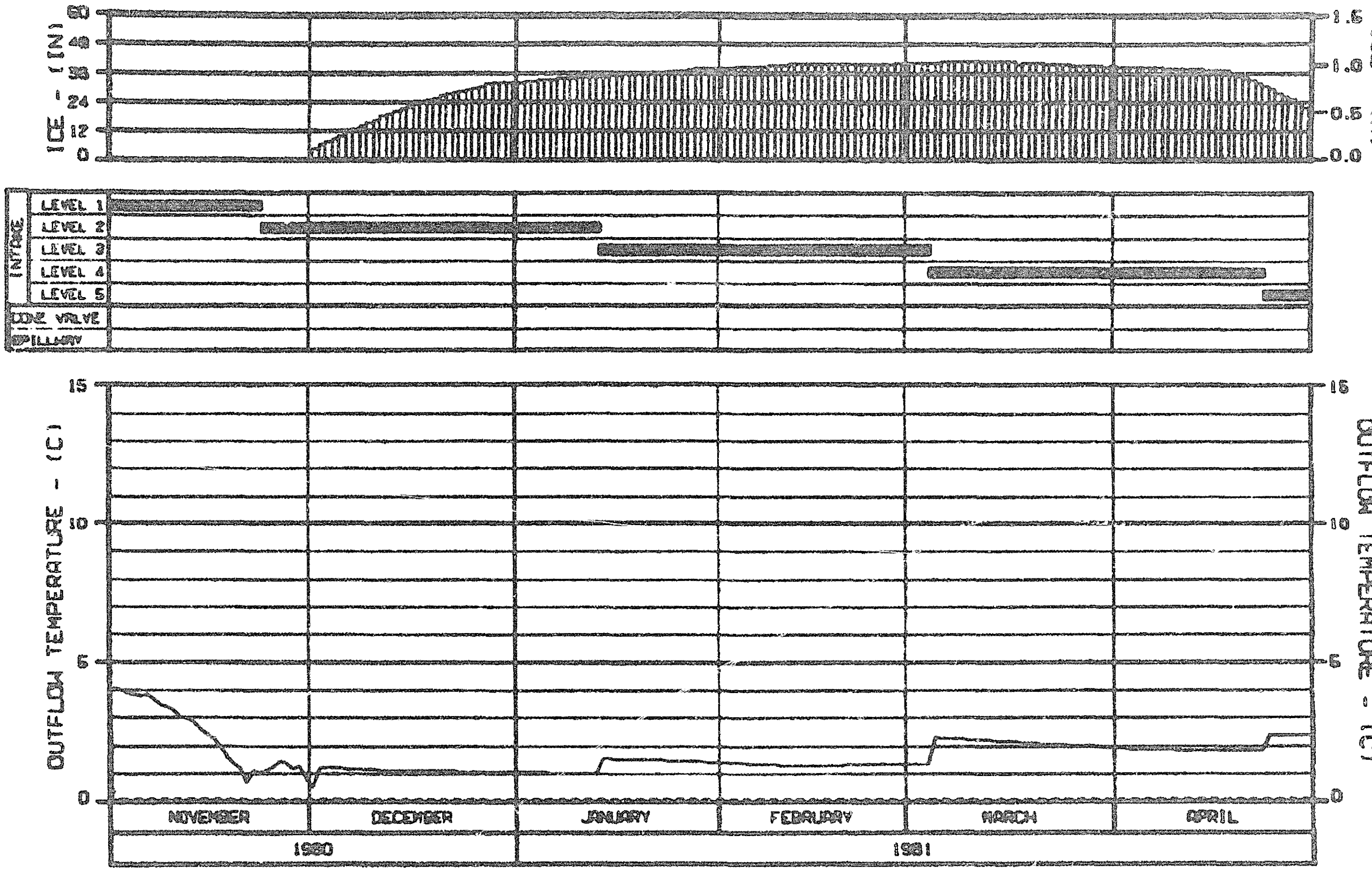
WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS	[illegible]	42-010-04

EXHIBIT G

CASE E-VI
STAGE II
THREE-STAGE PROJECT
INFLOW TEMPERATURE MATCHING



LEGEND: CASE: WA810202 WATANA OPERATION W/DEVIL CANYON IN 2002
CASE E-VI 62 NATURAL CONDITIONS CONE VALV. ELEV. CORRECTED

Natural cond't
50' drawdown at D.C

——— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

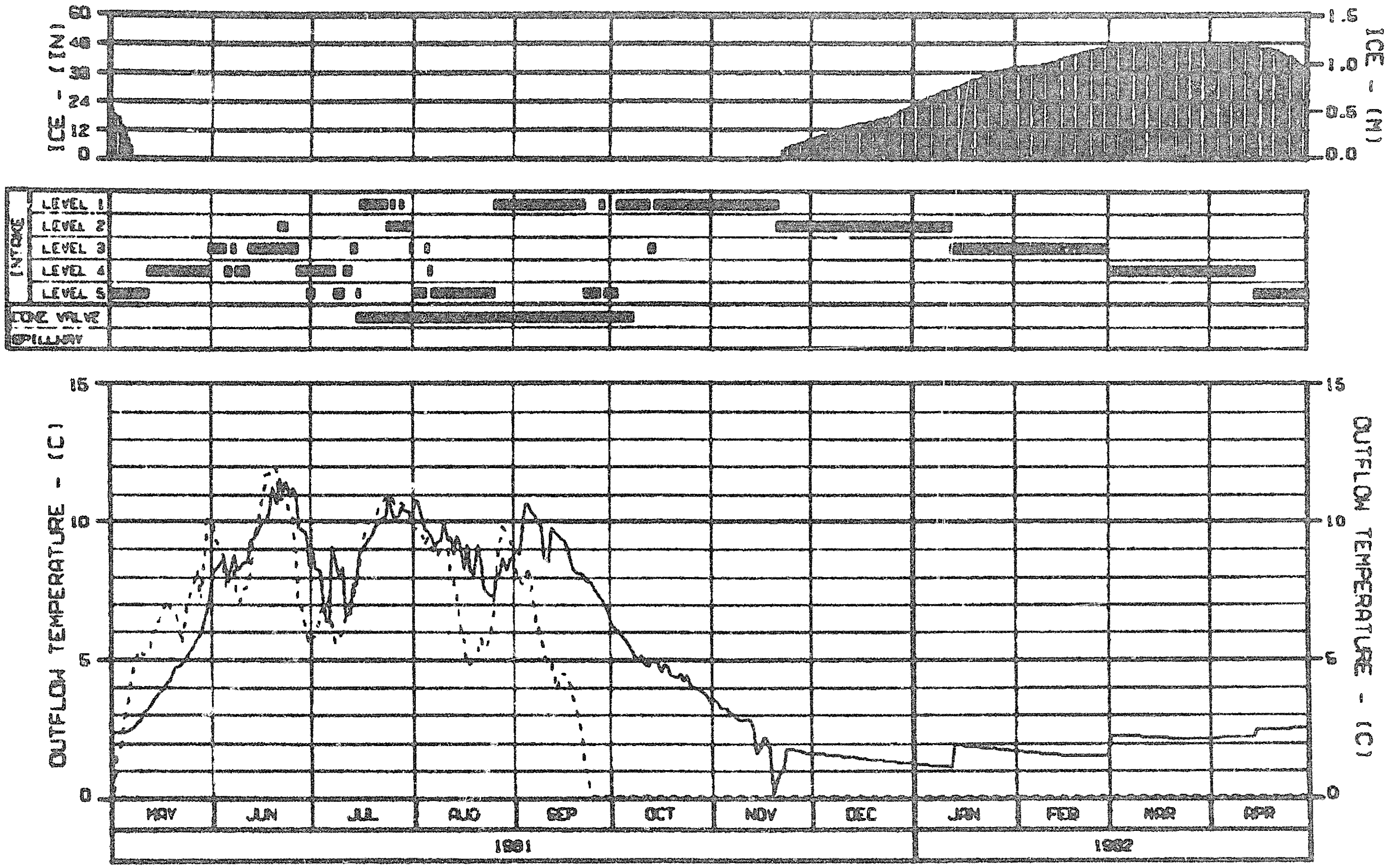
NOTES:
1. INTAKE PORT LEVEL 1 AT EL. 1964.5 FT. (599.8 M)
2. INTAKE PORT LEVEL 2 AT EL. 1926.5 FT. (587.2 M)
3. INTAKE PORT LEVEL 3 AT EL. 1988.5 FT. (576.6 M)
4. INTAKE PORT LEVEL 4 AT EL. 1850.5 FT. (564.0 M)
5. INTAKE PORT LEVEL 5 AT EL. 1812.5 FT. (552.5 M)
6. CONE VALVE AT ELEVATION 1929 FT (588.0 M)
7. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)
8. THIS RUN SUPERCEDES WA81020 (BAD CONE VALV. ELEV.)

ALASKA POWER AUTHORITY

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

42-010-04



LEGEND: CASE: WA810202 WATANA OPERATION W/DEVIL CANYON IN 2002
CASE E-VI 62 NATURAL CONDITIONS CONE VALV. ELEV. CORRECTED
——————— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT EL. 1964.5 FT. (598.8 M)
2. INTAKE PORT LEVEL 2 AT EL. 1926.5 FT. (587.2 M)
3. INTAKE PORT LEVEL 3 AT EL. 1888.5 FT. (575.6 M)
4. INTAKE PORT LEVEL 4 AT EL. 1850.5 FT. (564.0 M)
5. INTAKE PORT LEVEL 5 AT EL. 1812.5 FT. (552.5 M)
6. CONE VALVE AT ELEVATION 1929 FT (588.0 M)
7. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)
8. THIS RUN SUPERCEDES WA81020 (BAD CONE VALV. ELEV.)

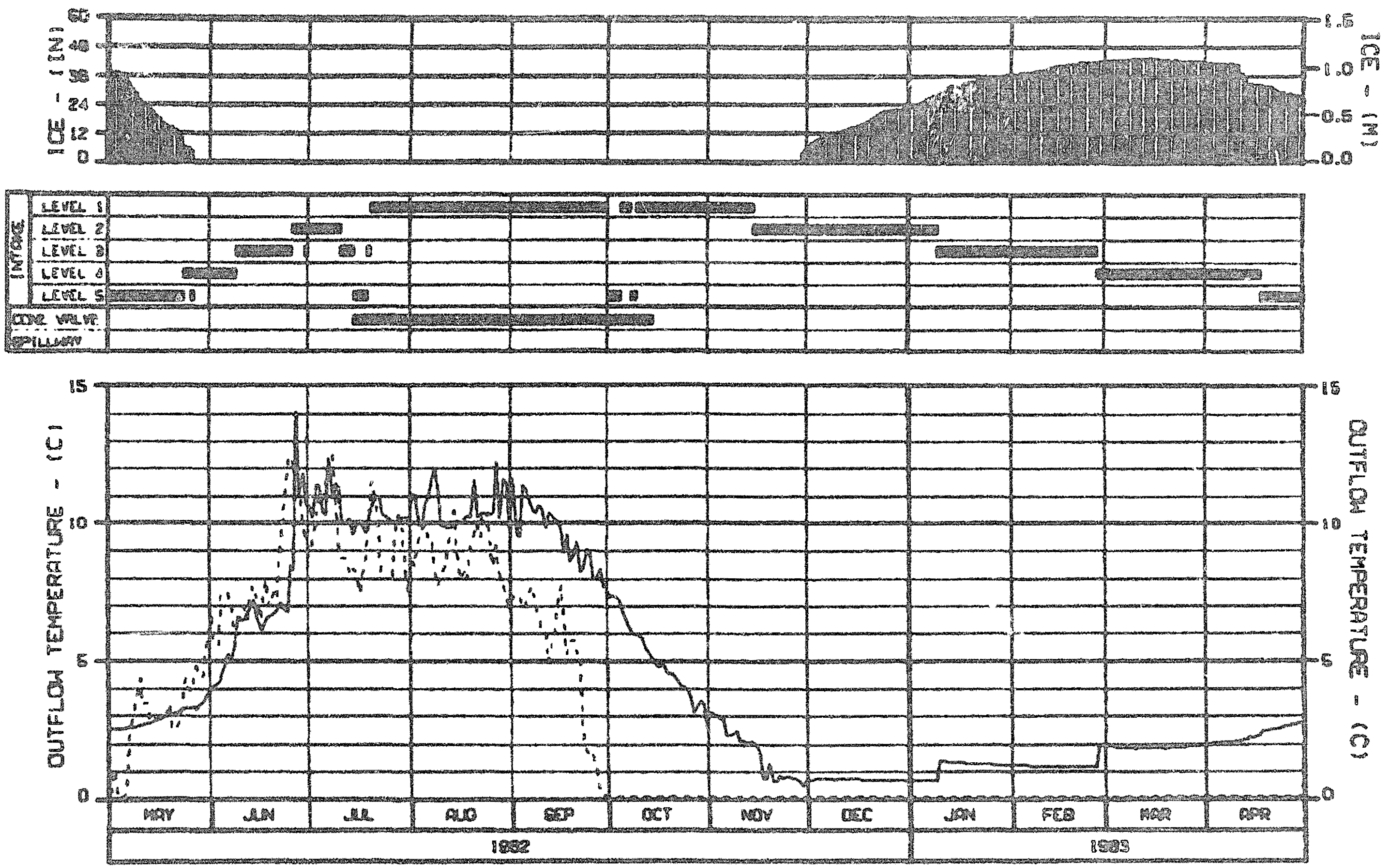
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

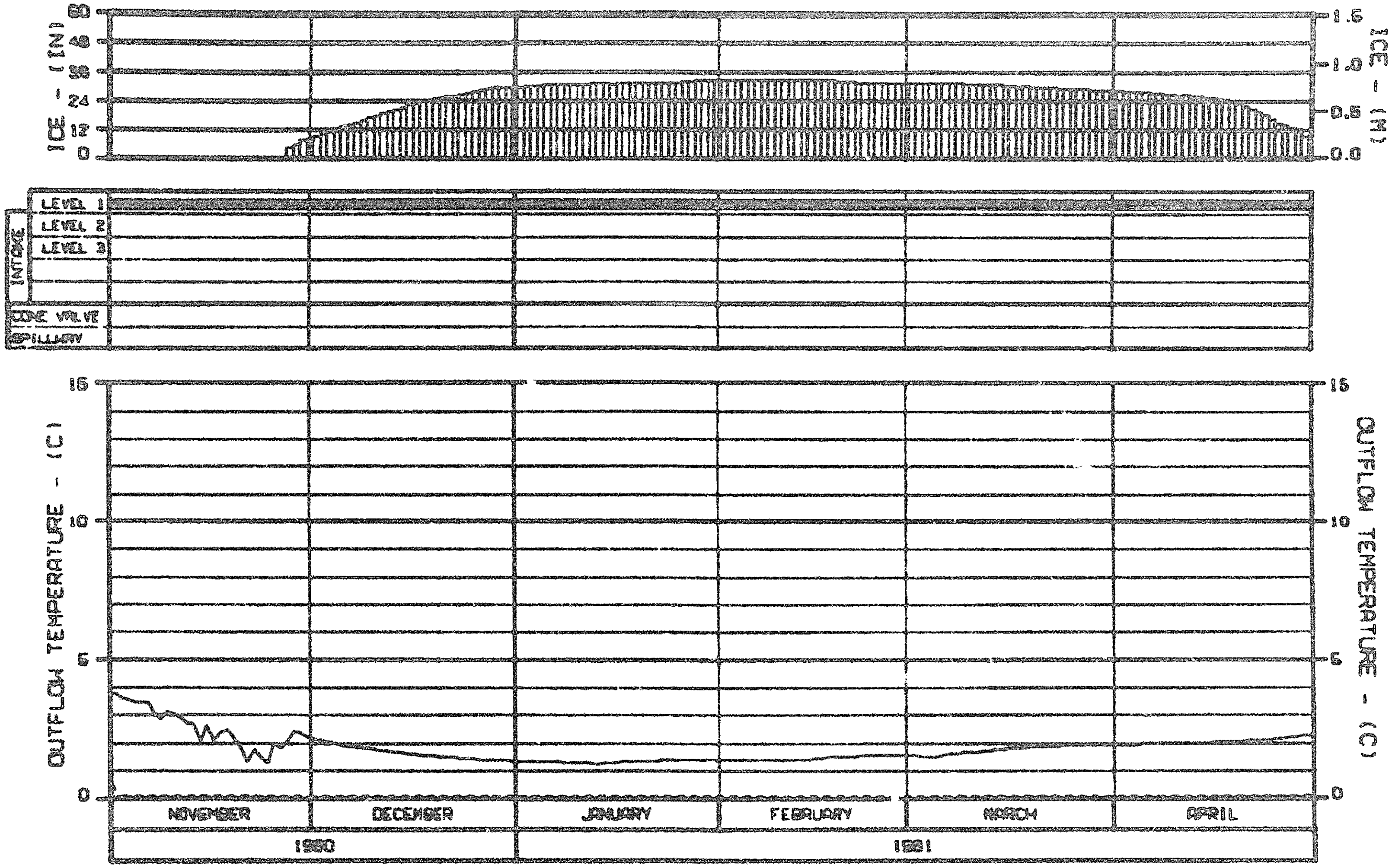
42-010-04



LEGEND: CASE: WA810202 WATANA OPERATION W/DEVIL CANYON IN 2002
CASE E-VI S2 NATURAL CONDITIONS CONE VALV. ELEV. CORRECTED
———— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT EL. 1964.5 FT. (598.8 M)
2. INTAKE PORT LEVEL 2 AT EL. 1926.5 FT. (587.2 M)
3. INTAKE PORT LEVEL 3 AT EL. 1888.5 FT. (575.6 M)
4. INTAKE PORT LEVEL 4 AT EL. 1850.5 FT. (564.0 M)
5. INTAKE PORT LEVEL 5 AT EL. 1812.5 FT. (552.5 M)
6. CONE VALVE AT ELEVATION 1930 FT (588.0 M)
7. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)
8. THIS RUN SUPERCEDES WA81020 (BAD CONE VALV. ELEV.)

ALASKA POWER AUTHORITY
SUSITNA PROJECT | DYRESM MODEL
WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH
HARZA-EBASCO JOINT VENTURE
CHICAGO, ILLINOIS | 10 MAY 85 | 42-010-04



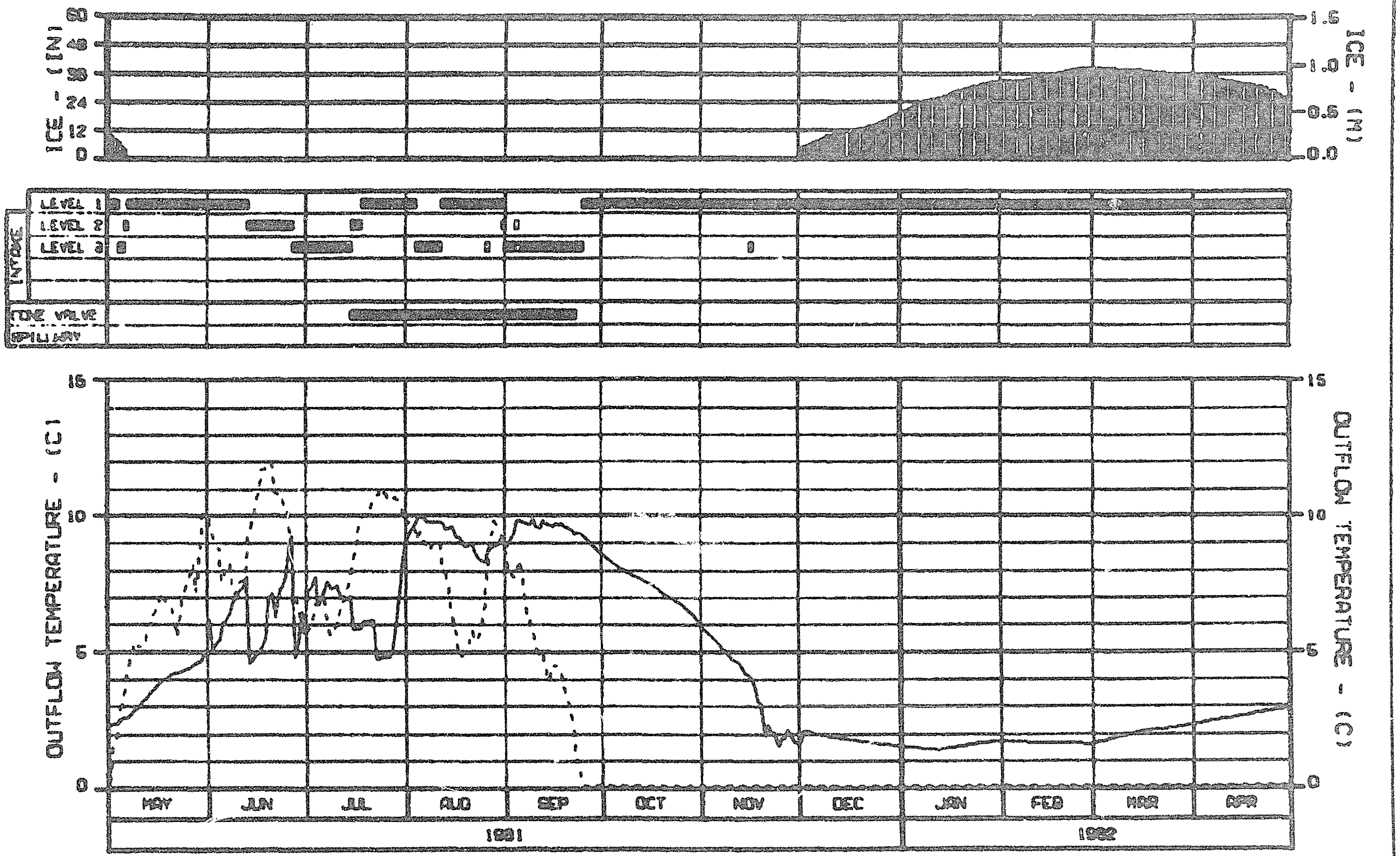
LEGEND: CASE: DC810202 - DEVIL CANYON OPERATION W/WATANA IN 2002
CASE E-VI 52 NATURAL COND. 3 LEVELS AT D.C. DRAWDOWN=50.FT

——— PREDICTED OUTFLOW TEMPERATURE

- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 1425 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1400 FT (426.72 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 1376 FT (419.10 M)
4. CONE VALVE AT ELEVATION 990 FT (301.75 M)
5. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)
6. THIS RUN SUPERCEDES DC81020

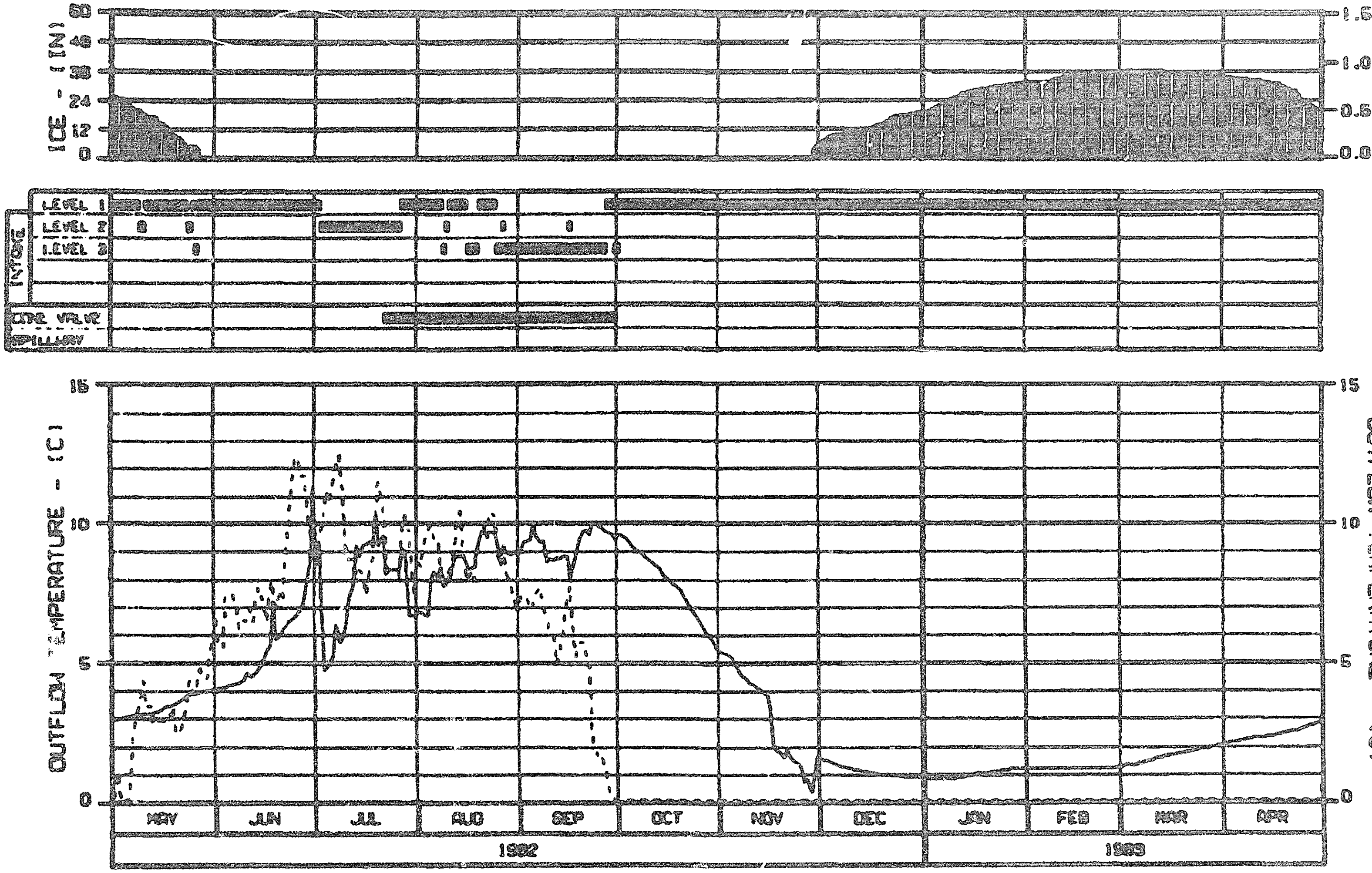
ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
DEVIL CANYON RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH	
HARZA-EBASCO JOINT VENTURE	
CHECKED. D.A. [illegible] | 10 NOV 83	42-010-04



LEGEND: CASE: DC810202 - DEVIL CANYON OPERATION W/WATANA IN 2002
CASE E-VI 82 NATURAL COND. 3 LEVELS AT D.C. DRAWDOWN=50.FT
——— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 1425 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1400 FT (426.72 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 1375 FT (419.10 M)
4. CONE VALVE AT ELEVATION 880 FT (201.75 M)
5. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)
6. THIS RUN SUPERCEDES DC81020

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	[illegible]
DEVIL CANYON RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH	
HARZA-EBASCO JOINT VENTURE	
[illegible]	[illegible] 42-010-04



LEGEND: CASE: DC810202 - DEVIL CANYON OPERATION W/WATANA IN 2002
CASE E-VI 82 NATURAL COND. 3 LEVELS AT D.C. DRAWDOWN=50.FT
———— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES: 1. INTAKE PORT LEVEL 1 AT ELEVATION 1425 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1400 FT (426.72 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 1375 FT (419.10 M)
4. CONE VALVE AT ELEVATION 880 FT (201.76 M)
5. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)
6. THIS RUN SUPERCEDES DC81020

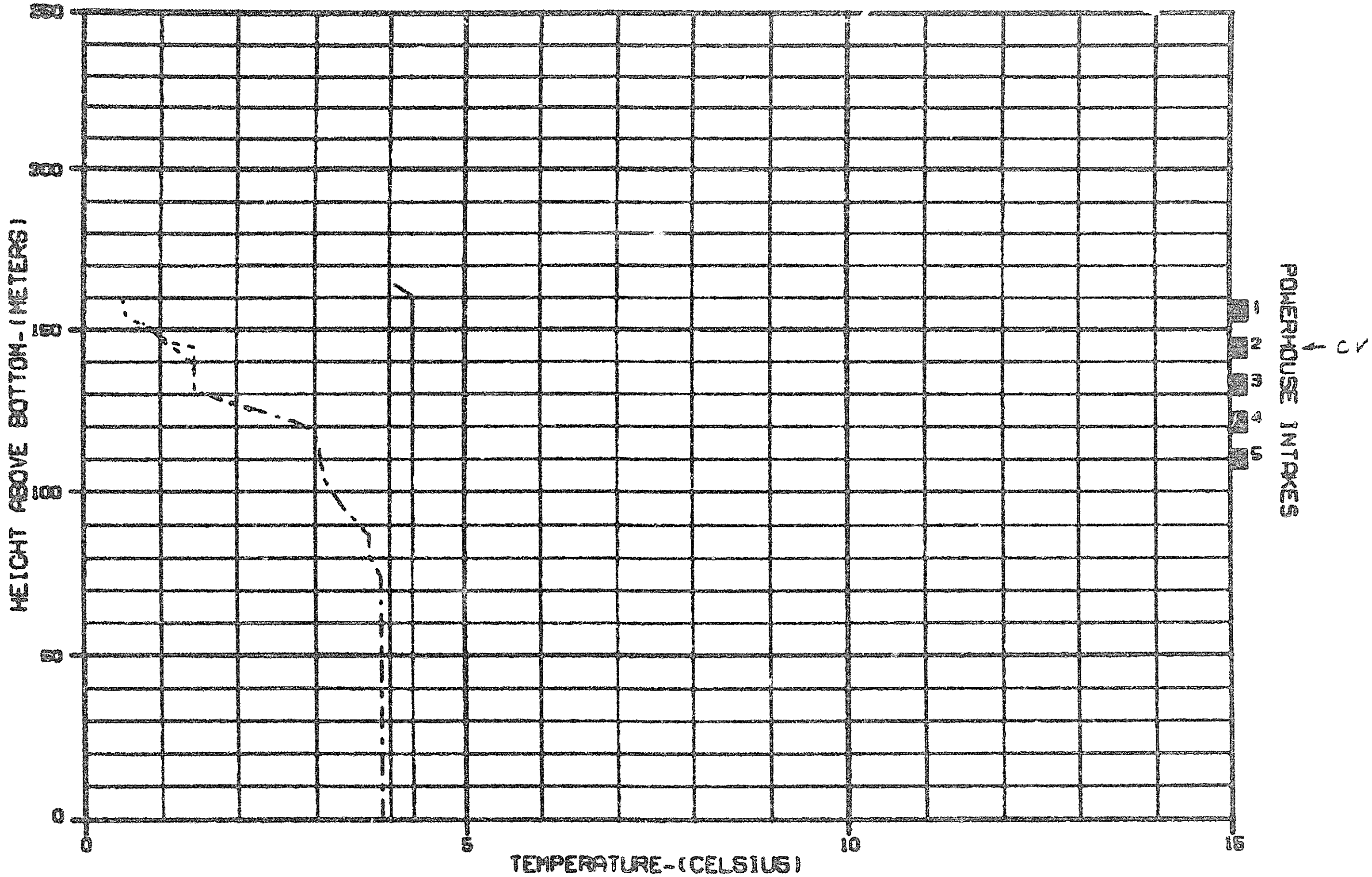
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

42-810-04



CASE: WA810202 WATANA OPERATION W/DEVIL CANYON IN 2002
CASE E-VI S2 NATURAL CONDITIONS CONE VALVE ELEV. CORRECTED

LEGEND:

PREDICTED TEMPERATURE PROFILES:

———— 1 NOVEMBER 1980
- - - - - 1 DECEMBER 1980
— - — - 1 JANUARY 1981

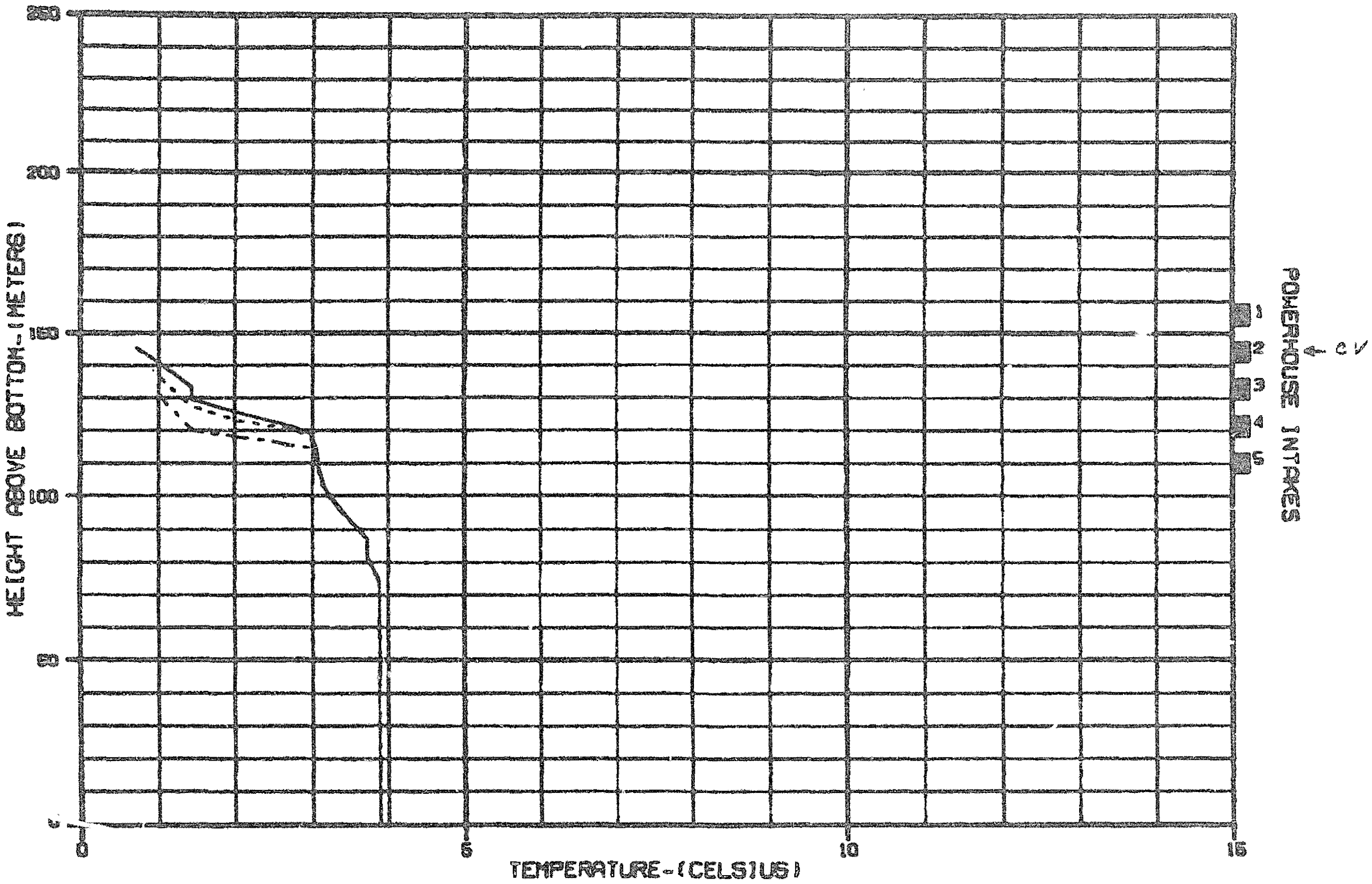
NOTE: THIS RUN SUPERCEDES WA81020

ALASKA POWER AUTHORITY

SUSITNA PROJECT

WATANA RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE



CASE: WA810202 WATANA OPERATION W/DEVIL CANYON IN 2002
CASE E-VI S2 NATURAL CONDITIONS CONE VALVE ELEV. CORRECTED

LEGEND:

PREDICTED TEMPERATURE PROFILES:

———— 1 FEBRUARY 1981
········ 1 MARCH 1981
—·—·— 1 APRIL 1981

NOTE: THIS RUN SUPERCEDES WA81020

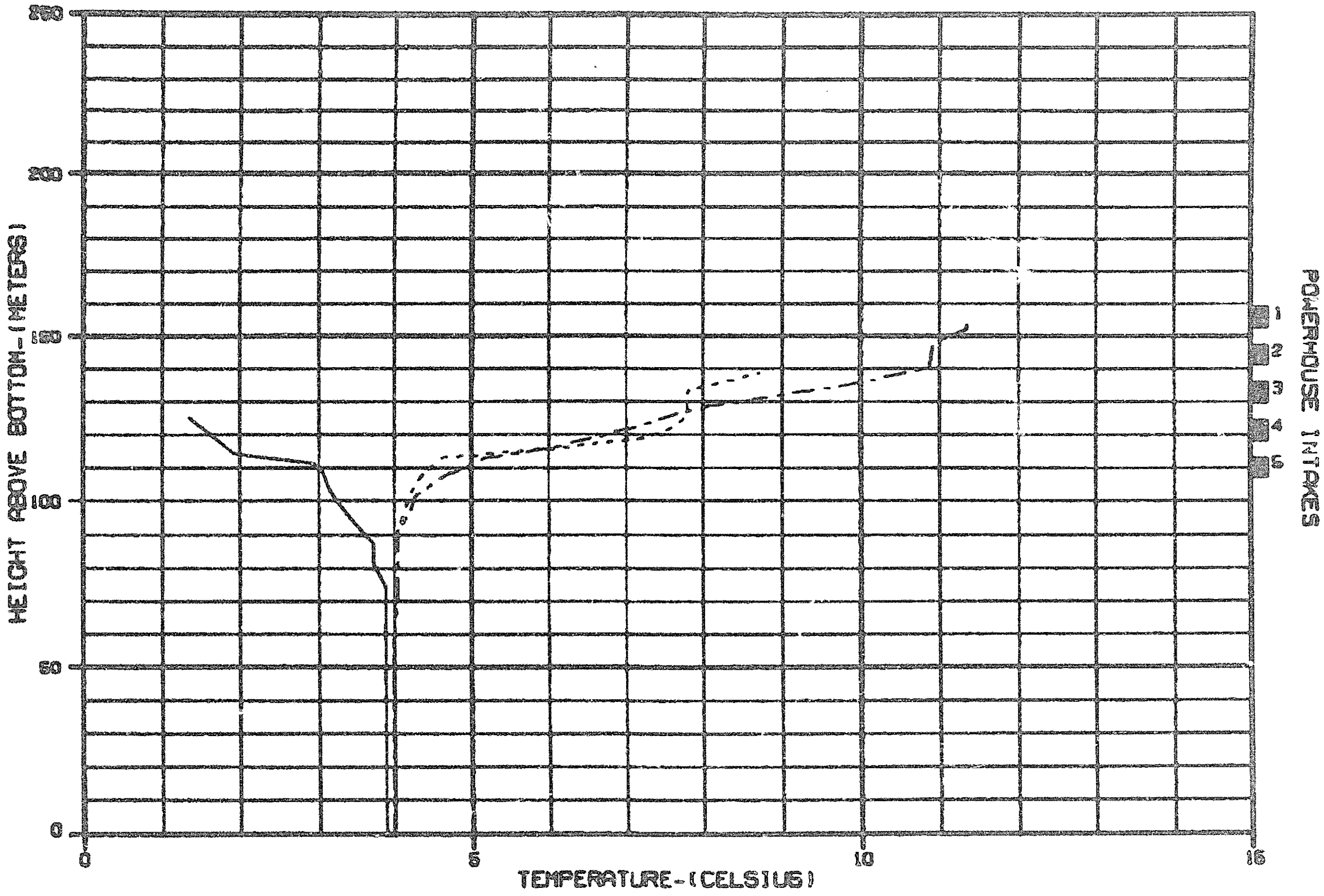
ALASKA POWER AUTHORITY

SUSITNA PROJECT | [illegible]

WATANA RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

[illegible] | [illegible]



CASE: WA810202 WATANA OPERATION W/DEVIL CANYON IN 2002
CASE E-VI S2 NATURAL CONDITIONS CONE VALVE ELEV. CORRECTED

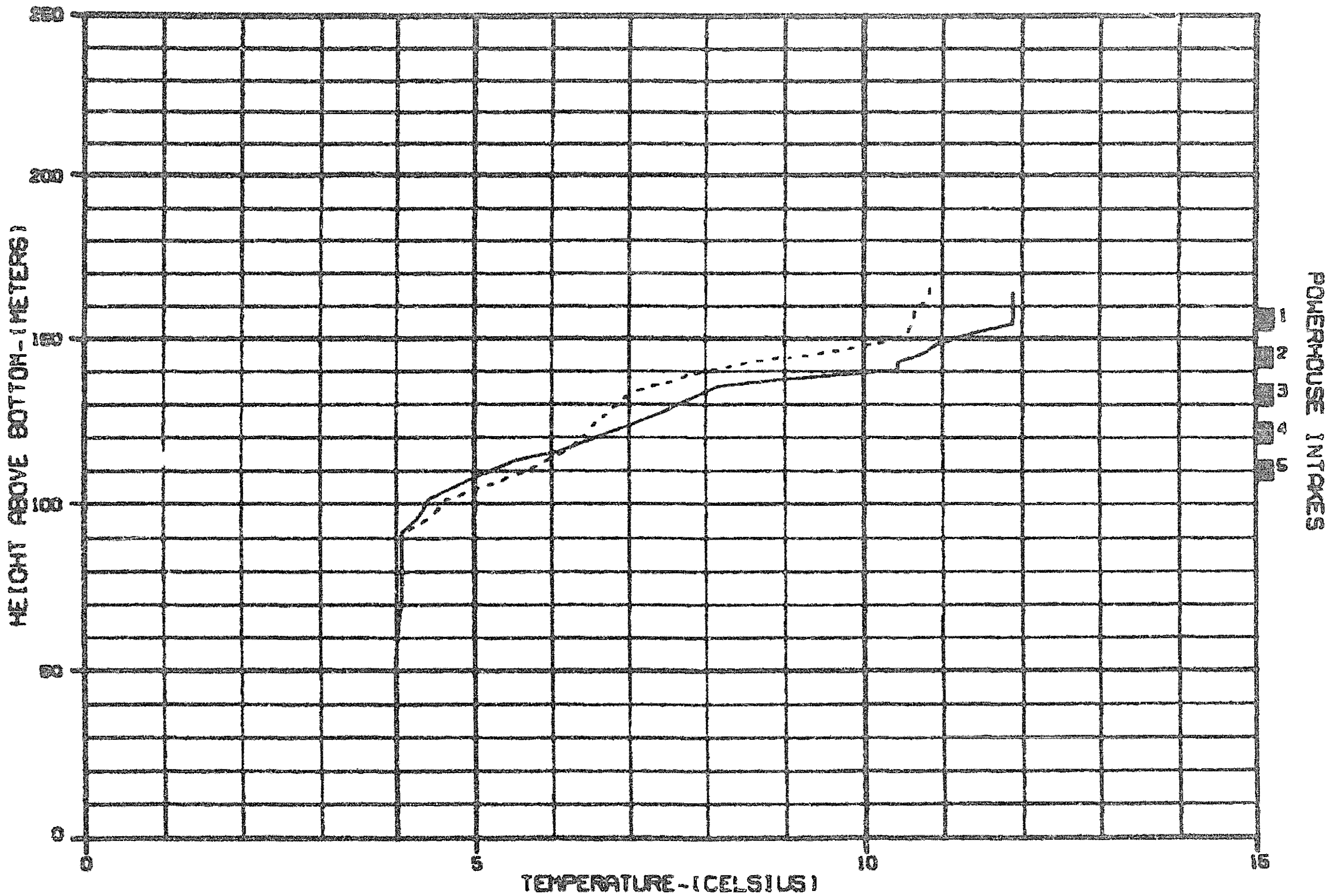
LEGEND:
PREDICTED TEMPERATURE PROFILES:
——— 1 MAY 1981
········ 1 JUNE 1981
—·—·— 1 JULY 1981

NOTE: THIS RUN SUPERCEDES WA81020

ALASKA POWER AUTHORITY

WATANA RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE



CASE: WA810202 WATANA OPERATION W/DEVIL CANYON IN 2002
CASE E-VI S2 NATURAL CONDITIONS CONE VALVE ELEV. CORRECTED

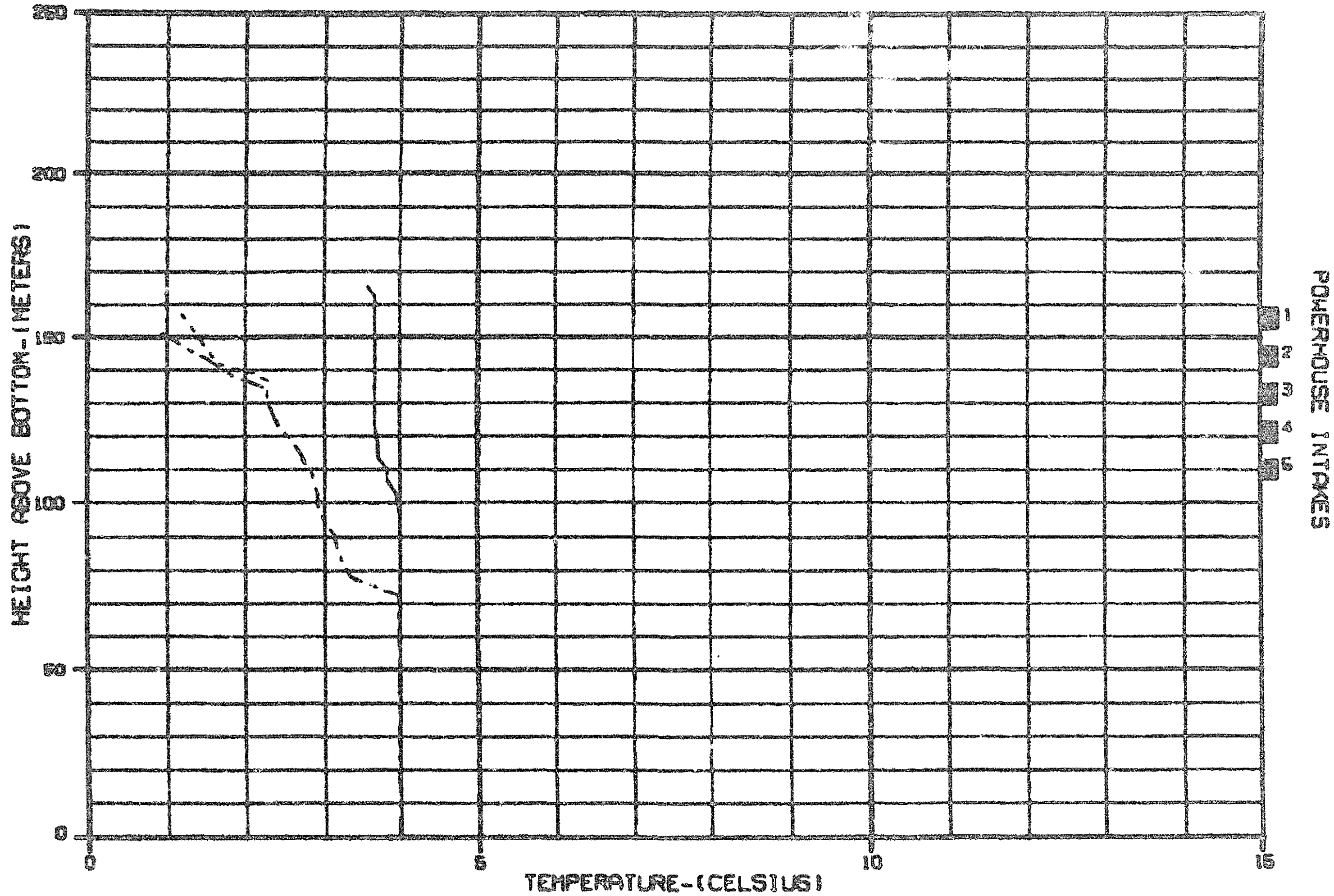
LEGEND:

PREDICTED TEMPERATURE PROFILES:

- ———— 1 AUGUST 1981
- - - - - - 1 SEPTEMBER 1981
- — - — - 1 OCTOBER 1981

NOTE: THIS RUN SUPERCEDES WA81020

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
WATANA RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
	42-010-04



CASE: WA810202 WATANA OPERATION W/DEVIL CANYON IN 2002
CASE E-VI S2 NATURAL CONDITIONS CONE VALVE ELEV. CORRECTED

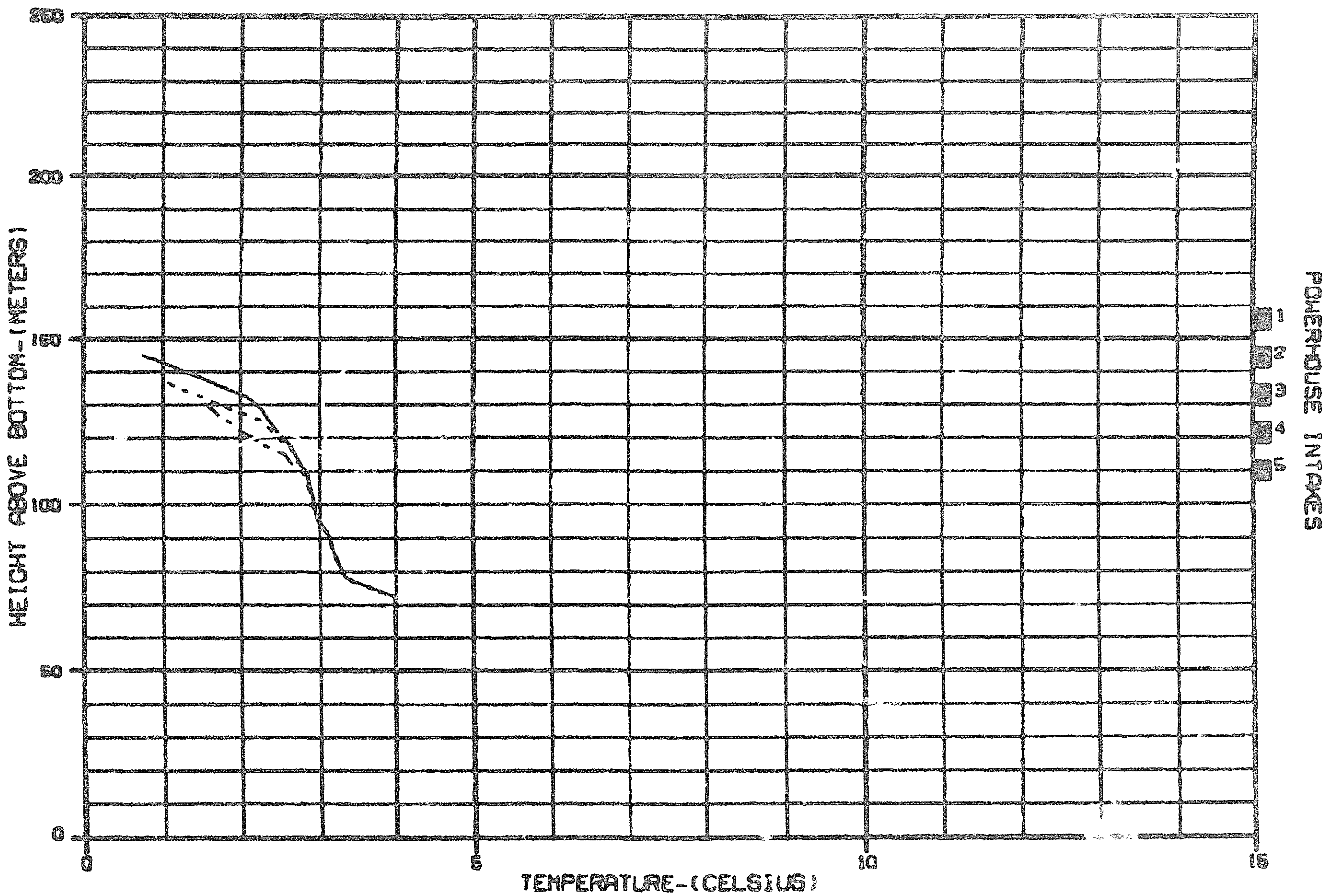
LEGEND:

PREDICTED TEMPERATURE PROFILES:

- ———— 1 NOVEMBER 1981
- - - - - - 1 DECEMBER 1981
- — · — · 1 JANUARY 1982

NOTE: THIS RUN SUPERCEDES WA81020

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	SYSTEM MODEL
WATANA RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
[illegible]	42-010-04



CASE: WA810202 WATANA OPERATION W/DEVIL CAN[illegible] 2002
CASE E-VI S2 NATURAL CONDITIONS CONE V[illegible] ELEV. CORRECTED

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 FEBRUARY	1982
- - - - - - - -	1 MARCH	1982
— - — - —	1 APRIL	1982

NOTE: THIS RUN SUPERCEDES WA81020

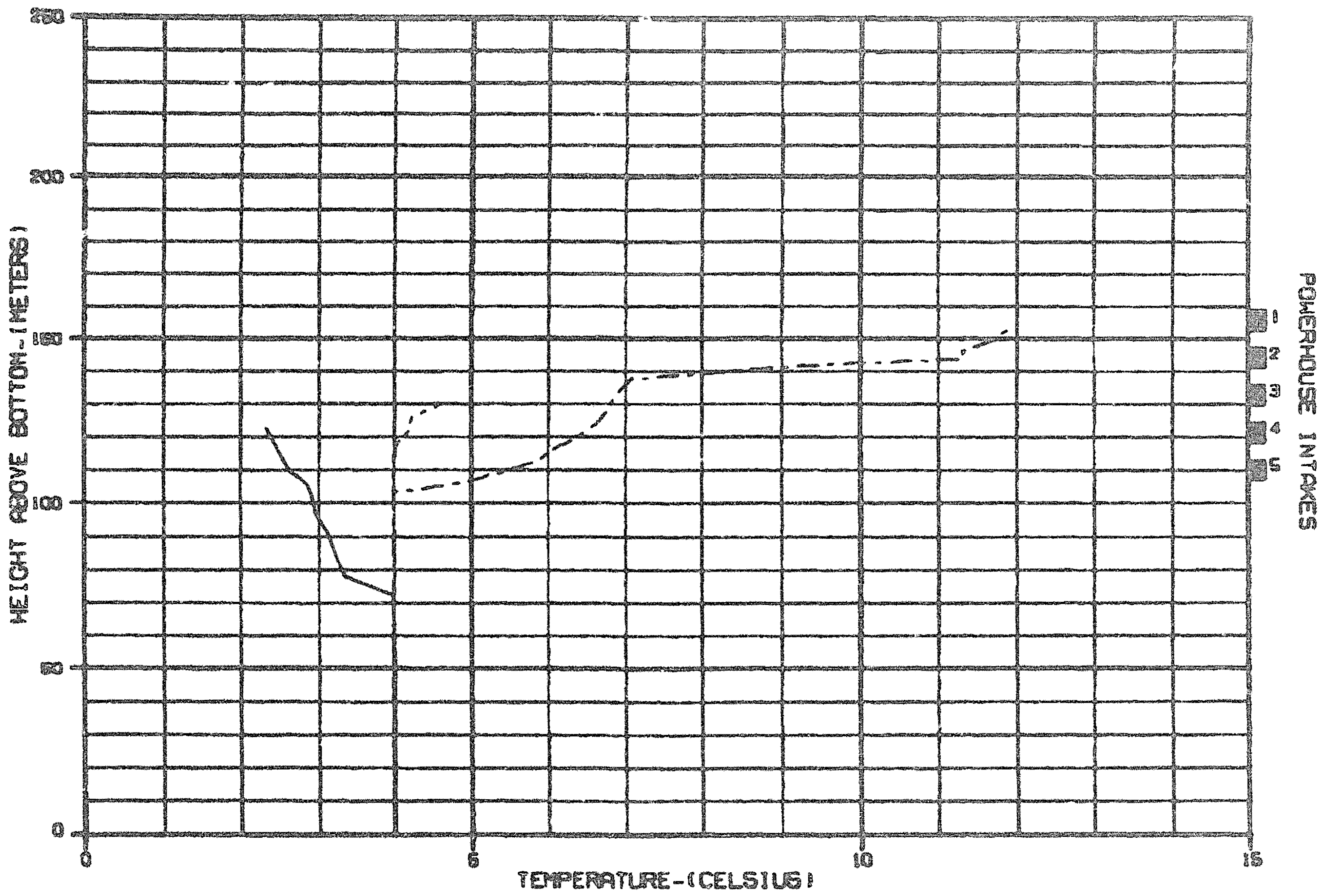
ALASKA POWER AUTHORITY

SUSITNA PROJECT

WATANA RESERVOIR TEMPERATURE PROFILES

[illegible]ASCO JOINT VENTURE

42-010-04



CASE: WA810202 WATANA OPERATION W/DEVIL CANYON IN 2002
CASE E-VI S2 NATURAL CONDITIONS CONE VALVE ELEV. CORRECTED

LEGEND:

PREDICTED TEMPERATURE PROFILES:

———— 1 MAY 1982
- - - - - 1 JUNE 1982
—·—·— 1 JULY 1982

NOTE: THIS RUN SUPERCEDES WA81020

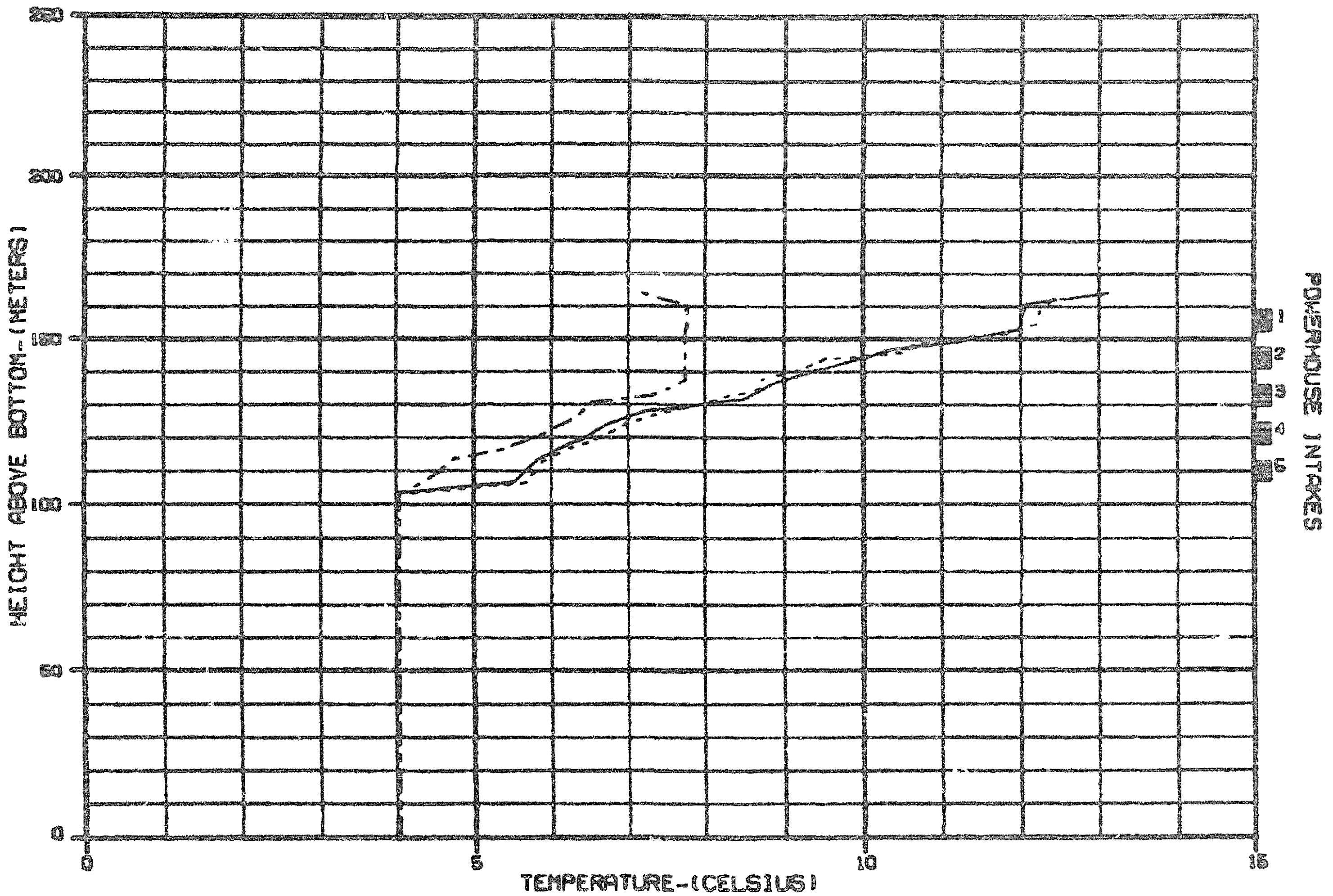
ALASKA POWER AUTHORITY

SUSITNA PROJECT | OXYGEN MODEL

WATANA RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

42-010-04



CASE: WA810202 WATANA OPERATION W/DEVIL CANYON IN 2002
CASE E-VI S2 NATURAL CONDITIONS CONE VALVE ELEV. CORRECTED

LEGEND:

PREDICTED TEMPERATURE PROFILES:

———— 1 AUGUST 1982
-------- 1 SEPTEMBER 1982
—·—·— 1 OCTOBER 1982

NOTE: THIS RUN SUPERCEDES WA81020

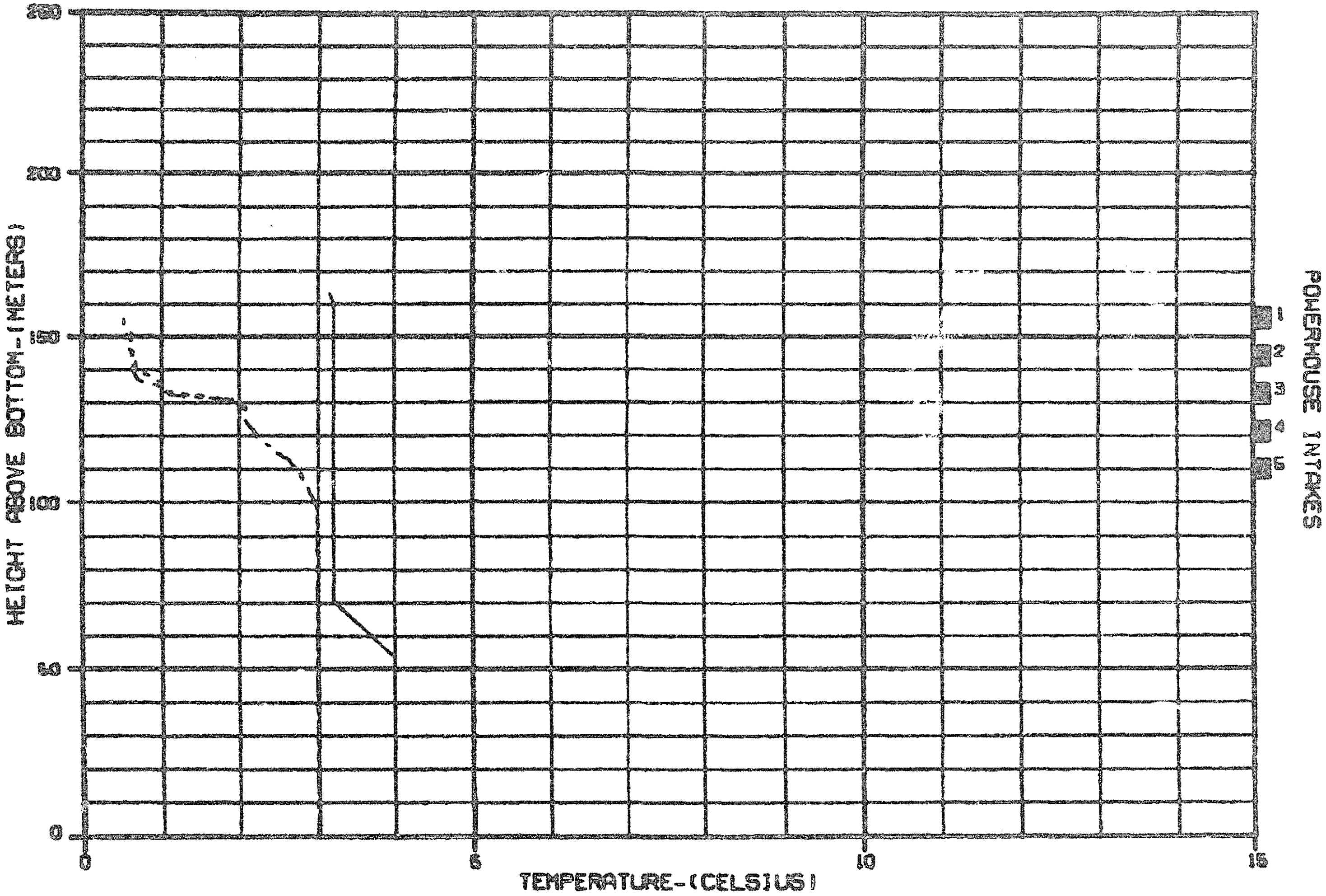
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DIFFUSION MODEL

WATANA RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

42-210-84



CASE: WA810202 WATANA OPERATION W/DEVIL CANYON IN 2002
CASE E-VI S2 NATURAL CONDITIONS CONE VALVE ELEV. CORRECTED

LEGEND:

PREDICTED TEMPERATURE PROFILES:

——— 1 NOVEMBER 1982
- - - - 1 DECEMBER 1982
—·—·— 1 JANUARY 1983

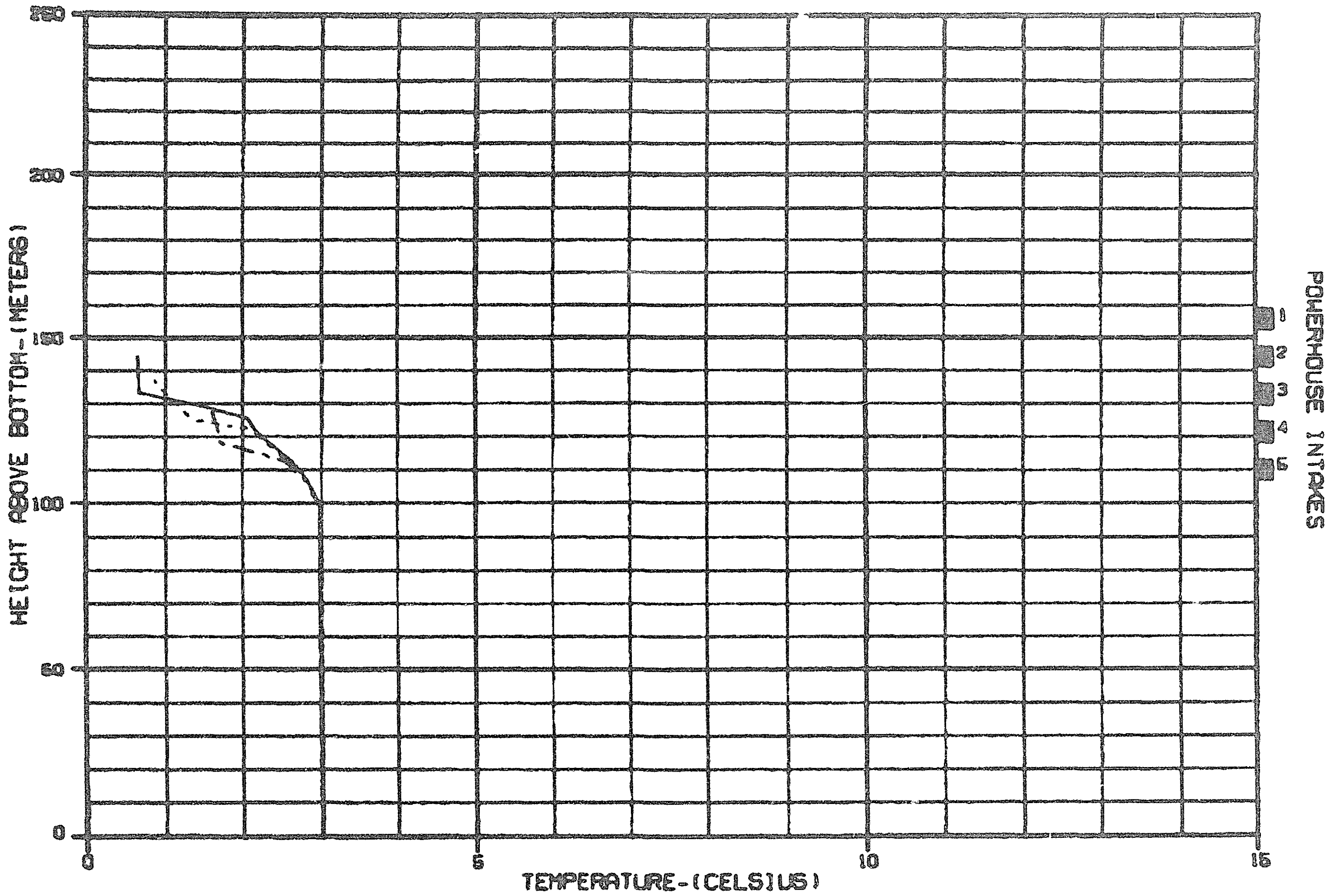
NOTE: THIS RUN SUPERCEDES WA81020

ALASKA POWER AUTHORITY

SUSITNA PROJECT

WATANA RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE



CASE: WA810202 WATANA OPERATION W/DEVIL CANYON IN 2002
CASE E-VI S2 NATURAL CONDITIONS CONE VALVE ELEV. CORRECTED

LEGEND:

PREDICTED TEMPERATURE PROFILES:

- ———— 1 FEBRUARY 1983
- - - - - - - 1 MARCH 1983
- — - — - 1 APRIL 1983

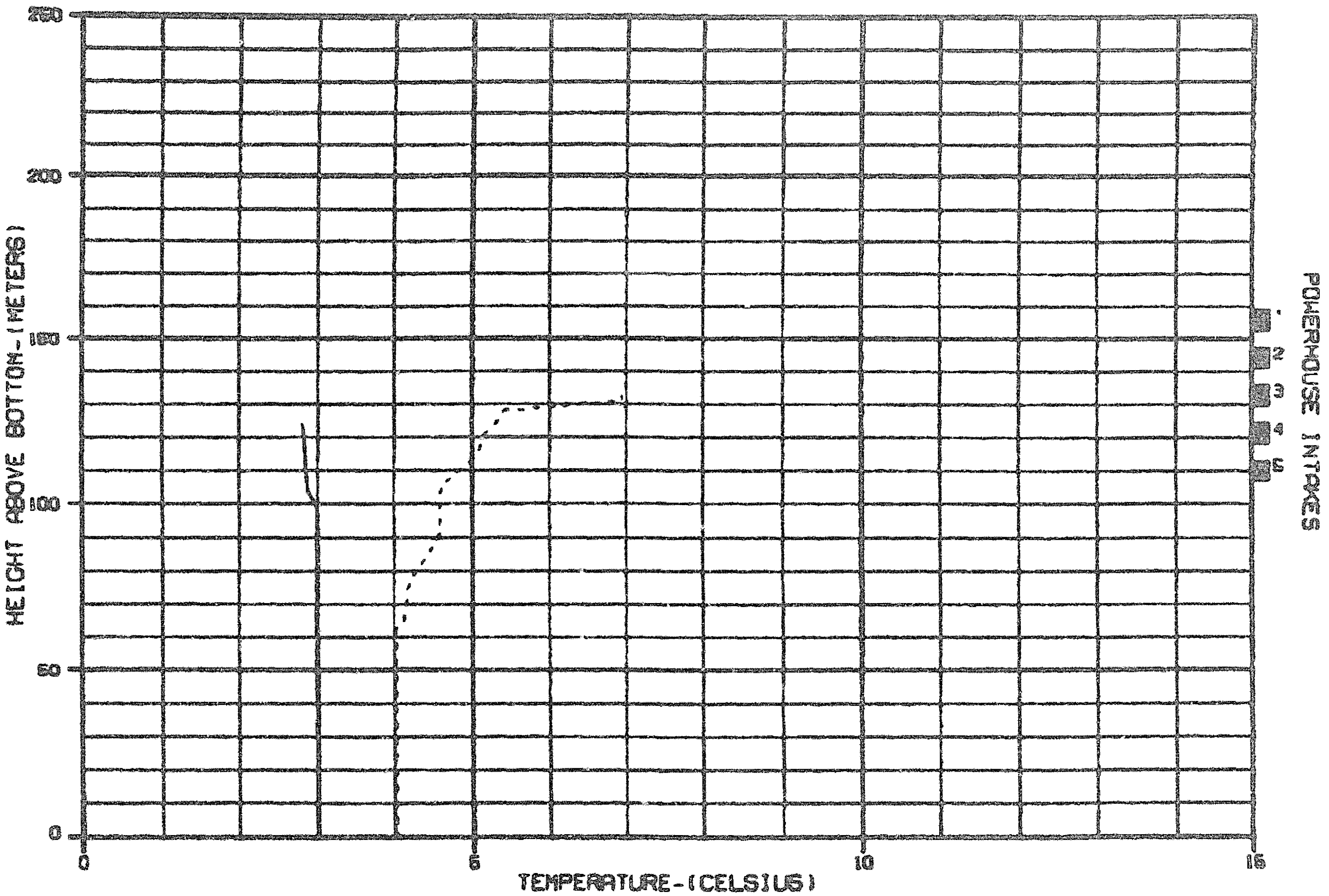
NOTE: THIS RUN SUPERCEDES WA81020

ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE



CASE: WA810202 WATANA OPERATION W/DEVIL CANYON IN 2002
CASE E-VI S2 NATURAL CONDITIONS CONE VALVE ELEV. CORRECTED

LEGEND:

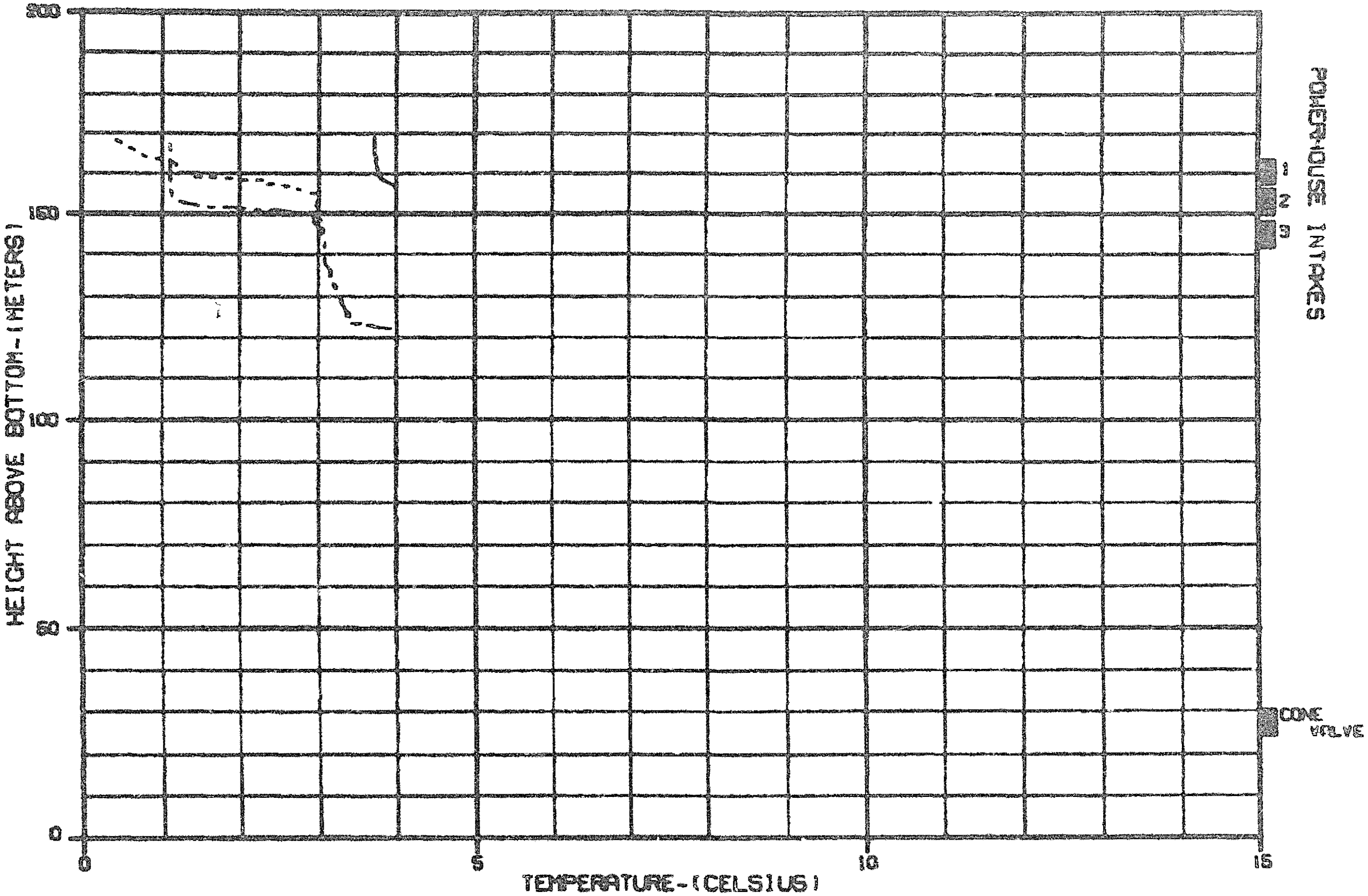
PREDICTED TEMPERATURE PROFILES:

———— 1 MAY 1983

- - - - - 1 JUNE 1983

NOTE: THIS RUN SUPERCEDES WA81020

ALASKA POWER AUTHORITY		
SUSITNA PROJECT	DYRESM MODEL	
WATANA RESERVOIR TEMPERATURE PROFILES		
HARZA-EBASCO JOINT VENTURE		
[illegible]	[illegible]	[illegible]



CASE: DC810202 - DEVIL CANYON OPERATION W/WATANA IN 2002
CASE E-VI S2 NATURAL COND. DRAWDOWN AT D.C. = 50.0 FT.

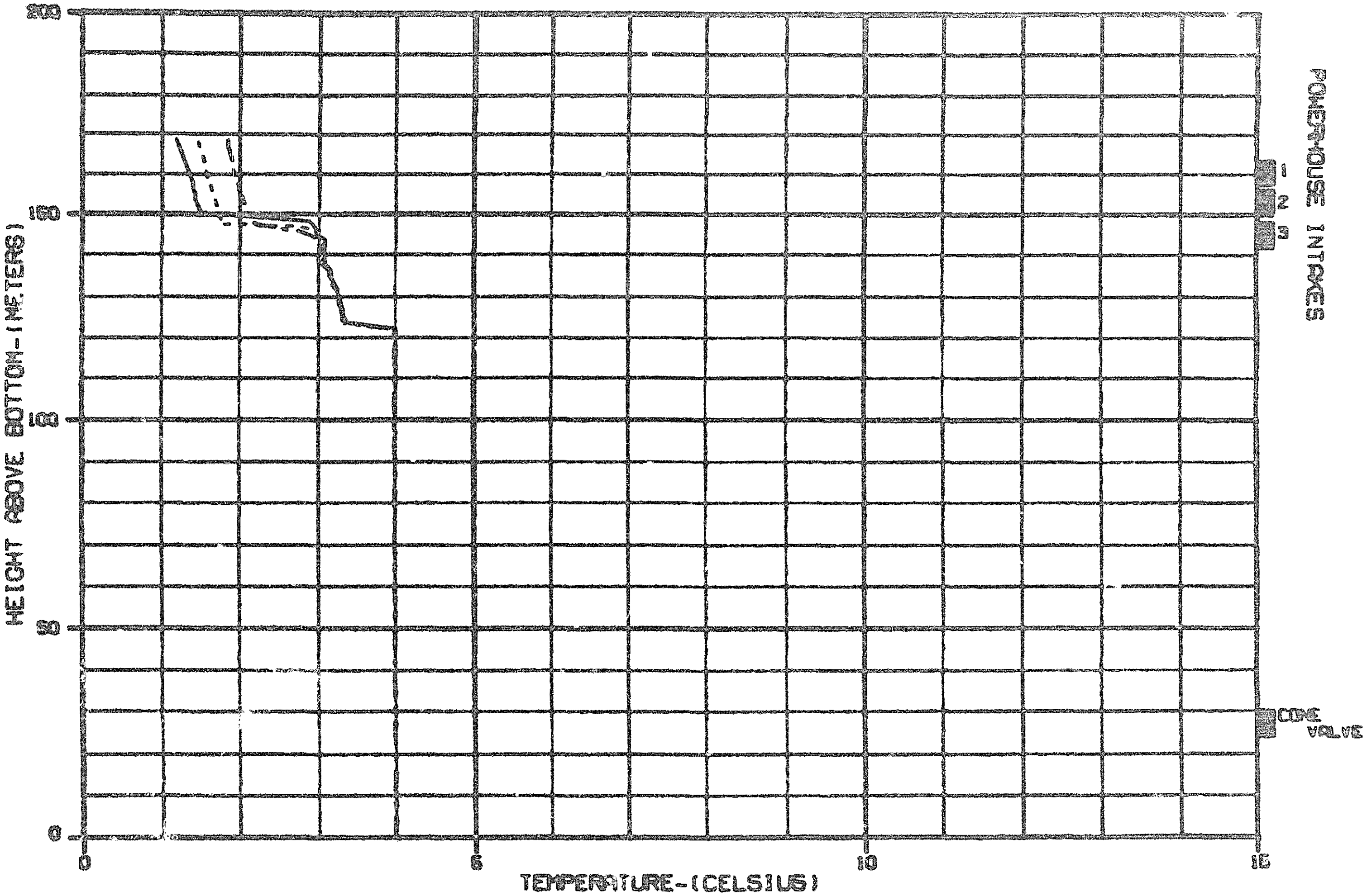
LEGEND:

PREDICTED TEMPERATURE PROFILES:

———— 1 NOVEMBER 1980
- - - - - 1 DECEMBER 1980
— - — - 1 JANUARY 1981

NOTE: THIS RUN SUPERCEDES DC81020

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
DEVIL CANYON RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	



CASE: DC810202 - DEVIL CANYON OPERATION W/WATANA IN 2002
CASE E-VI S2 NATURAL COND. DRAWDOWN AT D.C. = 50.0 FT.

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————————	1 FEBRUARY 1981
- - - - - - - -	1 MARCH 1981
— - — - —	1 APRIL 1981

NOTE: THIS RUN SUPERCEDES DC81020

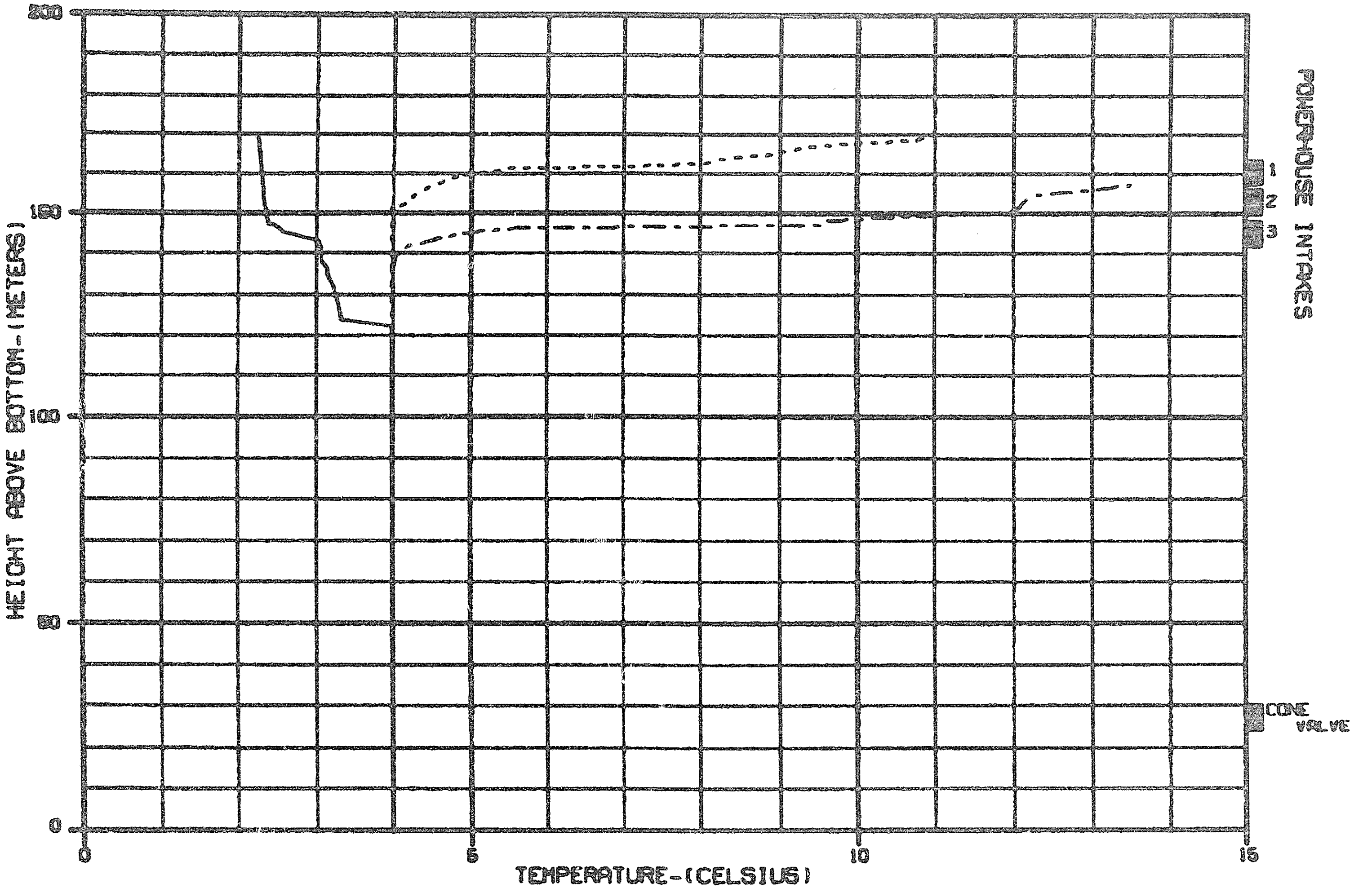
ALASKA POWER AUTHORITY

SUSITNA PROJECT | [illegible]

DEVIL CANYON RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | [illegible] | [illegible]



CASE: DC810202 - DEVIL CANYON OPERATION W/WATANA IN 2002
CASE E-VI S2 NATURAL COND. DRAWDOWN AT D.C. = 50.0 FT.

LEGEND:

PREDICTED TEMPERATURE PROFILES:

——————— 1 MAY 1981

- - - - - - - - 1 JUNE 1981

— - — - — 1 JULY 1981

NOTE: THIS RUN SUPERCEDES DC81020

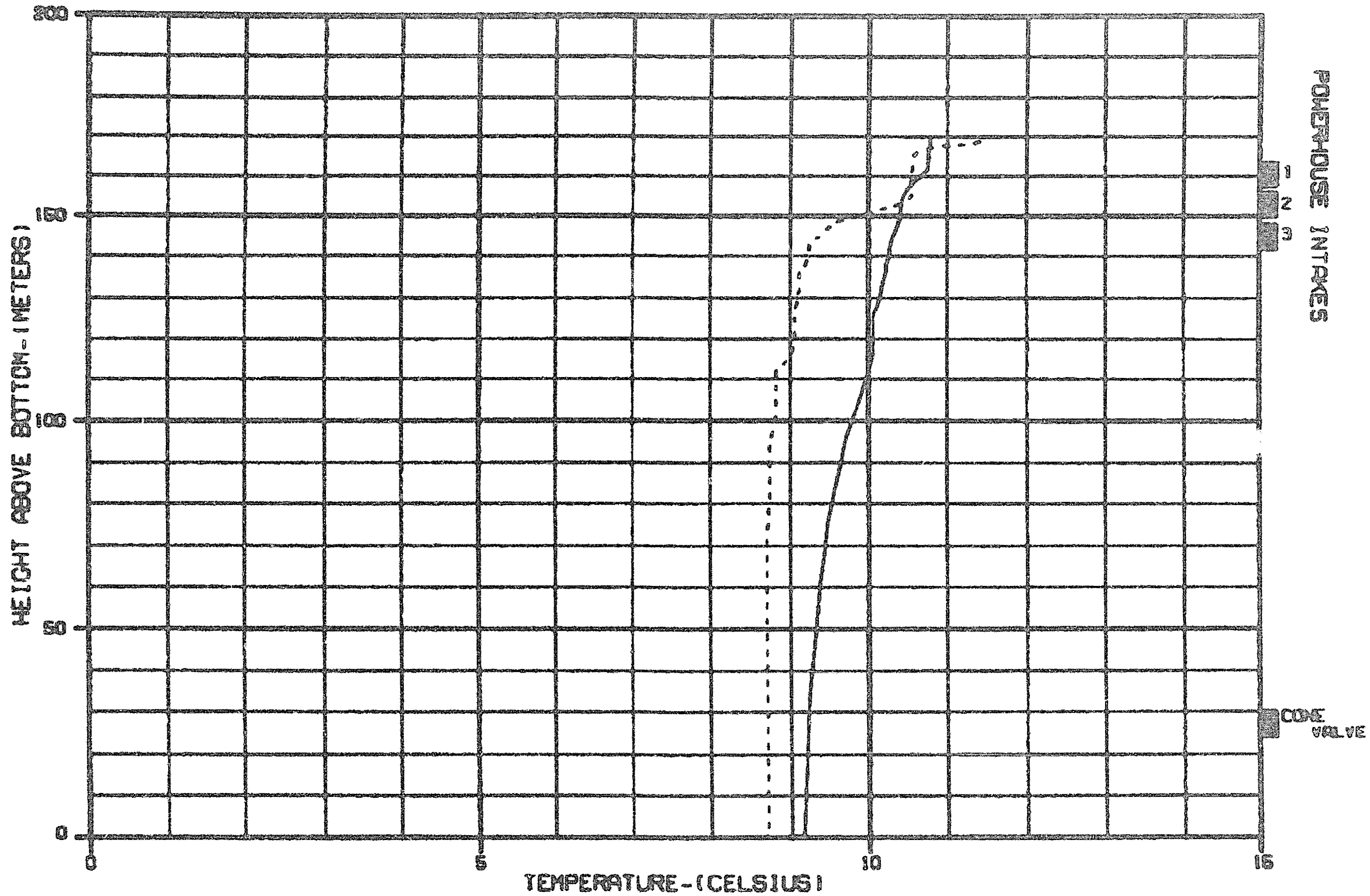
ALASKA POWER AUTHORITY

SUSITNA PROJECT

DEVIL CANYON RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

42-010-04



CASE: DC810202 - DEVIL CANYON OPERATION W/WATANA IN 2002
CASE E-VI S2 NATURAL COND. DRAWDOWN AT D.C. = 50.0 FT.

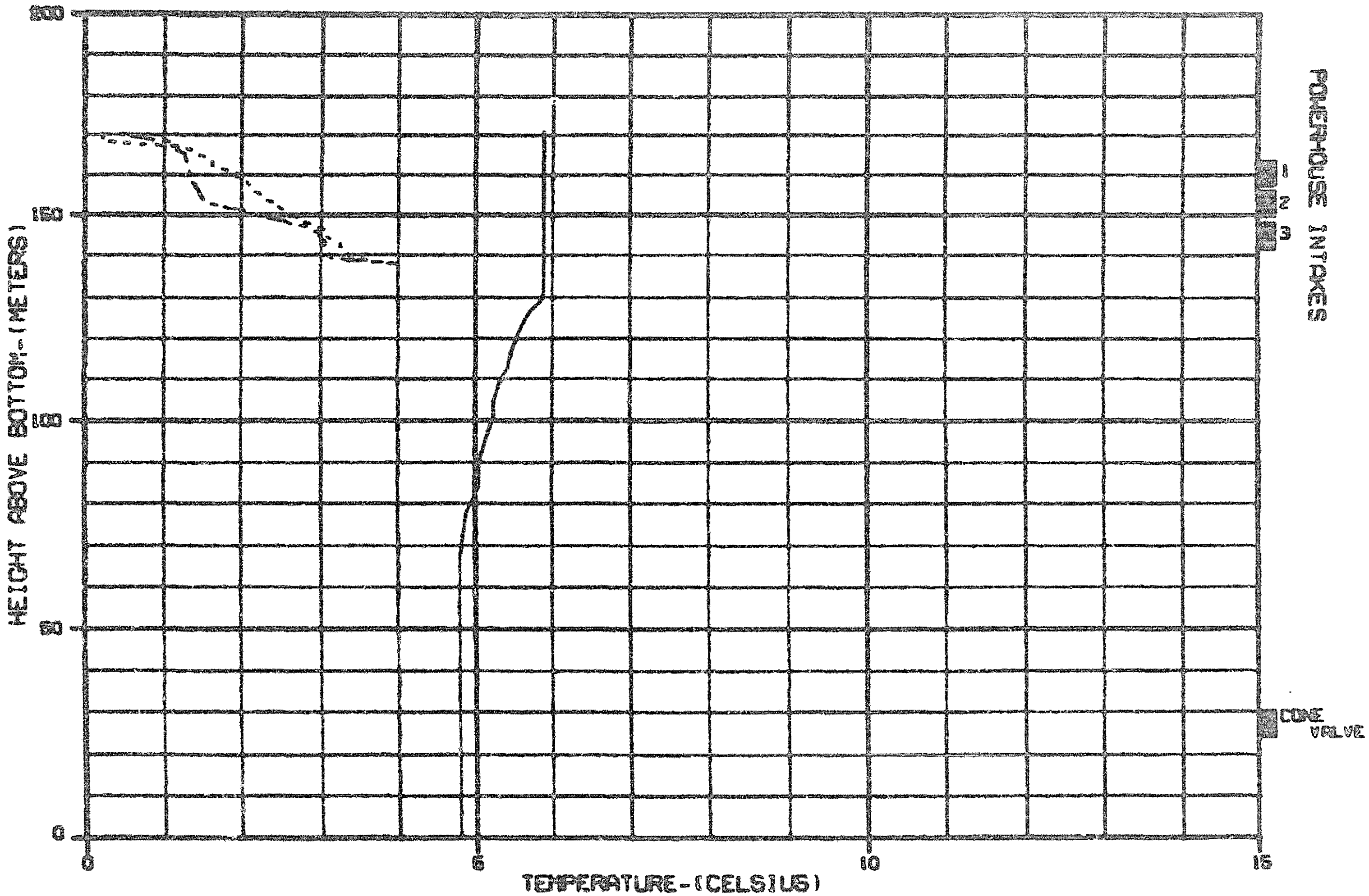
LEGEND:

PREDICTED TEMPERATURE PROFILES:

———————	1 AUGUST	1981
- - - - - - - -	1 SEPTEMBER	1981
— - — - —	1 OCTOBER	1981

NOTE: THIS RUN SUPERCEDES DC81020

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
DEVIL CANYON RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
[illegible]	[illegible]



CASE: DC810202 - DEVIL CANYON OPERATION W/WATANA IN 2002
CASE E-VI S2 NATURAL COND. DRAWDOWN AT D.C. = 50.0 FT.

LEGEND:

PREDICTED TEMPERATURE PROFILES:

- ———— 1 NOVEMBER 1981
- - - - - - 1 DECEMBER 1981
- — - — - 1 JANUARY 1982

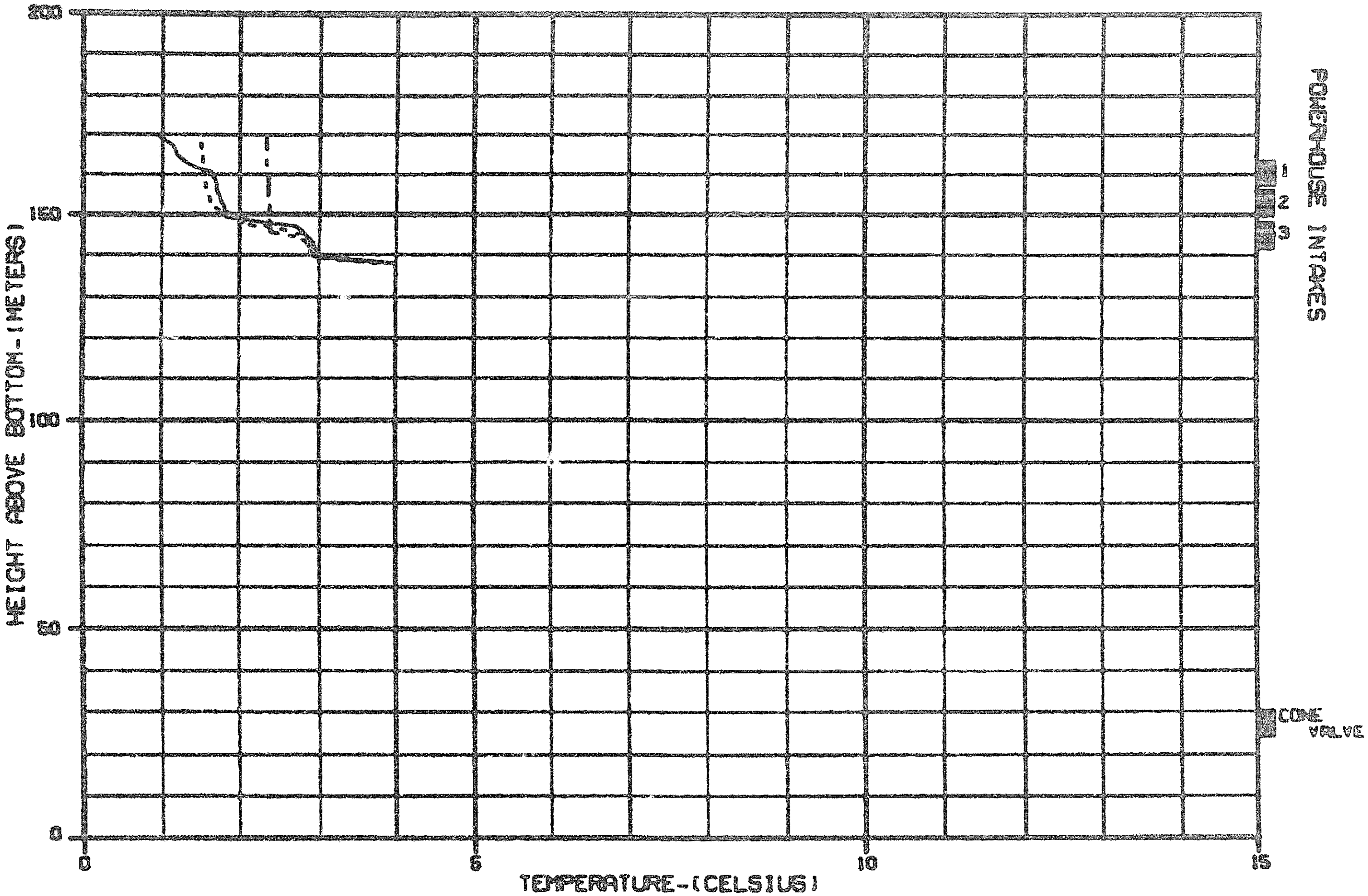
NOTE: THIS RUN SUPERCEDES DC81020

ALASKA POWER AUTHORITY

SUSITNA PROJECT | OXYGEN MODEL

DEVIL CANYON RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE



CASE: DC810202 - DEVIL CANYON OPERATION W/WATANA IN 2002
CASE E-VI S2 NATURAL COND. DRAWDOWN AT D.C. = 50.0 FT.

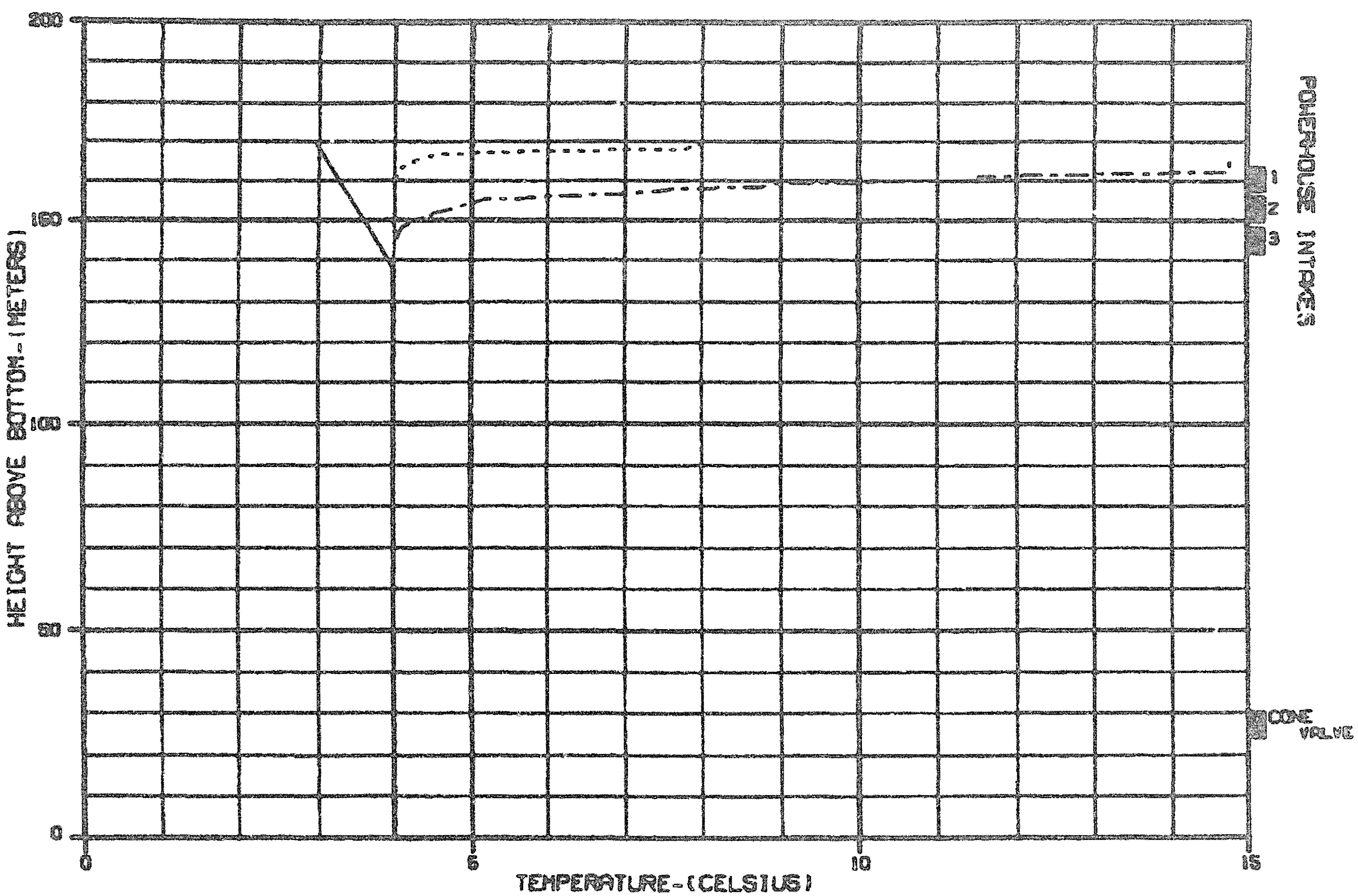
LEGEND:

PREDICTED TEMPERATURE PROFILES:

- ———— 1 FEBRUARY 1982
- ········ 1 MARCH 1982
- —·—·— 1 APRIL 1982

NOTE: THIS RUN SUPERCEDES DC8102Q

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	OXYGEN MODEL
DEVIL CANYON RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
42-010-04	



CASE: DC810202 - DEVIL CANYON OPERATION W/WATANA IN 2002
CASE E-VI S2 NATURAL COND. DRAWDOWN AT D.C. = 50.0 FT.

LEGEND:

PREDICTED TEMPERATURE PROFILES:

———————	1 MAY 1982
- - - - - - - -	1 JUNE 1982
— - — - —	1 JULY 1982

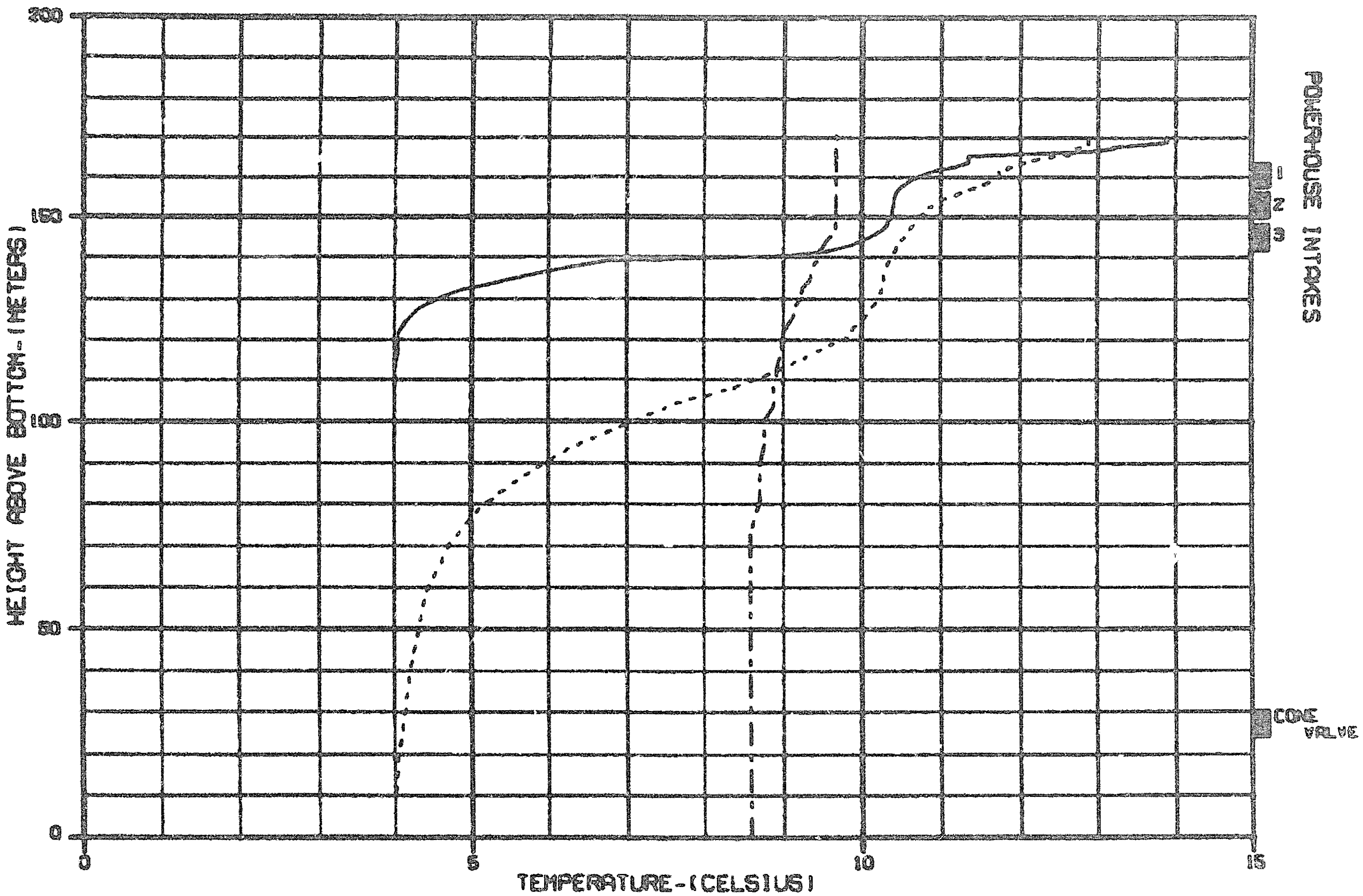
NOTE: THIS RUN SUPERCEDES DC81020

ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE



CASE: DC8102Q2 - DEVIL CANYON OPERATION W/WATANA IN 2002
CASE E-VI S2 NATURAL COND. DRAWDOWN AT D.C. = 50.0 FT.

LEGEND:

PREDICTED TEMPERATURE PROFILES:

———————	1 AUGUST 1982
- - - - - - - -	1 SEPTEMBER 1982
— - — - —	1 OCTOBER 1982

NOTE: THIS RUN SUPERCEDES DC8102Q

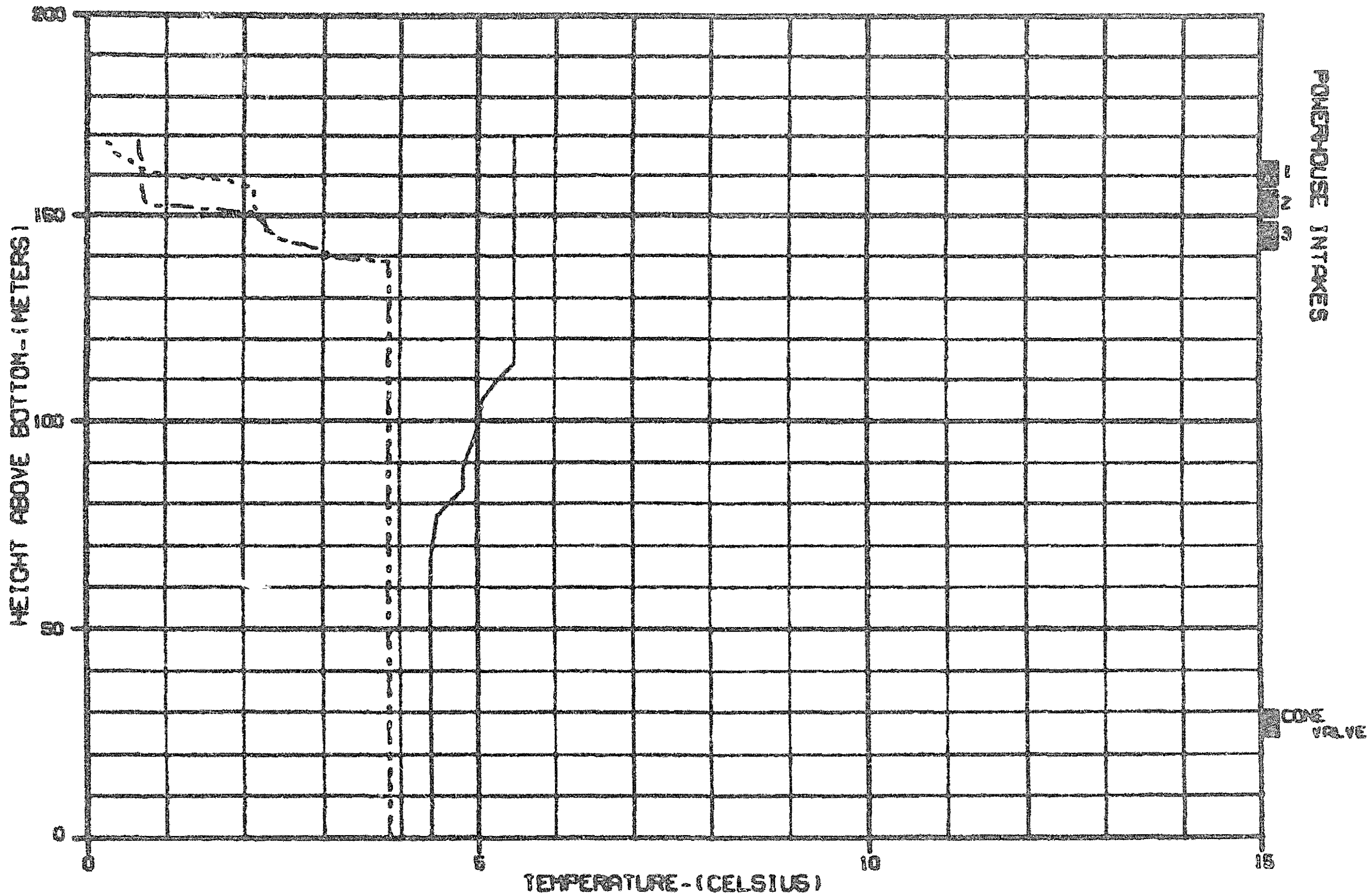
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

[illegible]



CASE: DC810202 - DEVIL CANYON OPERATION W/WATANA IN 2002
CASE E-VI S2 NATURAL COND. DRAWDOWN AT D.C. = 50.0 FT.

LEGEND:

PREDICTED TEMPERATURE PROFILES:

- ———— 1 NOVEMBER 1982
- - - - - - 1 DECEMBER 1982
- —·—·— 1 JANUARY 1983

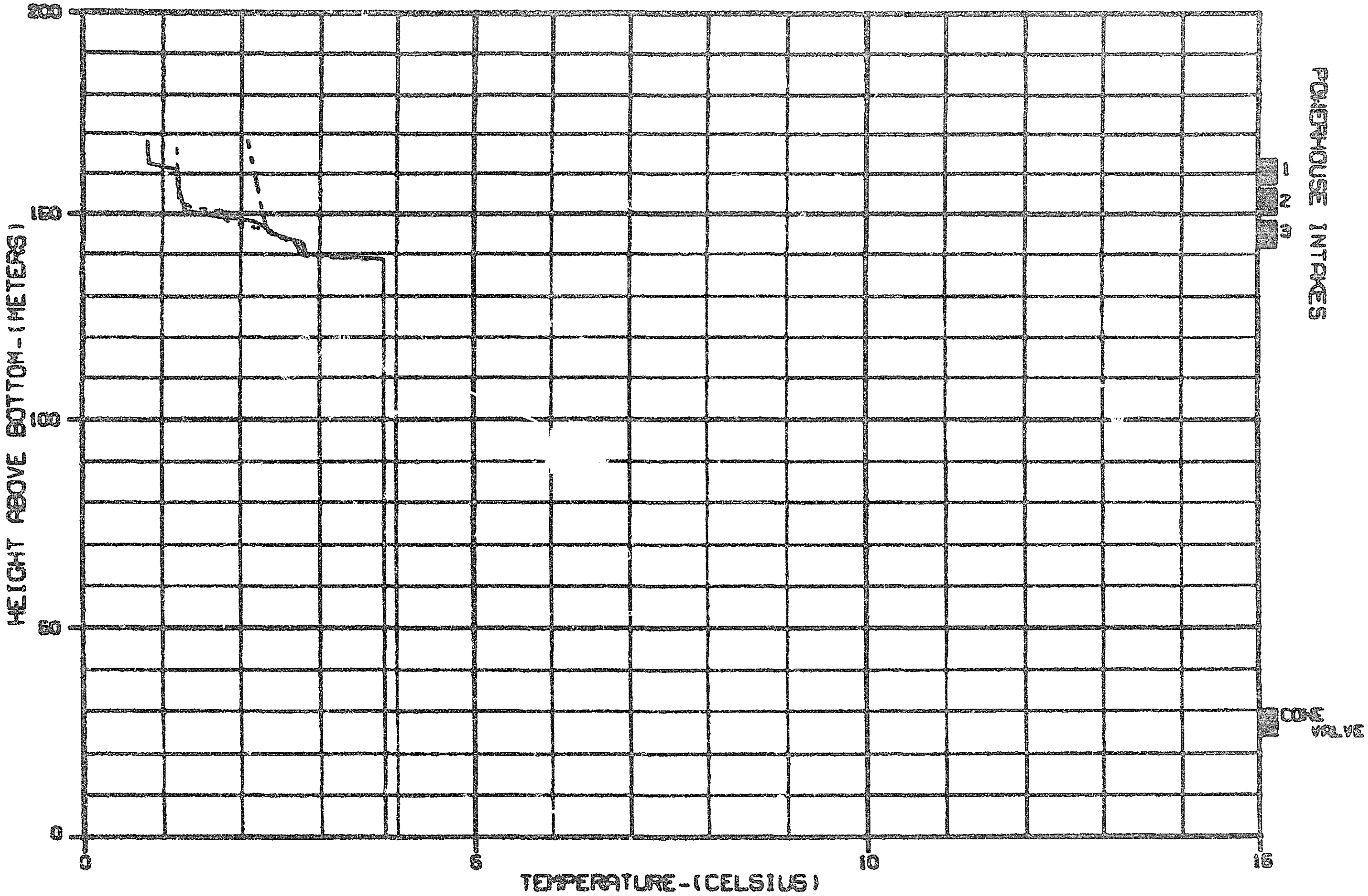
NOTE: THIS RUN SUPERCEDES DC81020

ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE



CASE: DC810202 - DEVIL CANYON OPERATION W/WATANA IN 2002
CASE E-VI S2 NATURAL COND. DRAWDOWN AT D.C. = 50.0 FT.

LEGEND:

PREDICTED TEMPERATURE PROFILES:

- ——— 1 FEBRUARY 1983
- ········ 1 MARCH 1983
- —·—·— 1 APRIL 1983

NOTE: THIS RUN SUPERCEDES DC8102Q

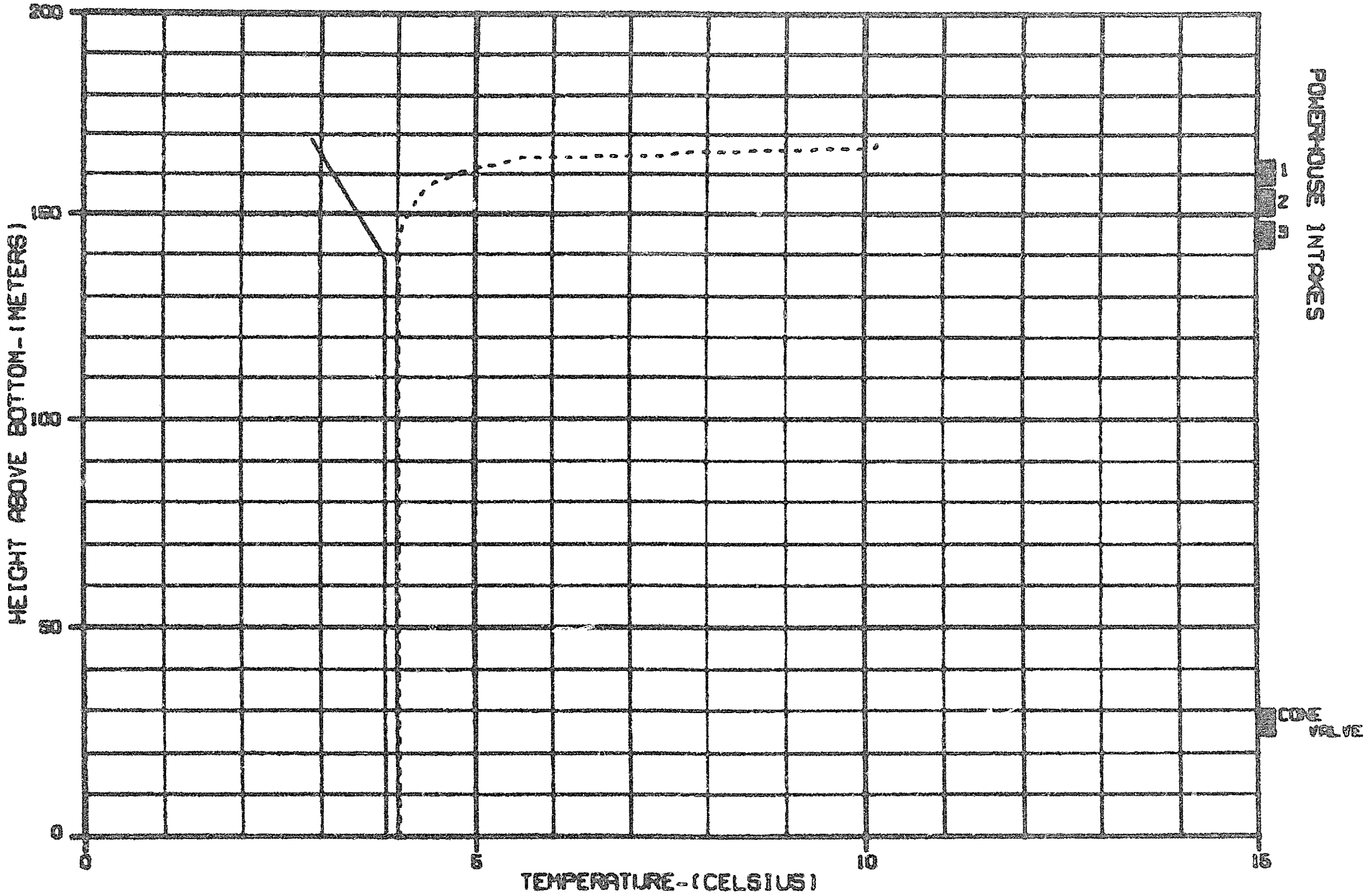
ALASKA POWER AUTHORITY

SUSITNA PROJECT | [illegible]

DEVIL CANYON RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

[illegible] | [illegible] | [illegible]



CASE: DC810202 - DEVIL CANYON OPERATION W/WATANA IN 2002
CASE E-VI S2 NATURAL COND. DRAWDOWN AT D.C. = 50.0 FT.

LEGEND:

PREDICTED TEMPERATURE PROFILES:

———— 1 MAY 1983

- - - - - 1 JUNE 1983

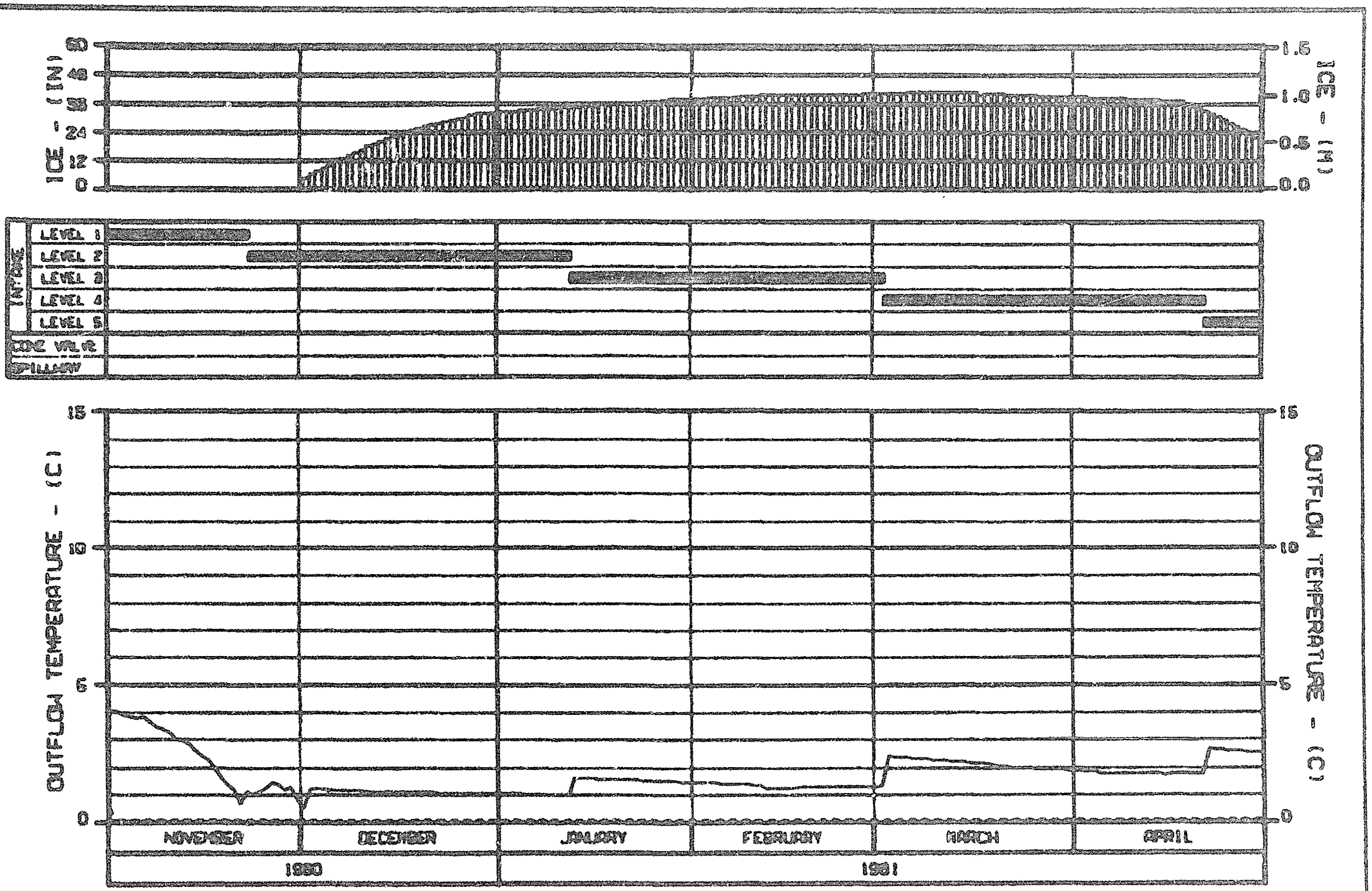
— - — - —

NOTE: THIS RUN SUPERCEDES DC81020

ALASKA POWER AUTHORITY		
SUSITNA PROJECT	DYRESM MODEL	
DEVIL CANYON RESERVOIR TEMPERATURE PROFILES		
HARZA-EBASCO JOINT VENTURE		
CHICAGO, ILLINOIS	[illegible]	42-010-04

EXHIBIT H

CASE E-VI
STAGE II
THREE-STAGE PROJECT
DEVIL CANYON 9-ft DRAWDOWN
INFLOW TEMPERATURE MATCHING



LEGEND: CASE: ** WAB102P - WATANA OPERATION W/DEVIL CANYON IN 2002 **
CASE E-VI 52. NAT. CONDITIONS. DRAWDOWN = 9 FT (DC). 6 LEVELS
———— PREDICTED OUTFLOW TEMPERATURE
- - - - - - INFLOW TEMPERATURE

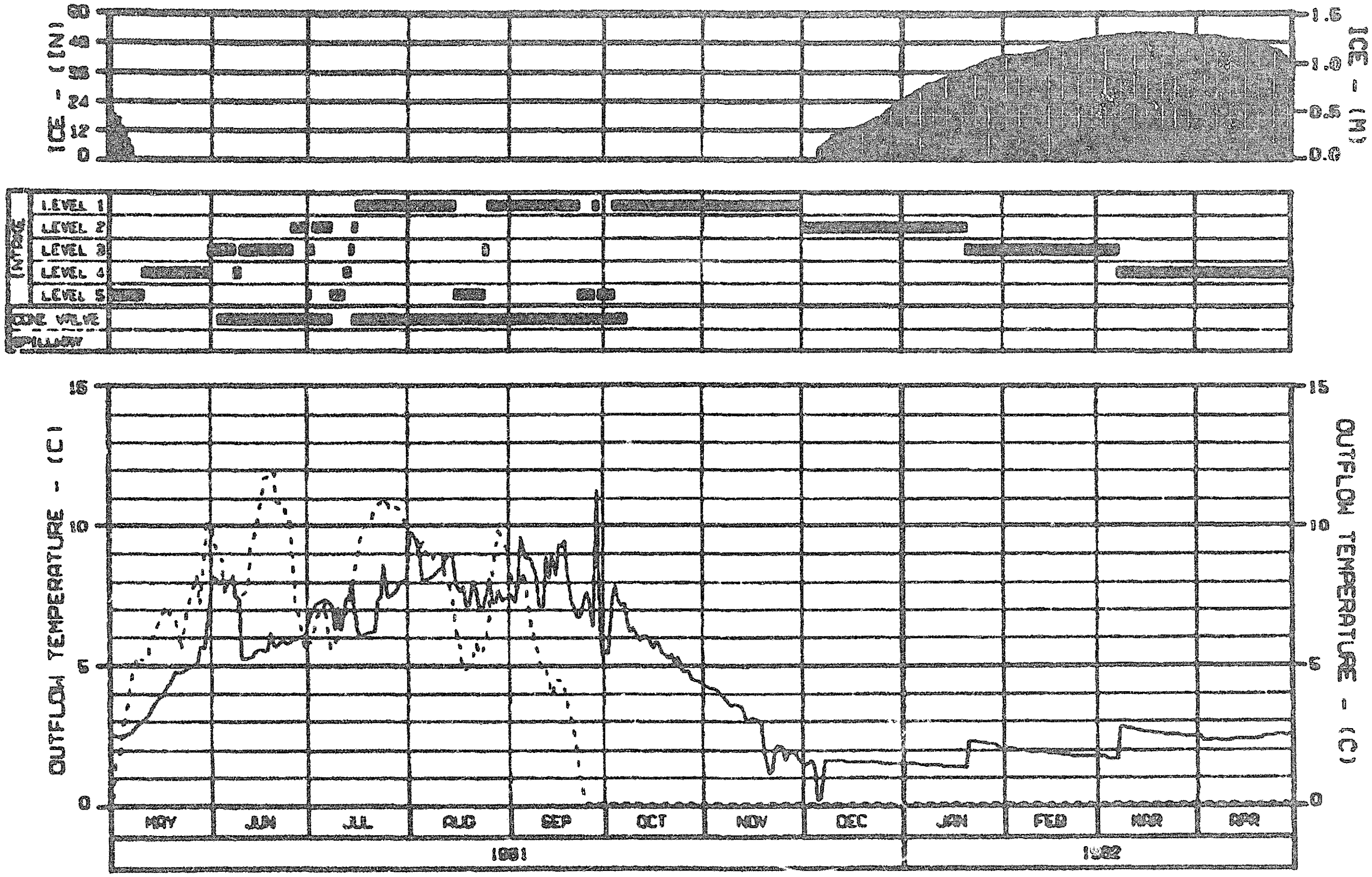
NOTES:
1. INTAKE PORT LEVEL 1 AT EL. 1964.5 FT. (598.8 M)
2. INTAKE PORT LEVEL 2 AT EL. 1926.5 FT. (587.4 M)
3. INTAKE PORT LEVEL 3 AT EL. 1888.5 FT. (575.8 M)
4. INTAKE PORT LEVEL 4 AT EL. 1850.5 FT. (564.2 M)
5. INTAKE PORT LEVEL 5 AT EL. 1812.5 FT. (552.6 M)
6. CONE VALVE AT ELEVATION 1791 FT (546.0 M)
7. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE



LEGEND: CASE: == WA8102P - WATANA OPERATION W/DEVIL CANYON IN 2002 ==
CASE E-VI 82. NAT. CONDITIONS. DRAWDOWN = 8 FT (DC). 5 LEVELS
———— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT EL. 1864.5 FT. (568.0 M)
2. INTAKE PORT LEVEL 2 AT EL. 1826.5 FT. (557.4 M)
3. INTAKE PORT LEVEL 3 AT EL. 1888.5 FT. (575.8 M)
4. INTAKE PORT LEVEL 4 AT EL. 1850.5 FT. (564.2 M)
5. INTAKE PORT LEVEL 5 AT EL. 1812.5 FT. (552.6 M)
6. CONE VALVE AT ELEVATION 1791 FT (546.0 M)
7. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

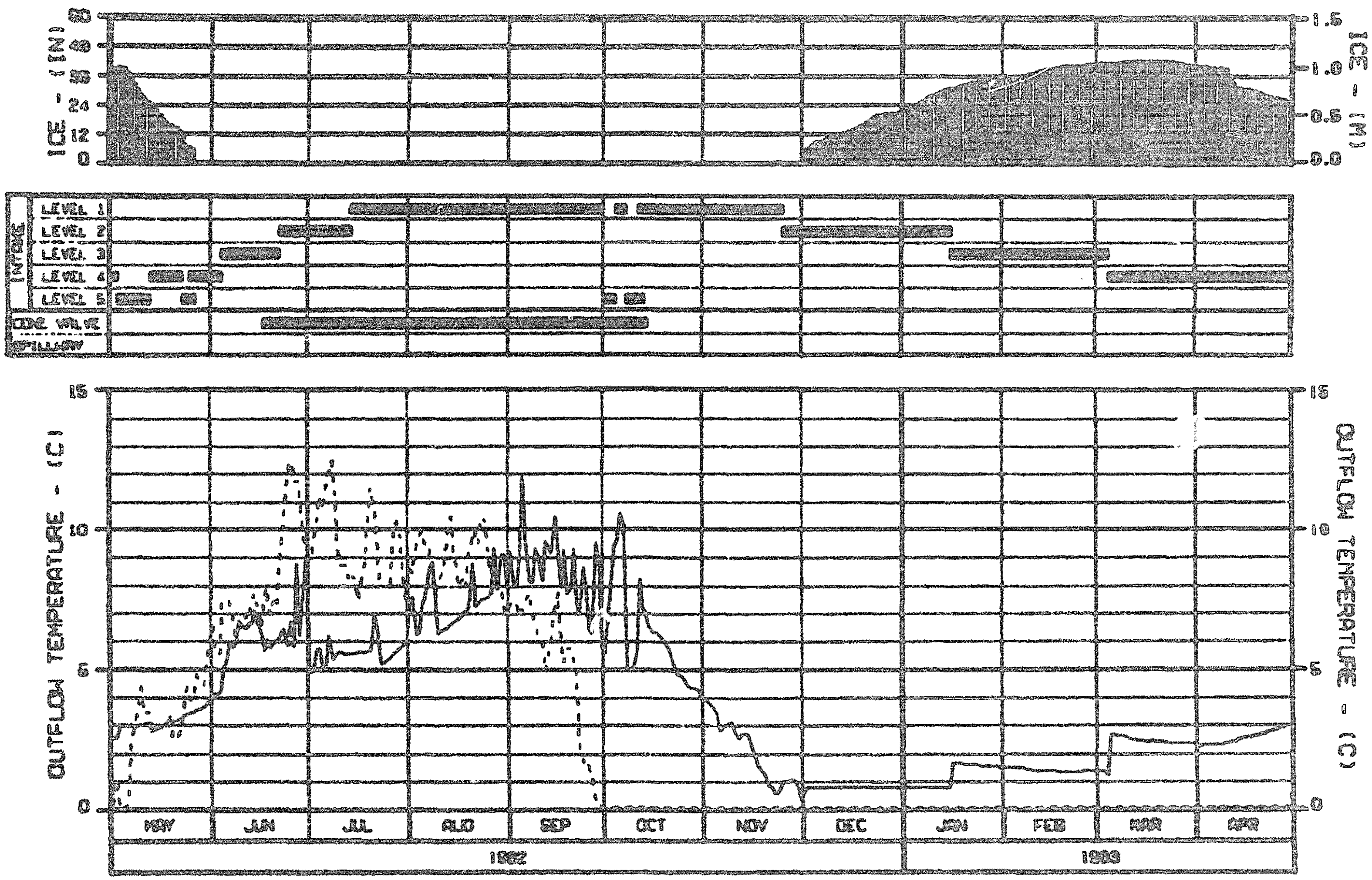
ALASKA POWER AUTHORITY

SUSITNA PROJECT | [illegible]

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

[illegible] | [illegible] | [illegible]



LEGEND: CASE: WA8102P - WATANA OPERATION W/DEVIL CANYON IN 2002
CASE E-VI 62. NAT. CONDITIONS. DRAWDOWN = 9 FT (DC). 5 LEVELS
——— PREDICTED OUTFLOW TEMPERATURE
- - - - - INFLOW TEMPERATURE

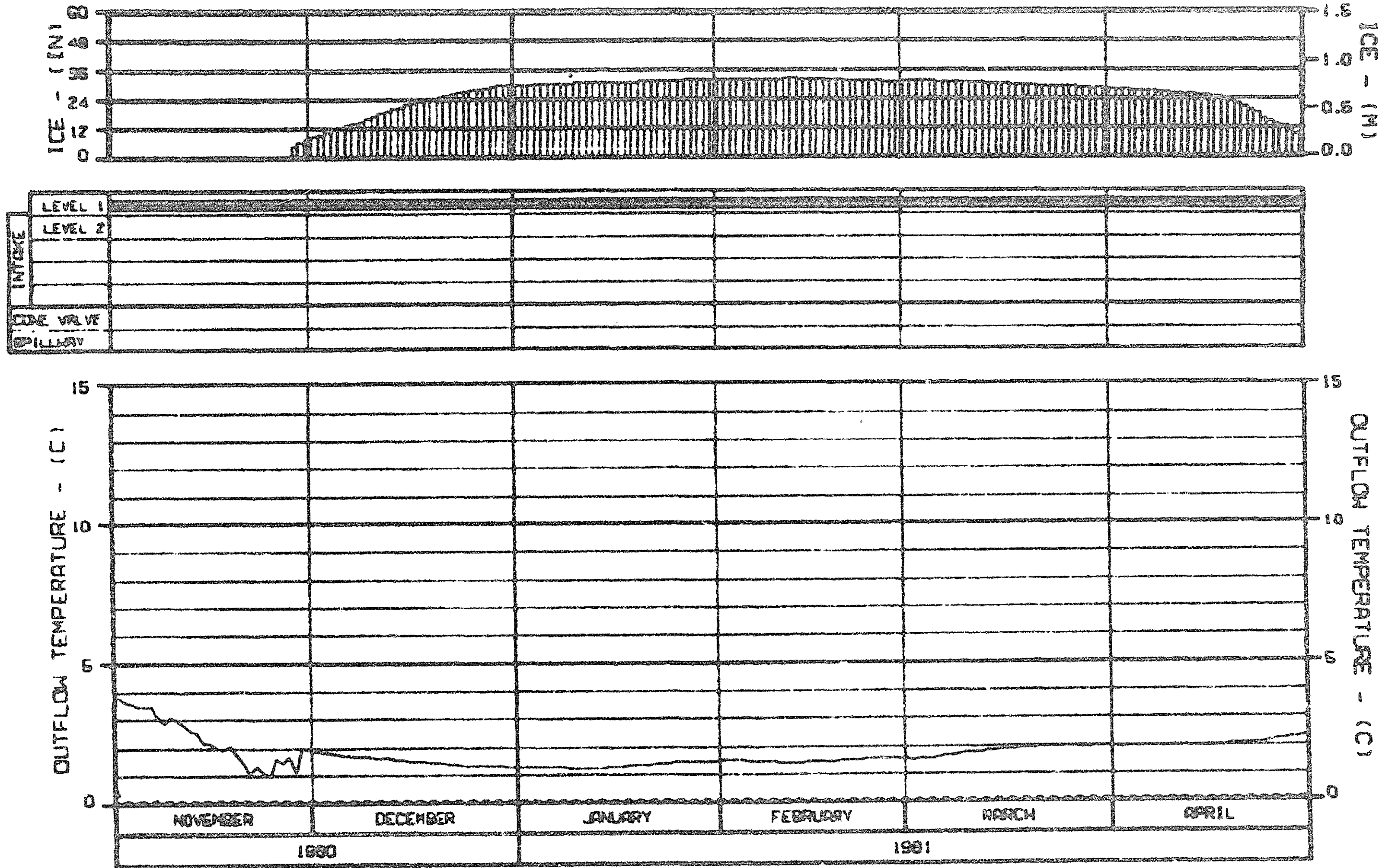
NOTES:
1. INTAKE PORT LEVEL 1 AT EL. 1964.5 FT. (598.8 M)
2. INTAKE PORT LEVEL 2 AT EL. 1926.5 FT. (587.4 M)
3. INTAKE PORT LEVEL 3 AT EL. 1988.5 FT. (575.8 M)
4. INTAKE PORT LEVEL 4 AT EL. 1850.5 FT. (564.2 M)
5. INTAKE PORT LEVEL 5 AT EL. 1812.5 FT. (552.6 M)
6. CONE VALVE AT ELEVATION 1791 FT (546.0 M)
7. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

ALASKA POWER AUTHORITY

SUSITNA PROJECT | [illegible]

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

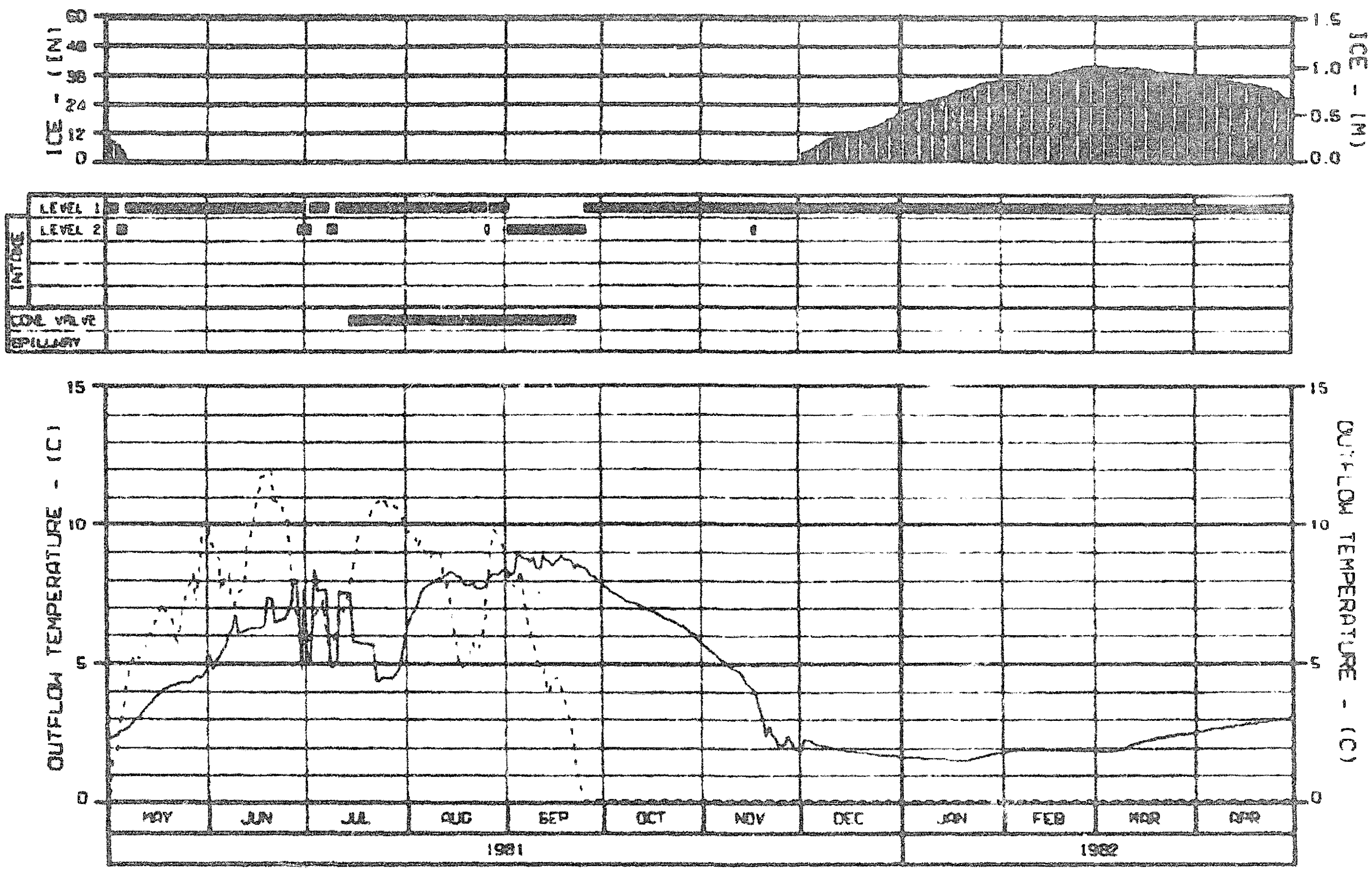
HARZA-EBASCO JOINT VENTURE



LEGEND: CASE: OC8102P - DEVIL CANYON OPERATION W/WATANA IN 2002
CASE E-VI S2. NATURAL CONDITIONS. DRAWDOWN = 8 FT. (DC)
———— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 1426 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1376 FT (419.10 M)
3. CONE VALVE AT ELEVATION 990 FT (301.75 M)
4. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
DEVIL CANYON RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH	
HARZA-EBASCO JOINT VENTURE	
42-010-04	



LEGEND: CASE: ** 7C8102P - DEVIL CANYON OPERATION W/WATANA IN 2002 **
CASE E-V; S2. NATURAL CONDITIONS. DRAWDOWN = 9 FT. (DC)
———— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES: 1. INTAKE PORT LEVEL 1 AT ELEVATION 1425 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1375 FT (419.10 M)
3. CONE VALVE AT ELEVATION 990 FT (301.75 M)
4. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)

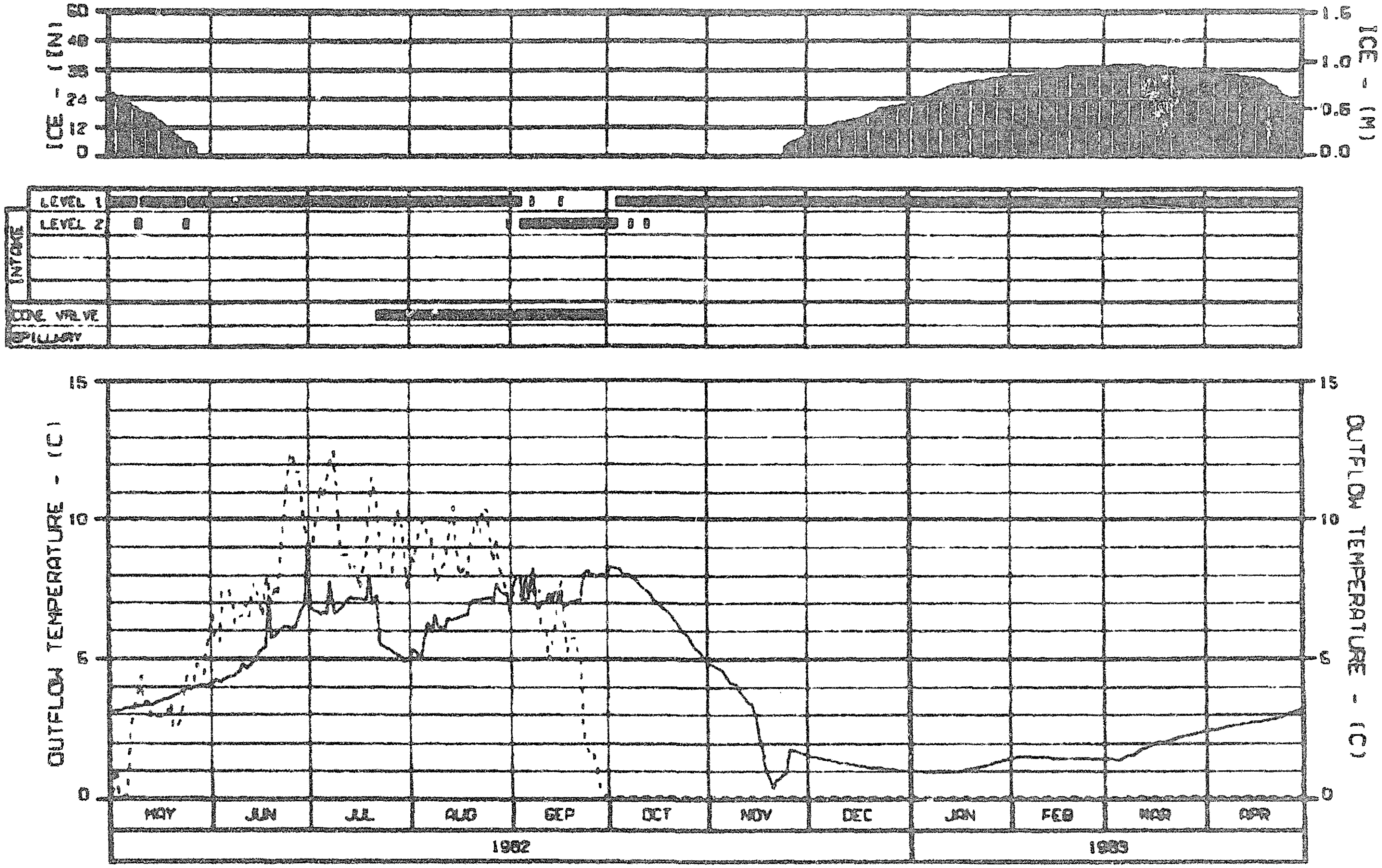
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | [illegible] | 42-010-04



LEGEND: CASE: DC8102P - DEVIL CANYON OPERATION W/WATANA IN 2002
CASE E-VI 52. NATURAL CONDITIONS. DRAWDOWN = 9 FT. (DC)

——————— PREDICTED OUTFLOW TEMPERATURE

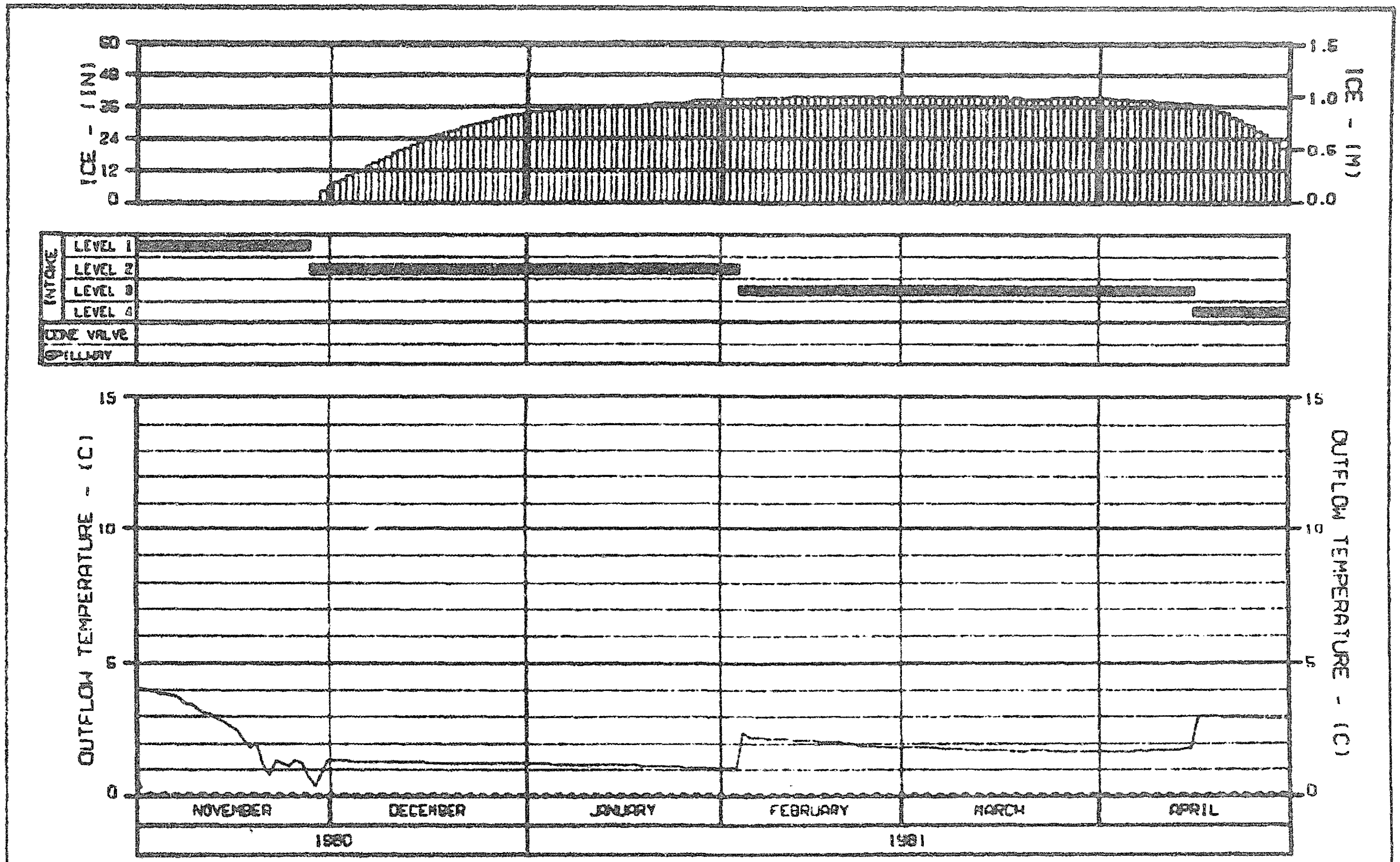
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 1425 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1375 FT (419.10 M)
3. CONE VALVE AT ELEVATION 990 FT (301.75 M)
4. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
DEVIL CANYON RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH	
HARZA-EBASCO JOINT VENTURE	
[illegible]	[illegible] / 42-010-04

EXHIBIT I

CASE E-VI
STAGE III
THREE-STAGE PROJECT
FULL GENERATING CAPACITY
INFLOW TEMPERATURE MATCHING



LEGEND: CASE: ## WA8120E - WATANA OPERATION W/DEVIL CANYON IN 2020 (CASE E-6) S-3

———— PREDICTED OUTFLOW TEMPERATURE
- - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 2183 FT (665.4 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2108 FT (642.7 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2066 FT (629.9 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2024 FT (617.1 M)
5. CONE VALVE AT ELEVATION 1929 FT (588.0 M)
6. SPILLWAY CREST AT ELEVATION 2297 FT (700.0 M)

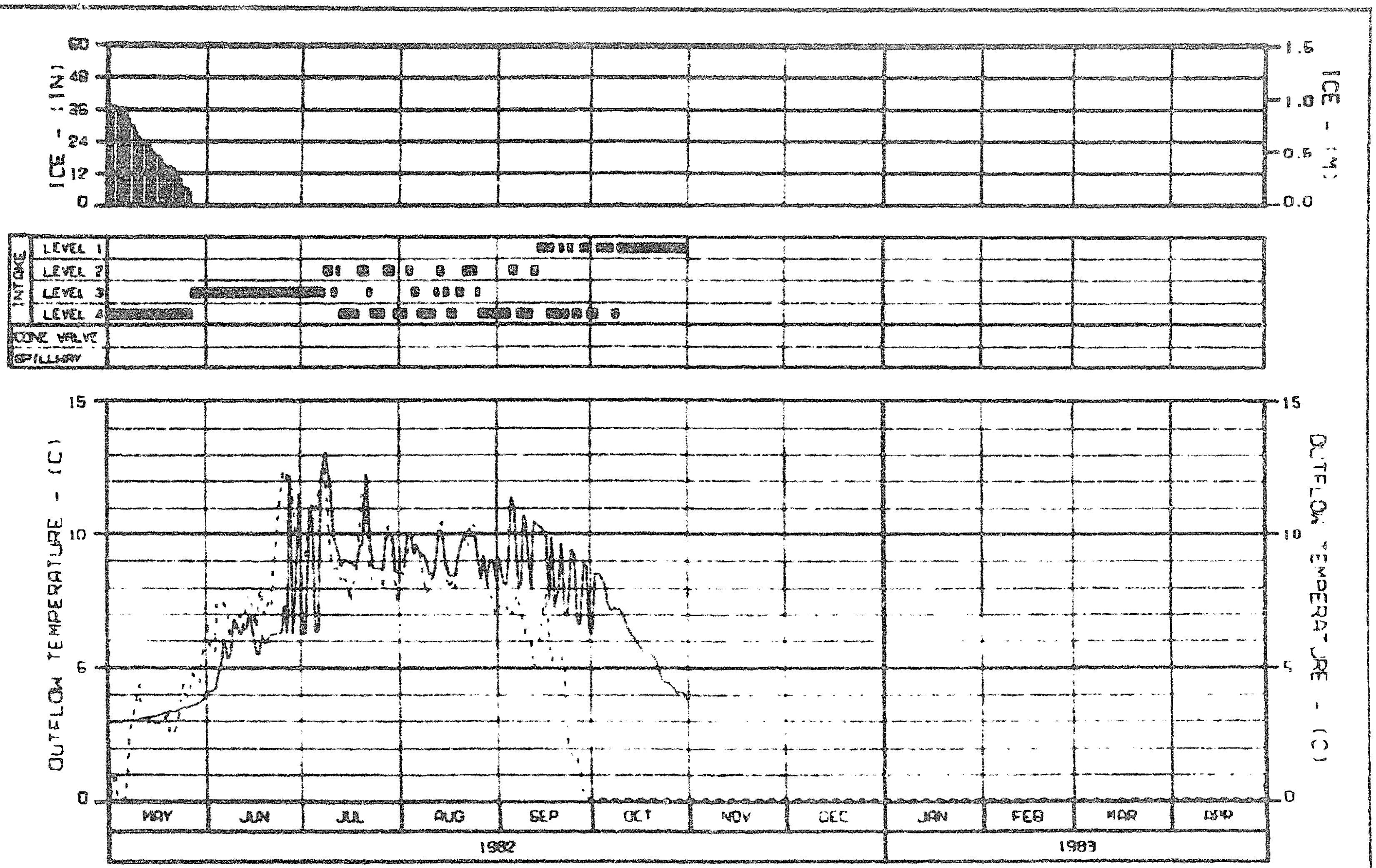
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | | 42-010-04

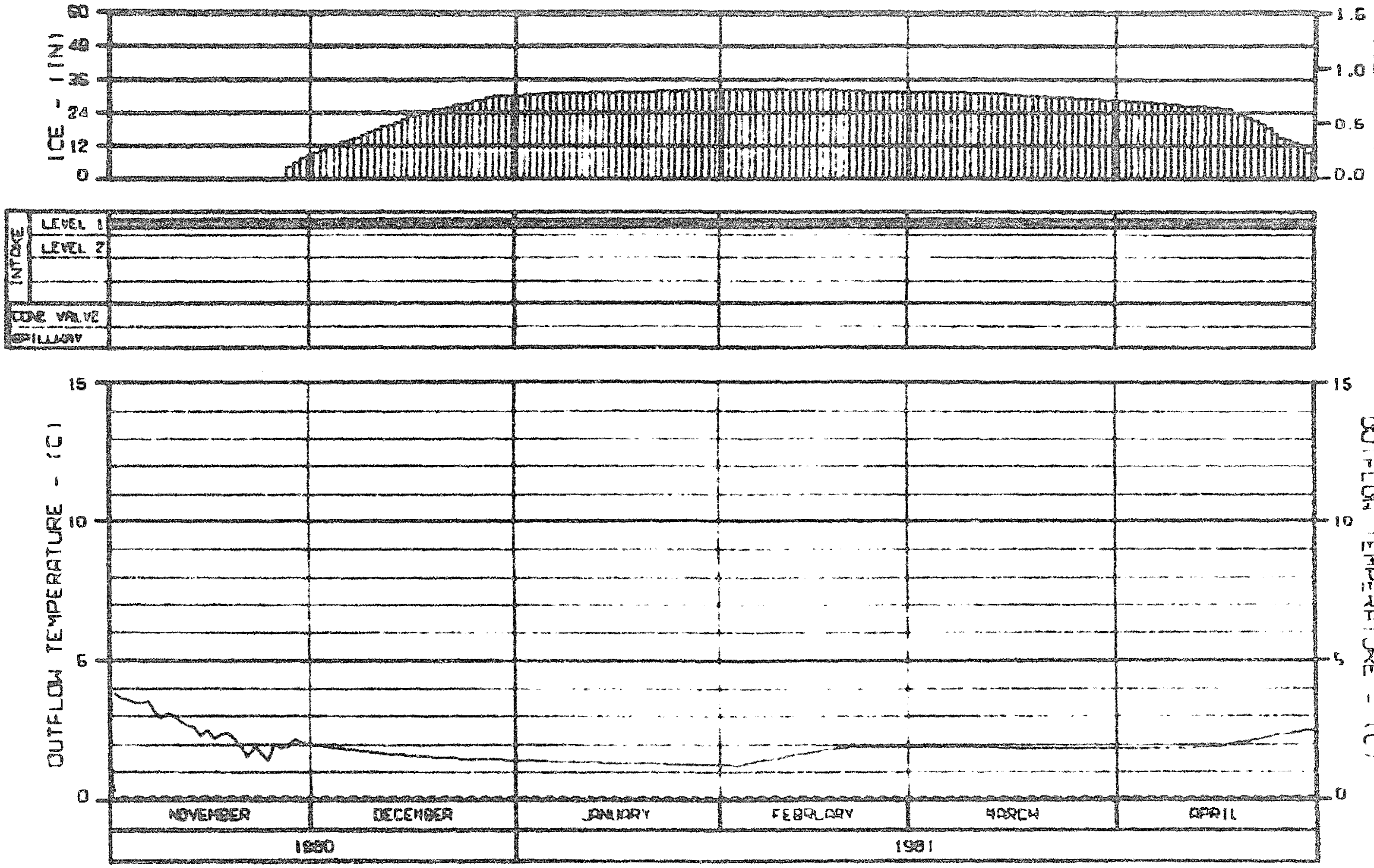


LEGEND: CASE: WAB120E - WATANA OPERATION W/DEVIL CANYON IN 2020 (CASE E.6)

———— PREDICTED OUTFLOW TEMPERATURE
- - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 2183 FT (665.4 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2108 FT (642.7 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2066 FT (629.9 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2024 FT (617.1 M)
5. CONE VALVE AT ELEVATION 1929 FT (588.0 M)
6. SPILLWAY CREST AT ELEVATION 2297 FT (700.0 M)

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
WATANA RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH	
HARZA-EBASCO JOINT VENTURE	
CHICAGO, ILLINOIS [illegible]	42.010.04



LEGEND: CASE: ** DC8120E - DEVIL CANYON OPERATION W/WATANA IN 2020 (CASE E-6)*

——— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES: 1. INTAKE PORT LEVEL 1 AT ELEVATION 1426 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1375 FT (419.10 M)
3. CONE VALVE AT ELEVATION 990 FT (301.75 M)
4. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)

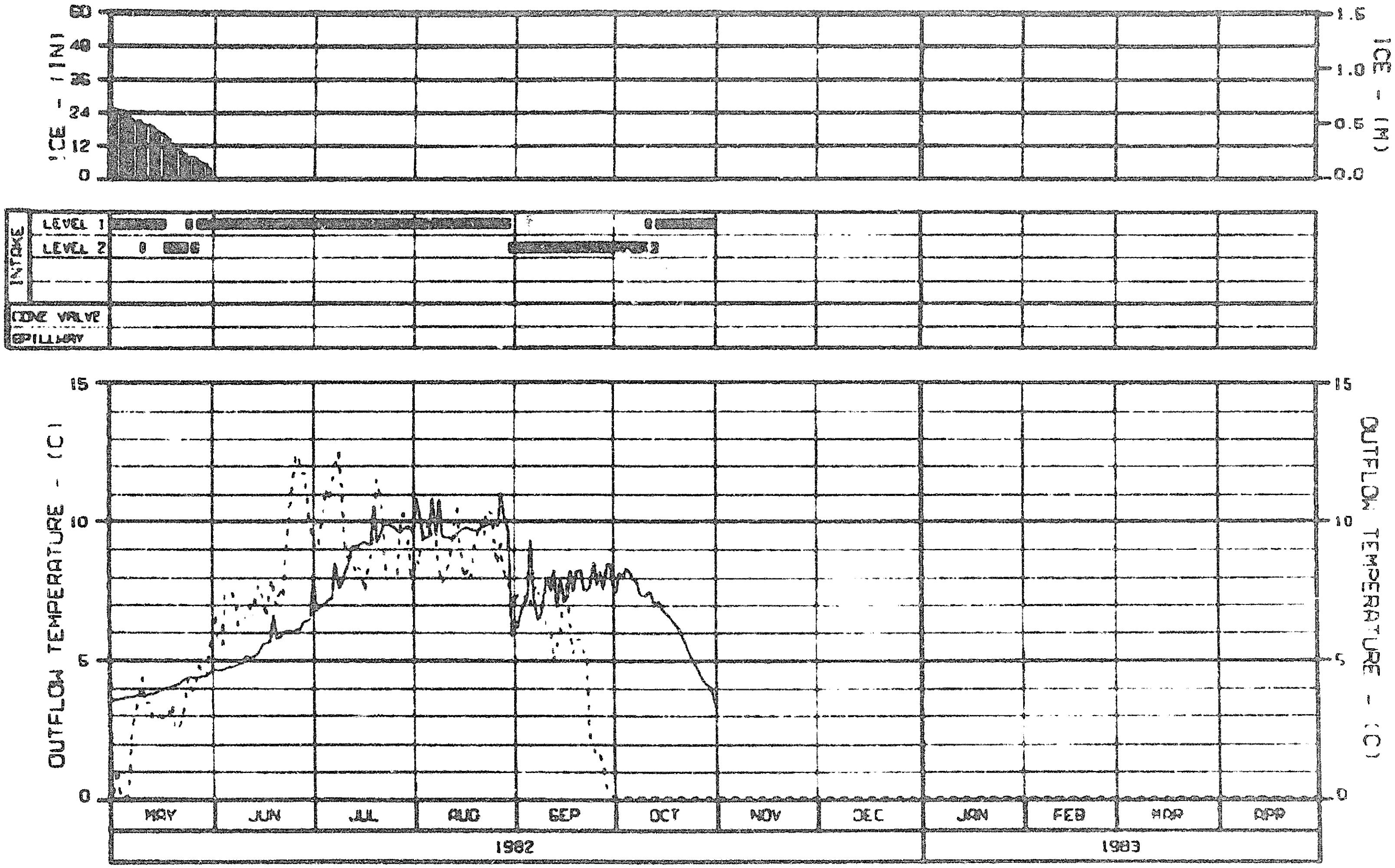
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 30 MAY 85 | 47-010-04



LEGEND: CASE: DC8120E - DEVIL CANYON OPERATION W/WATANA IN 2020 (CASE E-6)

———— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 1426 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1376 FT (419.10 M)
3. CONE VALVE AT ELEVATION 990 FT (301.75 M)
4. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)

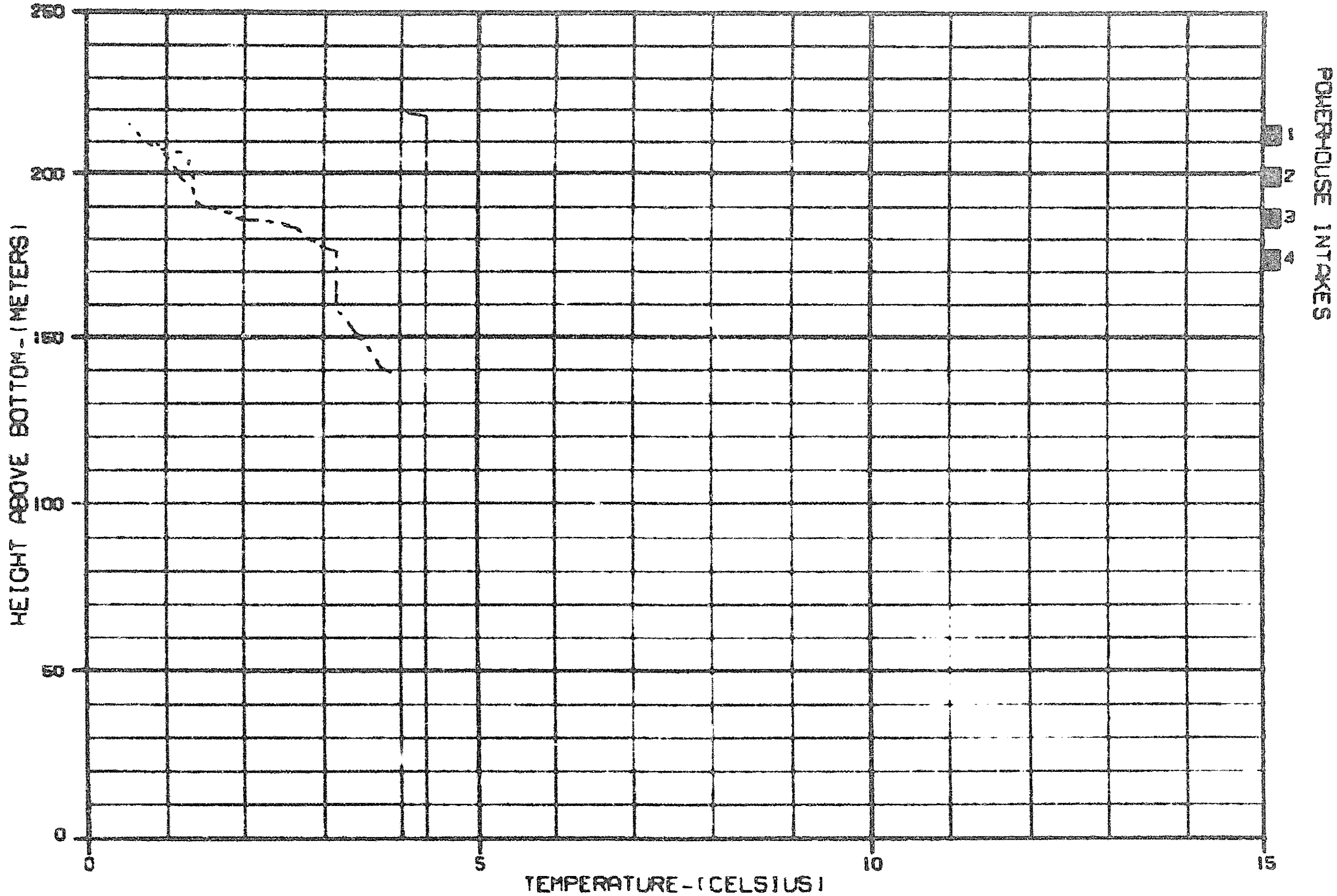
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 20 MAY 85 | 42-010-04



CASE: ** WA8120E - WATANA OPERATION W/DEVIL CANYON IN 2020 (CASE E-6) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

- ——— 1 NOVEMBER 1980
- - - - - 1 DECEMBER 1980
- —·—·— 1 JANUARY 1981

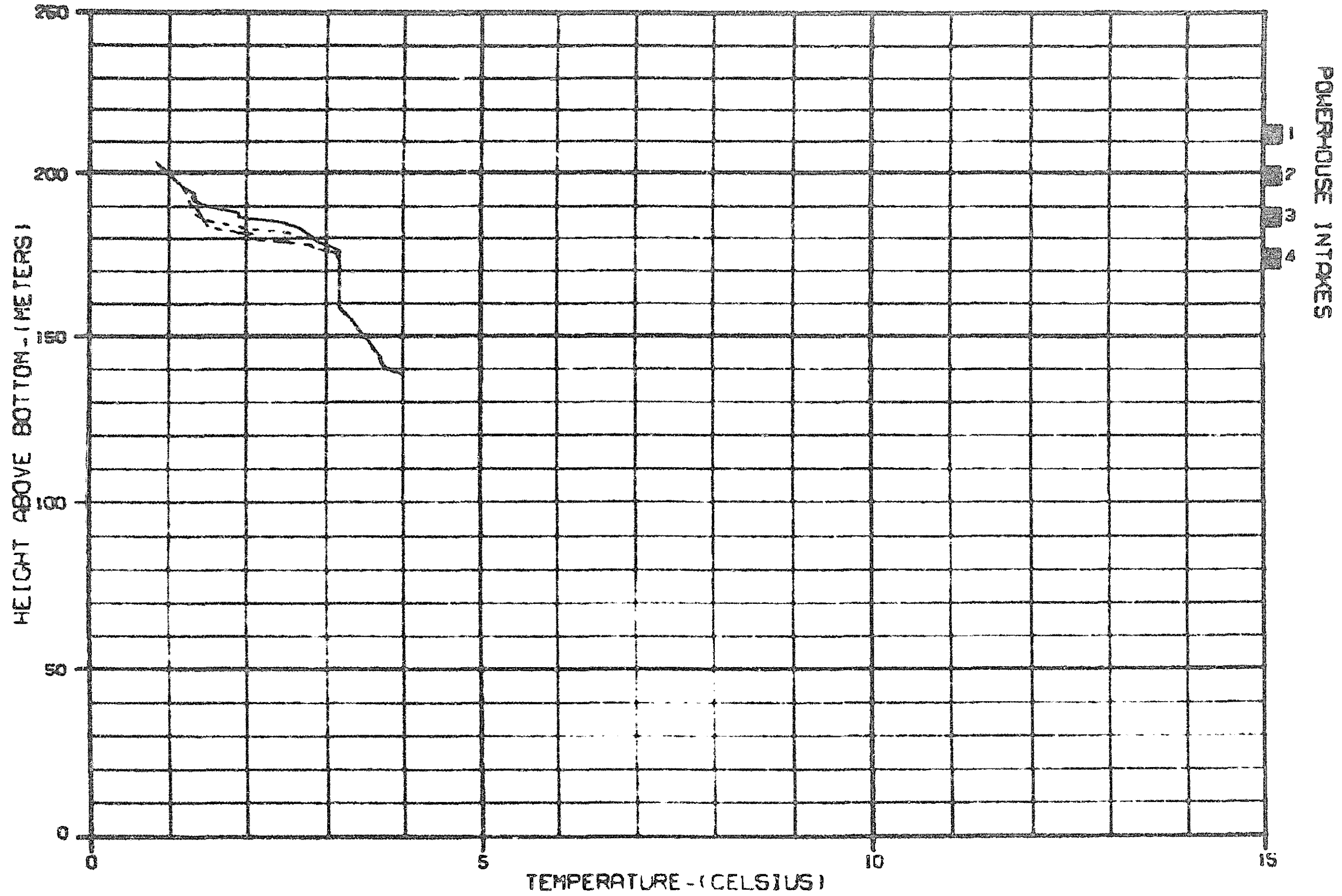
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 47-010-04



CASE: ** WA8120E - WATANA OPERATION W/DEVIL CANYON IN 2020 (CASE E-6) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

- ——— 1 FEBRUARY 1981
- - - - - 1 MARCH 1981
- —·—·— 1 APRIL 1981

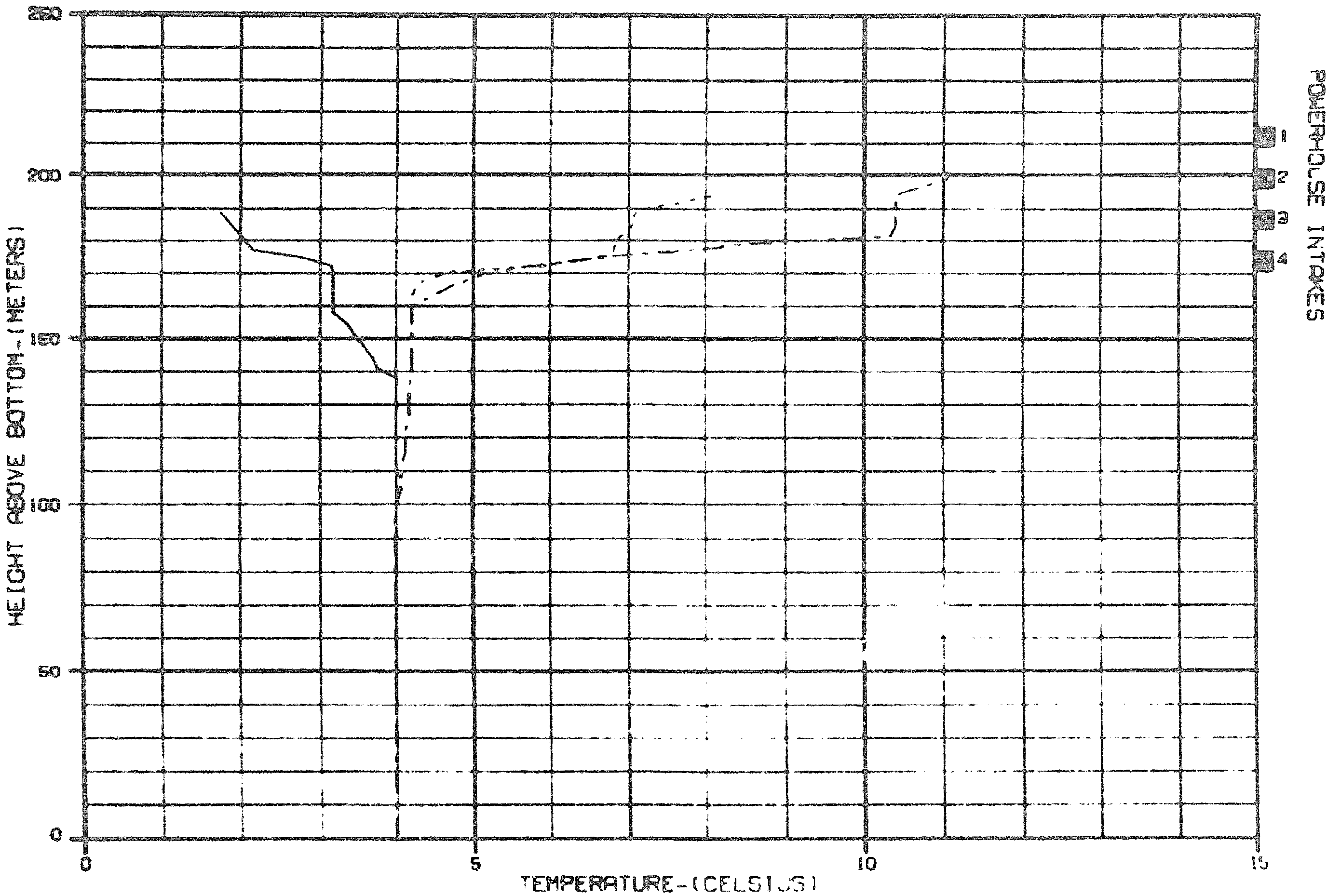
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

42-010-04



CASE: ** WA8120E - WATANA OPERATION W/DEVIL CANYON IN 2020 (CASE E-6) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

———— 1 MAY 1981
- - - - - - - 1 JUNE 1981
—·—·— 1 JULY 1981

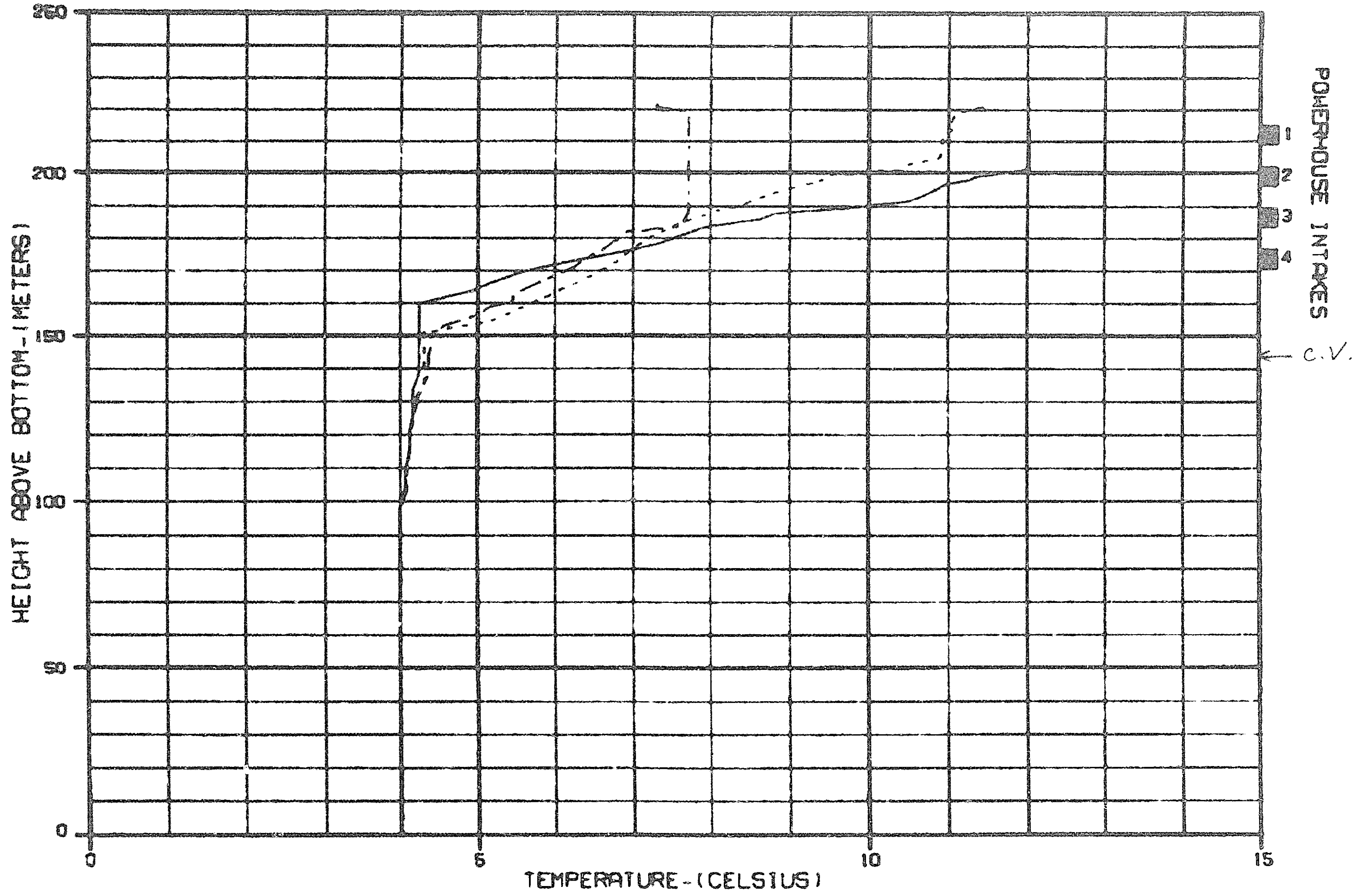
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 42-010-04



CASE: ■■ WA8120E - WATANA OPERATION W/DEVIL CANYON IN 2020 (CASE E-6) ■■

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 AUGUST	1981
- - - - - - - -	1 SEPTEMBER	1981
— - — - —	1 OCTOBER	1981

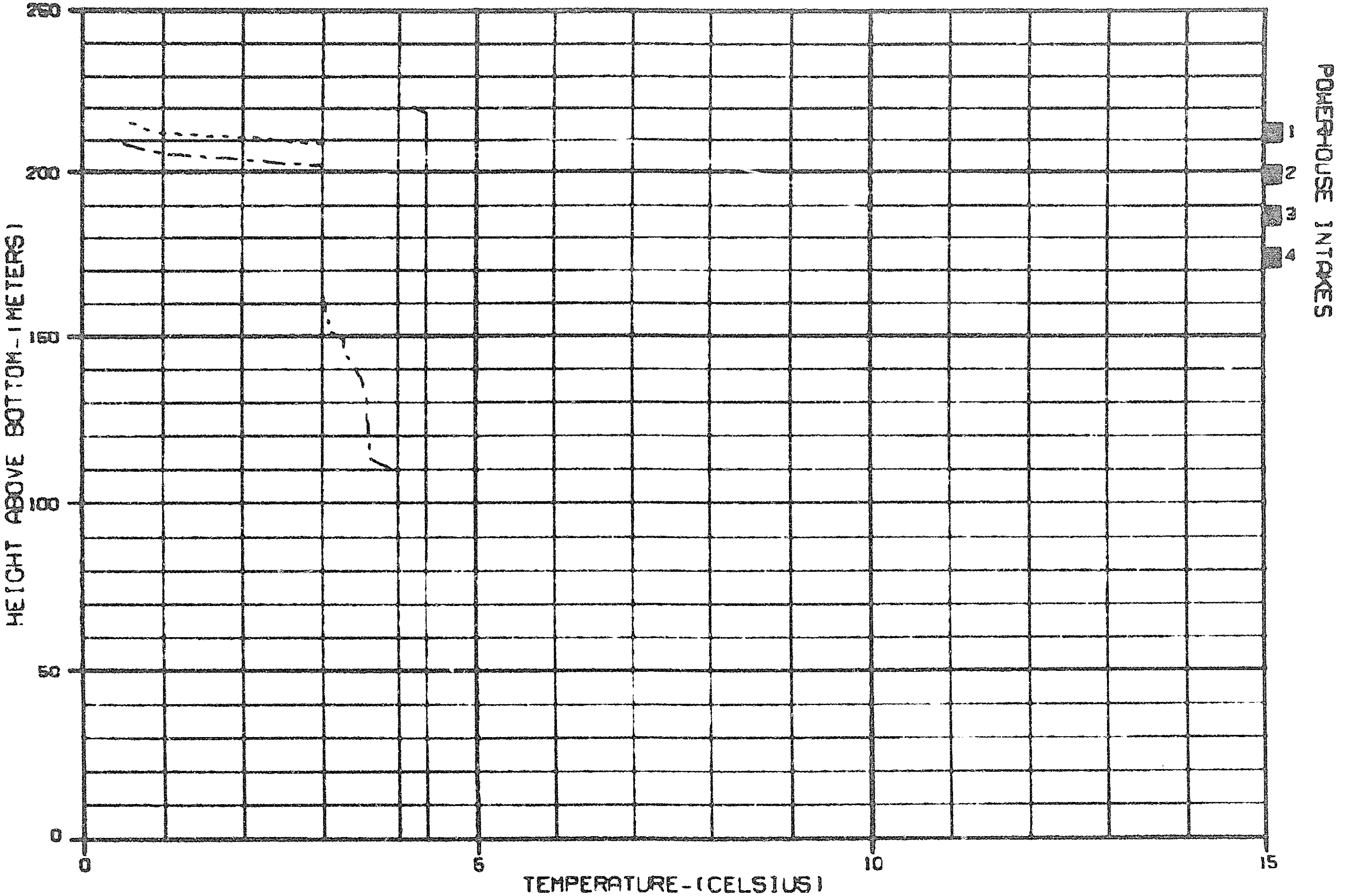
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 42-010-04



CASE: ** WA8120E - WATANA OPERATION W/DEVIL CANYON IN 2020 (CASE E-6) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

———— 1 NOVEMBER 1981

- - - - - 1 DECEMBER 1981

— - — - 1 JANUARY 1982

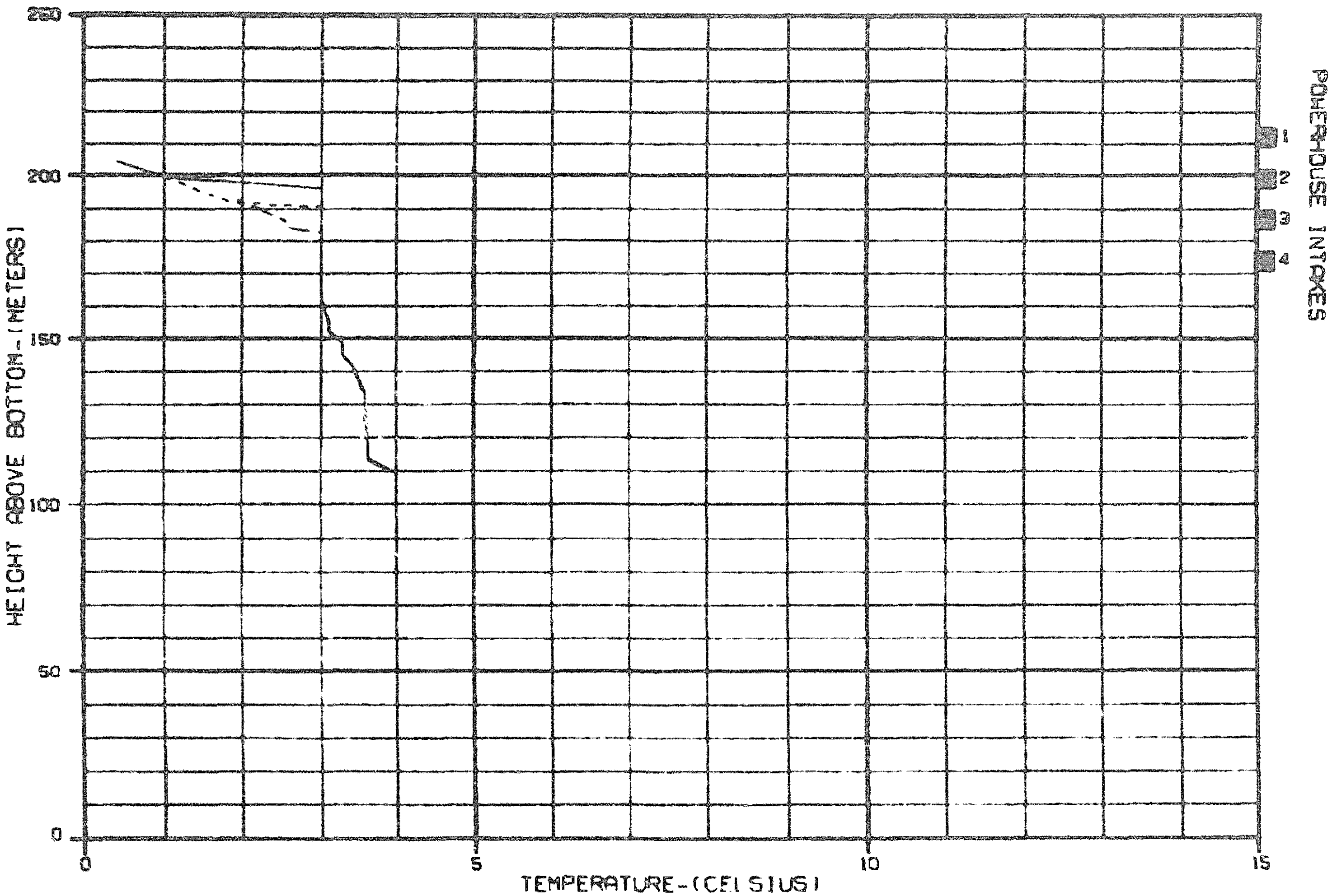
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | | 42-010-04



CASE: ■■ WAB120E - WATANA OPERATION W/DEVIL CANYON IN 2020 (CASE E-6) ■■

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————————	1 FEBRUARY 1982
- - - - - - - -	1 MARCH 1982
— - — - —	1 APRIL 1982

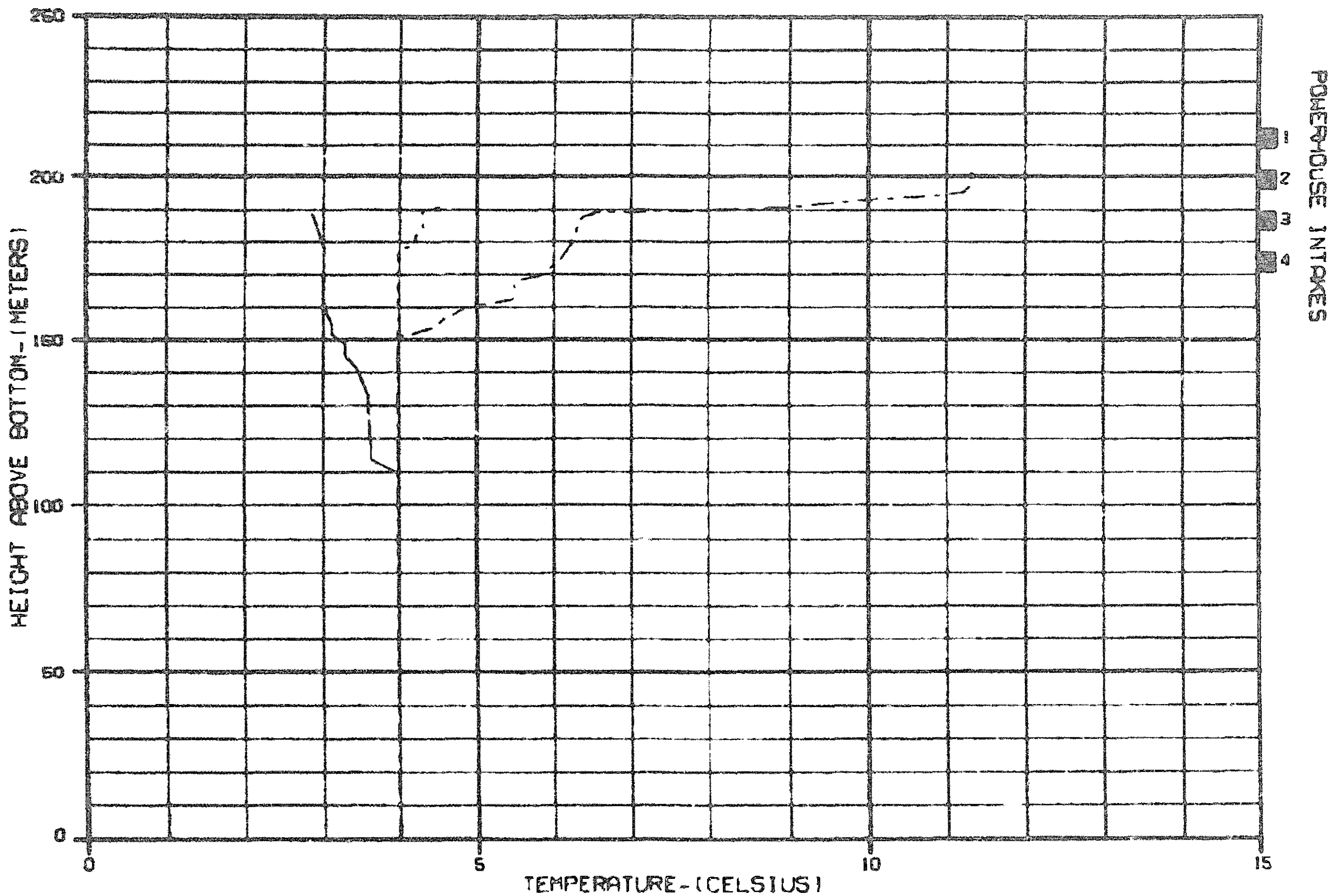
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

42-010-04



CASE: ** WA8120E - WATANA OPERATION W/DEVIL CANYON IN 2020 (CASE E-6) **

LEGEND:

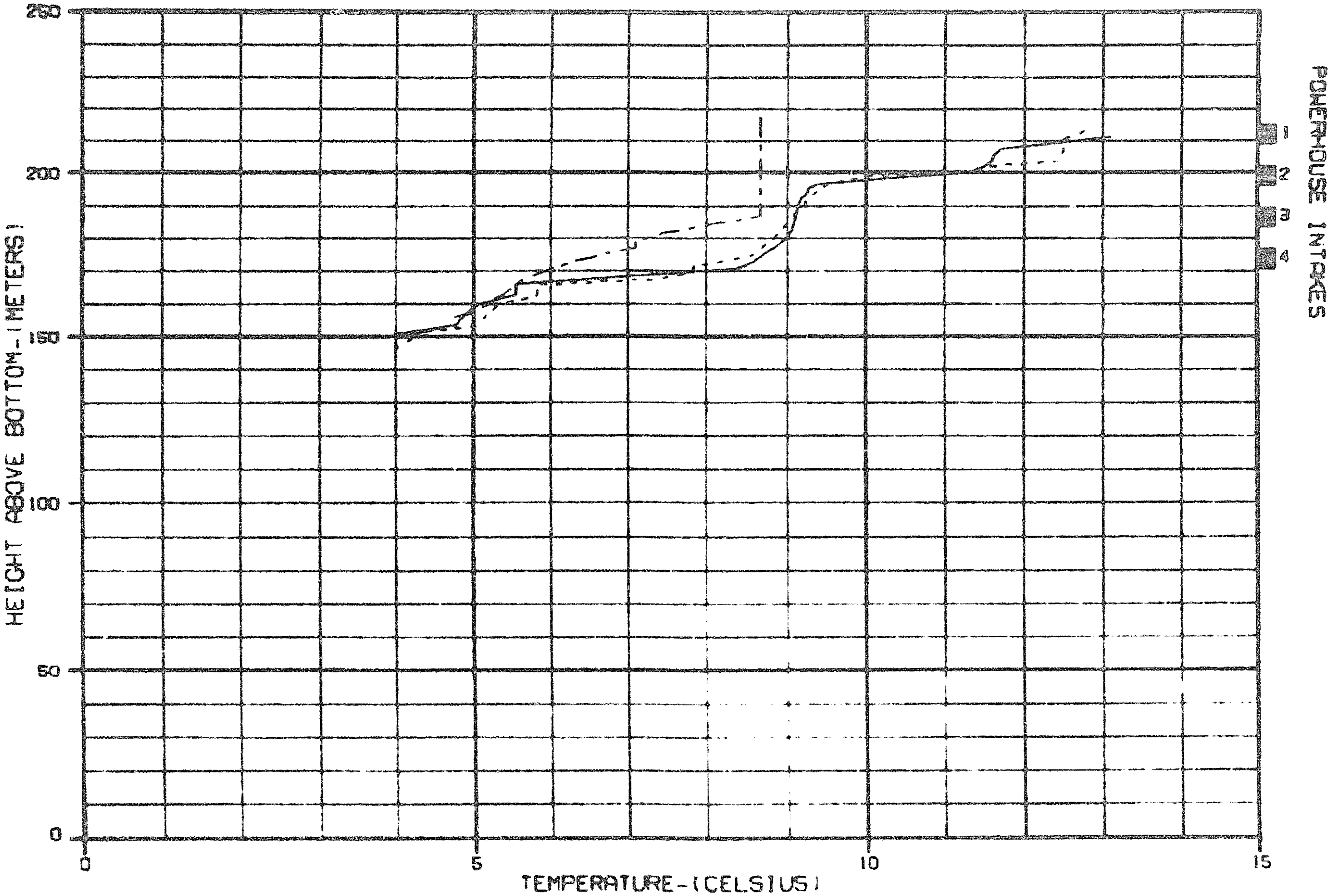
PREDICTED TEMPERATURE PROFILES:

——— 1 MAY 1982

- - - - 1 JUNE 1982

—·—· 1 JULY 1982

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
WATANA RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
CHICAGO, ILLINOIS	42-010-04



CASE: WA8120E - WATANA OPERATION W/DEVIL CANYON IN 2020 (CASE E-6)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

———— 1 AUGUST 1982
- - - - - 1 SEPTEMBER 1982
— - — - 1 OCTOBER 1982

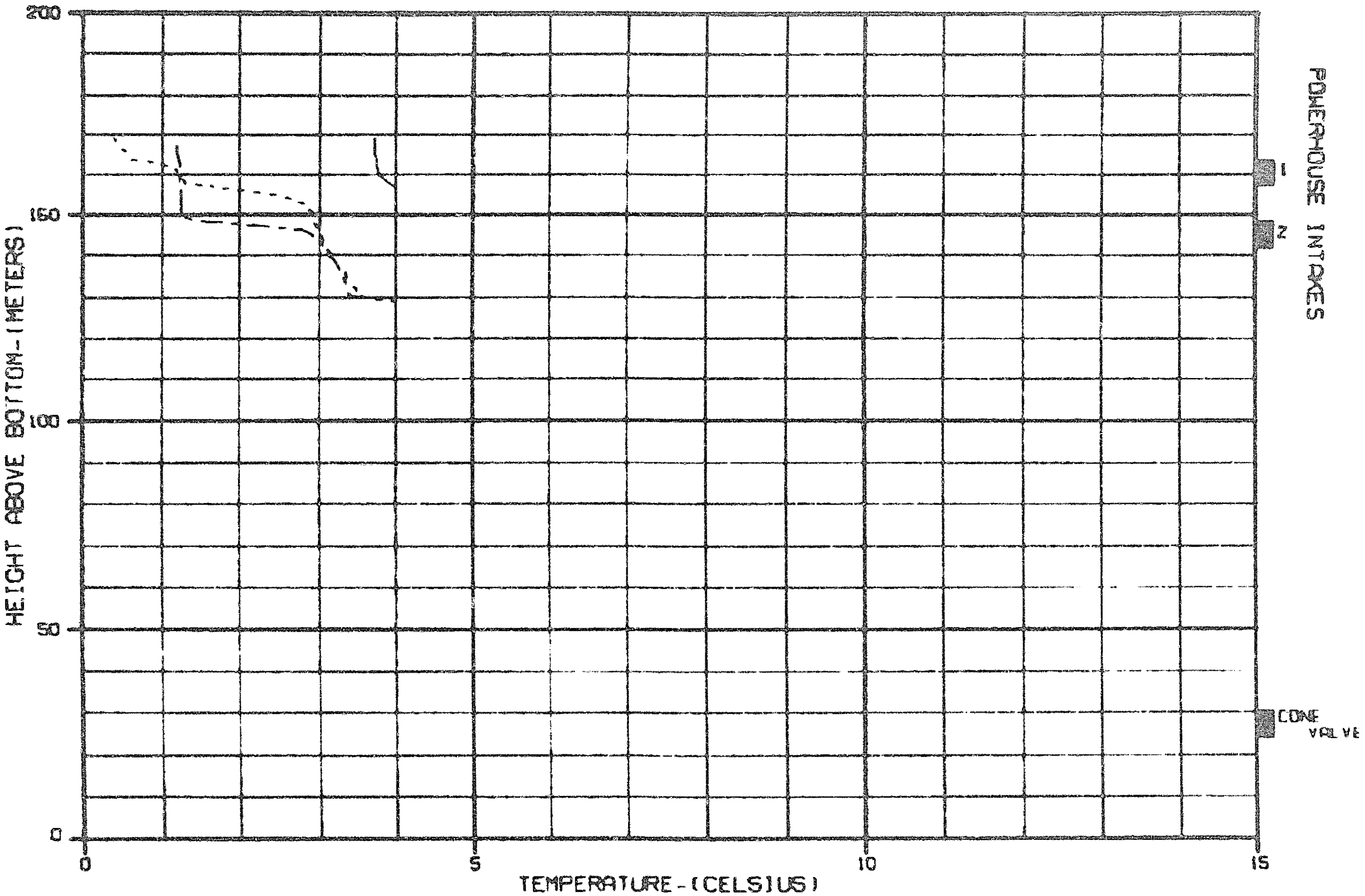
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA PESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 42-010-04



CASE: ■■ DC8120E - DEVIL CANYON OPERATION W/WATANA IN 2020 (CASE E-6) ■■

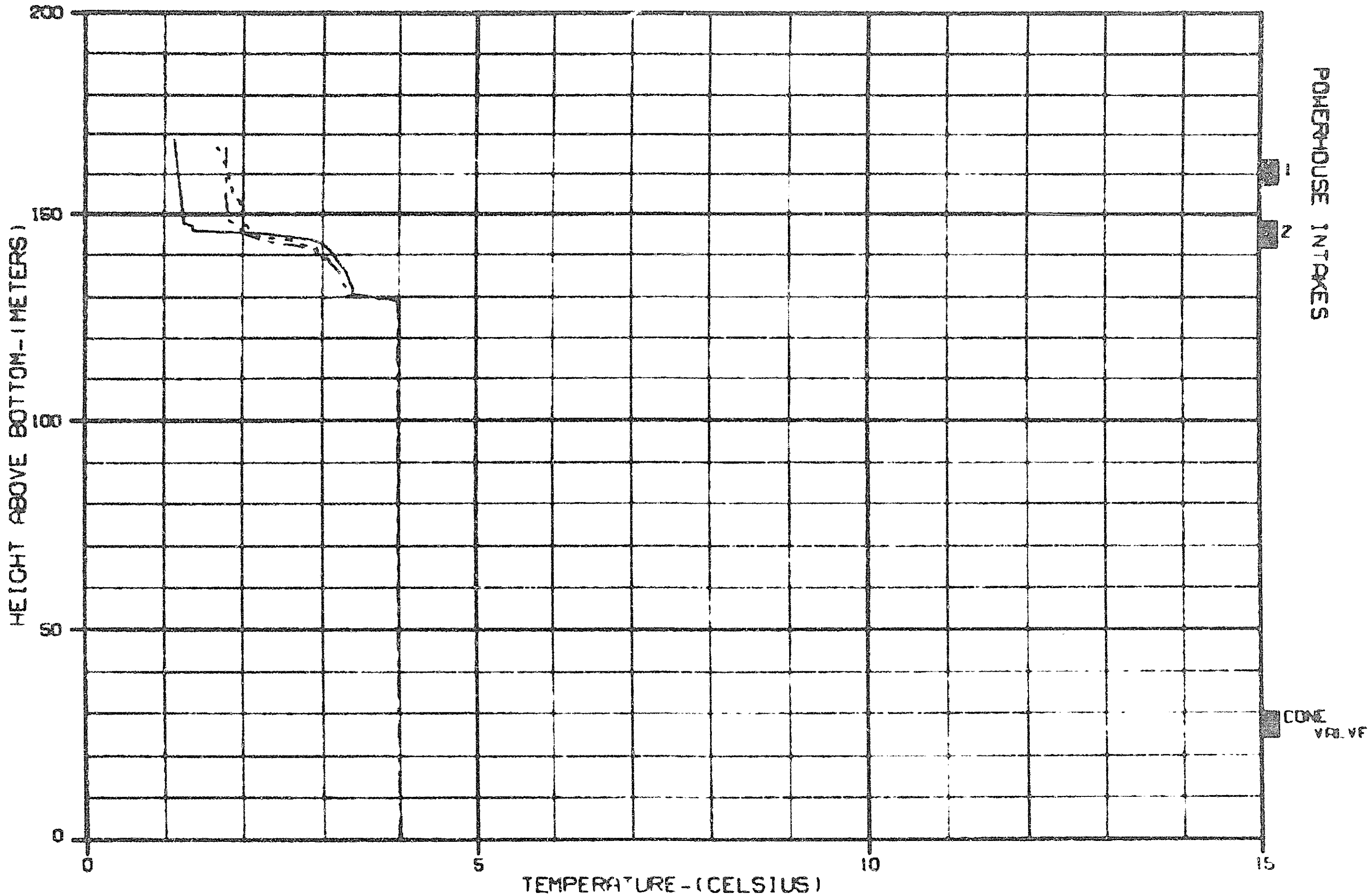
LEGEND:

PREDICTED TEMPERATURE PROFILES:

————————	1 NOVEMBER 1980
- - - - - - - -	1 DECEMBER 1980
—-—-—-	1 JANUARY 1981

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
DEVIL CANYON RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	

42-010-04



CASE: ** DC8120E - DEVIL CANYON OPERATION W/WATANA IN 2020 (CASE E-6) **

LEGEND:

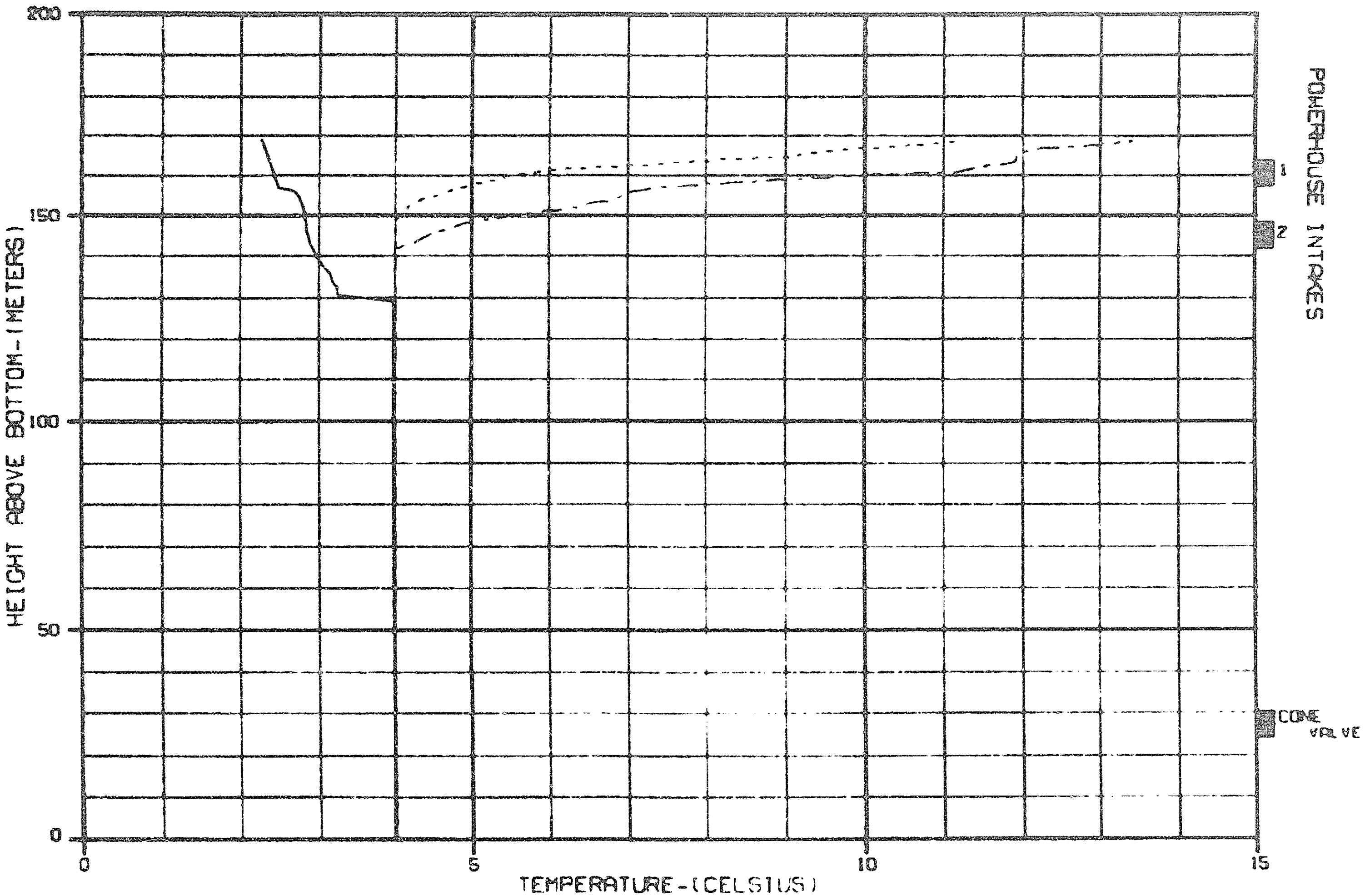
PREDICTED TEMPERATURE PROFILES:

———— 1 FEBRUARY 1981

- - - - - 1 MARCH 1981

— - — - 1 APRIL 1981

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
DEVIL CANYON RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
CHICAGO, ILLINOIS	42-010-04



CASE: ** DC8120E - DEVIL CANYON OPERATION W/WATANA IN 2020 (CASE E-6) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

———————	1 MAY 1981
- - - - - - - -	1 JUNE 1981
— · — · —	1 JULY 1981

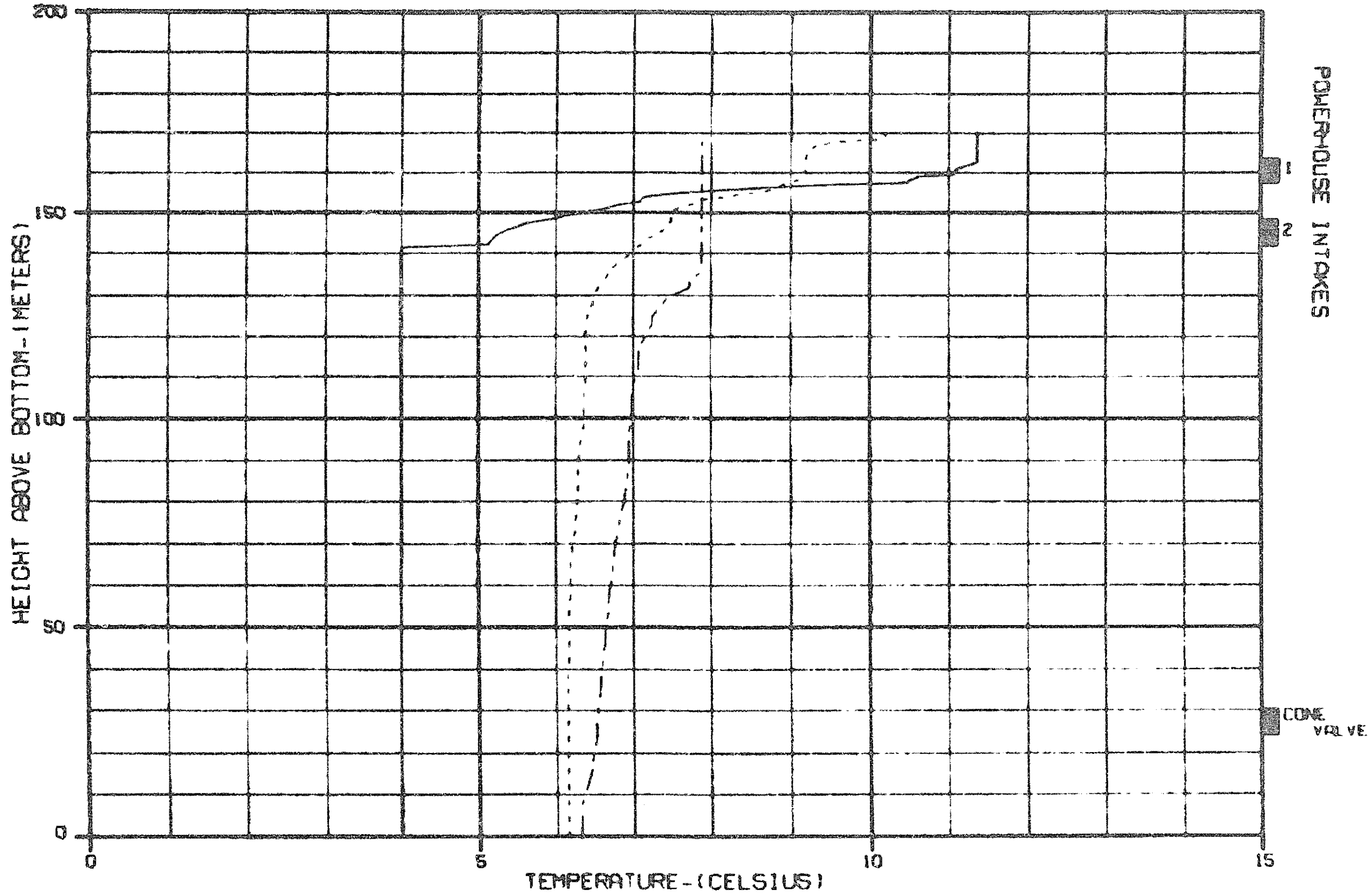
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 20 MAY 83 | 42-010-04



CASE: ** DCB120E - DEVIL CANYON OPERATION W/WATANA IN 2020 (CASE E-6) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————————	1 AUGUST 1981
- - - - - - - -	1 SEPTEMBER 1981
— - — - —	1 OCTOBER 1981

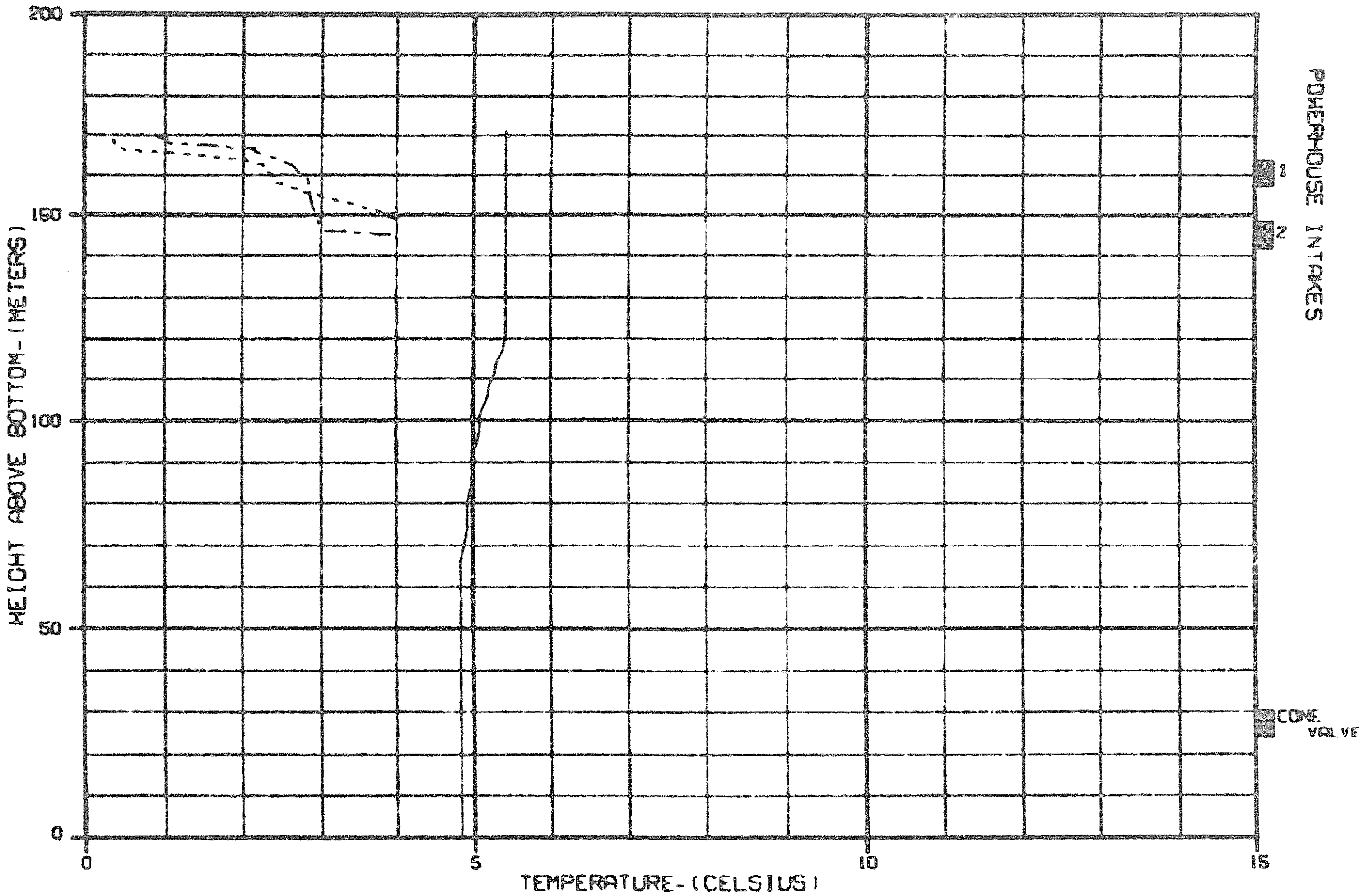
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

42-010-04



CASE: ** DCB120E - DEVIL CANYON OPERATION W/WATANA IN 2020 (CASE E-6) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 NOVEMBER 1981
- - - - - - - -	1 DECEMBER 1981
— - — - —	1 JANUARY 1982

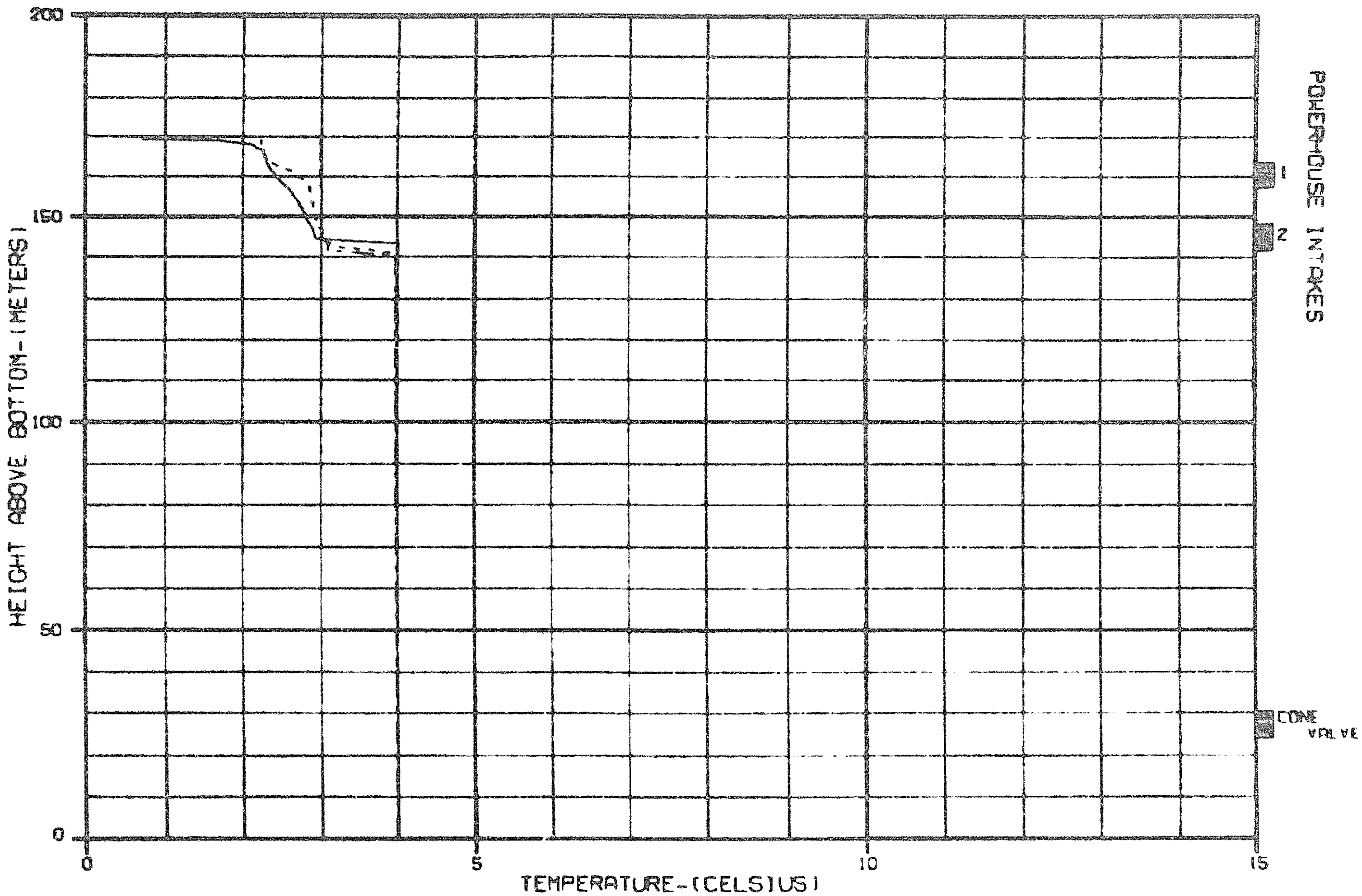
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 42-010-04



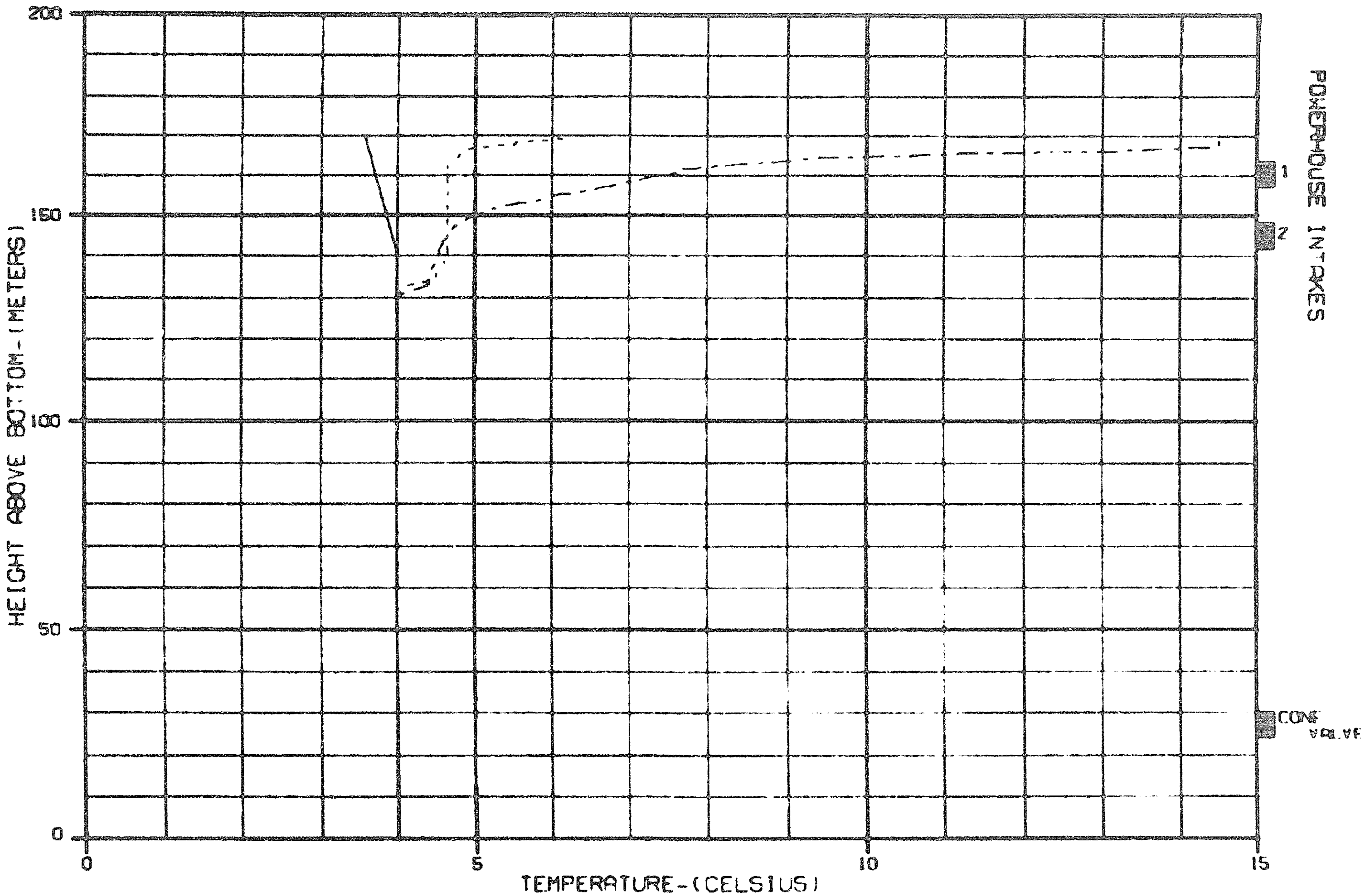
CASE: ** DC8120E - DEVIL CANYON OPERATION W/WATANA IN 2020 (CASE E-6) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 FEBRUARY 1982
- - - - - - - -	1 MARCH 1982
— - — - —	1 APRIL 1982

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	
DEVIL CANYON RES IR TEMPERATURE PROF .LES	
HARZA-EBASCO JOINT VENTURE	
CHICAGO, ILLINOIS	82-010-04



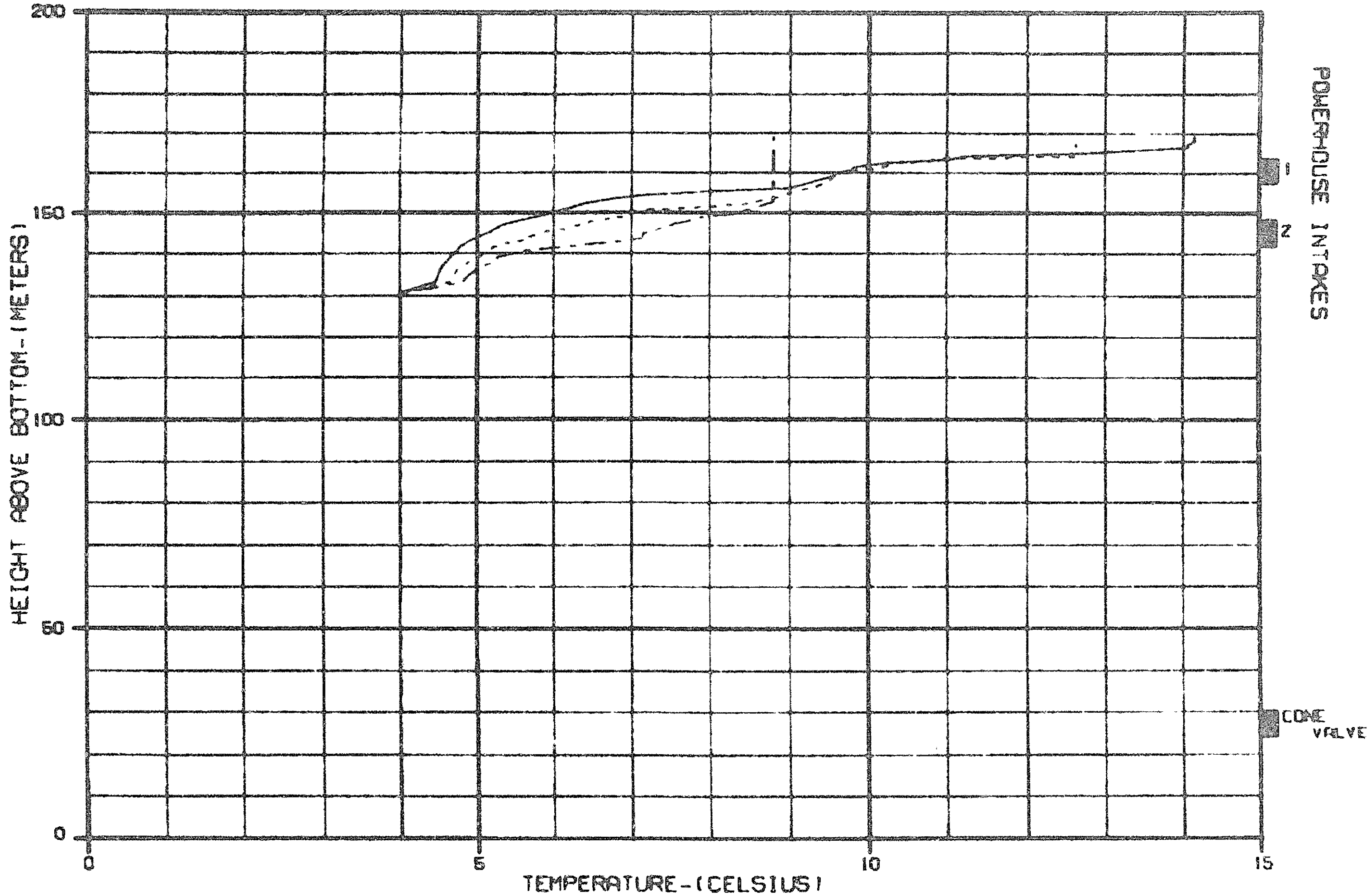
CASE: ** DCB120E - DEVIL CANYON OPERATION W/WATANA IN 2020 (CASE E-6) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

- ———— 1 MAY 1982
- .... 1 JUNE 1982
- —·—·— 1 JULY 1982

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
DEVIL CANYON RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
CHICAGO, ILLINOIS	42-010-04



CASE: ■■ DCB120E - DEVIL CANYON OPERATION W/WATANA IN 2020 (CASE E-6) ■■

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 AUGUST 1982
- - - - - - -	1 SEPTEMBER 1982
— - — - —	1 OCTOBER 1982

ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

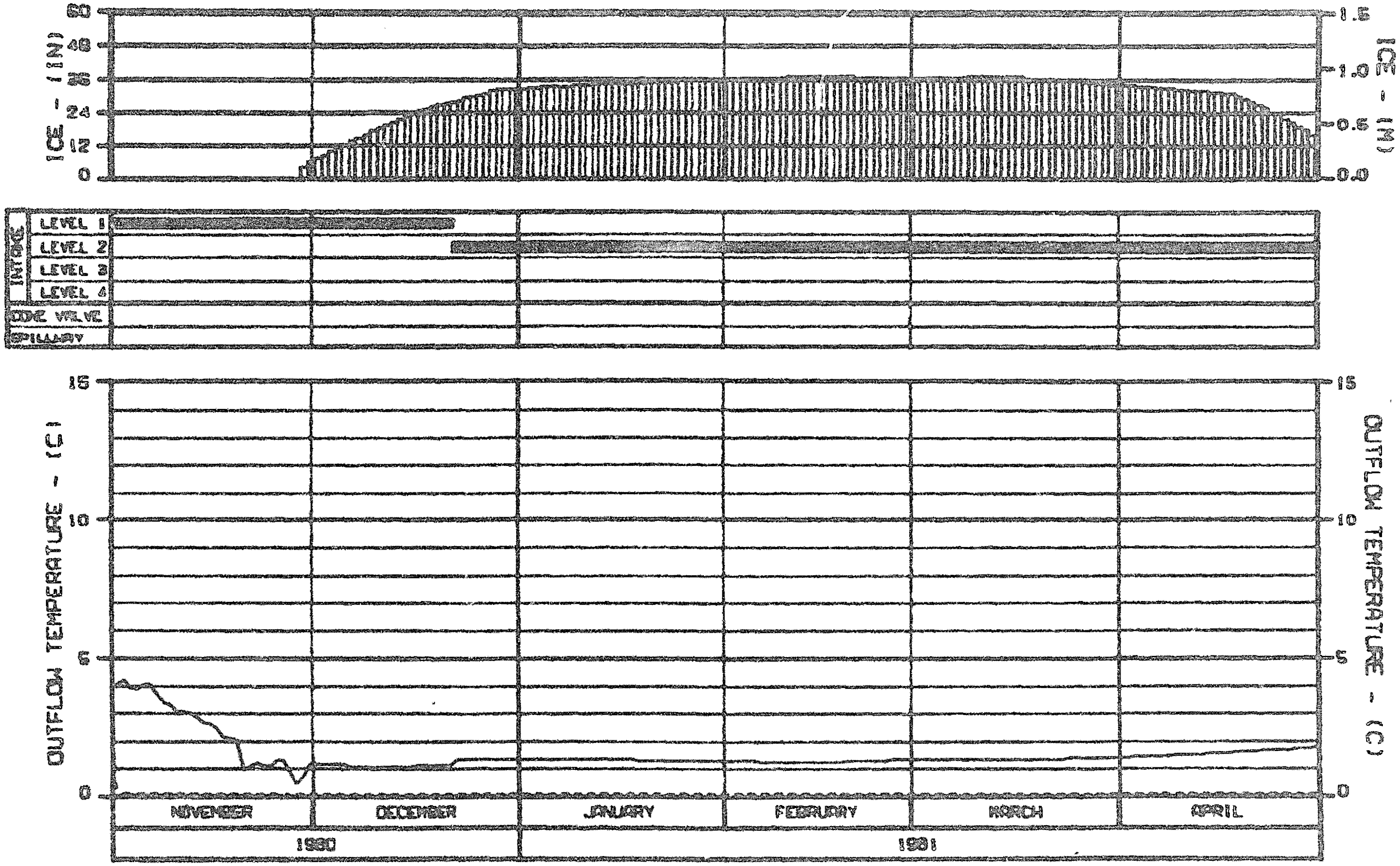
DEVIL CANYON RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

[illegible] | [illegible] | [illegible]-010-04

EXHIBIT J

MODIFIED CASE E-VI
STAGE II
TWO-STAGE PROJECT
LICENSE APPLICATION
INFLOW TEMPERATURE MATCHING



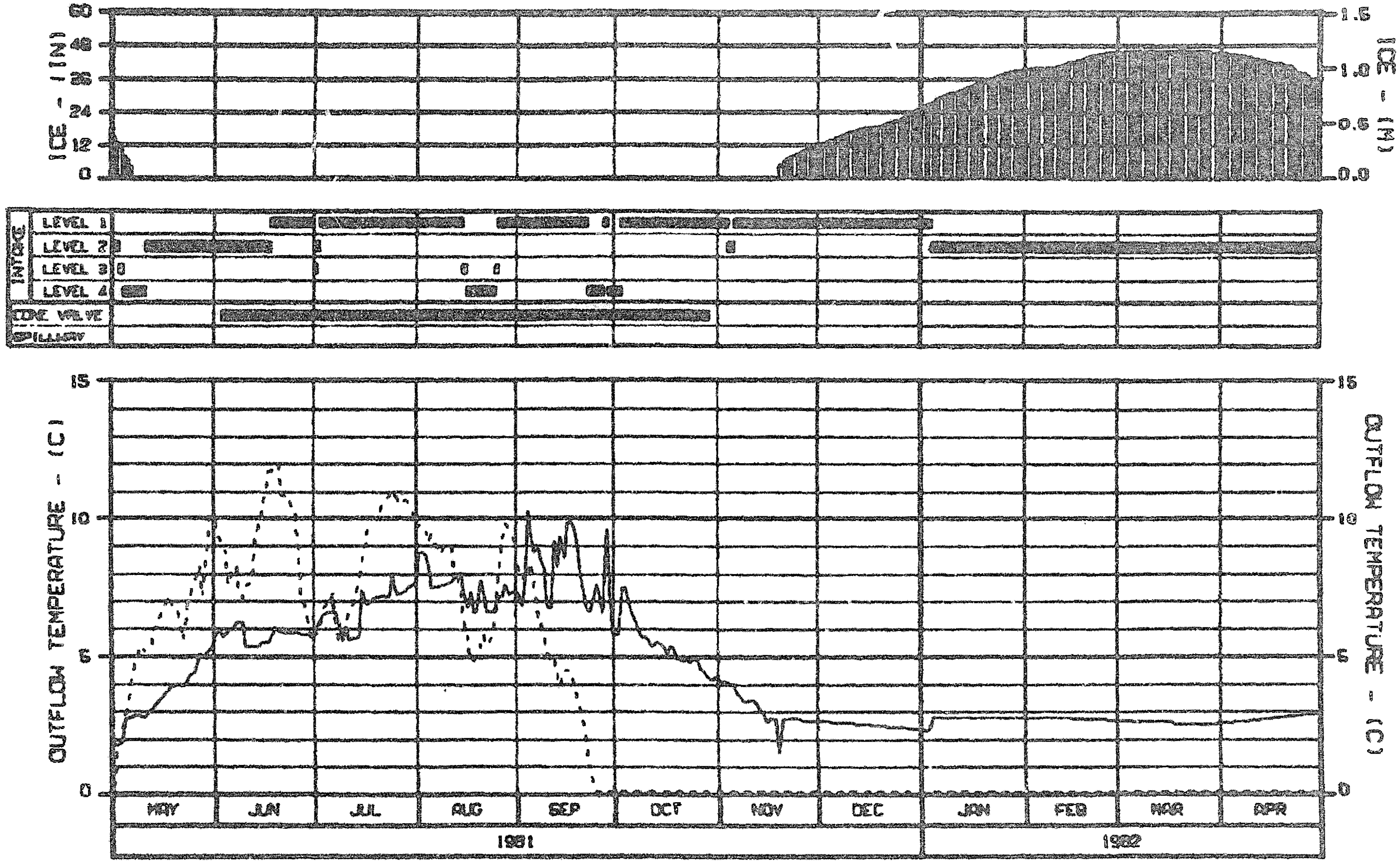
LEGEND: CASE: WA8102L - WATANA OPERATION W/DEVIL CANYON IN 2002 (E-VI-02)

D.C. min. W.S. El. 1446.0

——— PREDICTED OUTFLOW TEMPERATURE
- - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 2151 FT (655.6 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE AT ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST AT ELEVATION 2149 FT (654.7 M)

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
WATANA RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH	
HARZA-EBASCO JOINT VENTURE	

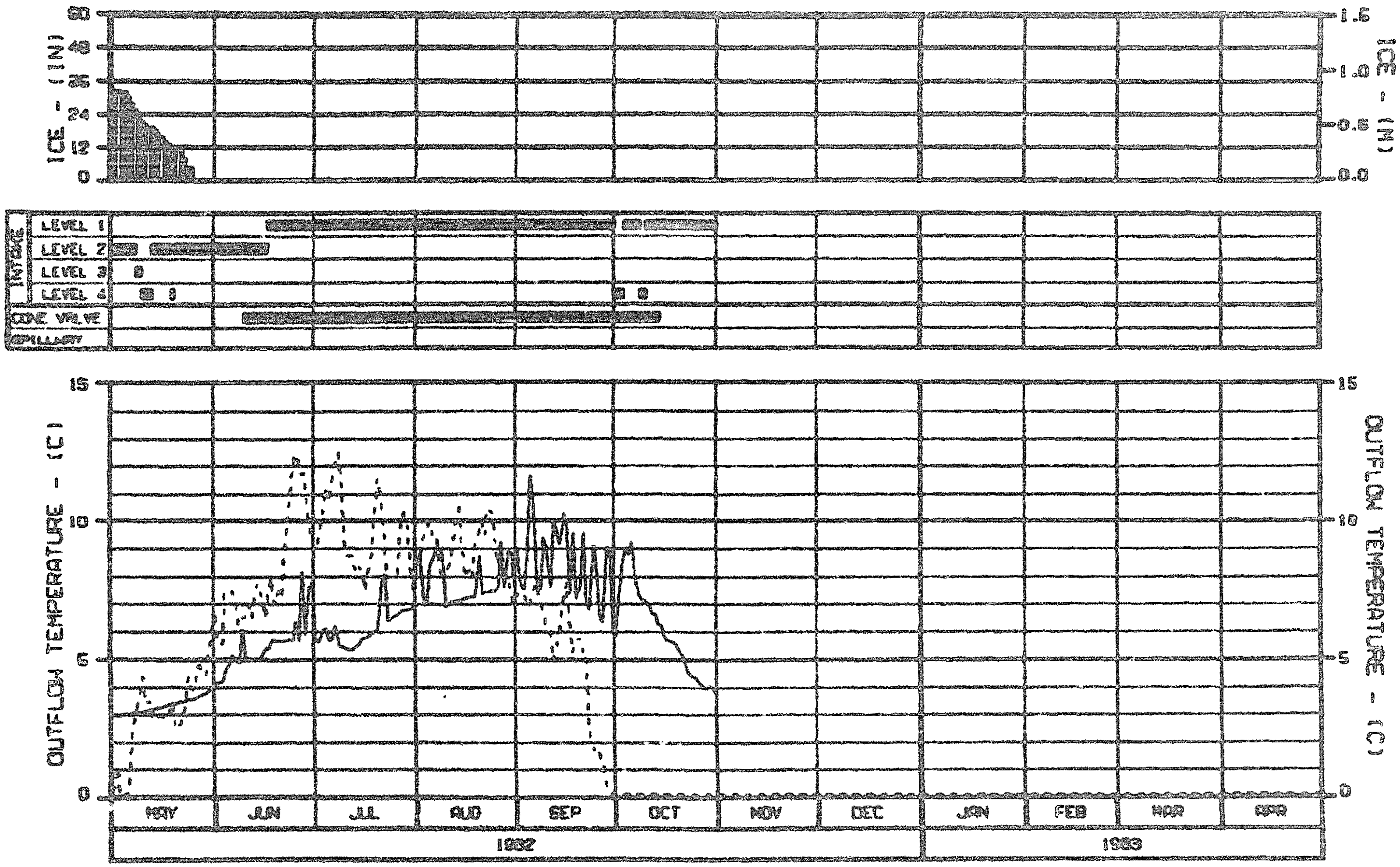


LEGEND: CASE: WA8102L - WATANA OPERATION W/DEVIL CANYON IN 2002 (E-VI-02)

——————— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 2151 FT (655.6 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE AT ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

ALASKA POWER AUTHORITY		
SUSITNA PROJECT	DYRESM MODEL	
WATANA RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH		
HARZA-EBASCO JOINT VENTURE		
CHICAGO, ILLINOIS	14 FEB 85	42-010-04



LEGEND: CASE: WA8102L - WATANA OPERATION W/DEVIL CANYON IN 2002 (E-VI-02)

——————— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES: 1. INTAKE PORT LEVEL 1 AT ELEVATION 2151 FT (655.6 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE AT ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST AT ELEVATION 2148 FT (664.7 M)

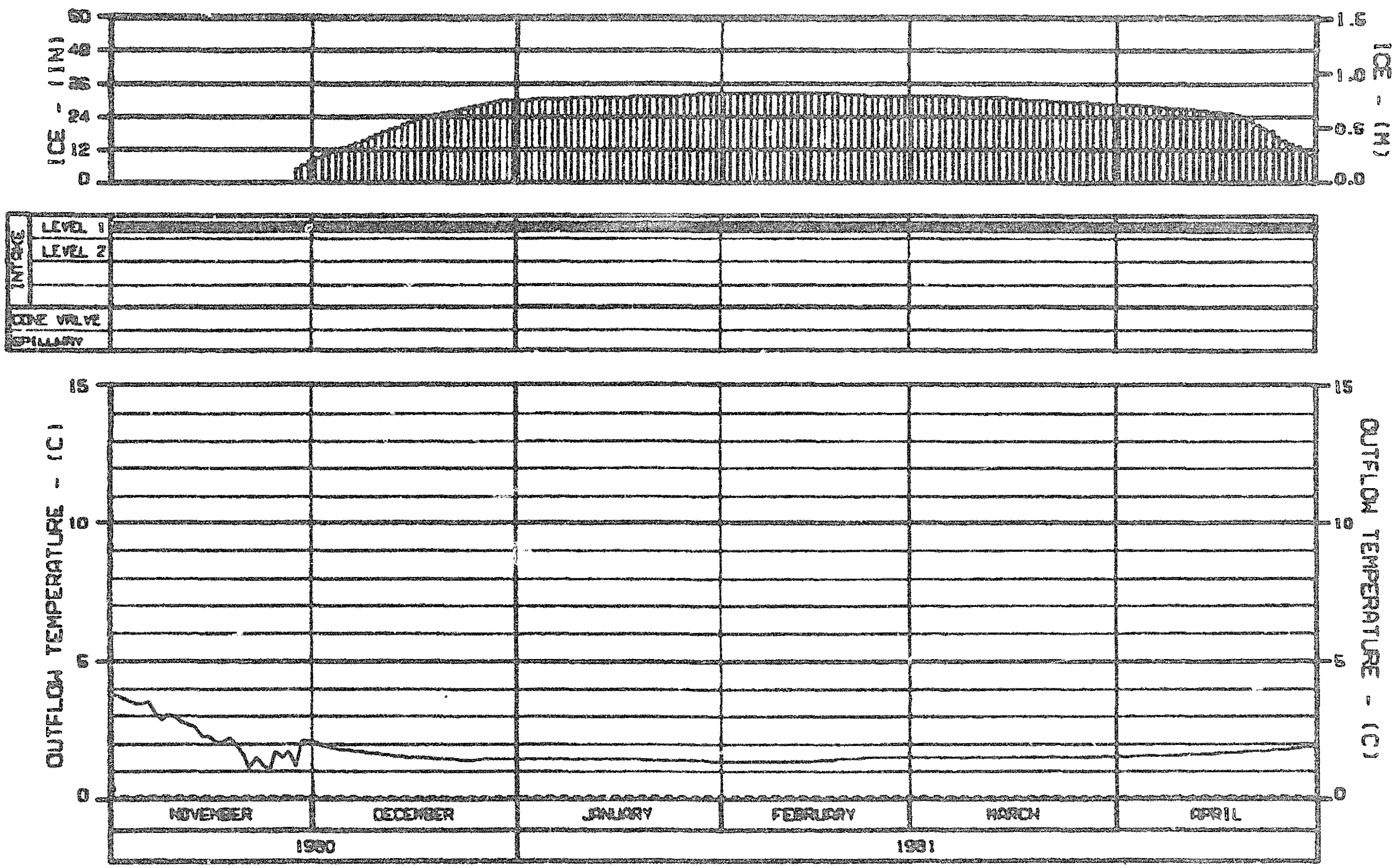
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

[illegible] | [illegible] | 82-010-04



LEGEND: CASE: DC8102L - DEVIL CANYON OPERATION W/WATANA IN 2002 (E-VI-02)

D.C. min. W.S. El. 1446.0

——————— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 1426 FT (434.24 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1376 FT (419.10 M)
3. CONE VALVE AT ELEVATION 990 FT (301.75 M)
4. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)

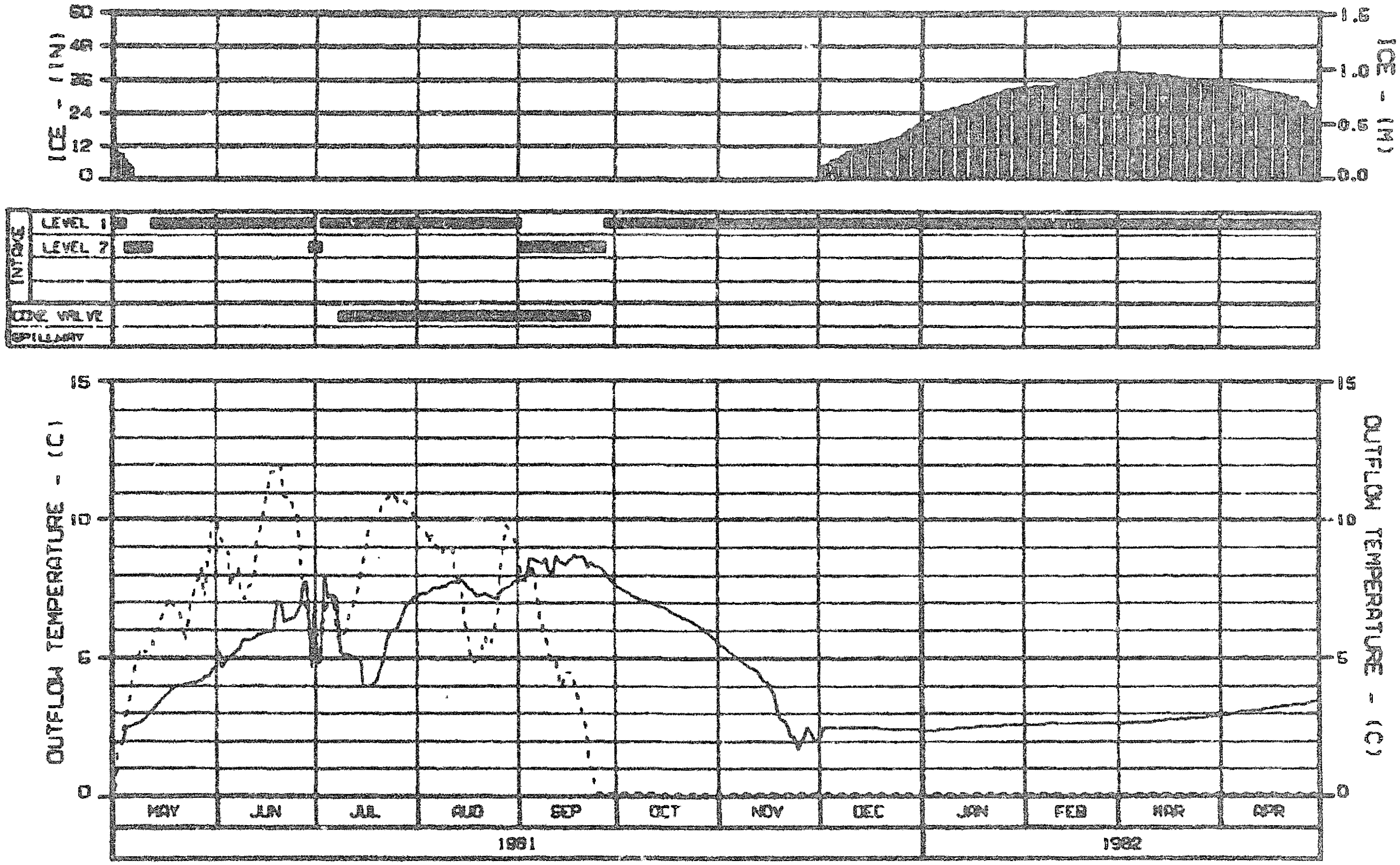
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

[illegible] | [illegible] | [illegible]



LEGEND: CASE: DC8102L - DEVIL CANYON OPERATION W/WATANA IN 2002 (E-VI-02)

——————— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 1425 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1375 FT (419.10 M)
3. CONE VALVE AT ELEVATION 990 FT (301.75 M)
4. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)

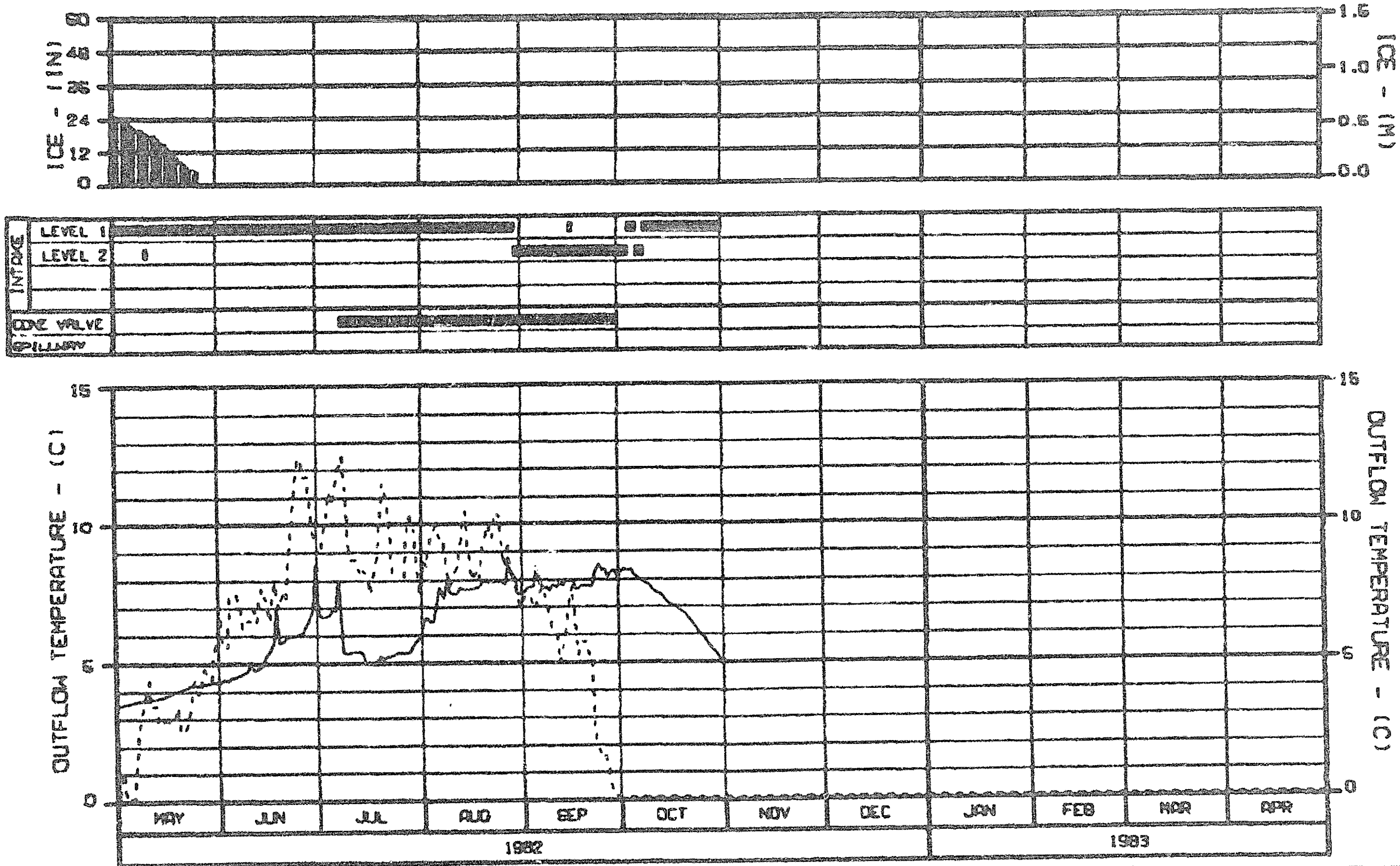
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

CHECKED: [illegible] | 11 FEB 83 | 42-010-04



LEGEND: CASE: DC8102L - DEVIL CANYON OPERATION W/WATANA IN 2002 (E-VI-02)

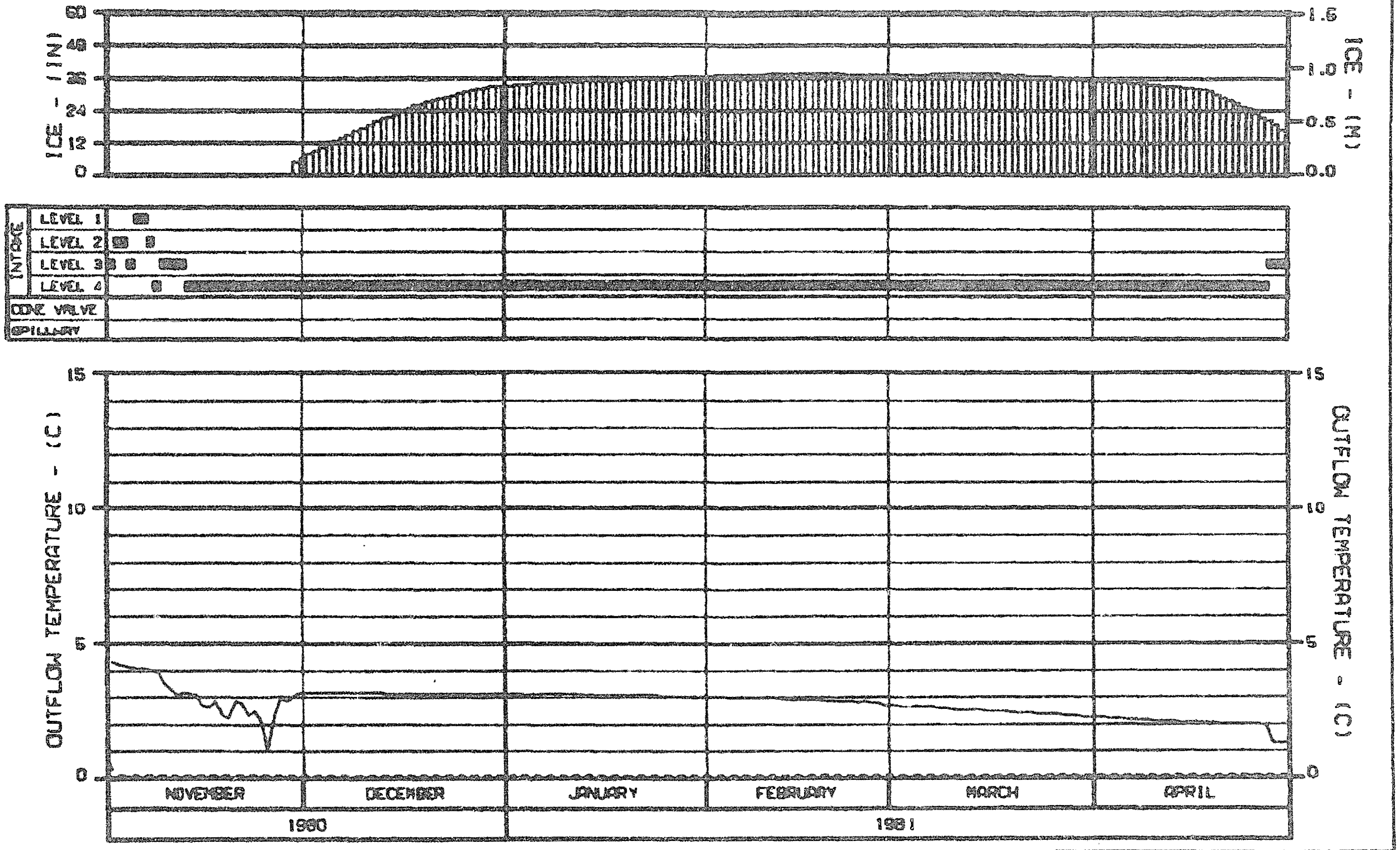
———— PREDICTED OUTFLOW TEMPERATURE
- - - - - - INFLOW TEMPERATURE

NOTES: 1. INTAKE PORT LEVEL 1 AT ELEVATION 1426 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1376 FT (419.10 M)
3. CONE VALVE AT ELEVATION 990 FT (301.75 M)
4. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
DEVIL CANYON RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH	
HARZA-EBASCO JOINT VENTURE	
CHICAGO, ILLINOIS | 11 FEB 85	42-010-04

EXHIBIT K

MODIFIED CASE E-VI
STAGE II
TWO-STAGE PROJECT
LICENSE APPLICATION
WARMEST POSSIBLE OUTFLOW



LEGEND: CASE: WA8102W - WATANA OPERATION W/DEVIL CANYON IN 2002 (E-VI-D2)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)
——— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

D.C. Min W.S. El. 1446.0

NOTES: 1. INTAKE PORT LEVEL 1 AT ELEVATION 2151 FT (655.6 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE AT ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

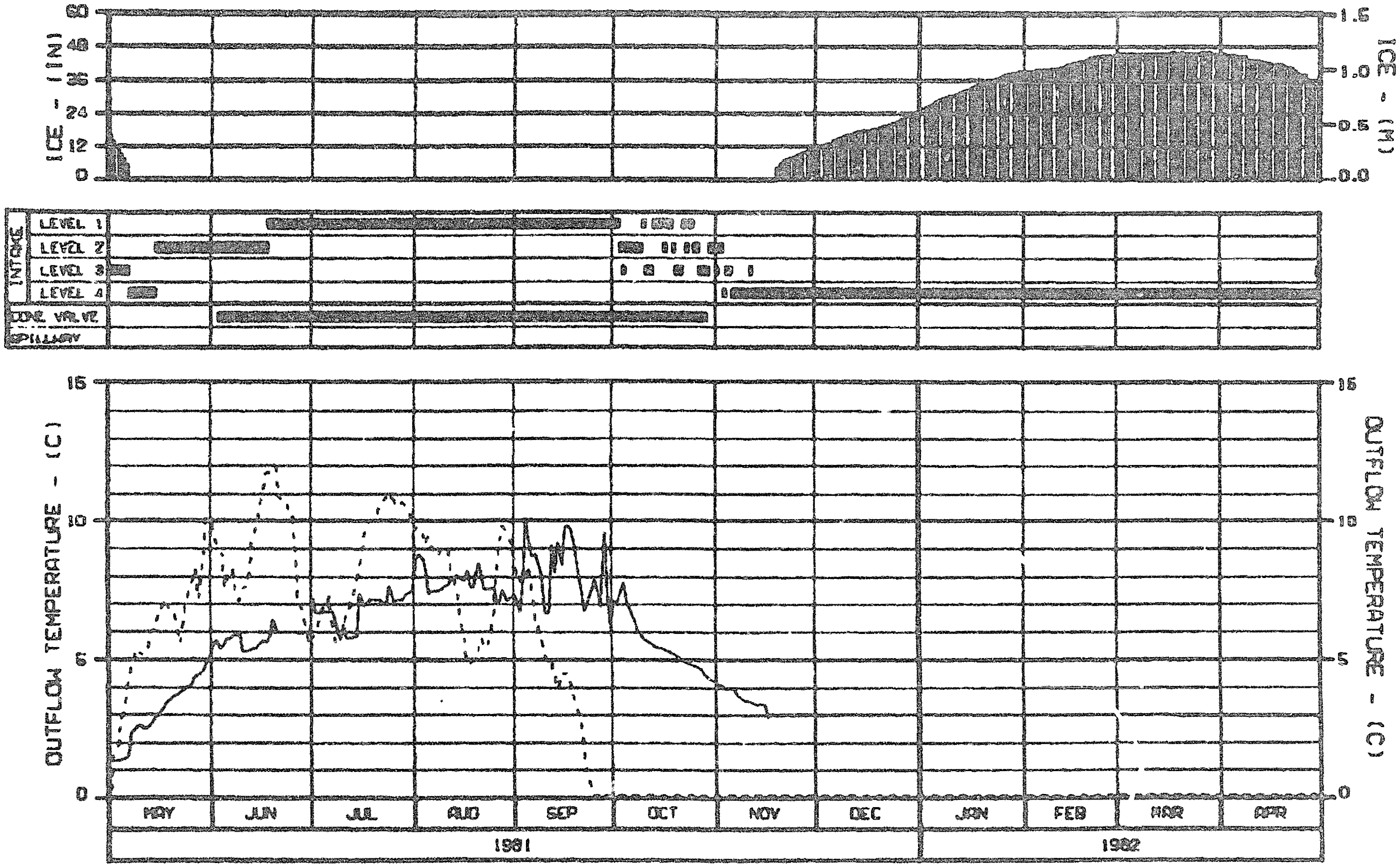
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

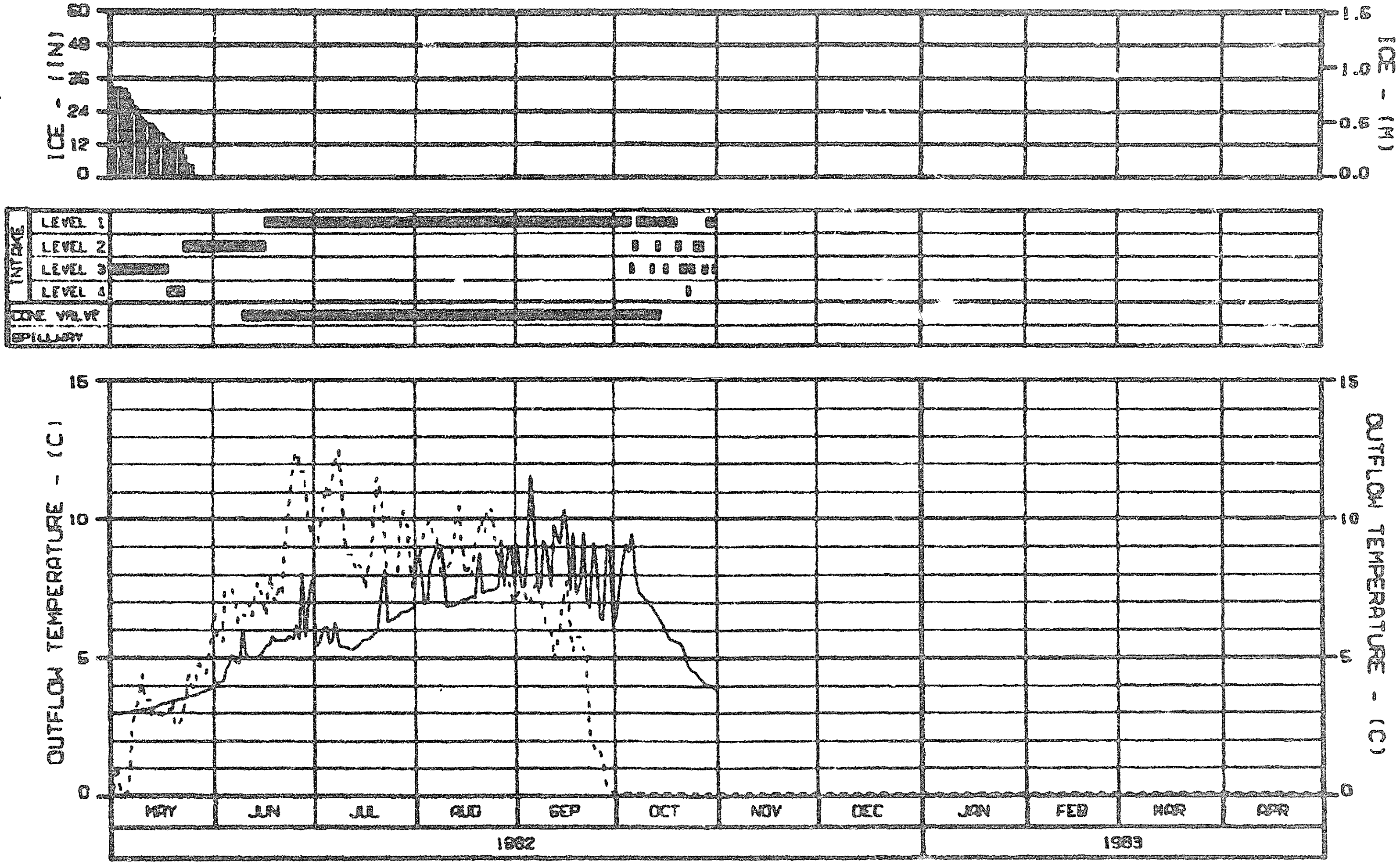
42-010-04



LEGEND: CASE: WA8102M - WATANA OPERATION W/DEVIL CANYON IN 2002 (E-VI-02)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)
———— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 2151 FT (655.6 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE AT ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

ALASKA POWER AUTHORITY		
SUSITNA PROJECT		INTERIM REPORT
WATANA RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH		
HARZA-EBASCO JOINT VENTURE		
CHICAGO, ILLINOIS	11 FEB 83	42-010-04



LEGEND: CASE: WA8102M - WATANA OPERATION W/DEVIL CANYON IN 2002 (E-VI-02)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)
———— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 2151 FT (655.6 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE AT ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST AT ELEVATION 2140 FT (654.7 M)

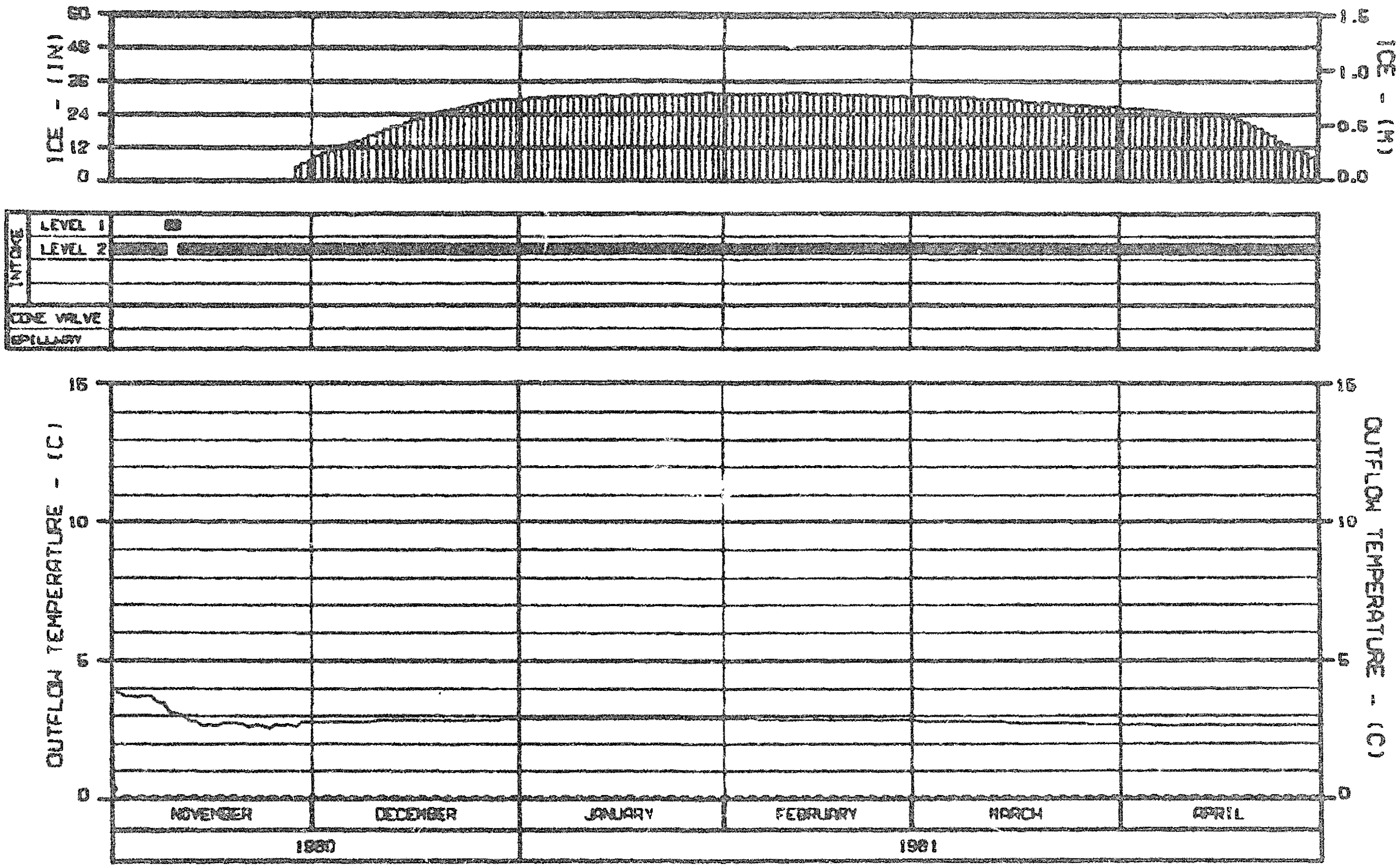
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 31 FEB 83 | 42-010-04

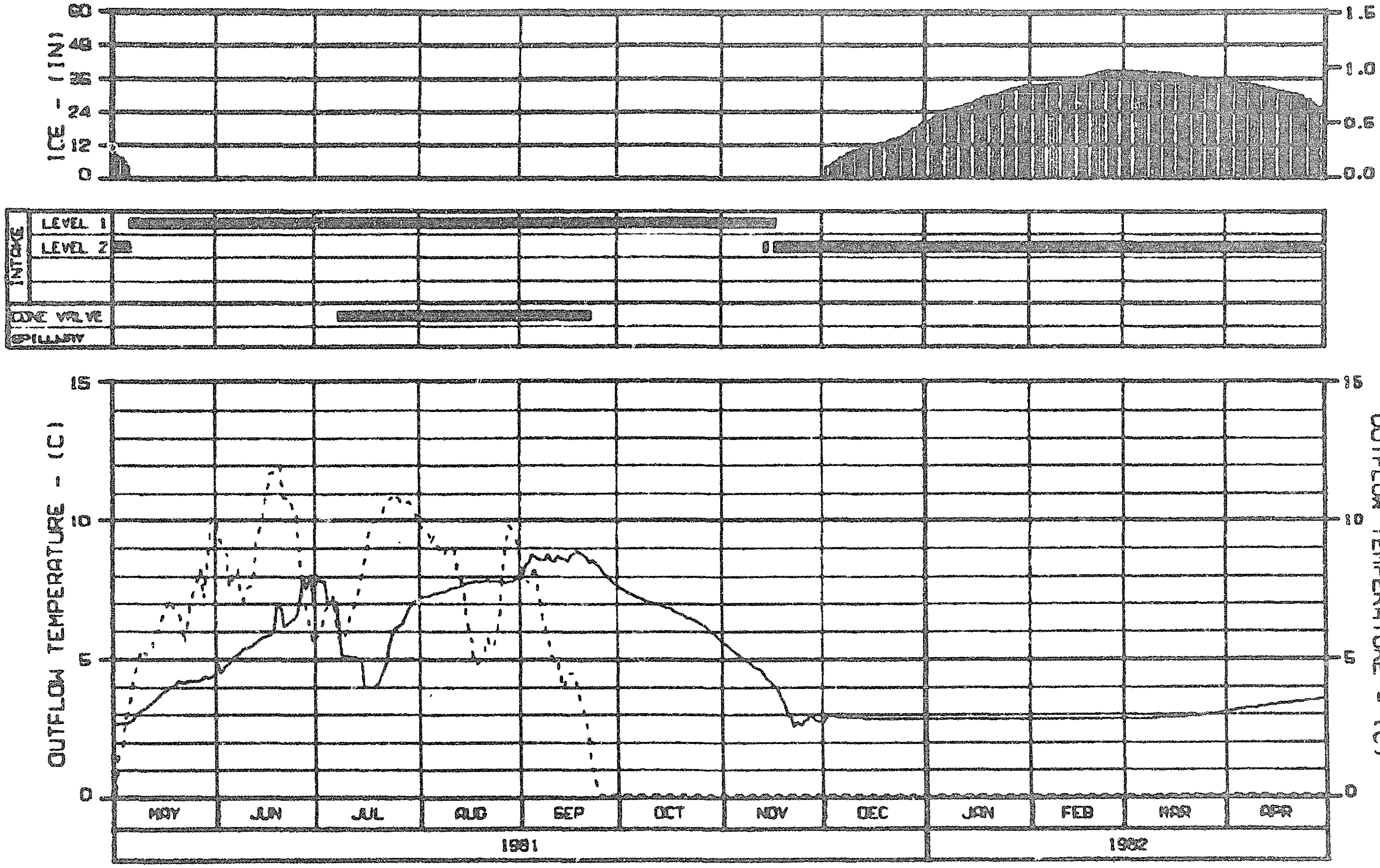


LEGEND: CASE: DC8102M - DEVIL CANYON OPERATION W/WATANA IN 2002 (E-VI-02)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)
———— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

D.C. min. W.S. El. 1446.0

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 1425 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1375 FT (419.10 M)
3. CONE VALVE AT ELEVATION 990 FT (301.75 M)
4. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	OXYGEN MODEL
DEVIL CANYON RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH	
HARZA-EBASCO JOINT VENTURE	
CHICAGO, ILLINOIS	11 FEB 85	42-010-04



LEGEND: CASE: DC8102M - DEVIL CANYON OPERATION W/WATANA IN 2002 (E-VI-02)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)
——— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 1425 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1375 FT (419.10 M)
3. CONE VALVE AT ELEVATION 990 FT (301.75 M)
4. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)

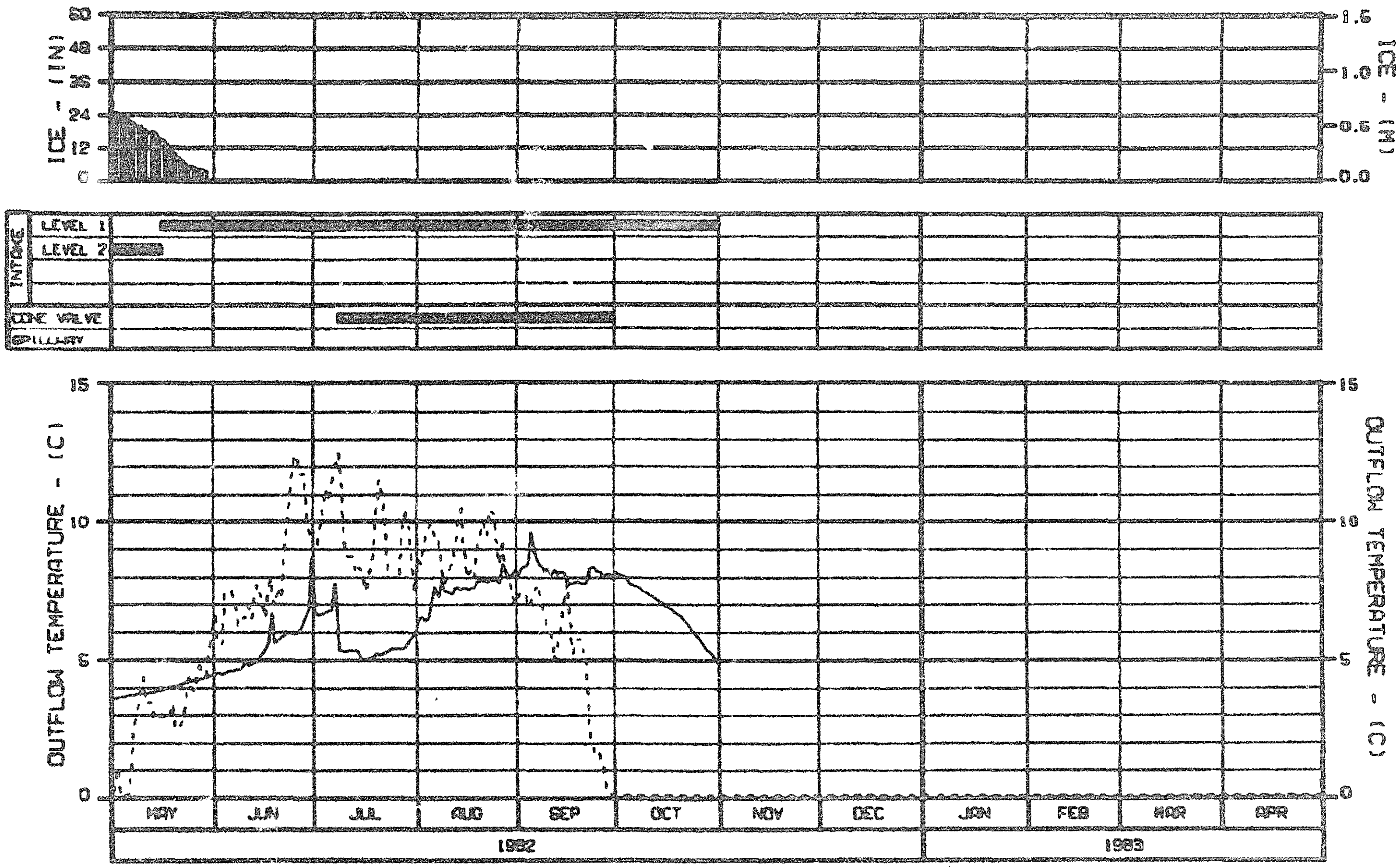
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 11 FEB 85 | 42-010-04



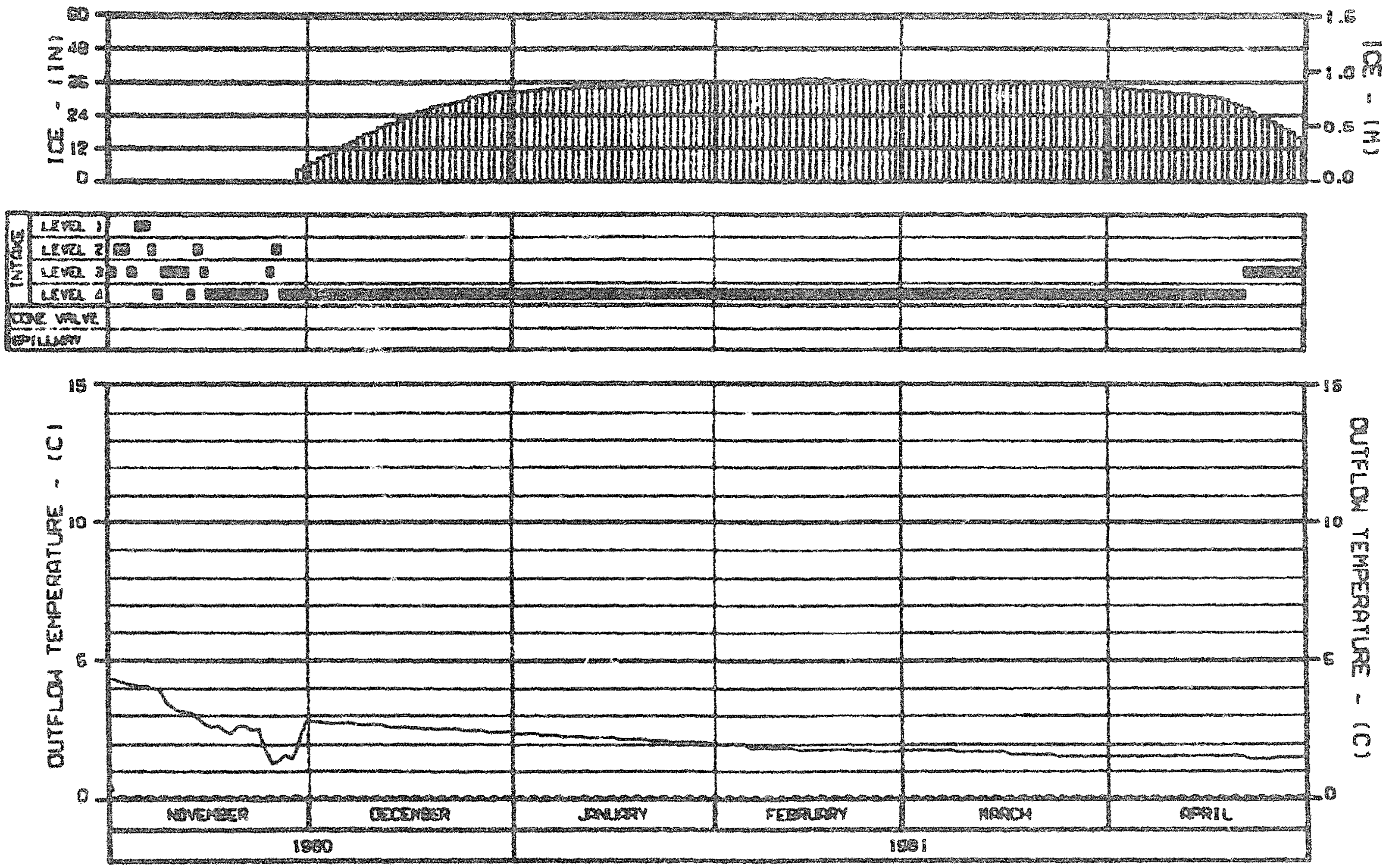
LEGEND: CASE: DC8102M - DEVIL CANYON OPERATION W/WATANA IN 2002 (E-VI-02)
WATANA SIMULATION --- WARMEST WATER (FULL YEAR)
——————— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES: 1. INTAKE PORT LEVEL 1 AT ELEVATION 1425 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1375 FT (419.10 M)
3. CONE VALVE AT ELEVATION 990 FT (301.75 M)
4. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	[illegible]
DEVIL CANYON RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH	
HARZA-EBASCO JOINT VENTURE	
[illegible]	[illegible]

EXHIBIT L

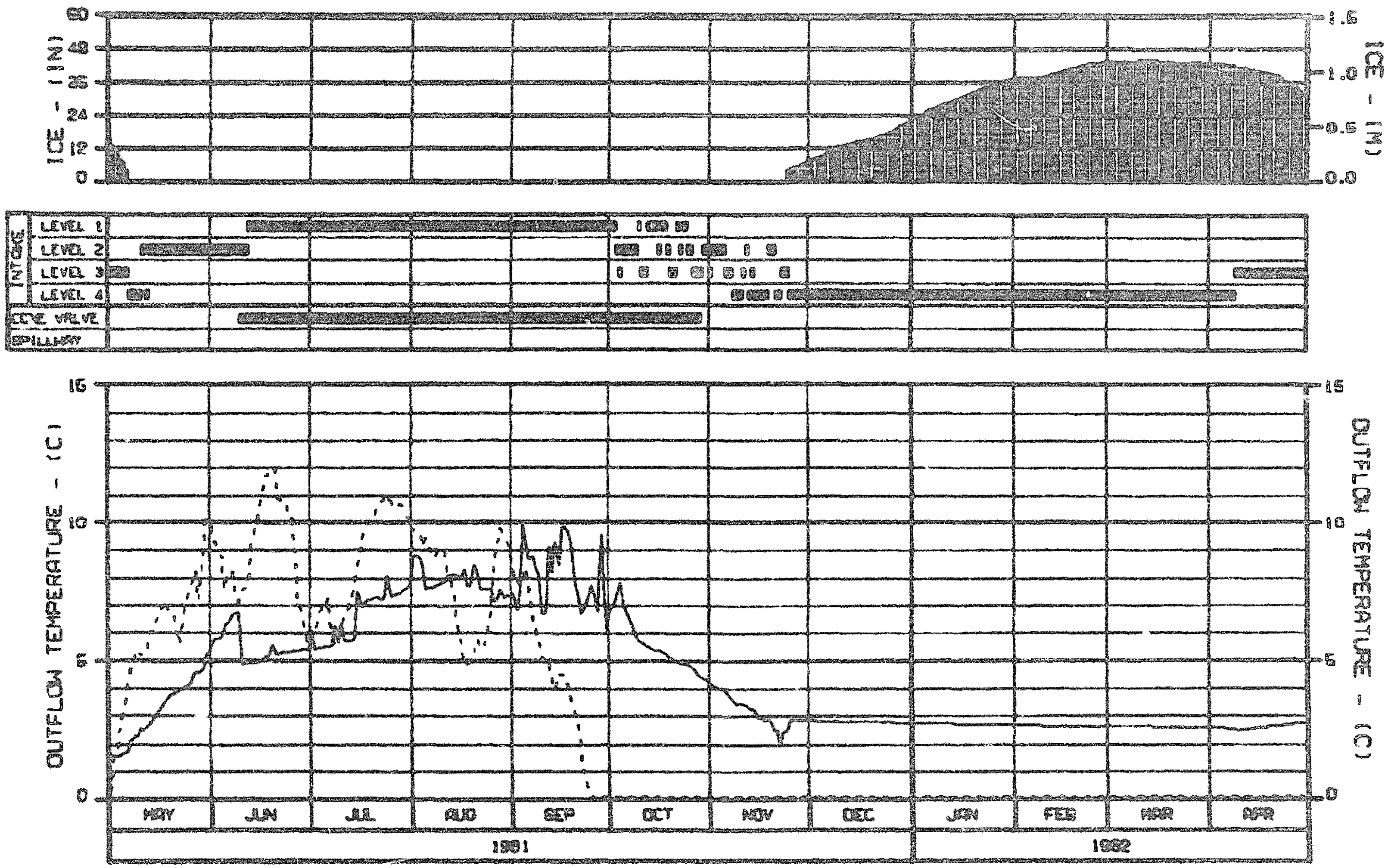
CASE E-I
STAGE II
TWO-STAGE PROJECT
LICENSE APPLICATION
WARMEST POSSIBLE OUTFLOW



LEGEND: CASE: ** WA8102A - WATANA OPERATION W/DEVIL CANYON IN 2002 **
CASE E-1. WARMEST WATER
———— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 2181 FT (665.6 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE AT ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

ALASKA POWER AUTHORITY		
SUSITNA PROJECT	DYRESM MODEL	
WATANA RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH		
HARZA-EBASCO JOINT VENTURE		
CHICAGO, ILLINOIS	7 MAY 85	42-010-04



LEGEND: CASE: ** WAS102R - WATANA OPERATION W/DEVIL CANYON IN 2002 **
CASE E-1. WARMEST WATER
——— PREDICTED OUTFLOW TEMPERATURE
- - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 2161 FT (665.6 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE AT ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

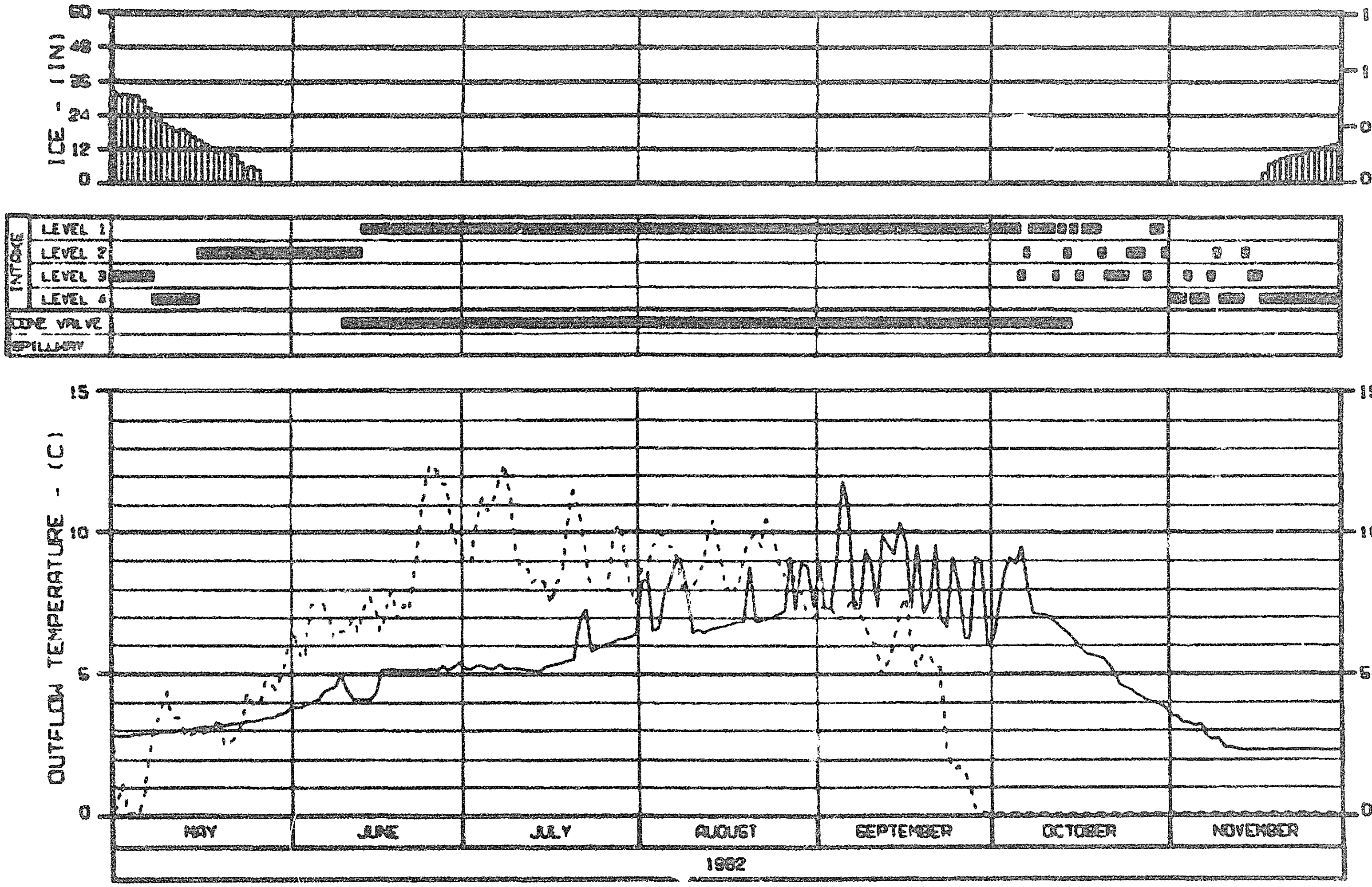
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

42-010-04



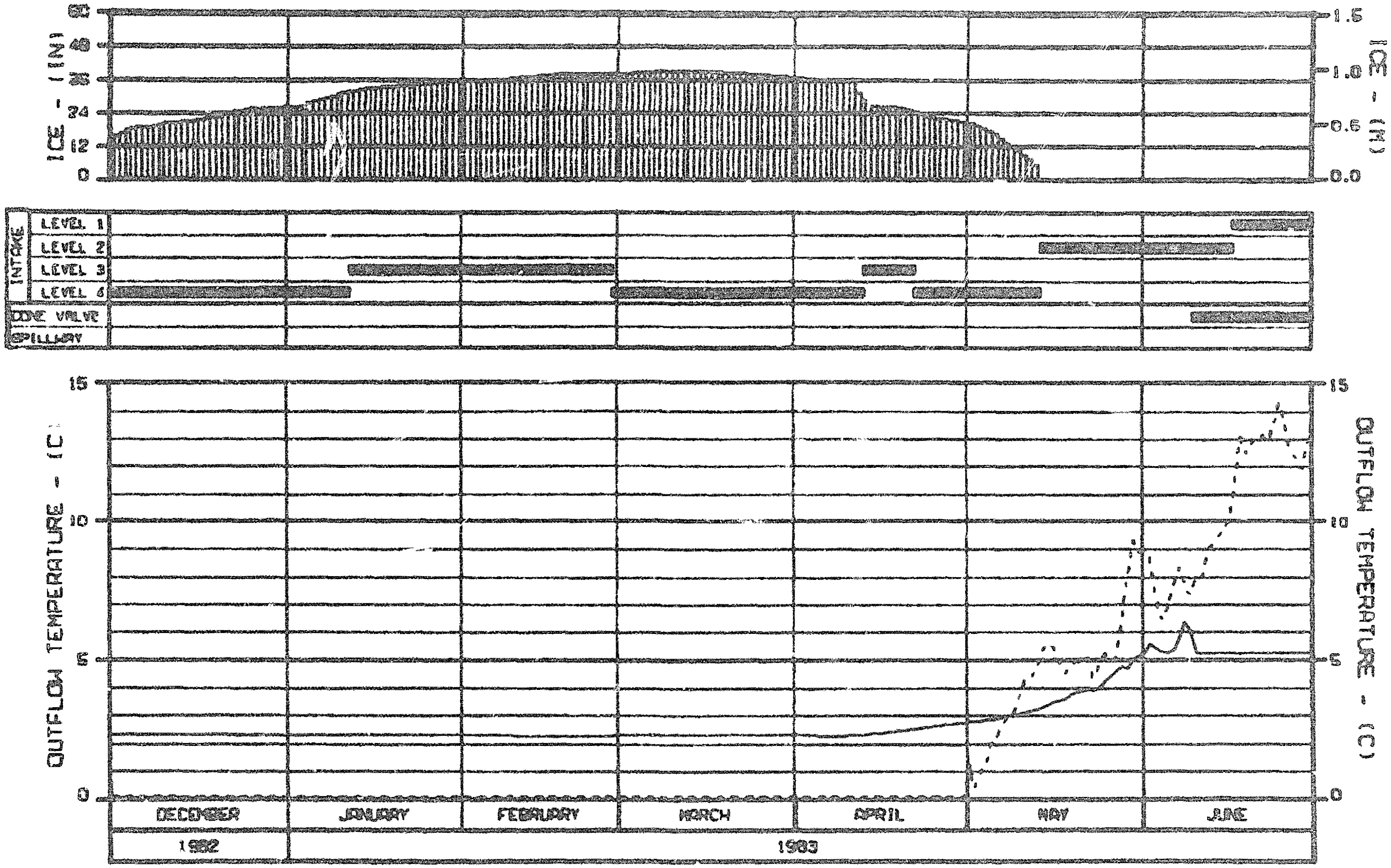
LEGEND: CASE: WAB102R - WATANA OPERATION W/DEVIL CANYON IN 2002
CASE E-1. WARMEST WATER

——— PREDICTED OUTFLOW TEMPERATURE

- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 2181 FT (665.6 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE AT ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

ALASKA POWER AUTHORITY		
SUSITNA PROJECT	DYRESM MODEL	
WATANA RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH		
HARZA-EBASCO JOINT VENTURE		
CHICAGO, ILLINOIS	7 MAY 85	42-810-04



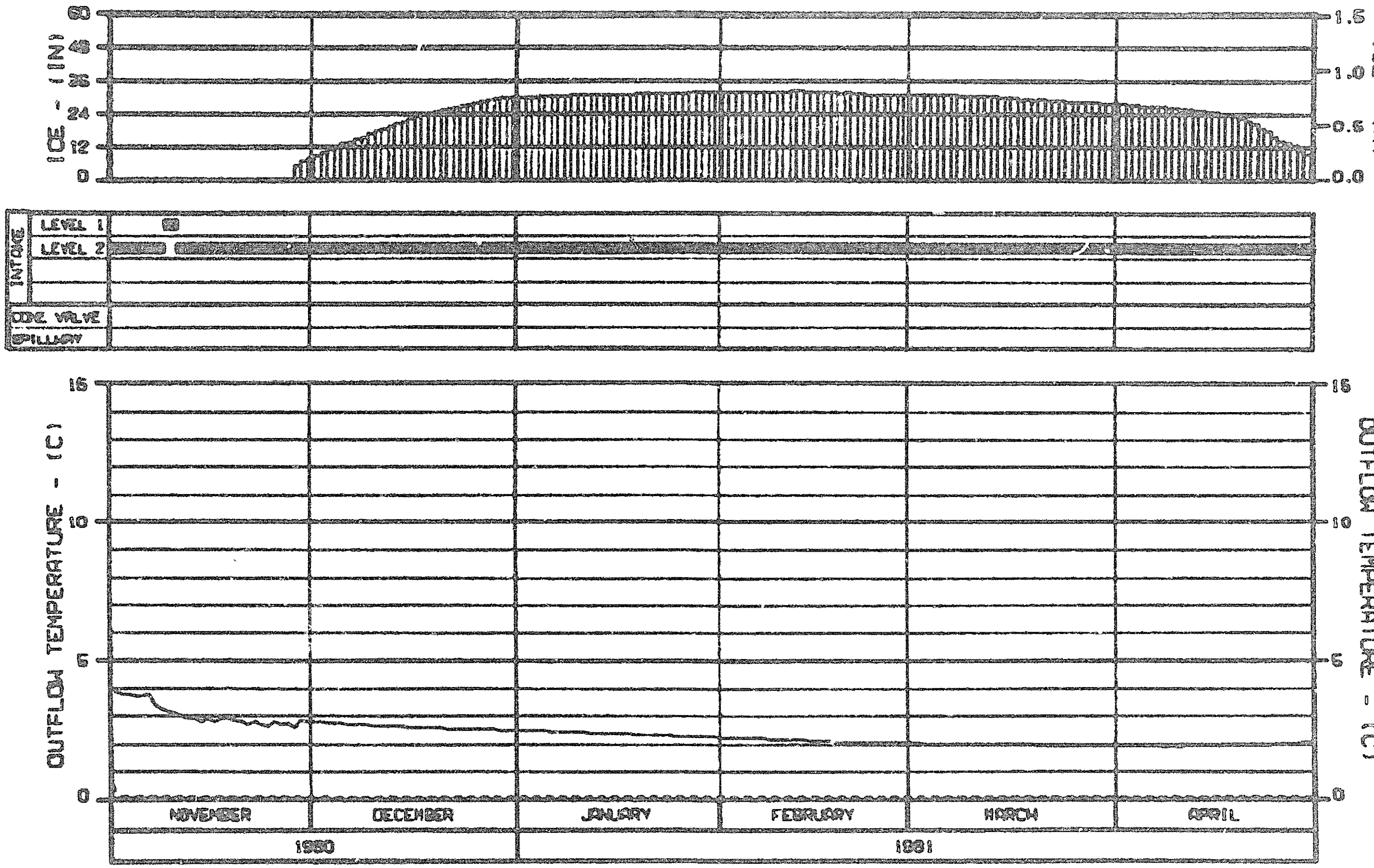
LEGEND: CASE: WA8102R - WATANA OPERATION W/DEVIL CANYON IN 2002
CASE E-1, WARMEST WATER

——— PREDICTED OUTFLOW TEMPERATURE

- - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 2161 FT (658.6 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE AT ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST AT ELEVATION 2148 FT (654.7 M)

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
WATANA RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH	
HARZA-EBASCO JOINT VENTURE	
42-010-04	



LEGEND: CASE: DC8102R - DEVIL CANYON OPERATION W/WATANA IN 2002
CASE E-1. WARMEST WATER
——— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES: 1. INTAKE PORT LEVEL 1 AT ELEVATION 1425 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1375 FT (419.10 M)
3. CONE VALVE AT ELEVATION 990 FT (301.75 M)
4. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)

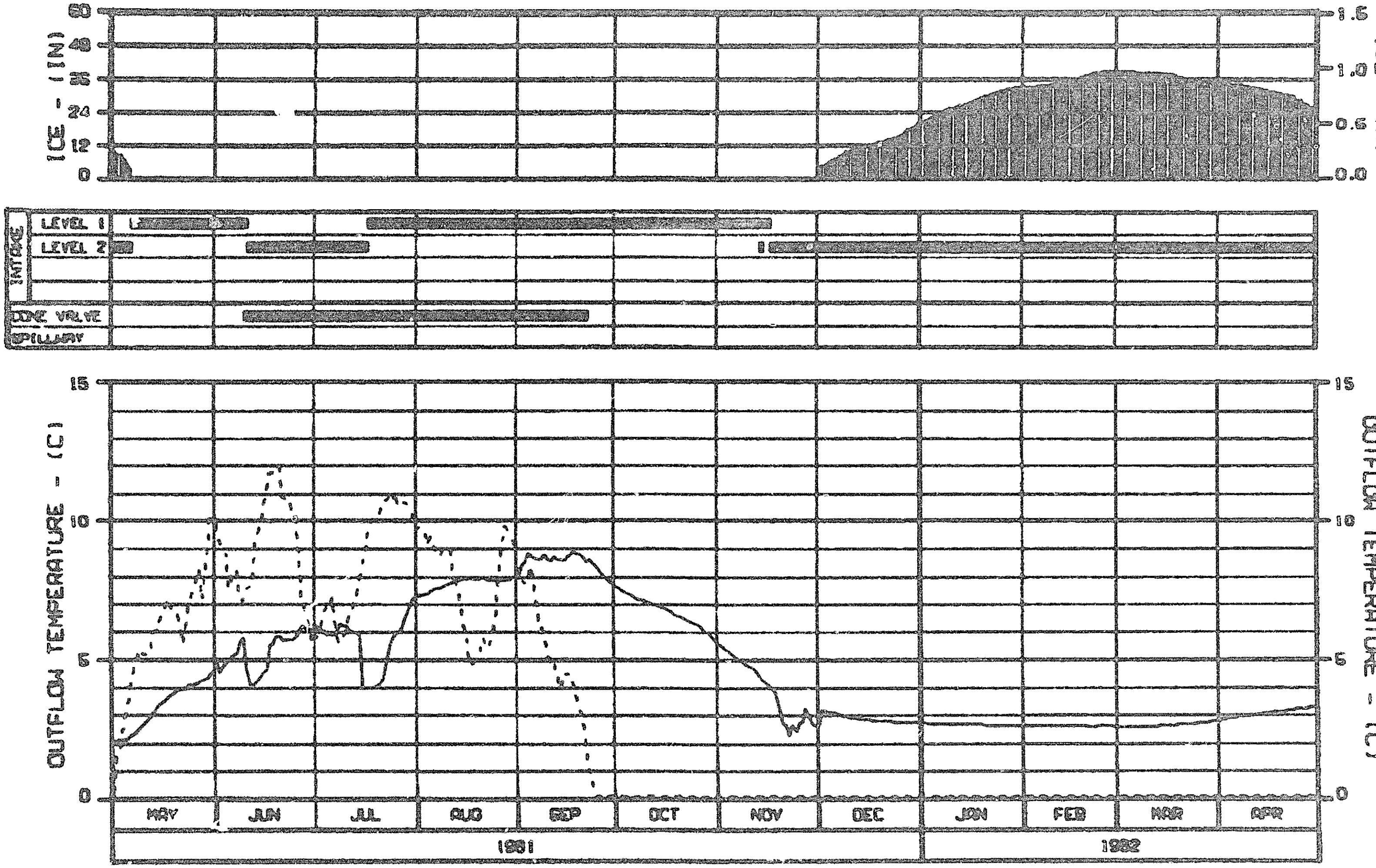
ALASKA POWER AUTHORITY

SUSITNA PROJECT | WQRRSQ MODEL

DEVIL CANYON RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

42-010-04



LEGEND: CASE: DC8102R - DEVIL CANYON OPERATION W/WATANA IN 2002
CASE E-1. WARMEST WATER
——————— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES: 1. INTAKE PORT LEVEL 1 AT ELEVATION 1425 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1375 FT (419.10 M)
3. CONE VALVE AT ELEVATION 930 FT (301.75 M)
4. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)

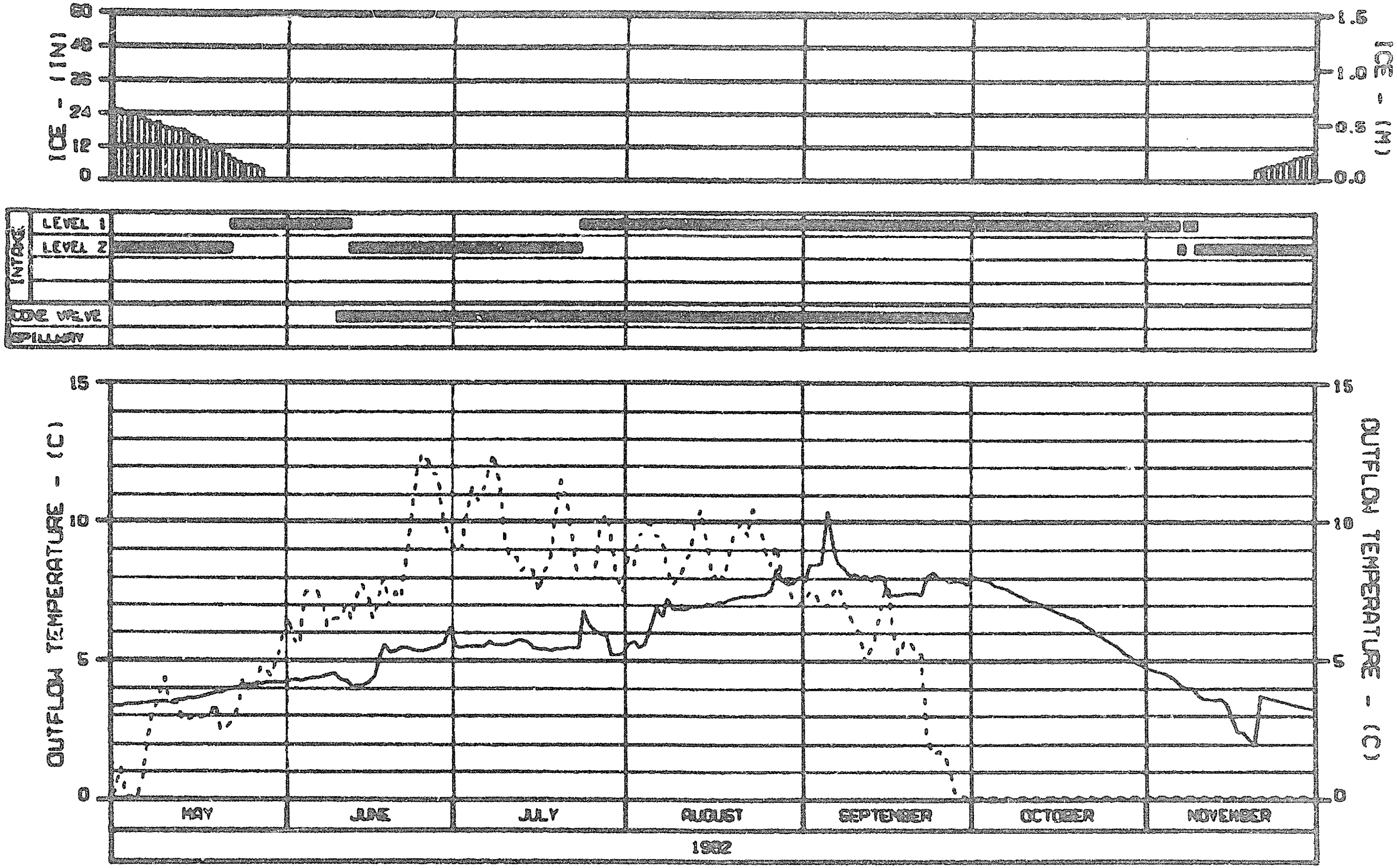
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 7 MAR 85 | 42-010-04



LEGEND: CASE: DC8102R - DEVIL CANYON OPERATION W/WATANA IN 2002
CASE E-1. WARMEST WATER

——————— PREDICTED OUTFLOW TEMPERATURE

- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 1425 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1375 FT (419.10 M)
3. CONE VALVE AT ELEVATION 930 FT (201.75 M)
4. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)

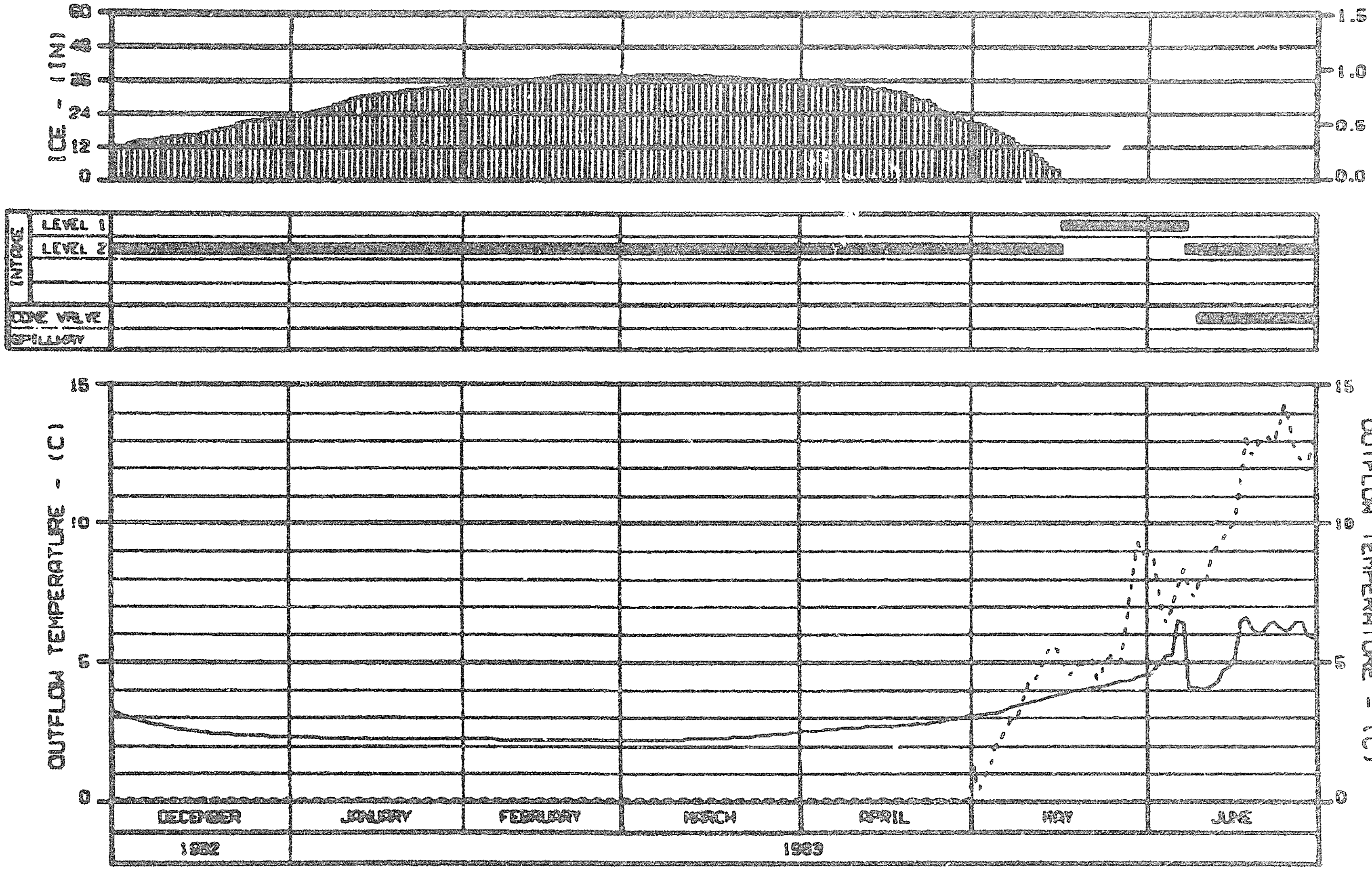
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

42-010-04



LEGEND: CASE: DCB102R - DEVIL CANYON OPERATION W/WATANA IN 2002
CASE E-1. WARMEST WATER

———— PREDICTED OUTFLOW TEMPERATURE

- - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 1455 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1375 FT (419.10 M)
3. CONE VALVE AT ELEVATION 930 FT (301.75 M)
4. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)

ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYNAMIC MODEL

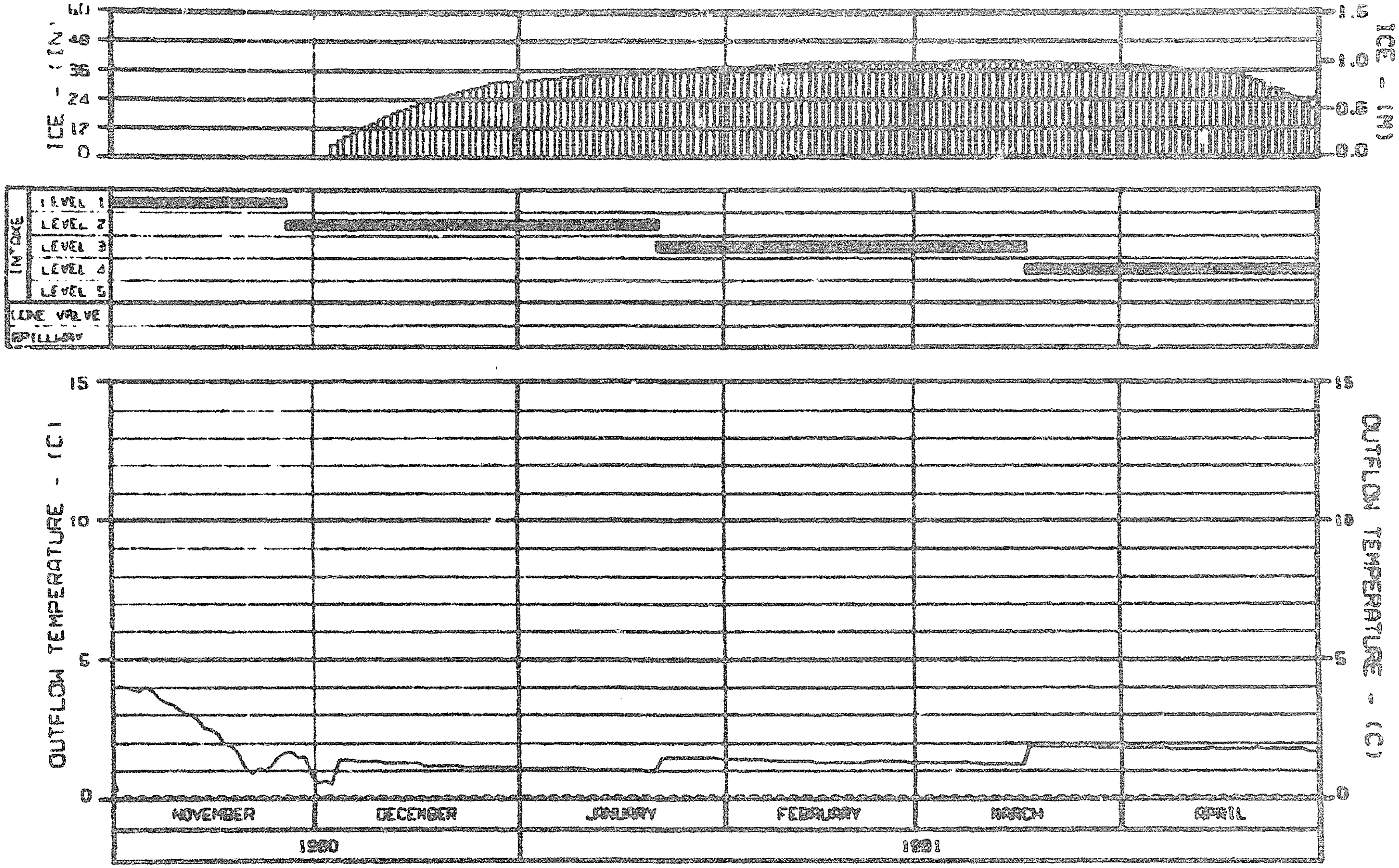
DEVIL CANYON RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

42-010-04

EXHIBIT M

CASE E-I
STAGE II
THREE-STAGE PROJECT
INFLOW TEMPERATURE MATCHING



LEGEND: CASE: WA8102U - WATANA OPERATION W/DEVIL CANYON IN 2002 (E-1. 62)

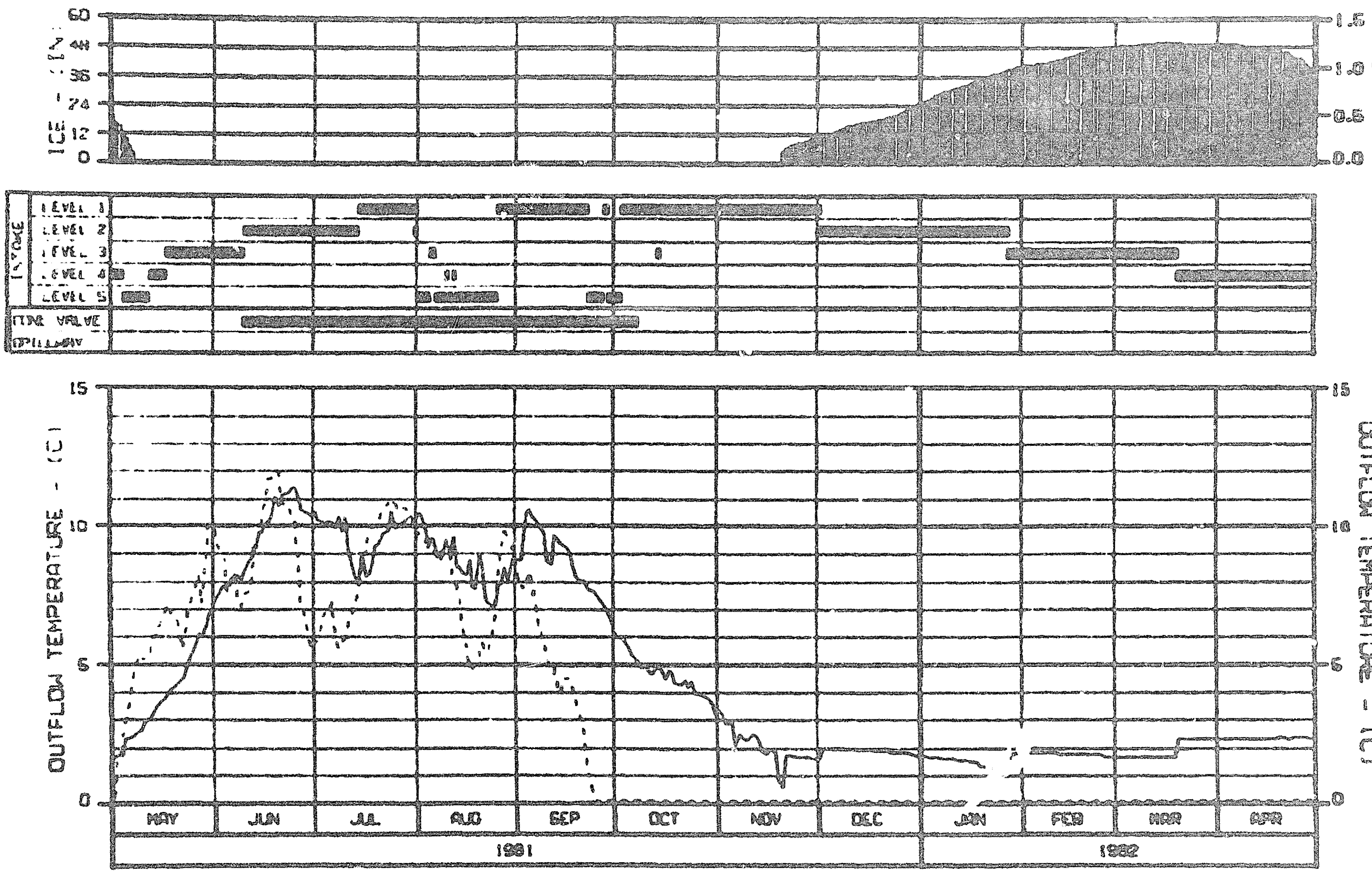
——————— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT EL. 1964.4 FT. (598.8 M)
2. INTAKE PORT LEVEL 2 AT EL. 1926.4 FT. (587.2 M)
3. INTAKE PORT LEVEL 3 AT EL. 1888.4 FT. (575.6 M)
4. INTAKE PORT LEVEL 4 AT EL. 1850.4 FT. (564.0 M)
5. INTAKE PORT LEVEL 5 AT EL. 1812.4 FT. (552.4 M)
6. CONE VALVE AT ELEVATION 1929 FT (588.0 M)
7. SPILLWAY CREST AT ELEVATION 2135 FT (650.7 M)

ALASKA POWER AUTHORITY

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE



LEGEND: CASE: ** WAS102U - WATANA OPERATION W/DEVIL CANYON IN 2002 (E-1. 82) *

———— PREDICTED OUTFLOW TEMPERATURE
- - - - - INFLOW TEMPERATURE

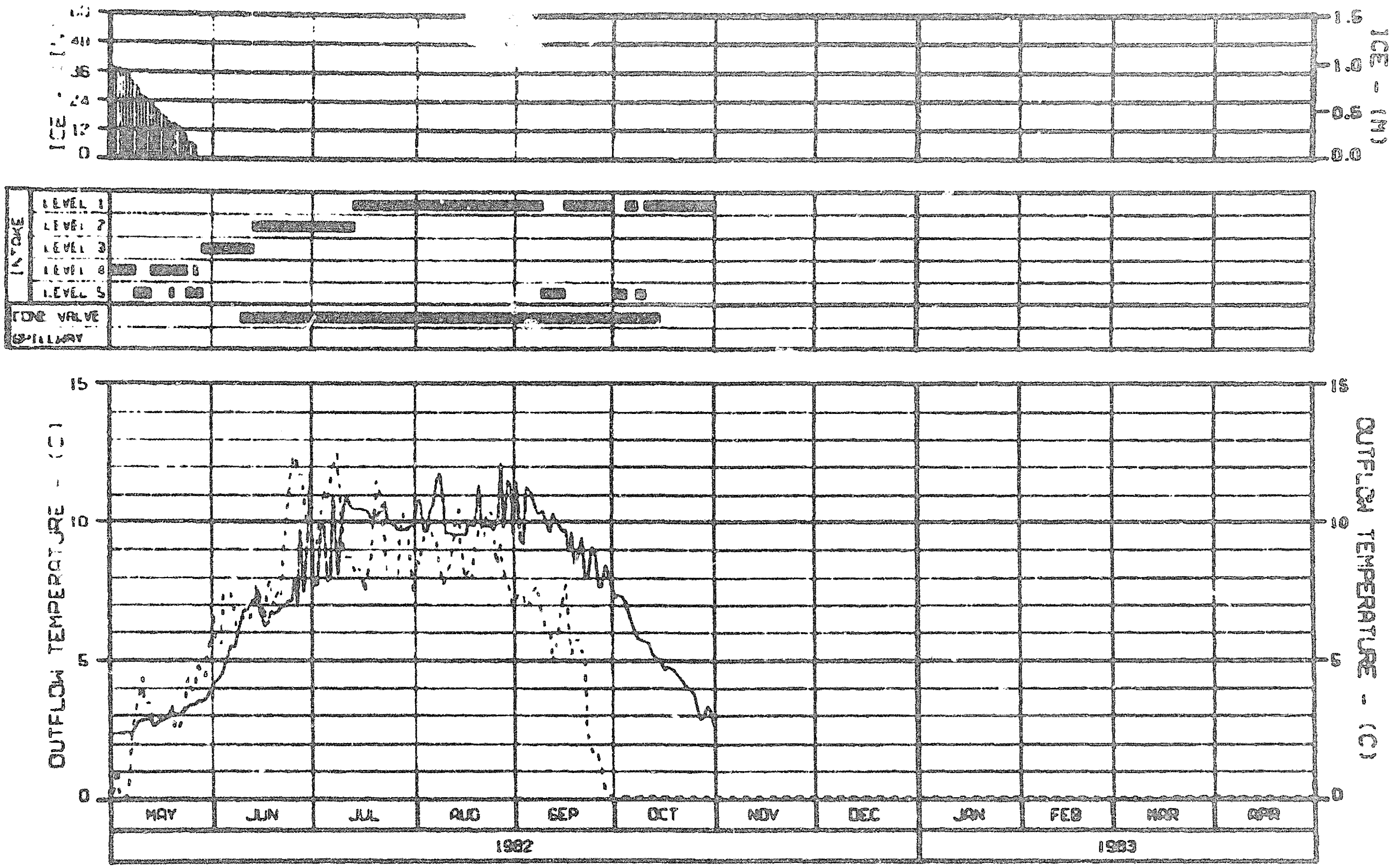
NOTES:
1. INTAKE PORT LEVEL 1 AT EL. 1964.4 FT. (598.8 M)
2. INTAKE PORT LEVEL 2 AT EL. 1926.4 FT. (587.2 M)
3. INTAKE PORT LEVEL 3 AT EL. 1888.4 FT. (575.6 M)
4. INTAKE PORT LEVEL 4 AT EL. 1850.4 FT. (564.0 M)
5. INTAKE PORT LEVEL 5 AT EL. 1812.4 FT. (552.4 M)
6. CONE VALVE AT ELEVATION 1929 FT (588.0 M)
7. SPILLWAY CREST AT ELEVATION 2136 FT (650.7 M)

ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE



LEGEND: CASE: WA8102U - WATANA OPERATION W/DEVIL CANYON IN 2002 (E-1. S2)

——————— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT EL. 1964.4 FT. (598.8 M)
2. INTAKE PORT LEVEL 2 AT EL. 1926.4 FT. (587.2 M)
3. INTAKE PORT LEVEL 3 AT EL. 1888.4 FT. (575.6 M)
4. INTAKE PORT LEVEL 4 AT EL. 1850.4 FT. (564.0 M)
5. INTAKE PORT LEVEL 5 AT EL. 1812.4 FT. (552.4 M)
6. CONE VALVE AT ELEVATION 1929 FT (588.0 M)
7. SPILLWAY CREST AT ELEVATION 2135 FT (650.7 M)

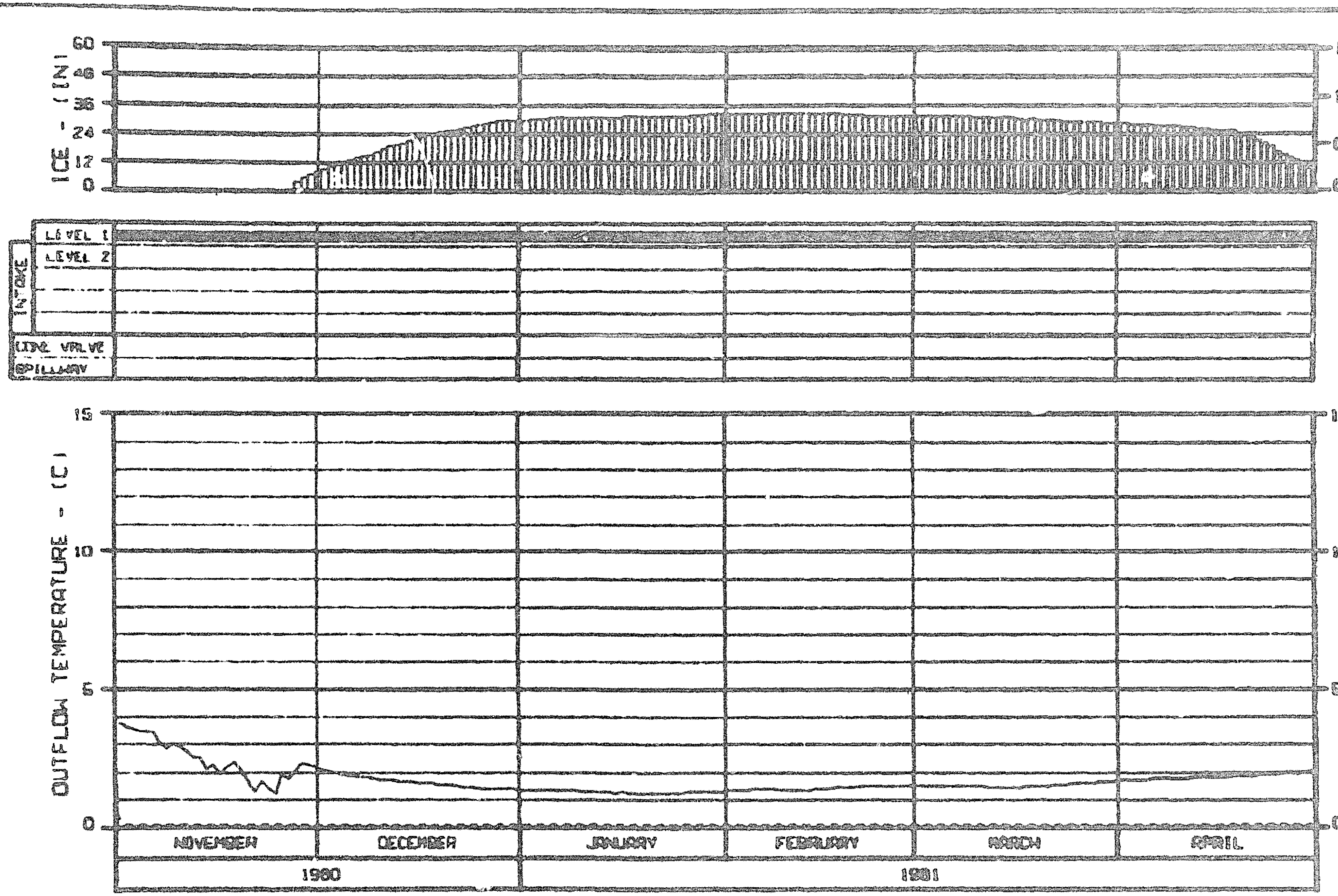
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 30 JUN 8? | 42-010-04

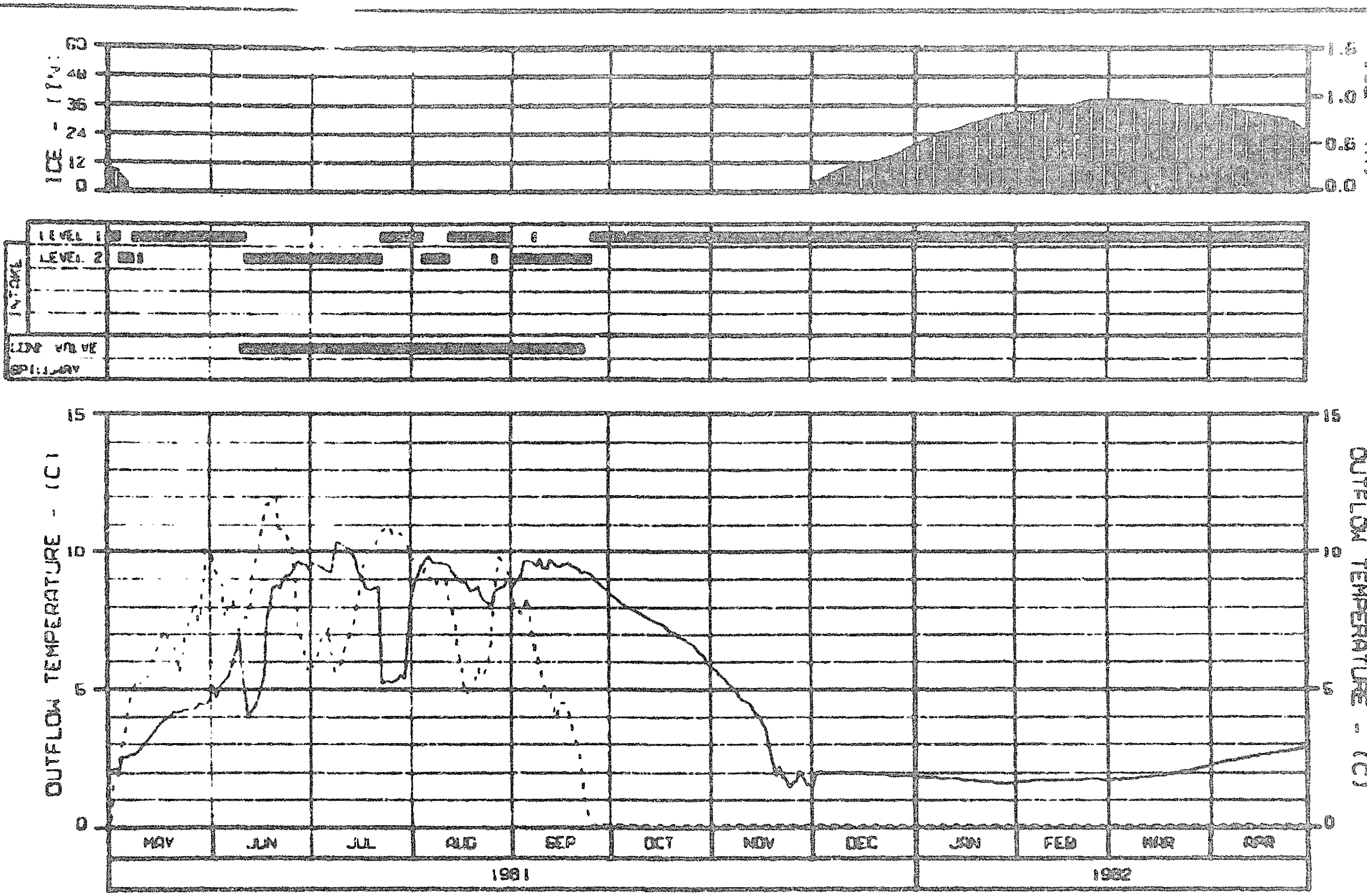


LEGEND: CASE: DC8102U - DEVIL CANYON OPERATION W/WATANA IN 2002 (E-1. 52)

——————— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES: 1. INTAKE PORT LEVEL 1 AT ELEVATION 1425 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1375 FT (419.10 M)
3. CONE VALVE AT ELEVATION 990 FT (301.76 M)
4. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	
DEVIL CANYON RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH	
HARZA-EBASCO JOINT VENTURE	



LEGEND: CASE: ** DC8102U - DEVIL CANYON OPERATION W/WATANA IN 2002 (E-1, 62) *

———— PREDICTED OUTFLOW TEMPERATURE
- - - - - - INFLOW TEMPERATURE

NOTES: 1. INTAKE PORT LEVEL 1 AT ELEVATION 1426 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1376 FT (419.10 M)
3. CONE VALVE AT ELEVATION 990 FT (301.75 M)
4 SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)

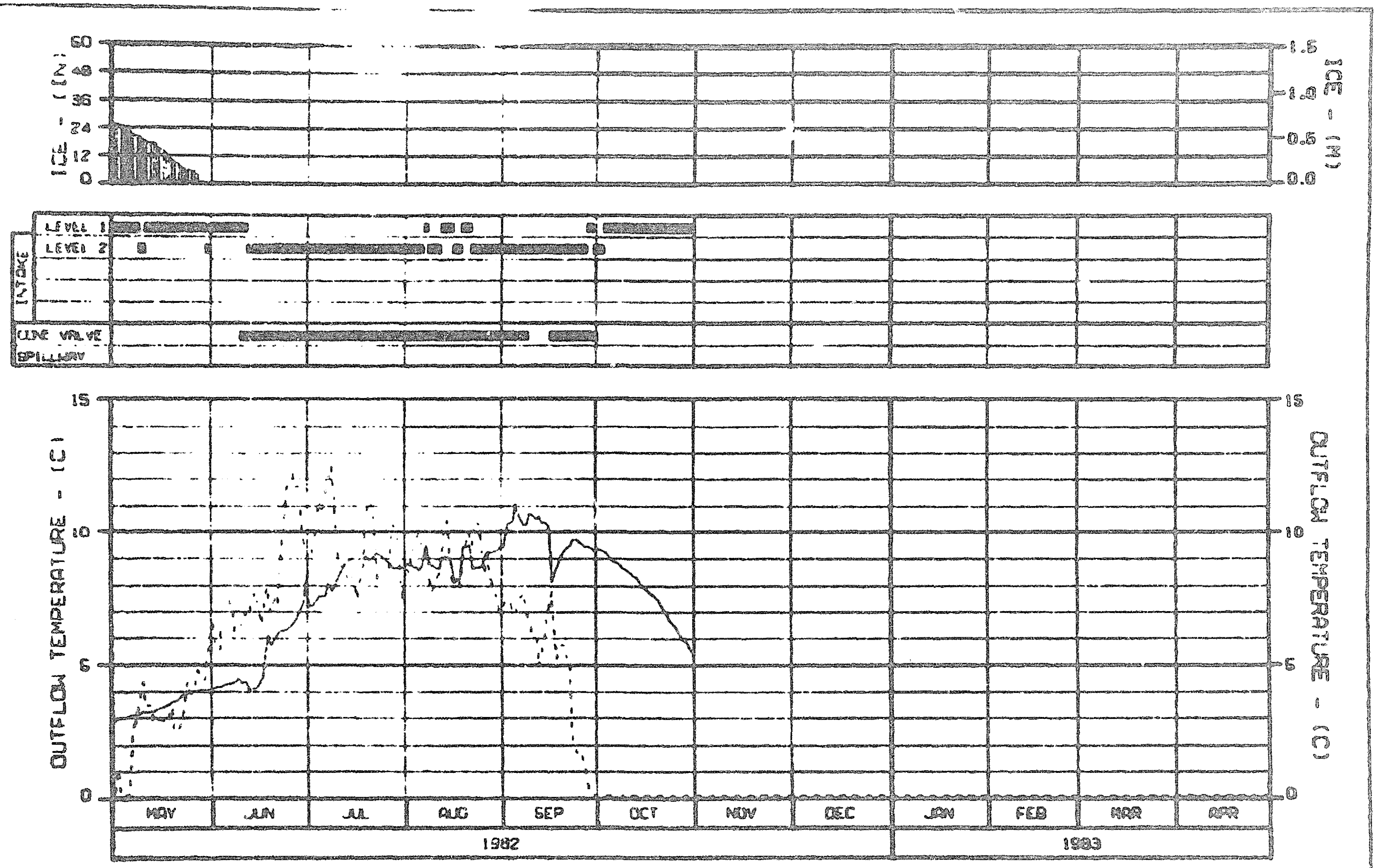
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 30 JAN 85 | E-010-04

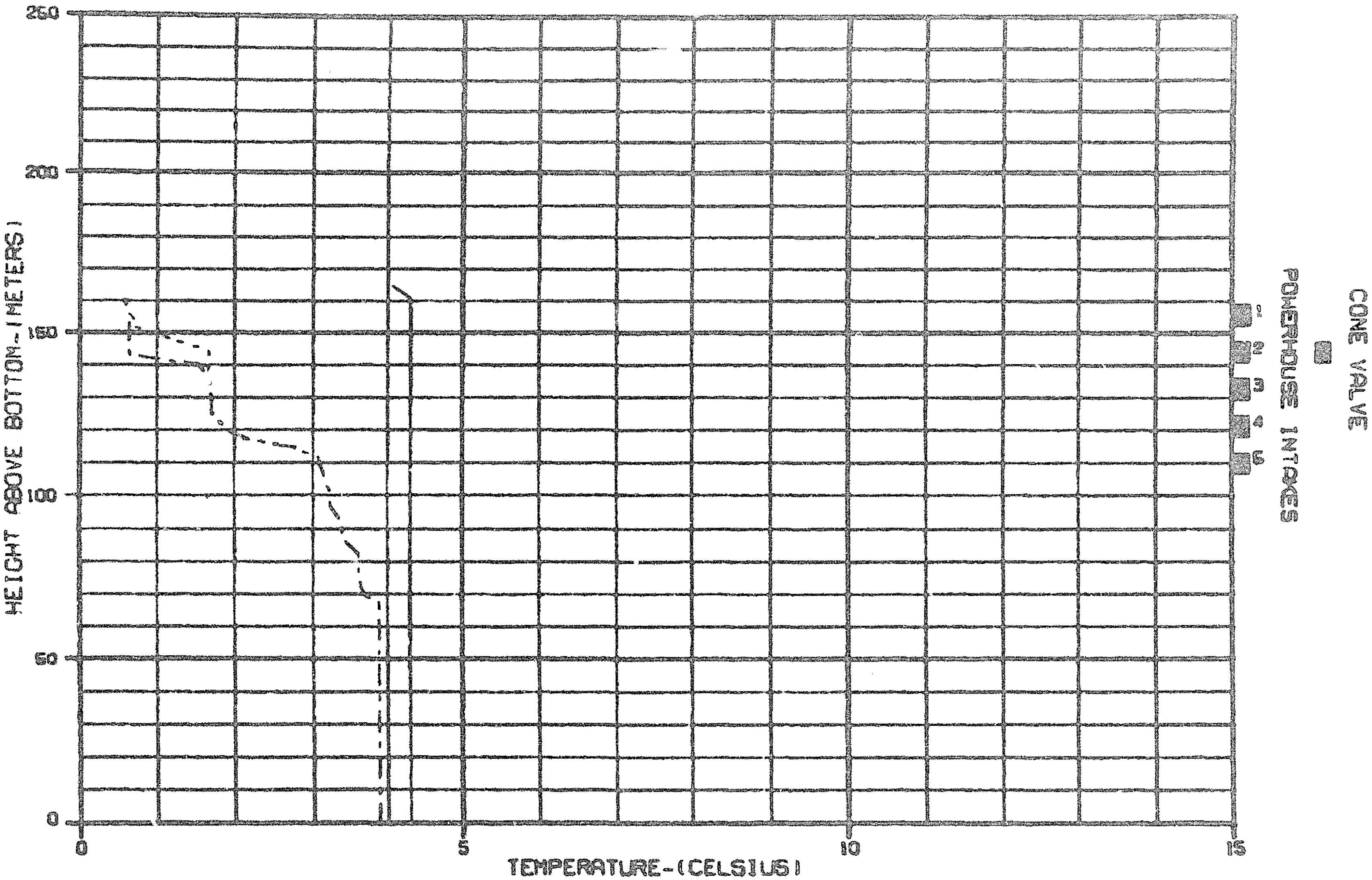


LEGEND: CASE: DCB102J - DEVIL CANYON OPERATION W/WATANA IN 2002 (E-1. 82)

——————— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES: 1. INTAKE PORT LEVEL 1 AT ELEVATION 1425 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1375 FT (419.10 M)
3. CONE VALVE AT ELEVATION 990 FT (301.75 M)
4. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)

ALASKA POWER AUTHORITY
SUSITNA PROJECT / DYRESM MODEL
DEVIL CANYON RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH
HARZA-EBASCO JOINT VENTURE
CHICAGO, ILLINOIS / 20 JAN 83 / 42-010-04



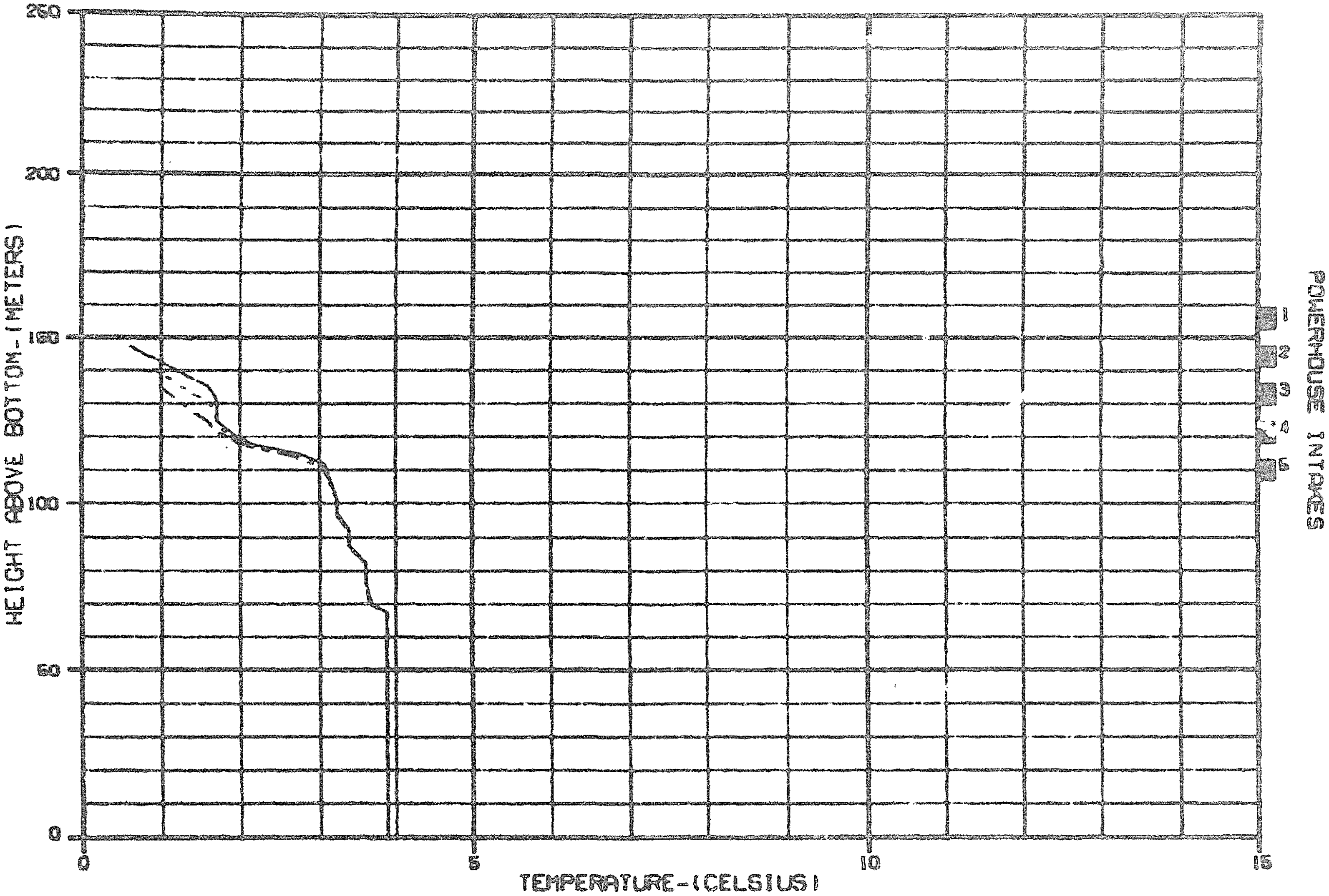
CASE: ** WAB102U - WATANA OPERATION W/DEVIL CANYON IN 2002 (E-1, S2) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

- ——————— 1 NOVEMBER 1980
- - - - - - - - 1 DECEMBER 1980
- — - — - — 1 JANUARY 1981

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
WATANA RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
[illegible]	[illegible]



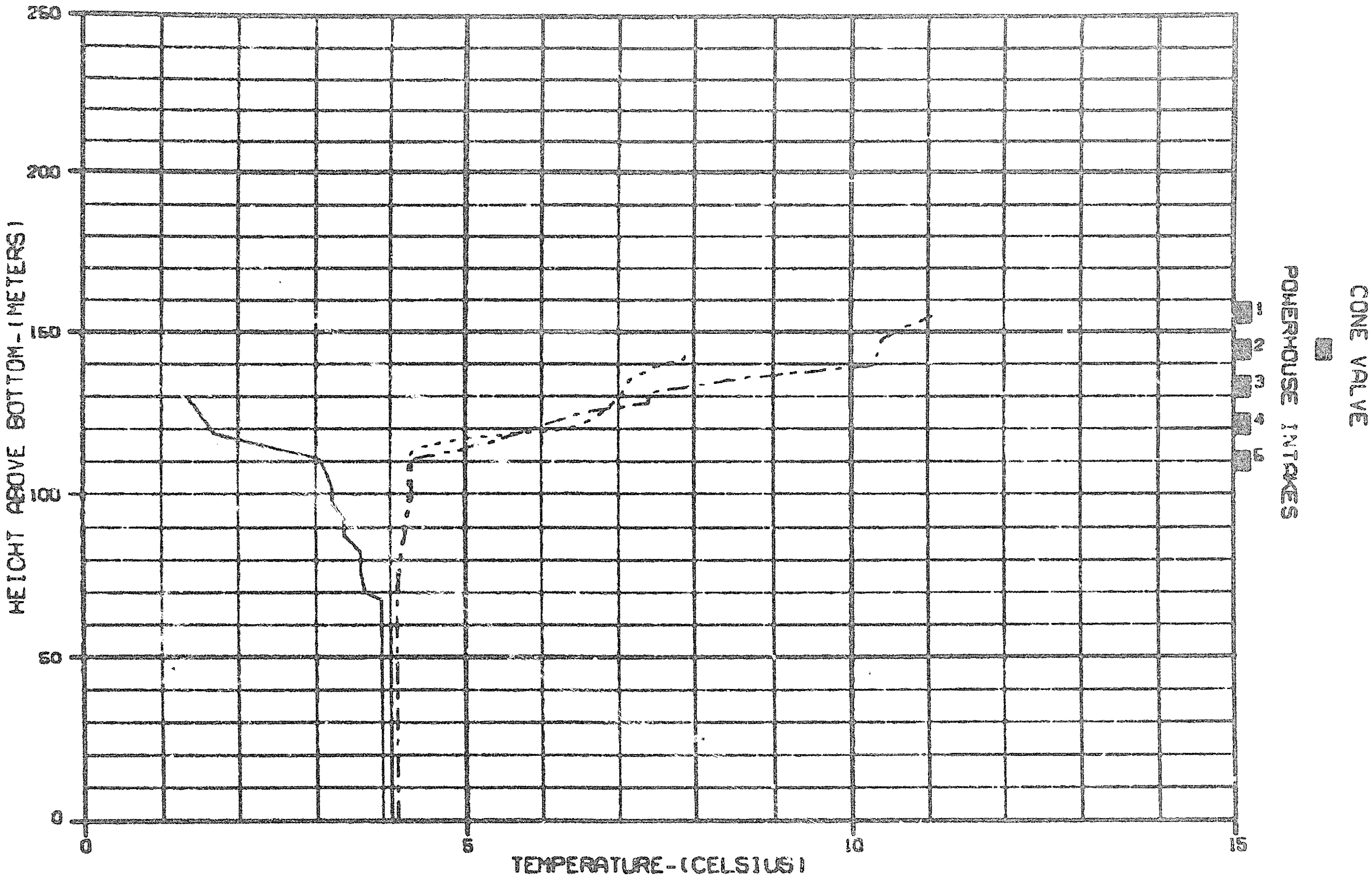
CASE: WA8102U - WATANA OPERATION W/DEVIL CANYON IN 2002 (E-1, S2)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 FEBRUARY 1981
· · · · · · · ·	1 MARCH 1981
— · — · —	1 APRIL 1981

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
WATANA RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
CHICAGO, ILLINOIS [illegible]	[illegible]



CASE: ** WAB102U - WATANA OPERATION W/DEVIL CANYON IN 2002 (E-1, S2) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

- ———— 1 MAY 1981
- -------- 1 JUNE 1981
- —-—-— 1 JULY 1981

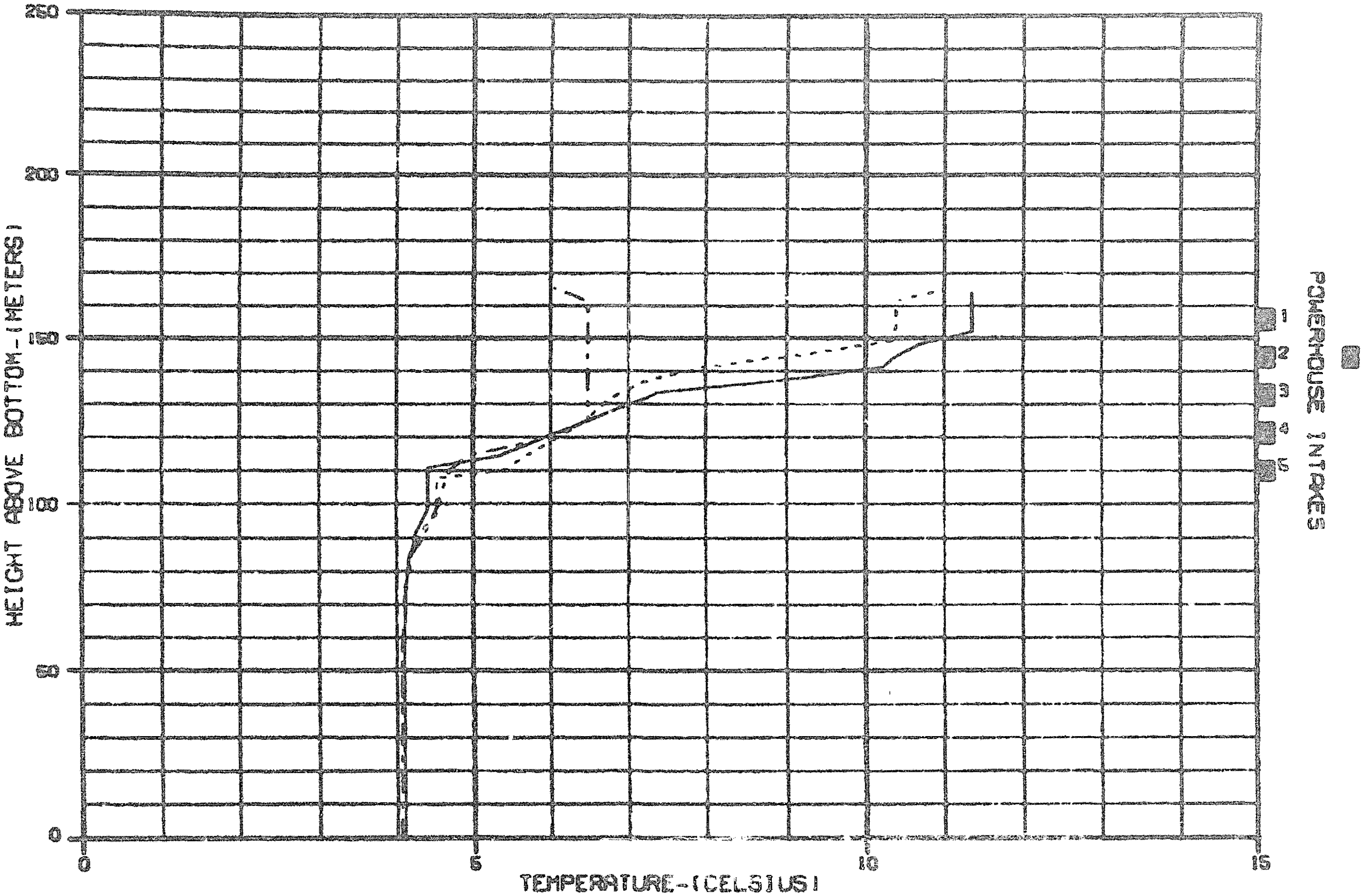
ALASKA POWER AUTHORITY

SUSITNA PROJECT

WATANA RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS



CASE: WA8102U - WATANA OPERATION W/DEVIL CANYON IN 2002 (E-1. S2)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

———— 1 AUGUST 1981
- - - - - 1 SEPTEMBER 1981
— - — - — 1 OCTOBER 1981

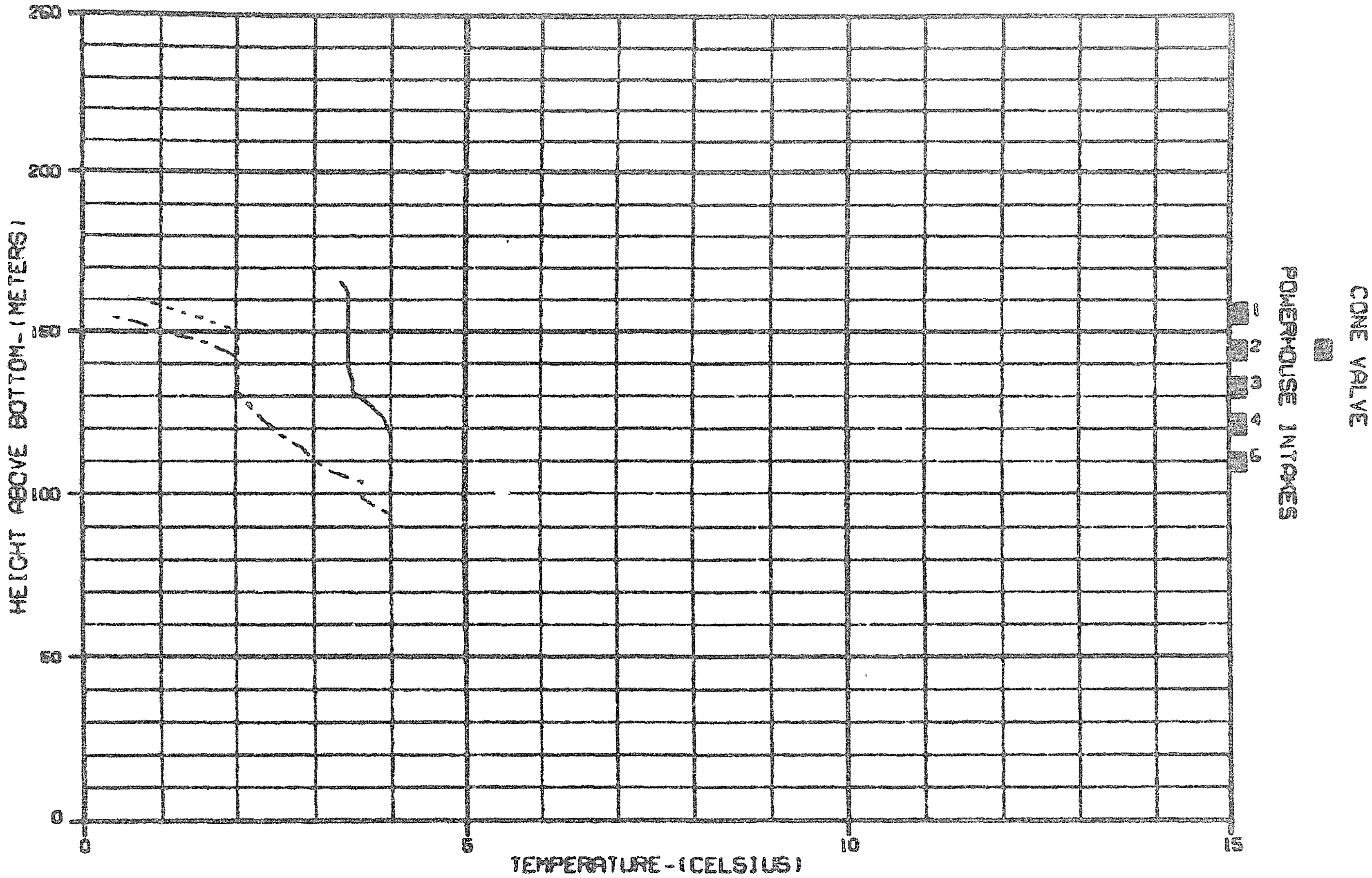
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESN MODEL

WATANA RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 42-010-04



CASE: ■■ WA8102U - WATANA OPERATION W/DEVIL CANYON IN 2002 (E-1. S2) ■■

LEGEND:

PREDICTED TEMPERATURE PROFILES

———— 1 NOVEMBER 1981

- - - - - - 1 DECEMBER 1981

— - — - — 1 JANUARY 1982

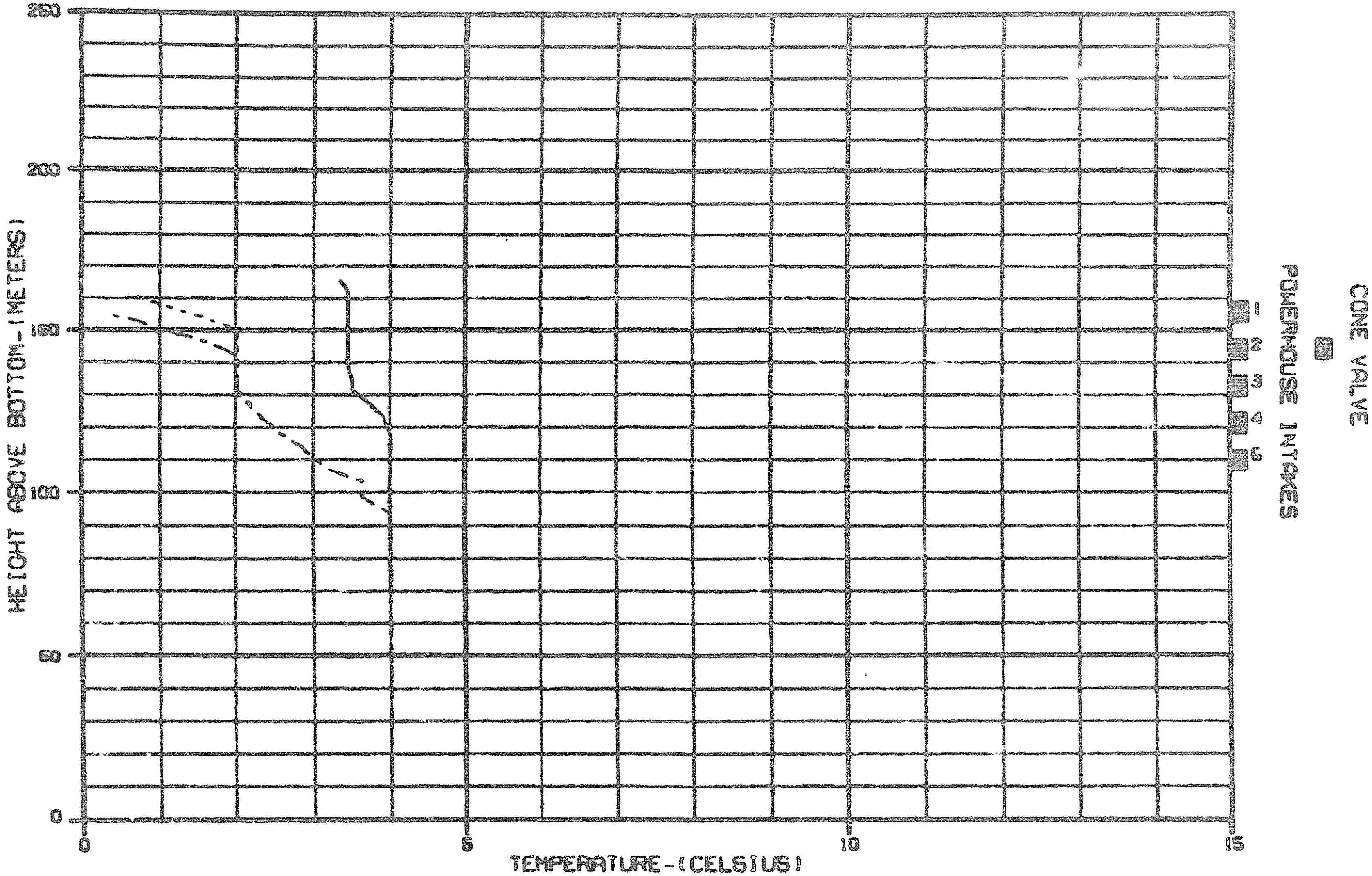
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

[illegible]



CASE: ** WA8102U - WATANA OPERATION W/DEVIL CANYON IN 2002 (E-1, S2) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

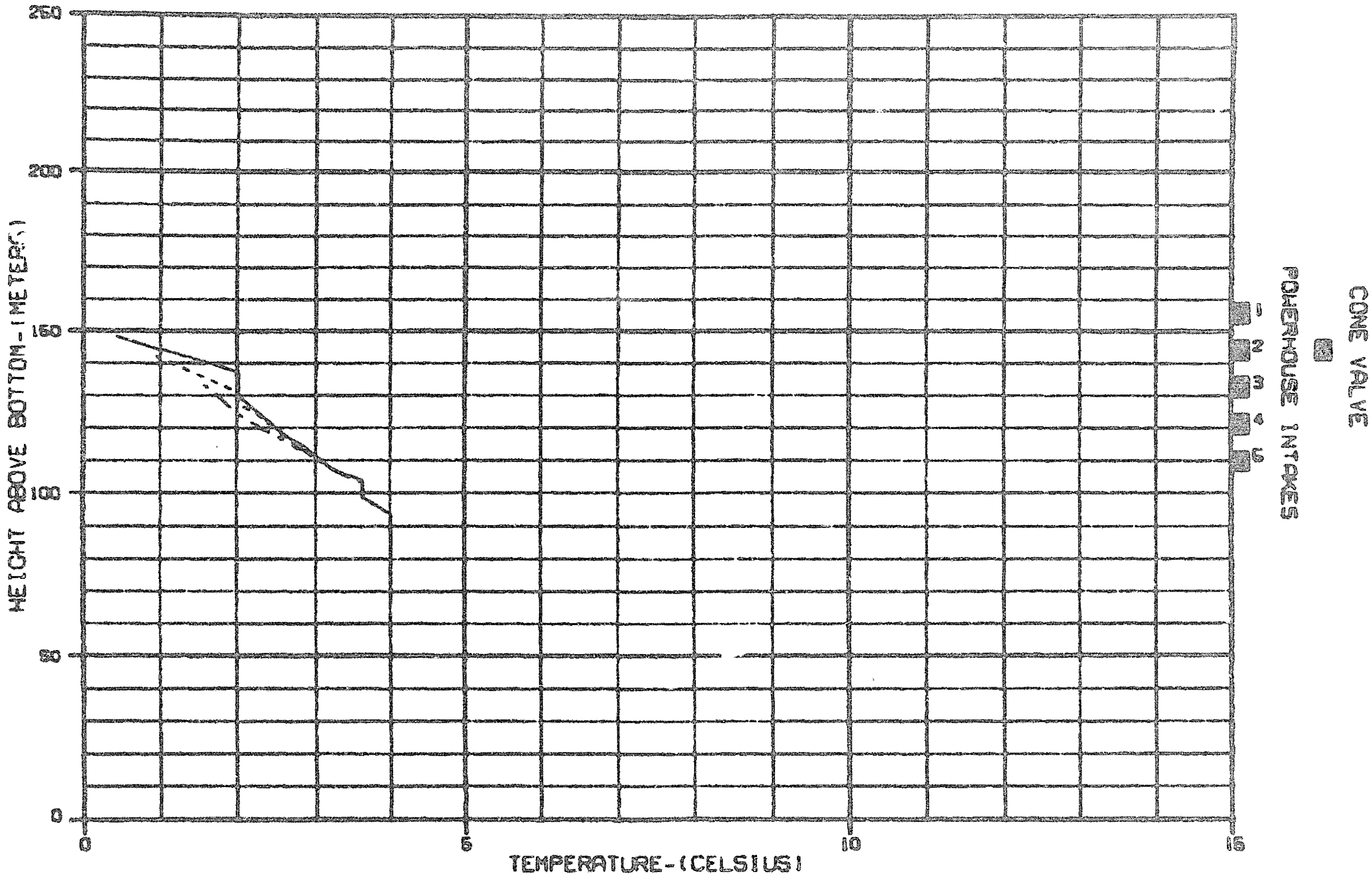
————	1 NOVEMBER 1981
- - - - - - - -	1 DECEMBER 1981
— - — - —	1 JANUARY 1982

ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE



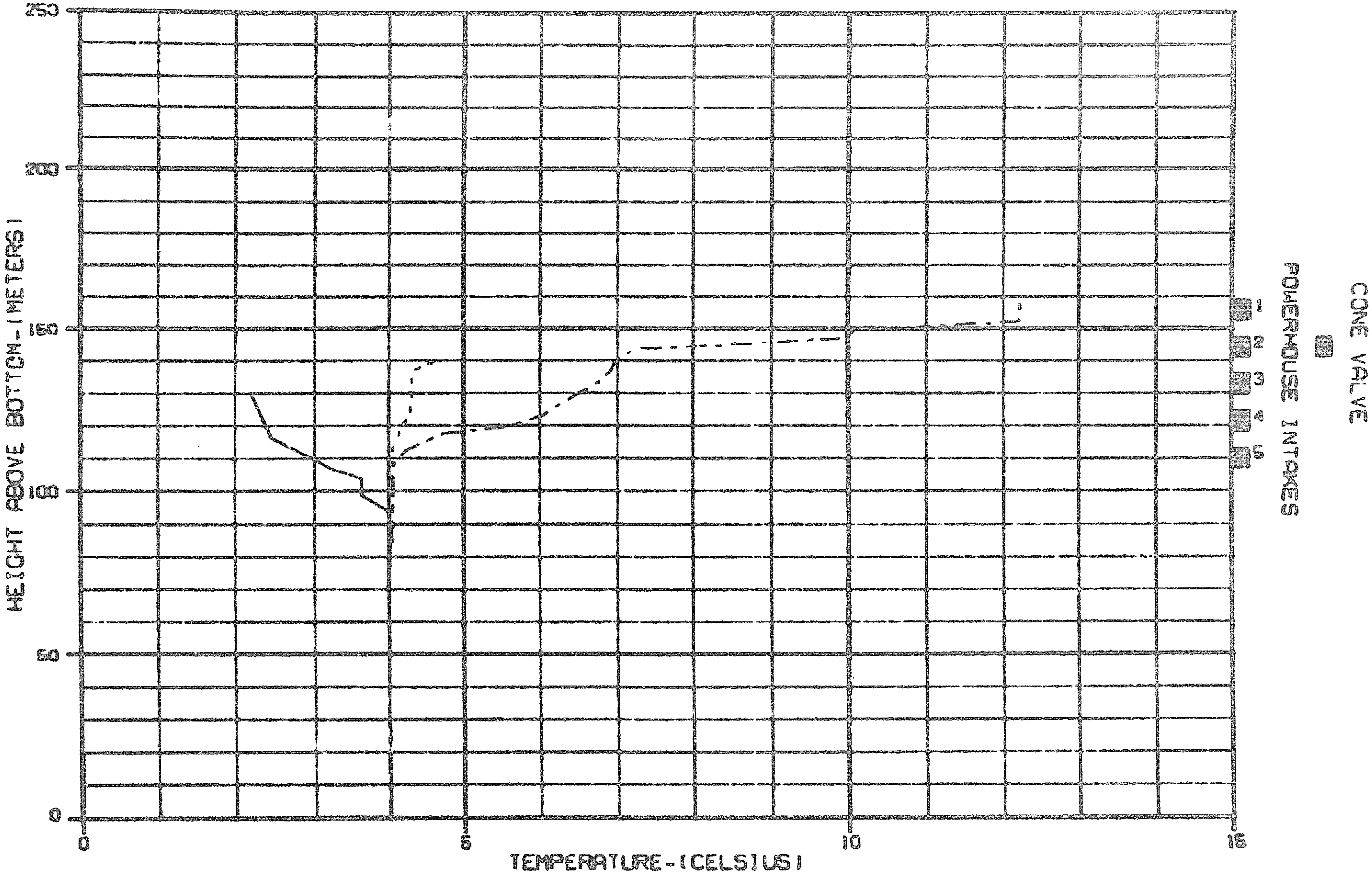
CASE: ** WA8102U - WATANA OPERATION W/DEVIL CANYON IN 2002 (E-1, S2) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

- ———— 1 FEBRUARY 1982
- - - - - - 1 MARCH 1982
- — - — - 1 APRIL 1982

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	[illegible]
WATANA RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
[illegible]	[illegible]



CASE: ** WA8102U - WATANA OPERATION W/DEVIL CANYON IN 2002 (E-1. S2) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

———— 1 MAY 1982
- - - - - - 1 JUNE 1982
— - — - — 1 JULY 1982

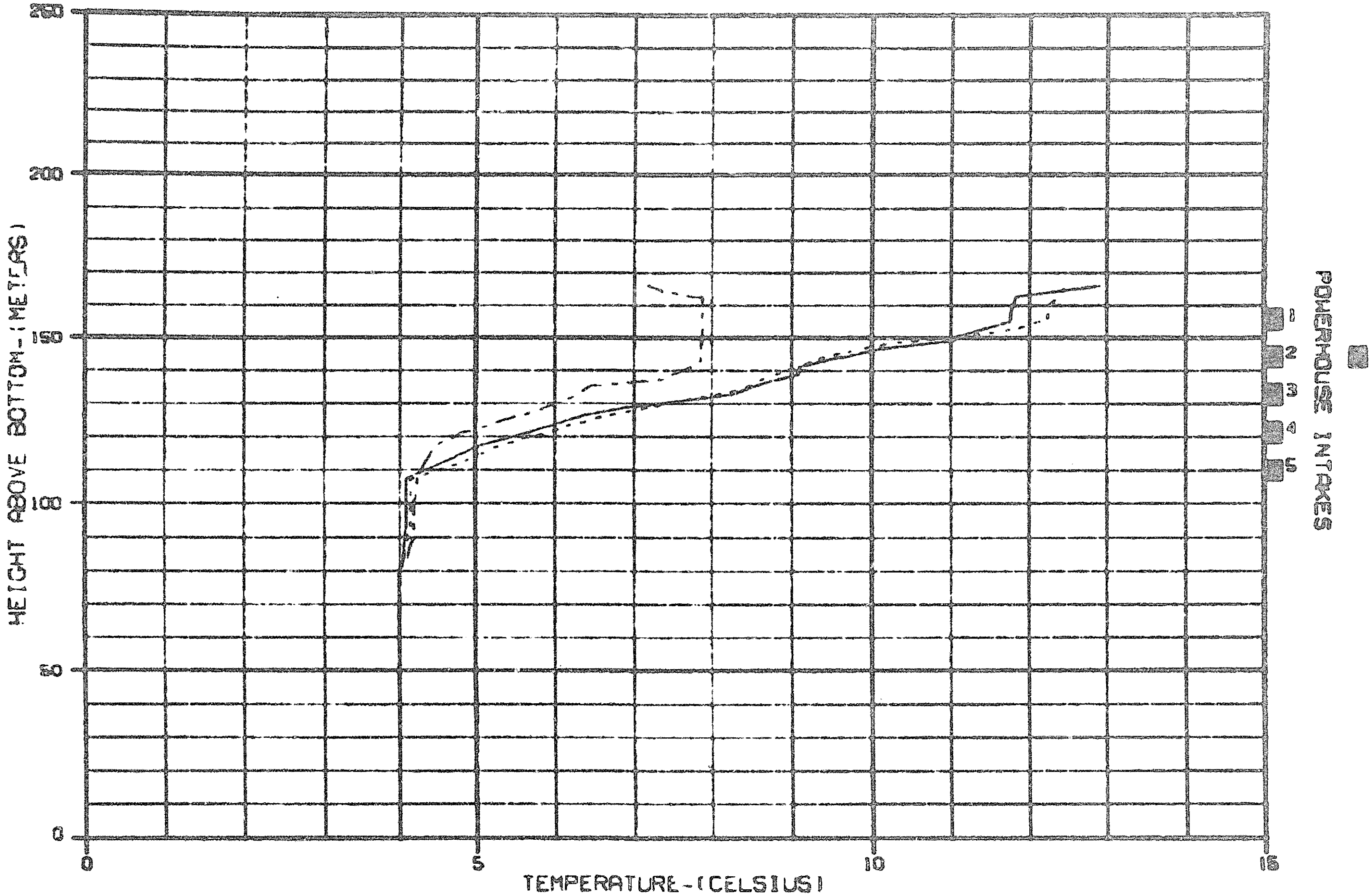
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 30 JUN 83 | 42-010-04



CASE: WAB102U - WATANA OPERATION W/DEVIL CANYON IN 2002 (E-1. S2)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

———— 1 AUGUST 1982

- - - - - - 1 SEPTEMBER 1982

— · — · — 1 OCTOBER 1982

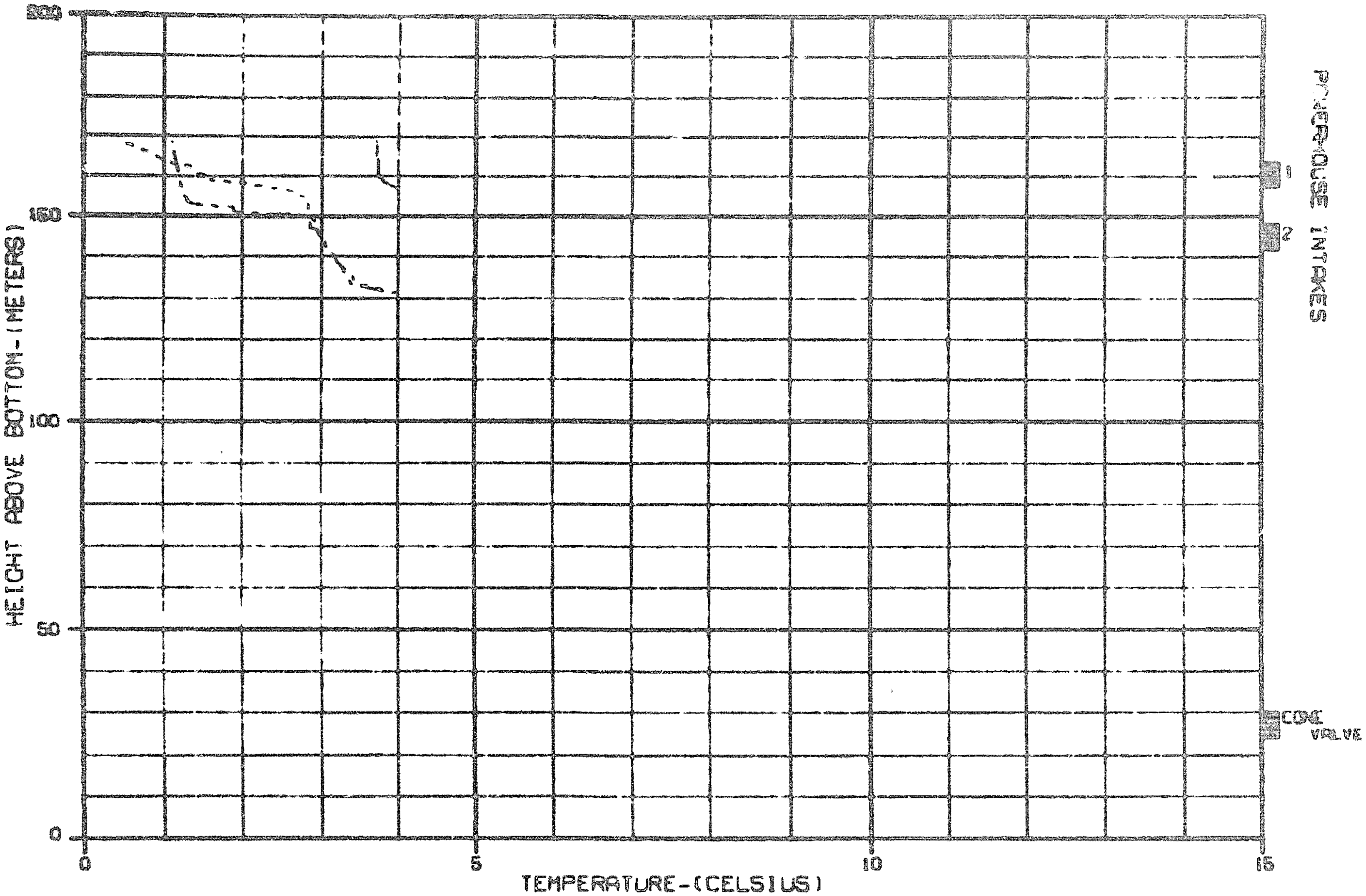
ALASKA POWER AUTHORITY

SUSITNA PROJECT

WATANA RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS



CASE: ** DCB102U - DEVIL CANYON OPERATION W/WATANA IN 2002 (E-1. S2) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

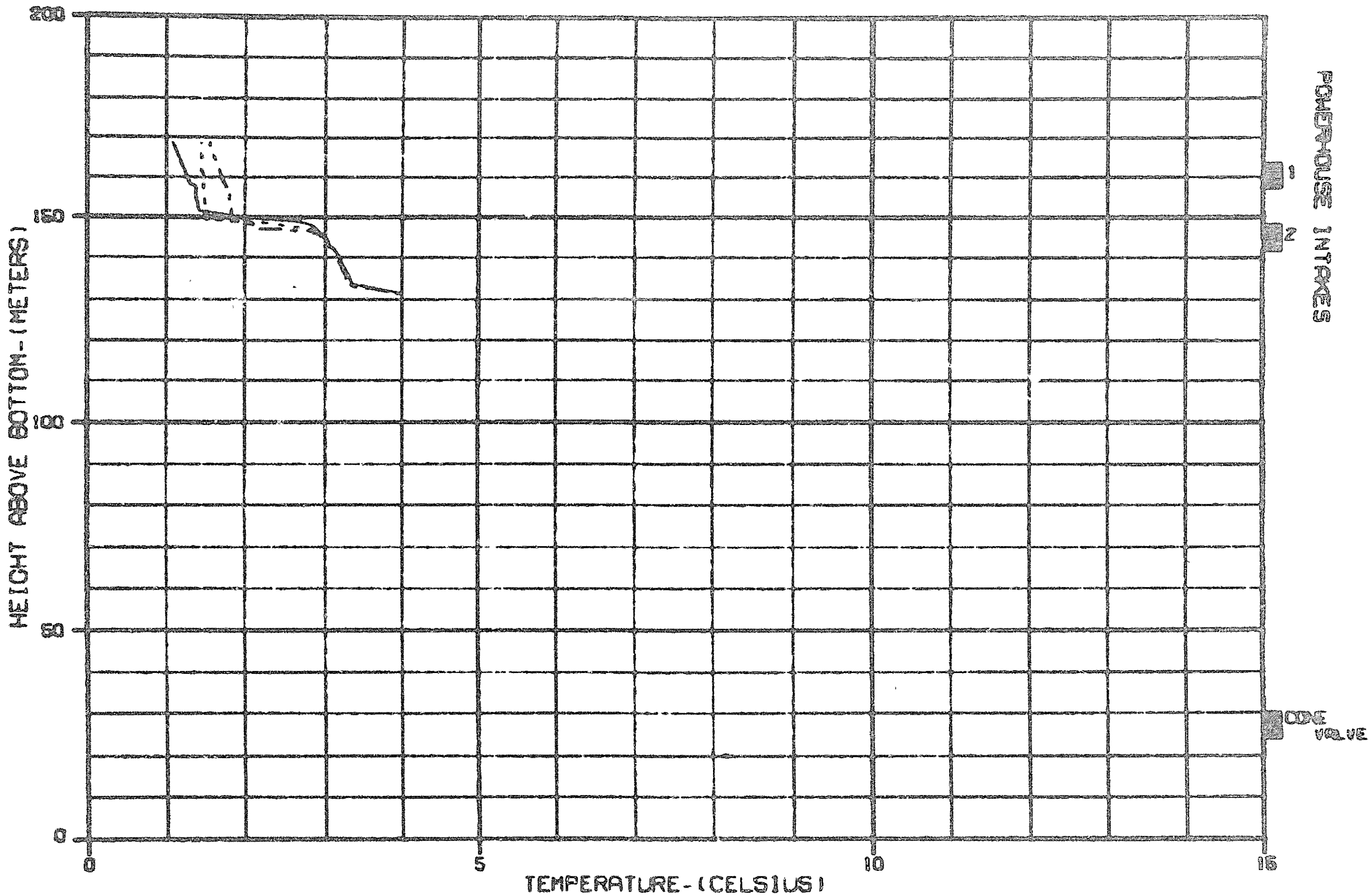
————	1 NOVEMBER 1980
- - - - - -	1 DECEMBER 1980
— · — · —	1 JANUARY 1981

ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE



CASE: ** DC8102U - DEVIL CANYON OPERATION W/WATANA IN 2002 (E-1, S2) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 FEBRUARY	1981
- - - - - -	1 MARCH	1981
— - — - —	1 APRIL	1981

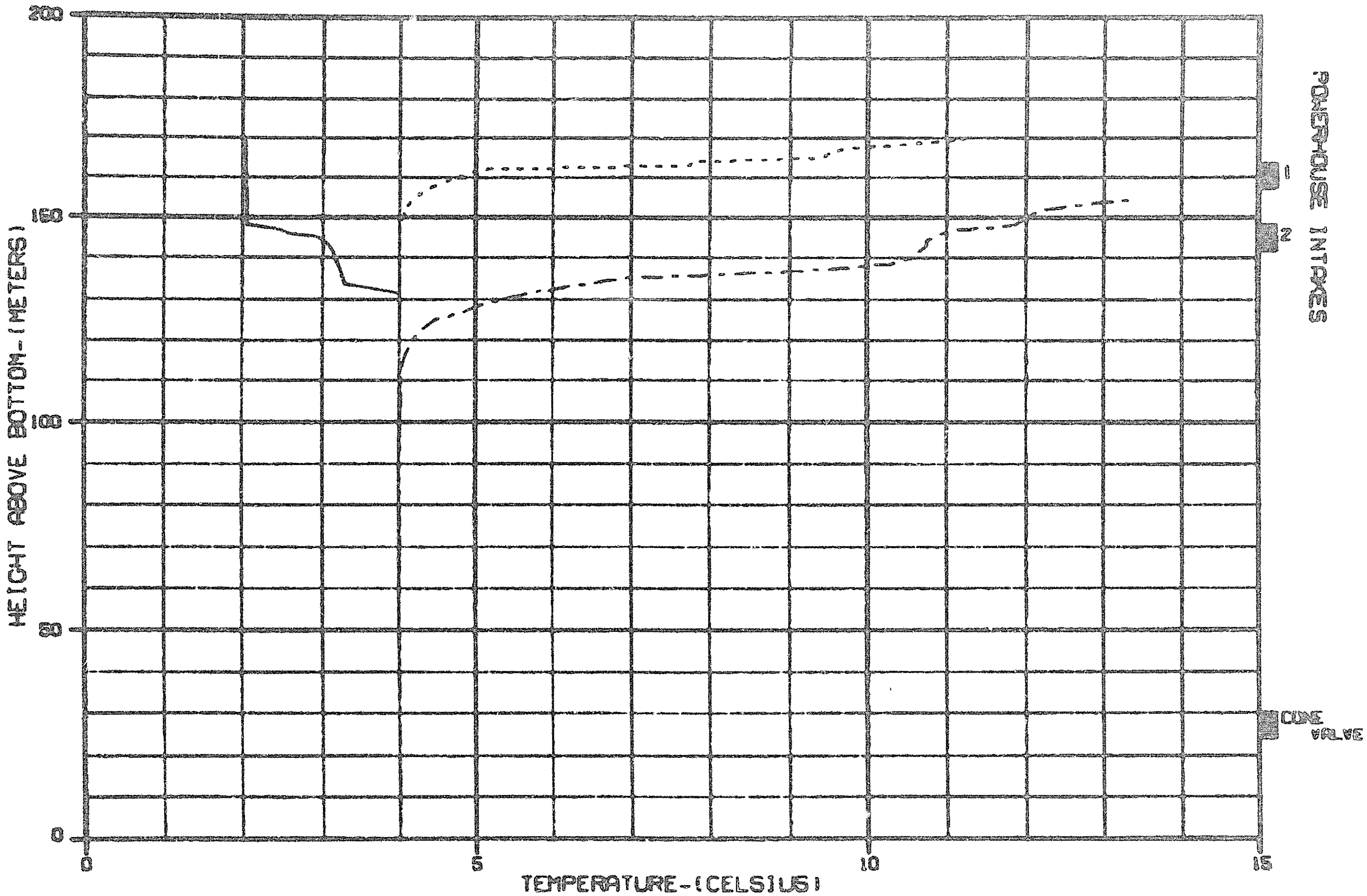
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYNAMIC MODEL

DEVIL CANYON RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 30 JAN 85 | 42-010-04



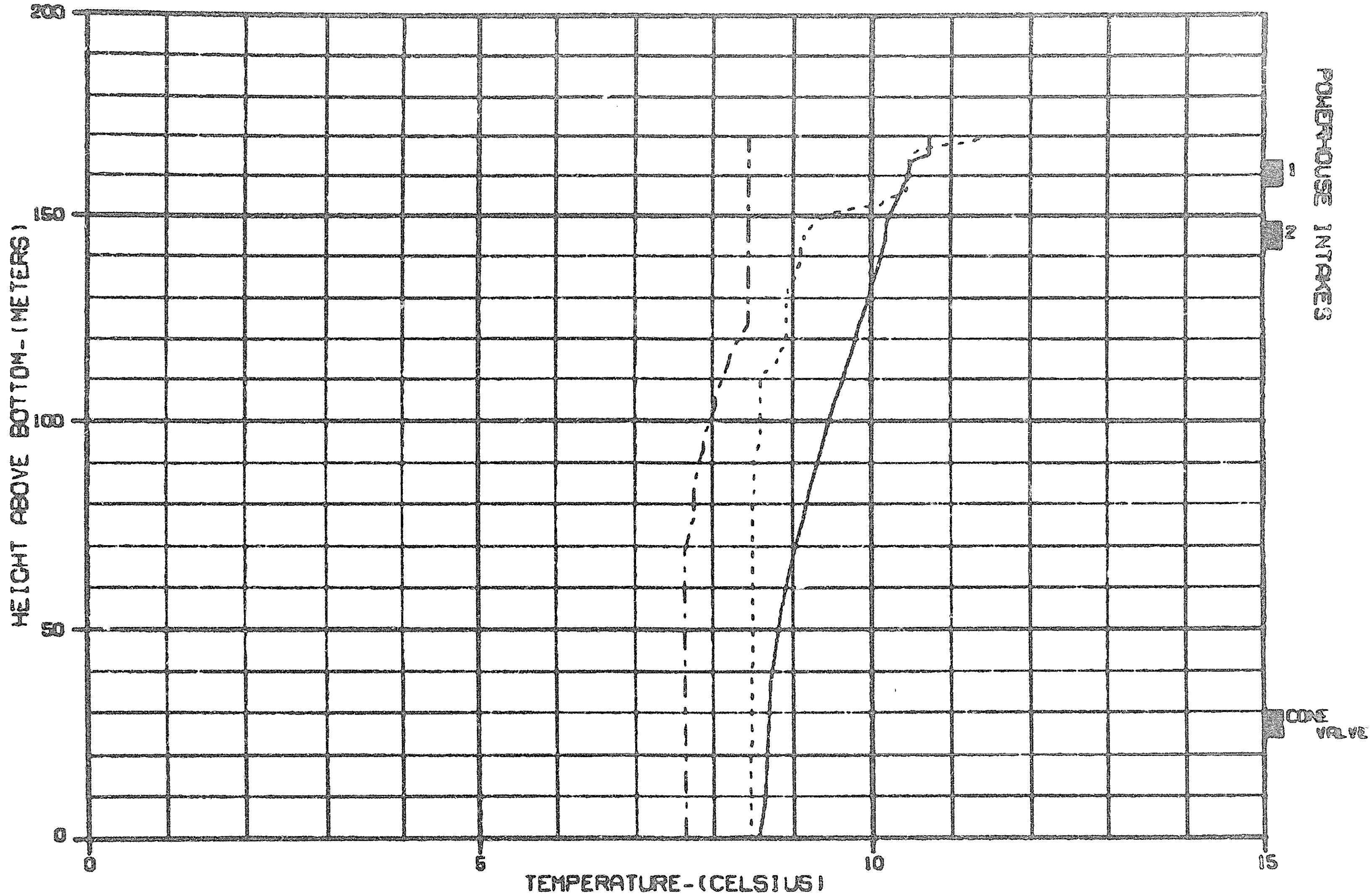
CASE: ** DC8102U - DEVIL CANYON OPERATION W/WATANA IN 2002 (E-1, C2) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 MAY 1981
- - - - - -	1 JUNE 1981
— - — - —	1 JULY 1981

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
DEVIL CANYON RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	



CASE: ** DC8102U - DEVIL CANYON OPERATION W/WATANA IN 2002 (E-1, S2) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 AUGUST	1981
- - - - - -	1 SEPTEMBER	1981
—·—·—	1 OCTOBER	1981

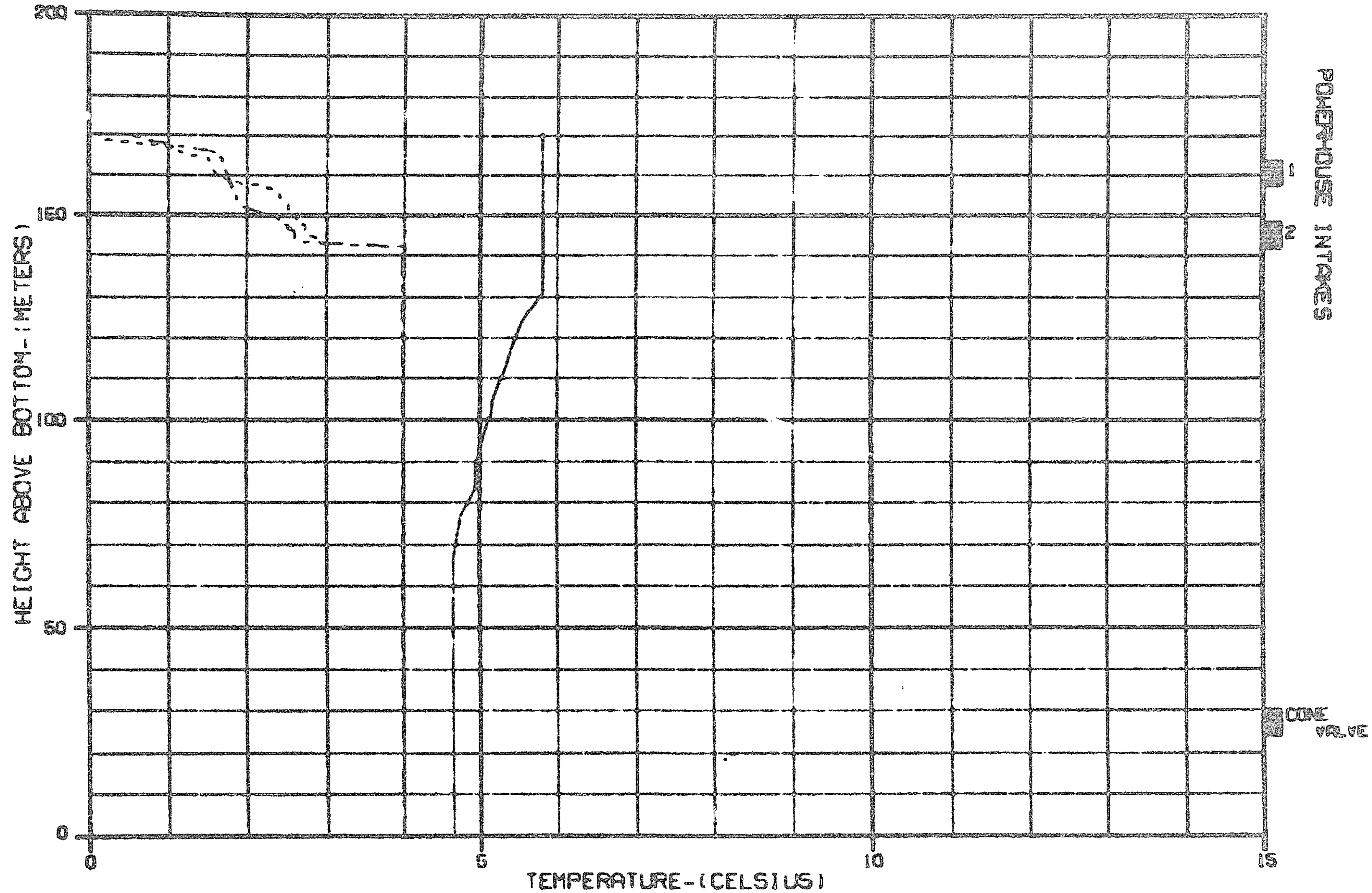
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | [illegible] | 42-010-04



CASE: ■■ DC8102U - DEVIL CANYON OPERATION W/WATANA IN 2002 (E-1. S2) ■■

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 NOVEMBER 1981
· · · · · · · ·	1 DECEMBER 1981
— · — · —	1 JANUARY 1982

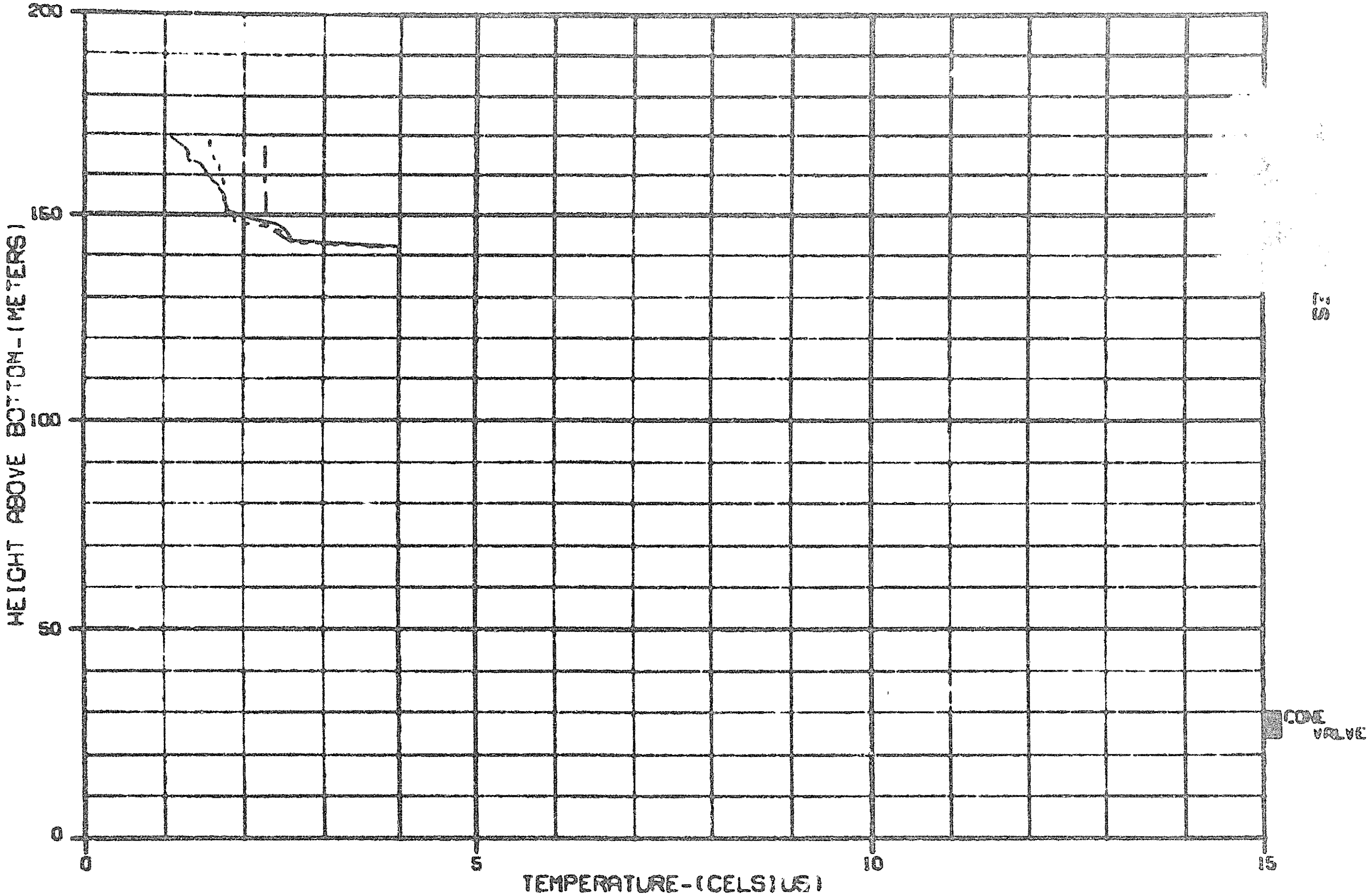
ALASKA POWER AUTHORITY

SUSITNA PROJECT | [illegible]

DEVIL CANYON RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | [illegible] | [illegible]



CASE: ** DC8102U - DEVIL CANYON OPERATION W/WATANA IN 2002 (E-1, S2) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————————	1 FEBRUARY	1982
- - - - - - - -	1 MARCH	1982
— - — - —	1 APRIL	1982

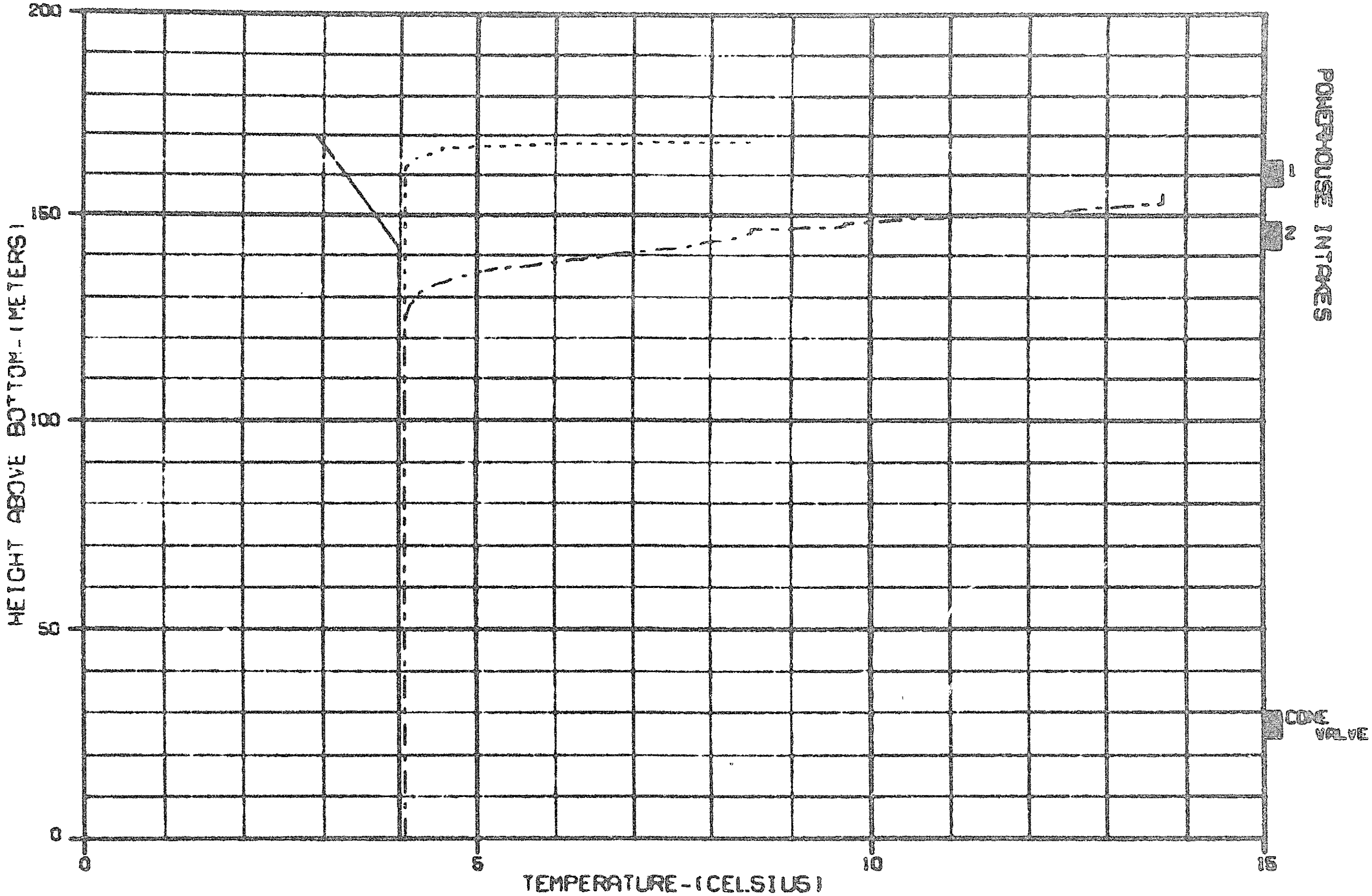
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | [illegible] | [illegible]



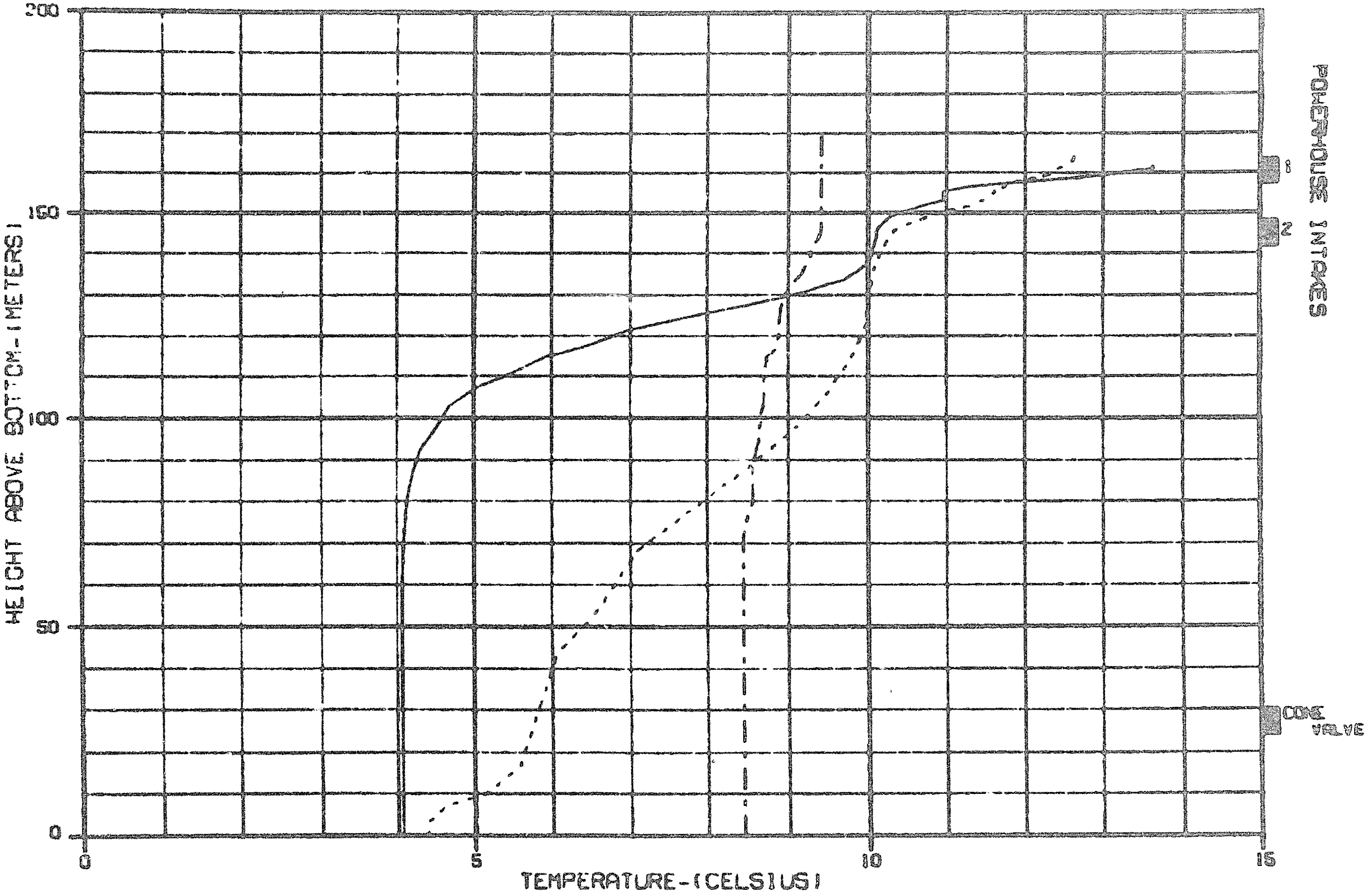
CASE: ** DC8102U - DEVIL CANYON OPERATION W/WATANA IN 2002 (E-1, S2) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

———— 1 MAY 1982
- - - - - 1 JUNE 1982
— - — - 1 JULY 1982

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
DEVIL CANYON RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
[illegible]	[illegible]	[illegible]



CASE: ** DC8102U - DEVIL CANYON OPERATION W/WATANA IN 2002 (E-1. S2) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 AUGUST 1982
- - - - - - -	1 SEPTEMBER 1982
— - — - —	1 OCTOBER 1982

ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

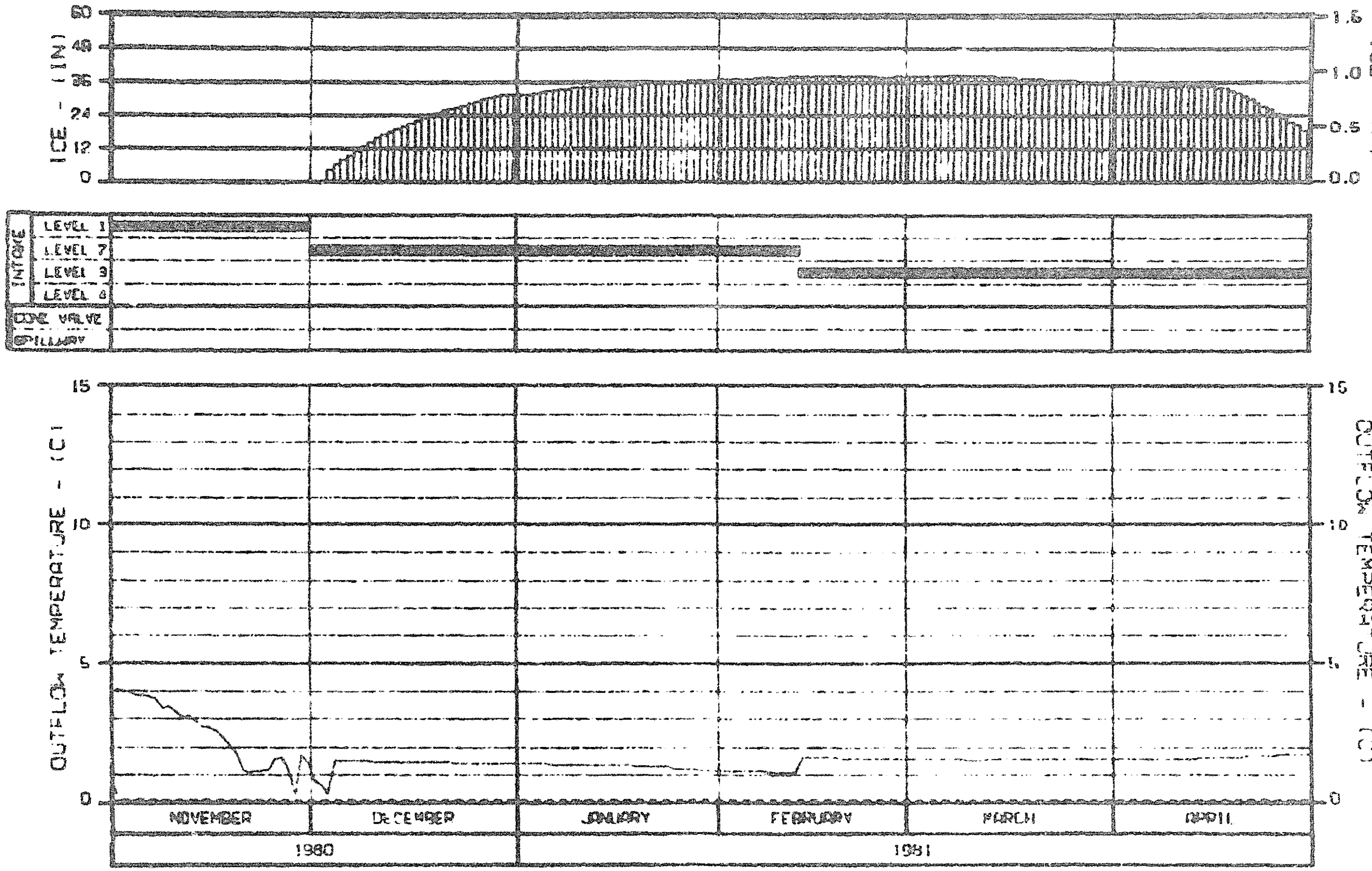
DEVIL CANYON RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | [illegible] | 42-010-04

EXHIBIT N

CASE E-I
STAGE III
THREE-STAGE PROJECT
INFLOW TEMPERATURE MATCHING



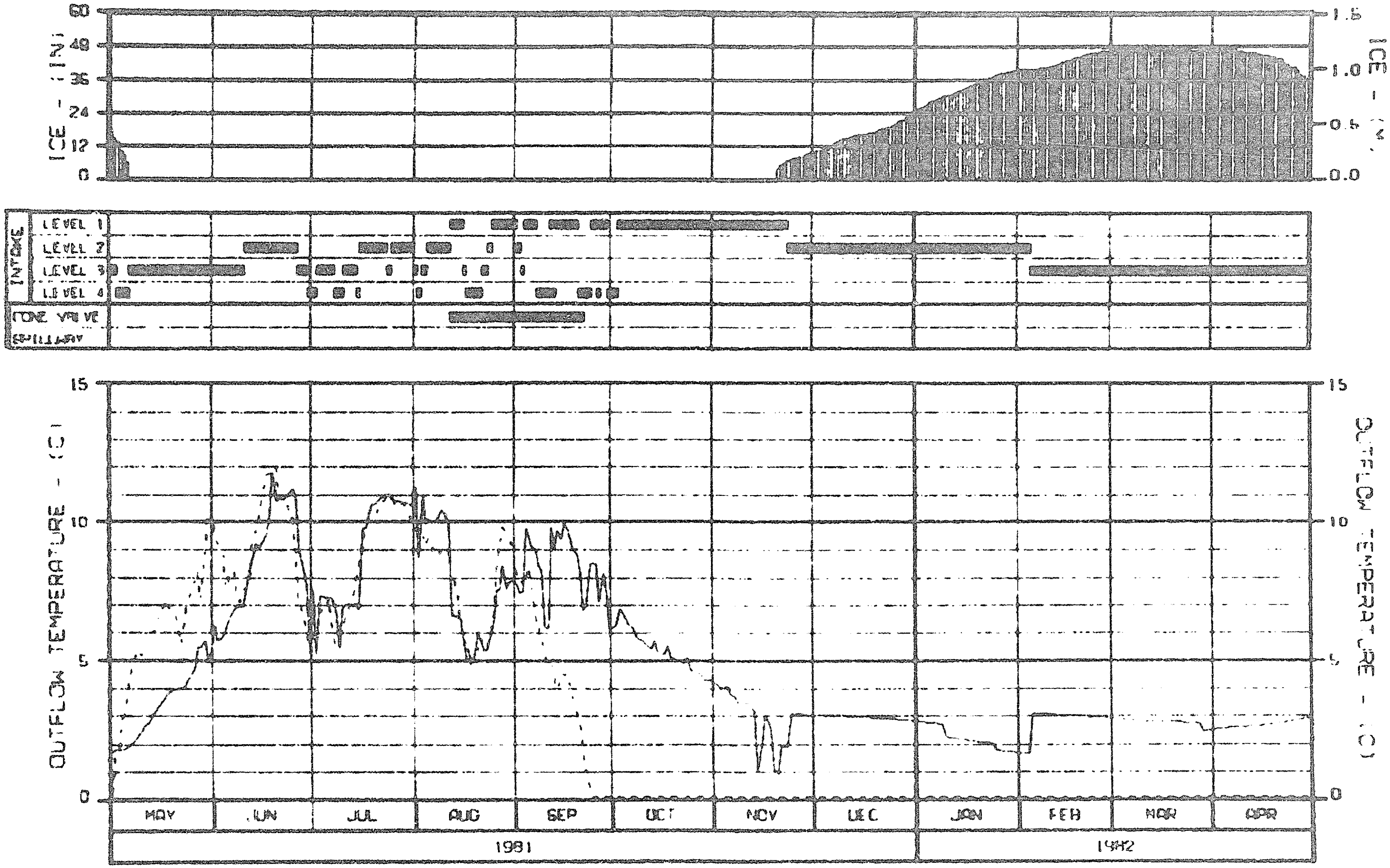
LEGEND: CASE: WA81200 - WATANA OPERATION W/DEVIL CANYON IN 2020 (CASE E-1) *stage III*

——— PREDICTED OUTFLOW TEMPERATURE

- - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 2183 FT (666.4 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2108 FT (642.7 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2066 FT (629.9 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2024 FT (617.1 M)
5. CONE VALVE AT ELEVATION 1929 FT (588.0 M)
6. SPILLWAY CREST AT ELEVATION 2297 FT (700.0 M)

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	
WATANA RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH	
HARZA-EBASCO JOINT VENTURE	
CHICAGO, ILLINOIS	42-010-04



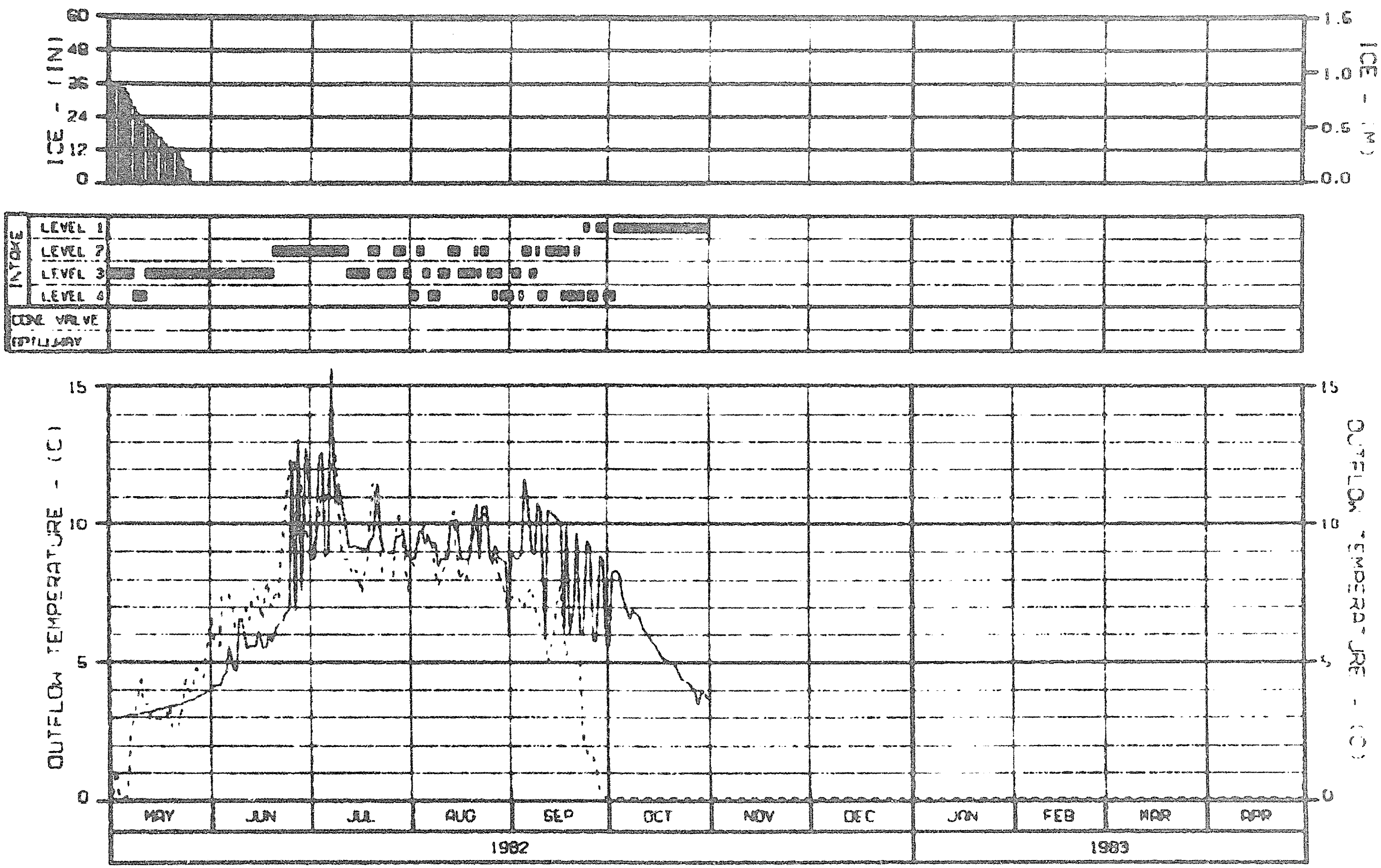
LEGEND: CASE: ** WA81200 - WATANA OPERATION W/DEVIL CANYON IN 2020 (CASE E-1)

———— PREDICTED OUTFLOW TEMPERATURE

- - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 2183 FT (665.4 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2108 FT (642.7 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2066 FT (629.9 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2024 FT (617.1 M)
5. CONE VALVE AT ELEVATION 1929 FT (588.0 M)
6. SPILLWAY CREST AT ELEVATION 2297 FT (700.0 M)

ALASKA POWER AUTHORITY		
SUSITNA PROJECT	DYRESM MODEL	
WATANA RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH		
HARZA-EBASCO JOINT VENTURE		
CHICAGO, ILLINOIS	20 MAY 85	42-010-04



LEGEND: CASE: WA81200 - WATANA OPERATION W/DEVIL CANYON IN 2020 (CASE E-1)

———— PREDICTED OUTFLOW TEMPERATURE
- - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 2183 FT (665.4 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2108 FT (642.7 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2066 FT (629.9 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2024 FT (617.1 M)
5. CONE VALVE AT ELEVATION 1929 FT (588.0 M)
6. SPILLWAY CREST AT ELEVATION 2297 FT (700.0 M)

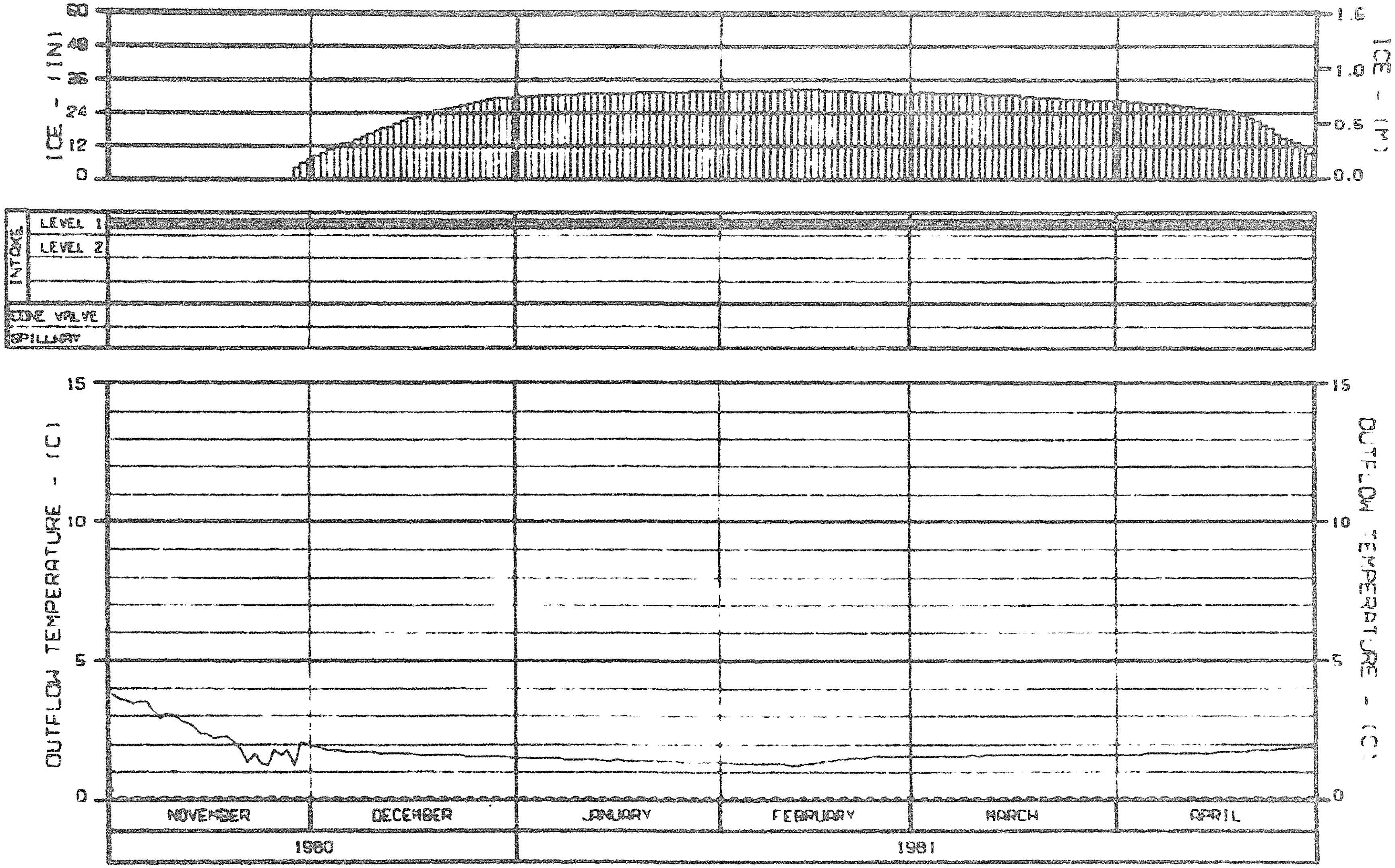
ALASKA POWER AUTHORITY

SUSITNA PROJECT | [illegible]

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 20 MAY 85 | 42-010-04

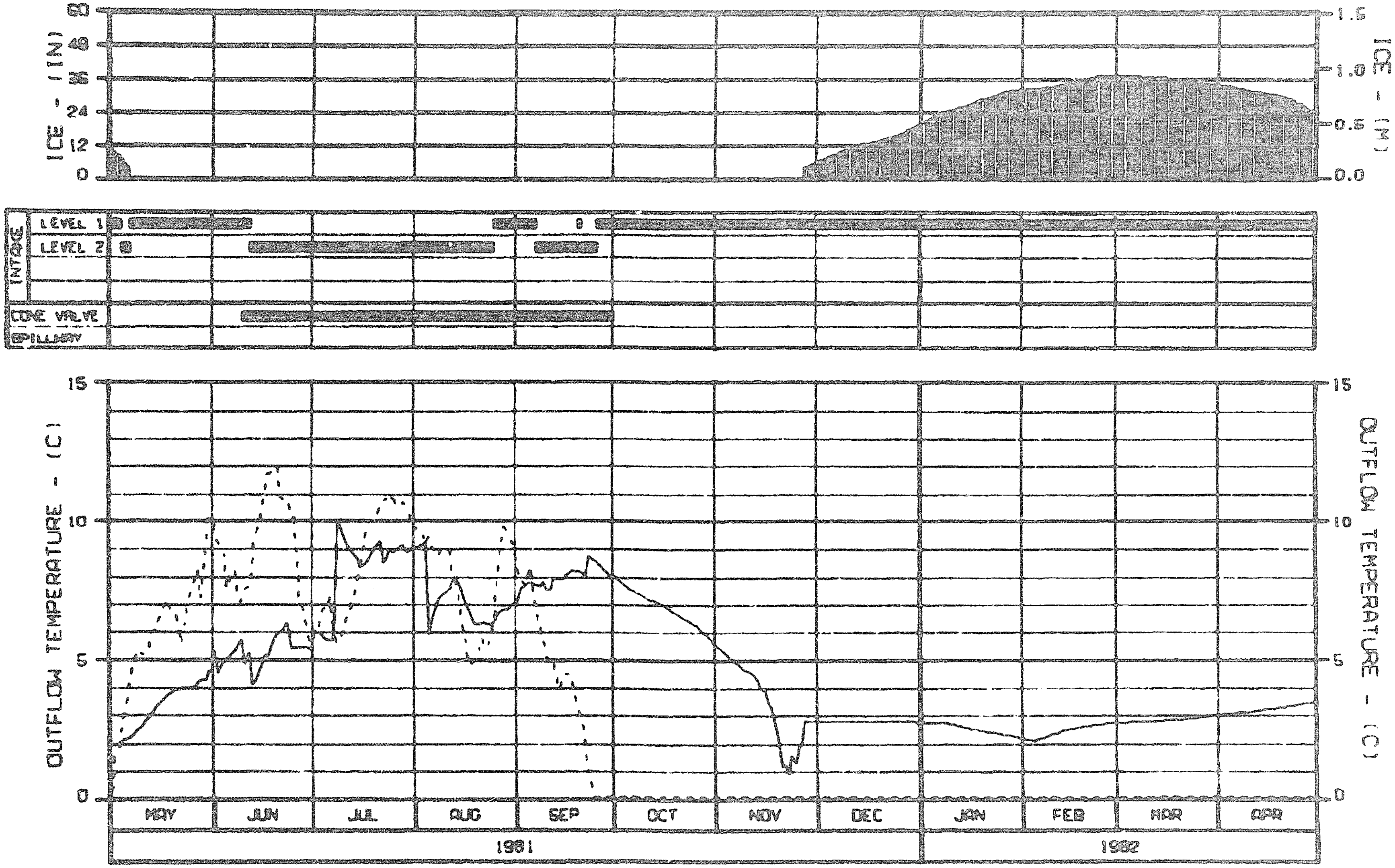


LEGEND: CASE: ** DC81200 - DEVIL CANYON OPERATION W/WATANA IN 2020 (CASE E-1)*

——— PREDICTED OUTFLOW TEMPERATURE
- - - - - INFLOW TEMPERATURE

NOTES: 1. INTAKE PORT LEVEL 1 AT ELEVATION 1426 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1376 FT (419.10 M)
3. CONE VALVE AT ELEVATION 990 FT (301.75 M)
4. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
DEVIL CANYON RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH	
HARZA-EBASCO JOINT VENTURE	
CHICAGO, ILLINOIS 29 MAR 85	42-010-04

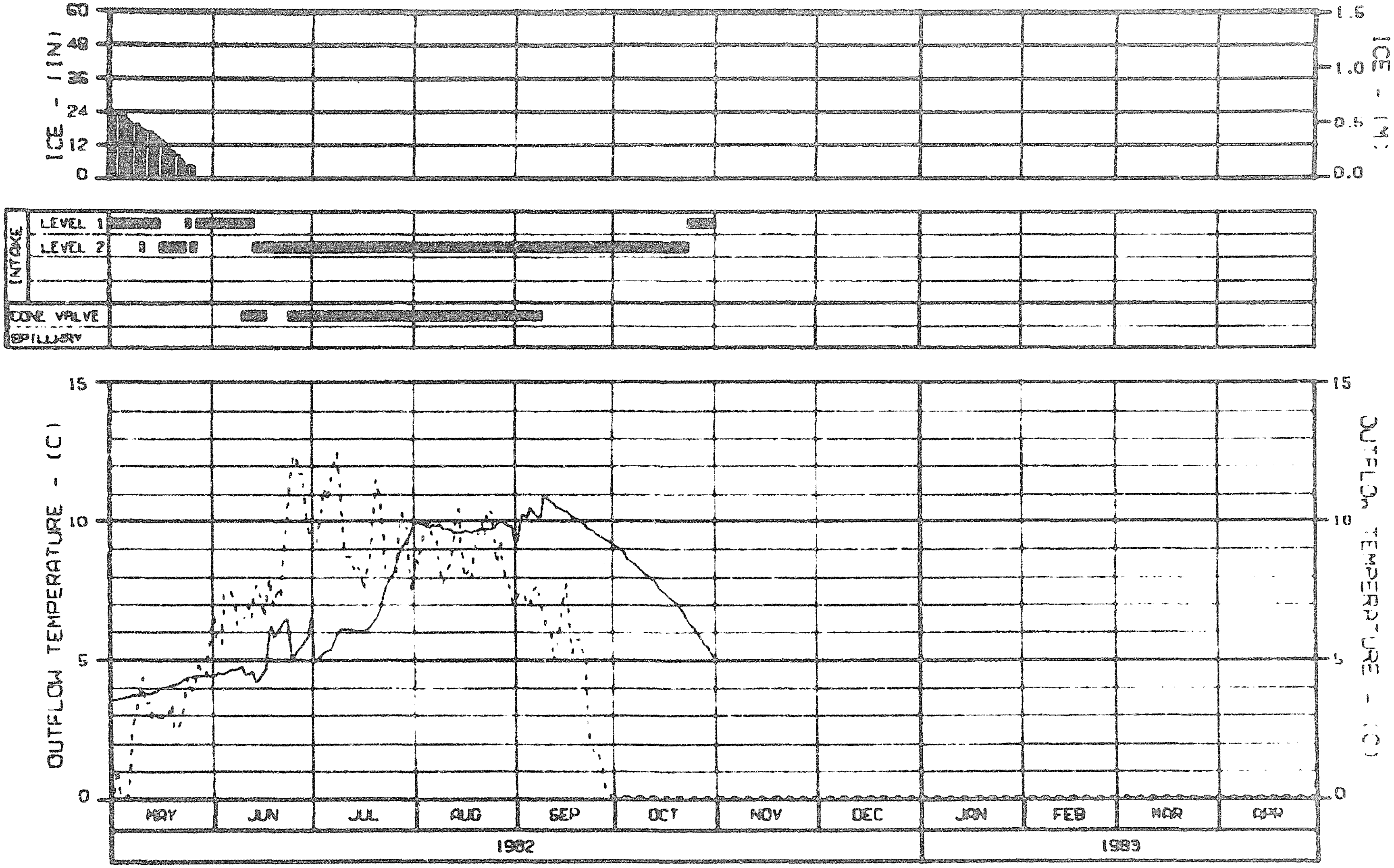


LEGEND: CASE: DC81200 - DEVIL CANYON OPERATION W/WATANA IN 2020 (CASE E-1)

——————— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 1425 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1375 FT (419.10 M)
3. CONE VALVE AT ELEVATION 990 FT (301.75 M)
4. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
DEVIL CANYON RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH	
HARZA-EBASCO JOINT VENTURE	
CHICAGO, ILLINOIS	42-010-04

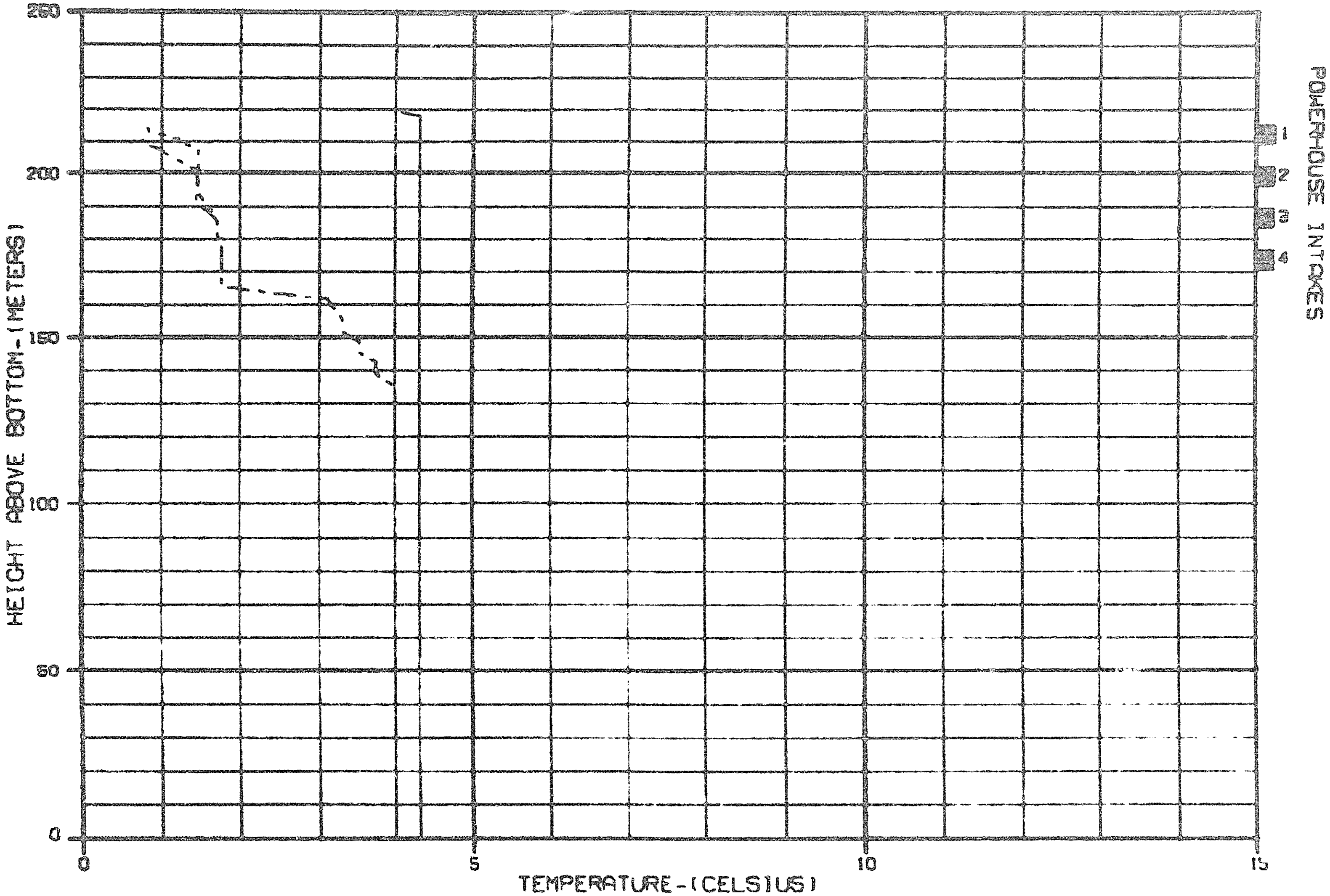


LEGEND: CASE: DC81200 - DEVIL CANYON OPERATION W/WATANA IN 2020 (CASE E-1)

——— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 1426 FT (434.34 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 1376 FT (419.10 M)
3. CONE VALVE AT ELEVATION 990 FT (301.76 M)
4. SPILLWAY CREST AT ELEVATION 1404 FT (427.94 M)

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
DEVIL CANYON RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH	
HARZA-EBASCO JOINT VENTURE	
CHICAGO, ILLINOIS	42-010-04



CASE: ** WA81200 - WATANA OPERATION W/DEVIL CANYON IN 2020 (CASE E-1) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 NOVEMBER 1980
- - - - - - -	1 DECEMBER 1980
— · — · —	1 JANUARY 1981

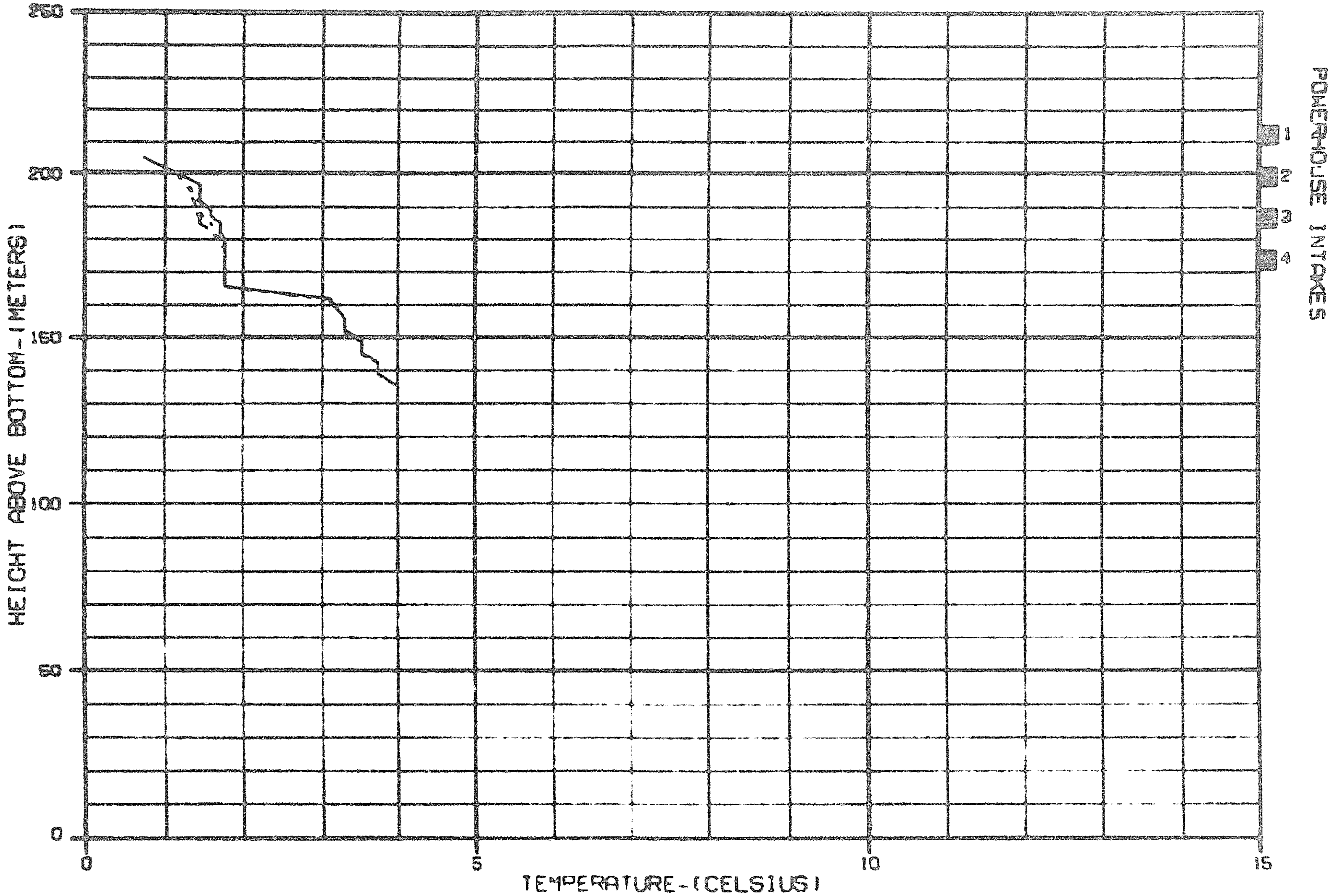
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 42-010-04



CASE: ** WA81200 - WATANA OPERATION W/DEVIL CANYON IN 2020 (CASE E-1) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————————	1 FEBRUARY	1981
· · · · · · · ·	1 MARCH	1981
— · — · —	1 APRIL	1981

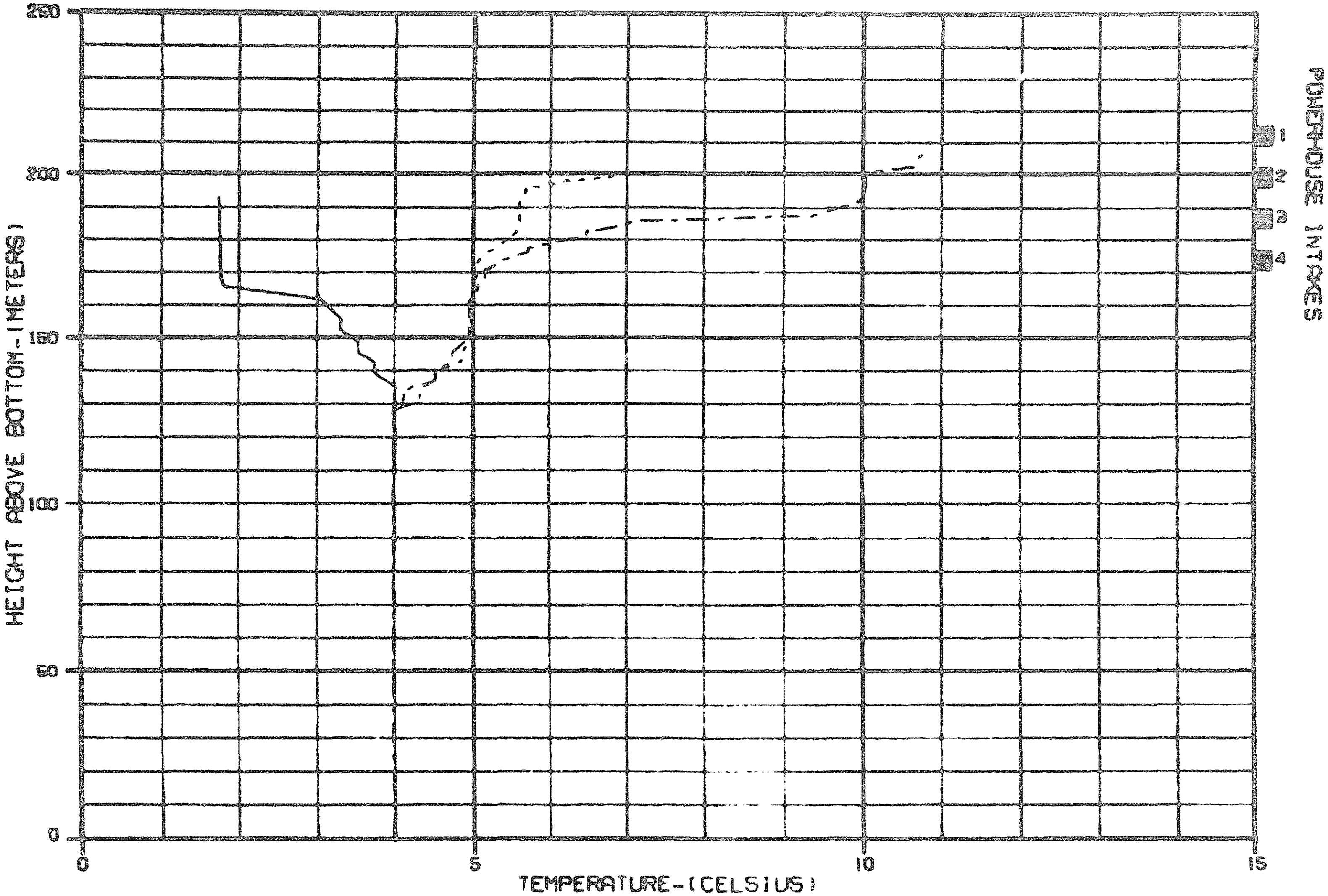
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

42-010-04



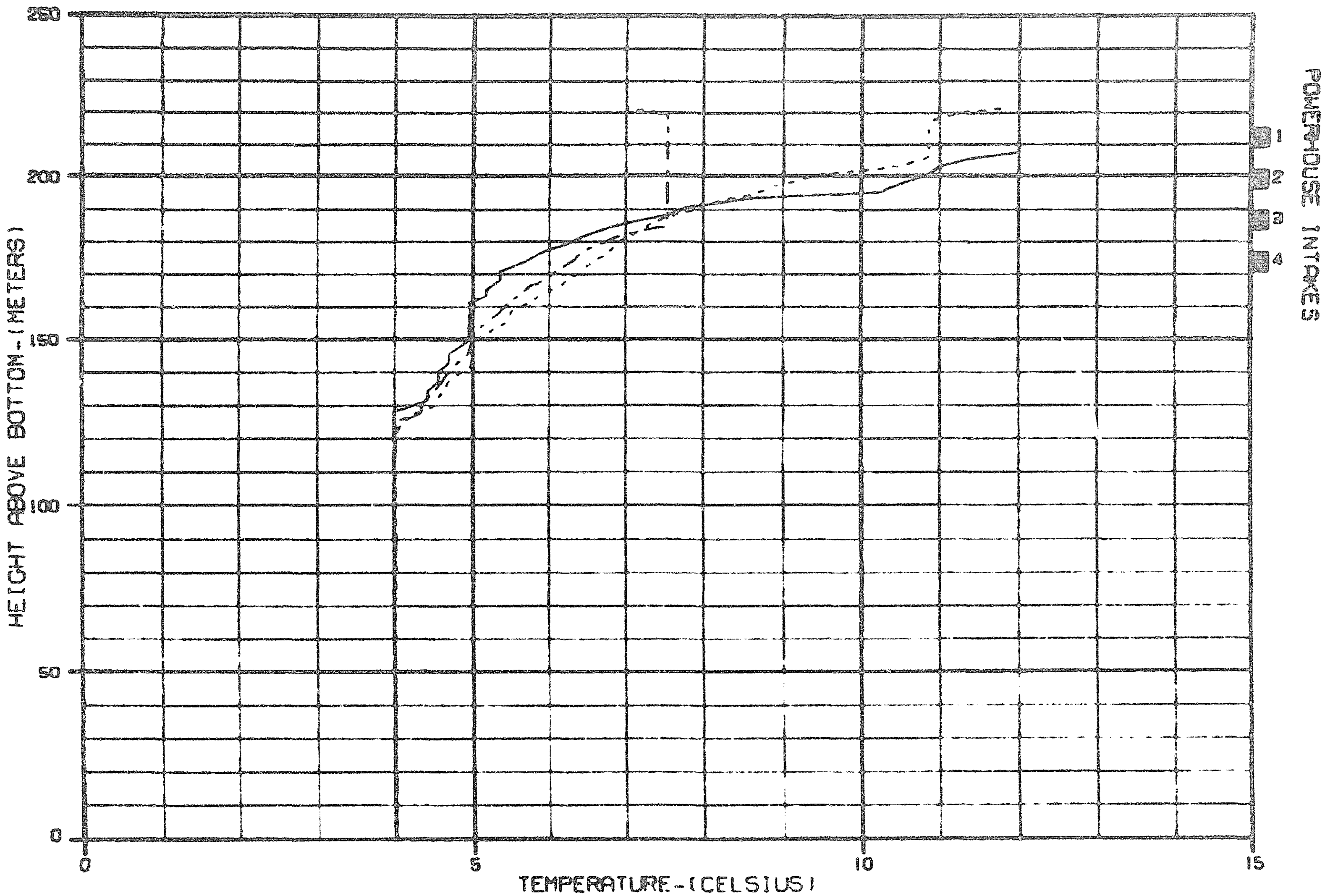
CASE: ** WA81200 - WATANA OPERATION W/DEVIL CANYON IN 2020 (CASE E-1) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————————	1 MAY 1981
- - - - - - - -	1 JUNE 1981
—·—·—·	1 JULY 1981

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
WATANA RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
[illegible]	42-010-04



CASE: WA81200 - WATANA OPERATION W/DEVIL CANYON IN 2020 (CASE E-1)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 AUGUST	1981
- - - - - -	1 SEPTEMBER	1981
— - — - —	1 OCTOBER	1981

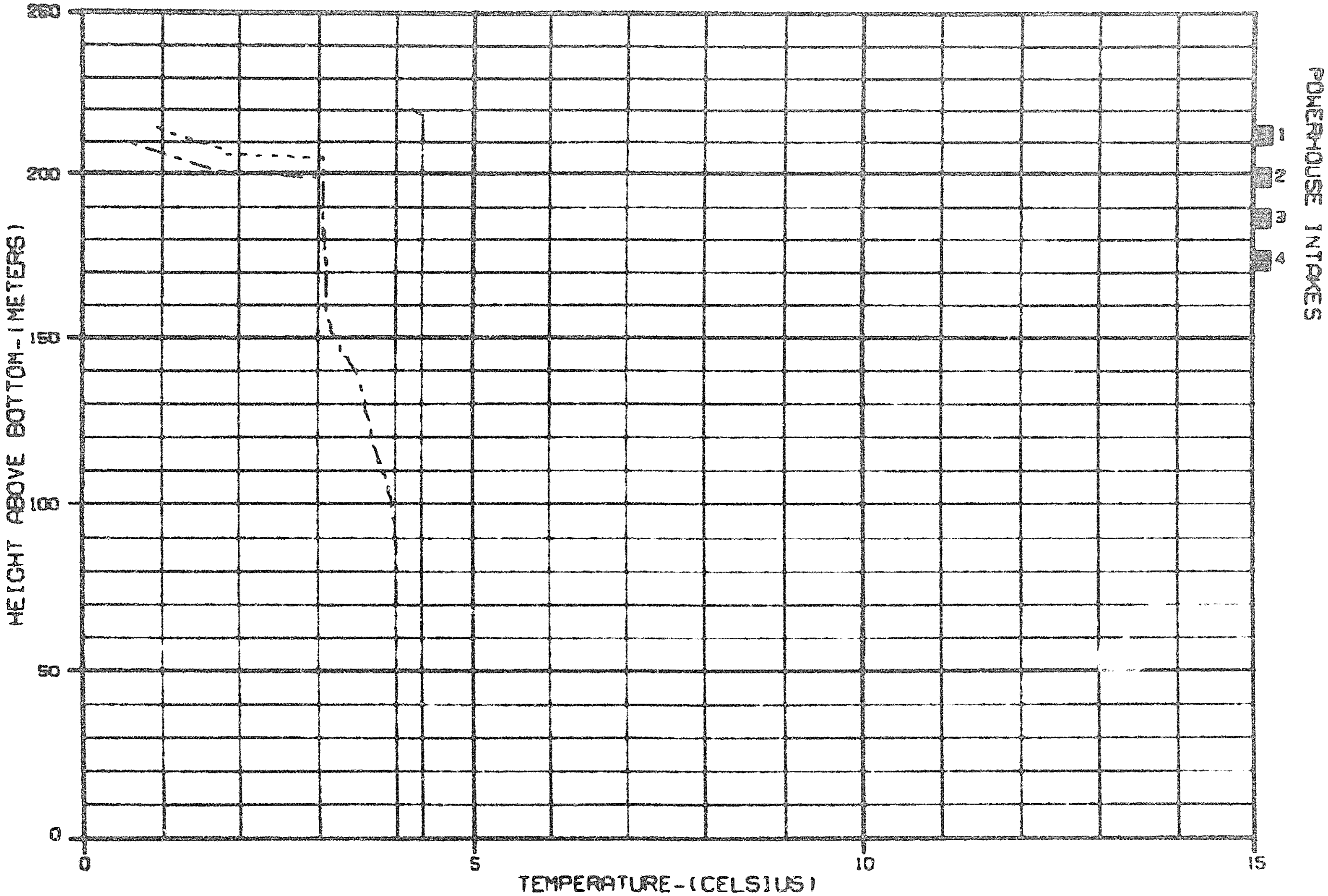
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 42-010-04



CASE: ** WA81200 - WATANA OPERATION W/DEVIL CANYON IN 2020 (CASE E-1) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 NOVEMBER 1981
········	1 DECEMBER 1981
— · — · —	1 JANUARY 1982

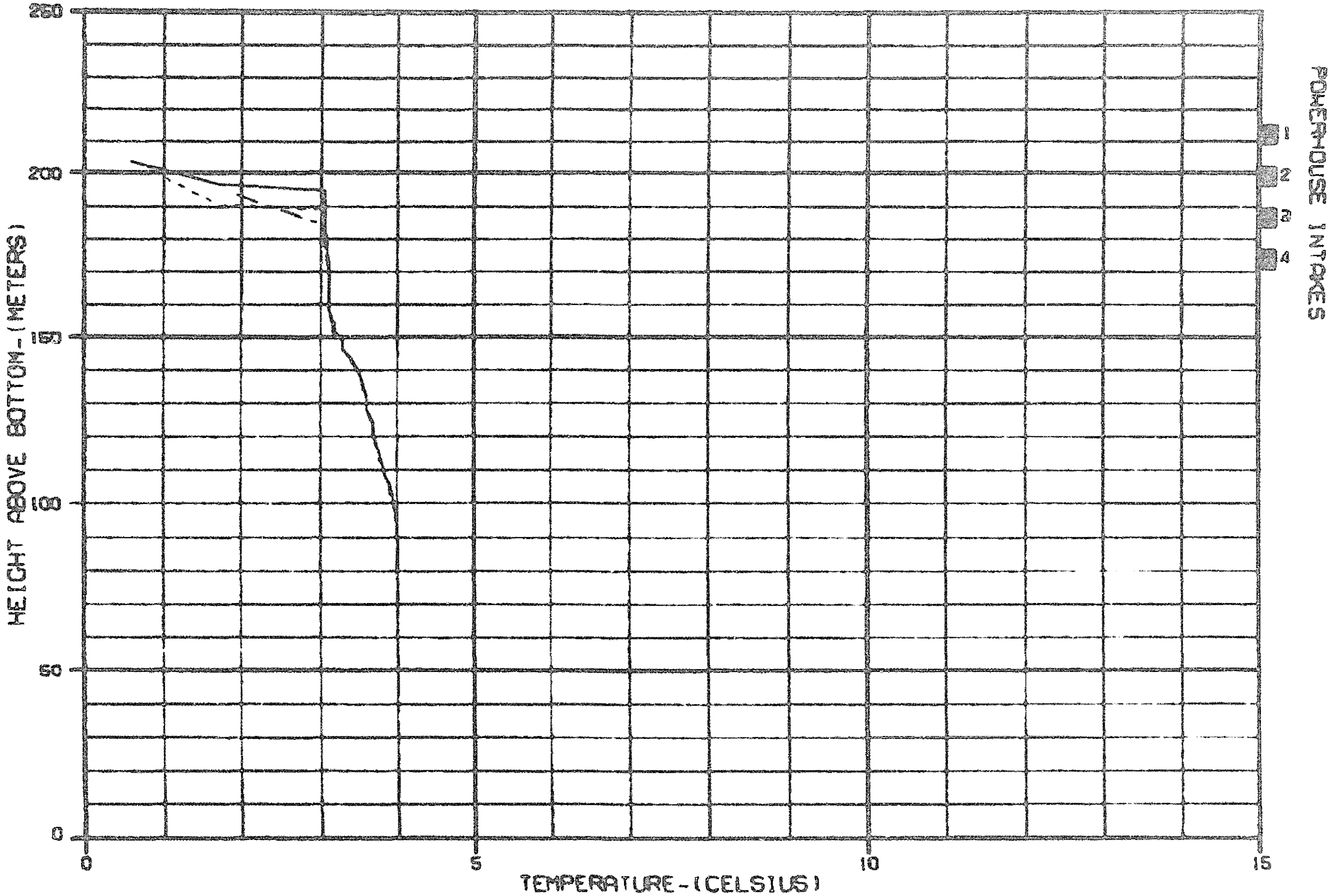
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | | 42-010-04



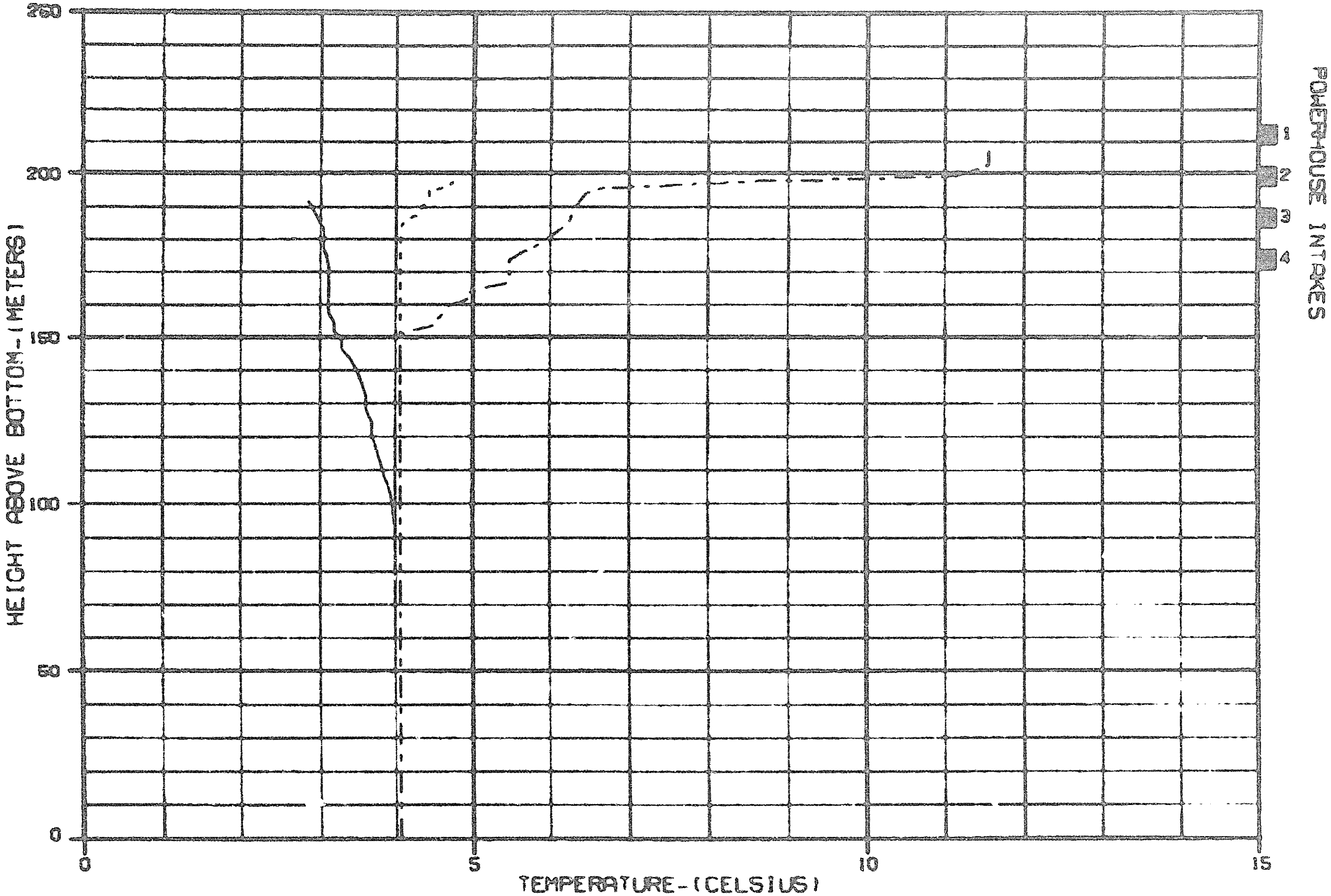
CASE: WAB120D - WATANA OPERATION W/DEVIL CANYON IN 2020 (CASE E-1)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

———————	1 FEBRUARY	1982
- - - - - - -	1 MARCH	1982
— - — - —	1 APRIL	1982

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
WATANA RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
	42-010-04



CASE: WA8120D - WATANA OPERATION W/DEVIL CANYON IN 2020 (CASE E-1)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

- ———— 1 MAY 1982
- - - - - 1 JUNE 1982
- —·—·— 1 JULY 1982

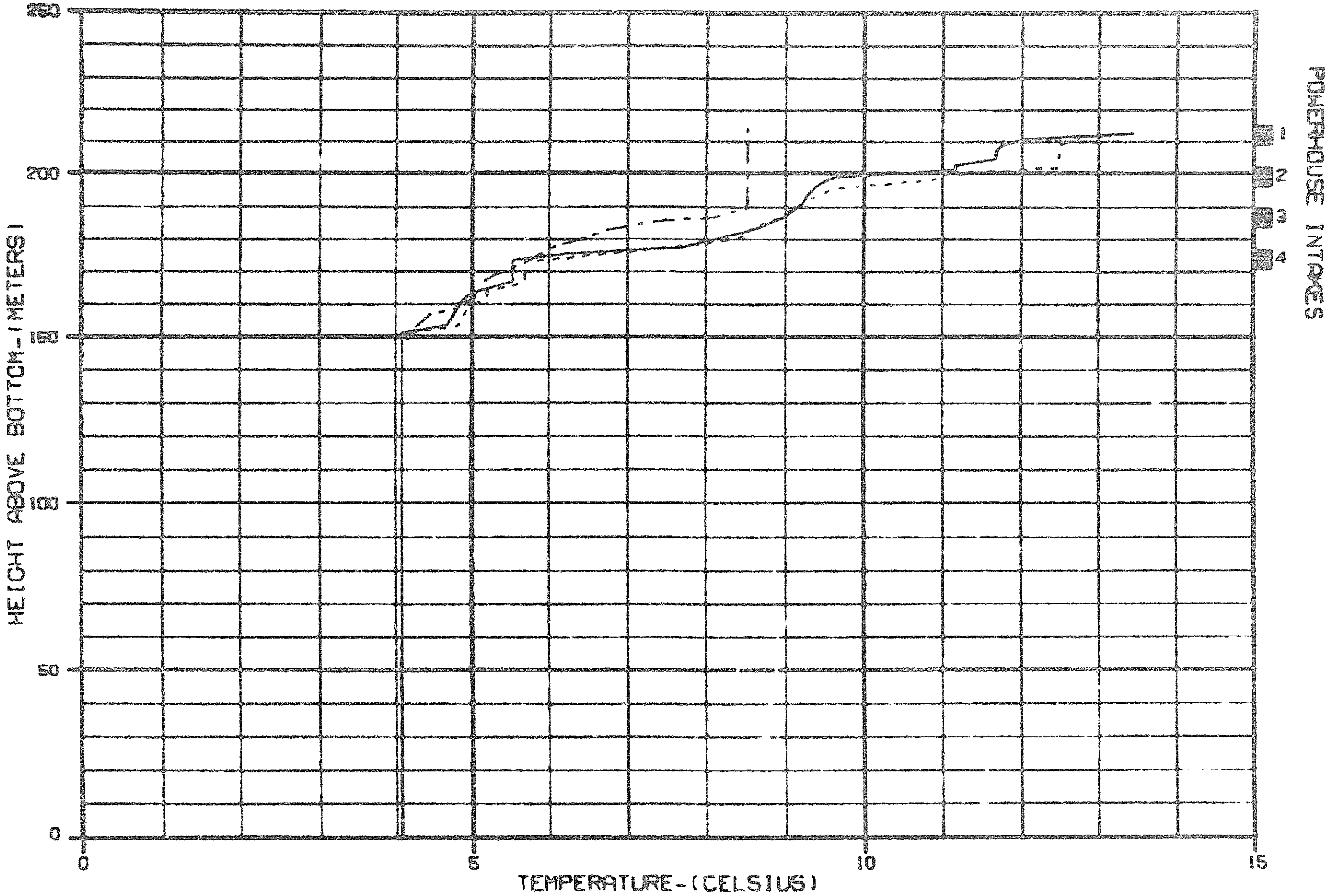
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS



CASE: ** WA8120D - WATANA OPERATION W/DEVIL CANYON IN 2020 (CASE E-1) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 AUGUST	1982
- - - - - -	1 SEPTEMBER	1982
— · — · —	1 OCTOBER	1982

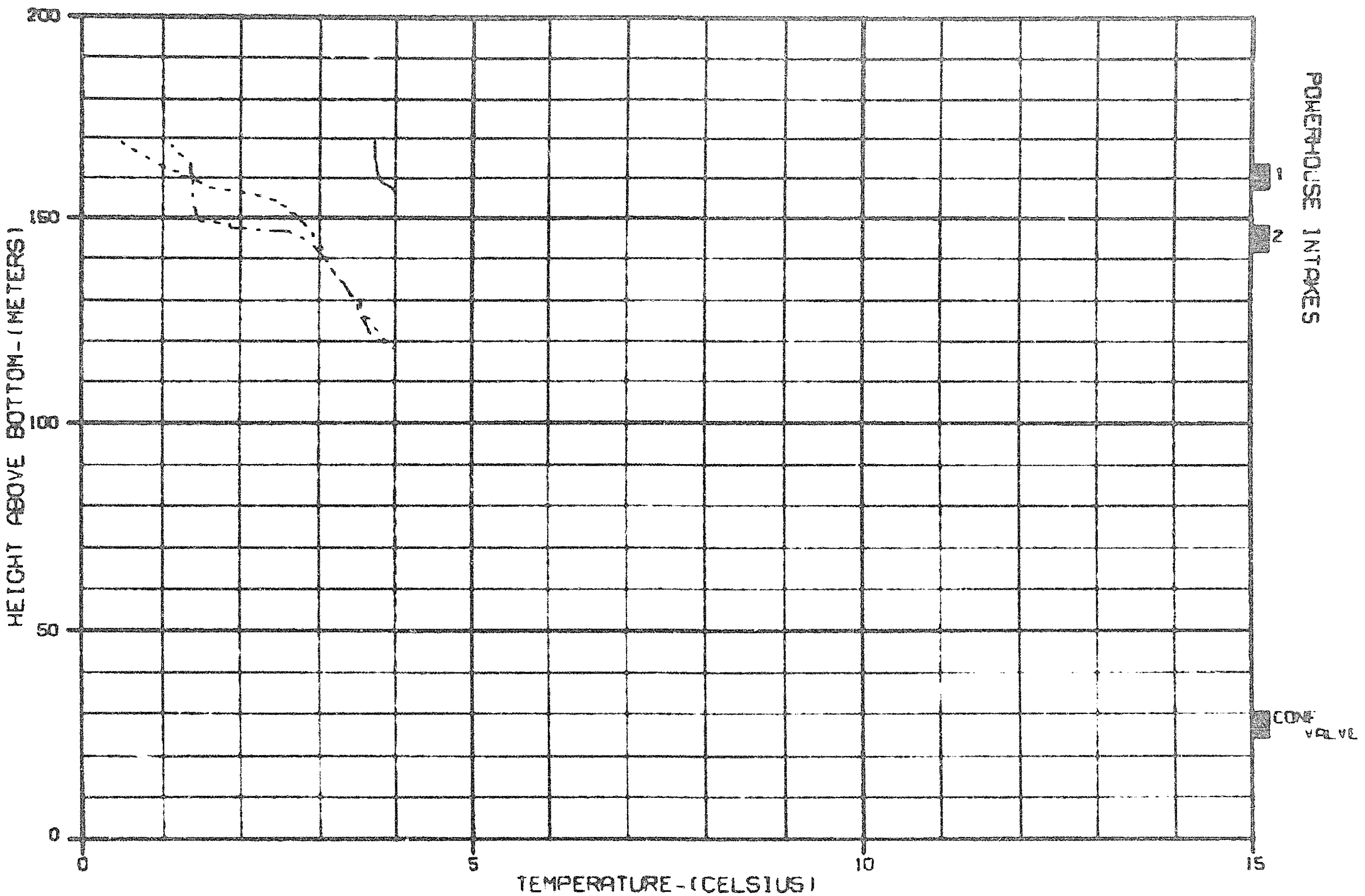
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 42-010-04



CASE: ** DC8120D - DEVIL CANYON OPERATION W/WATANA IN 2020 (CASE E-1) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

———— 1 NOVEMBER 1980

- - - - 1 DECEMBER 1980

—·—·— 1 JANUARY 1981

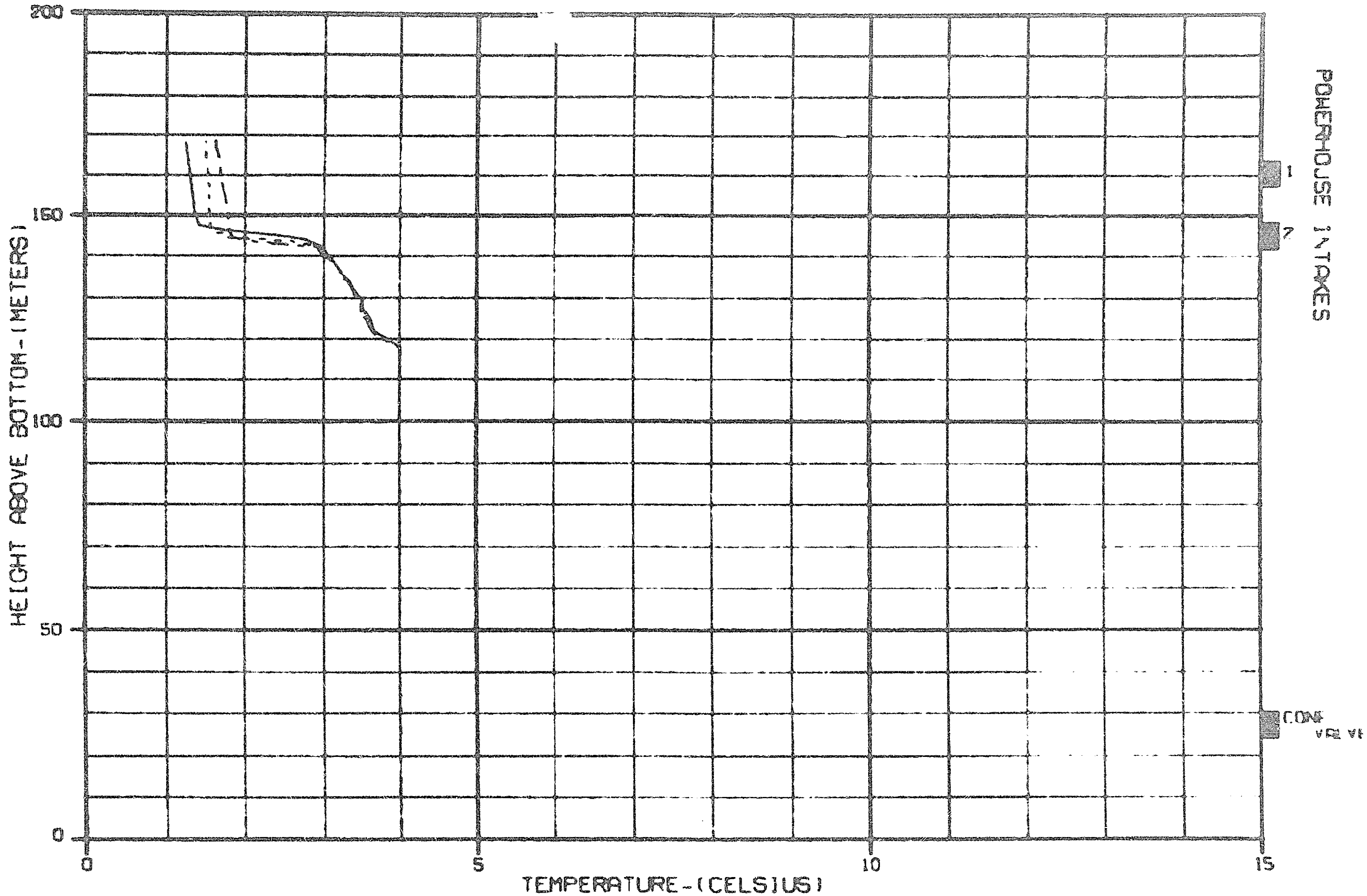
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 42-010-04



ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 42-010-04

CASE: ** DC8120D - DEVIL CANYON OPERATION W/WATANA IN 2020 (CASE E-1) **

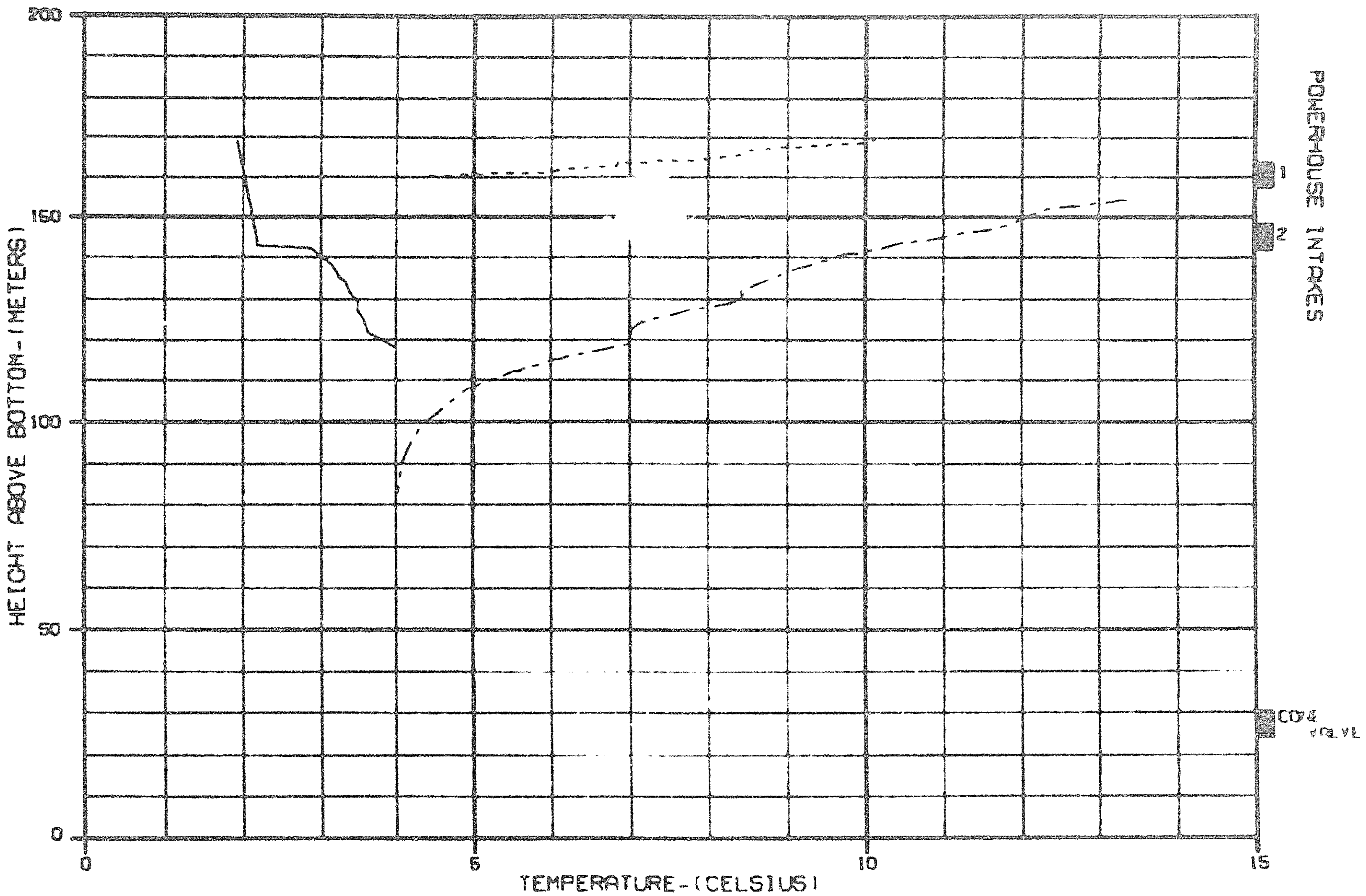
LEGEND:

PREDICTED TEMPERATURE PROFILES:

———— 1 FEBRUARY 1981

- - - - - 1 MARCH 1981

— - — - 1 APRIL 1981



CASE: DC81200 - DEVIL CANYON OPERATION W/WATANA IN 2020 (CASE E-1)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 MAY 1981
- - - - - -	1 JUNE 1981
— · — · —	1 JULY 1981

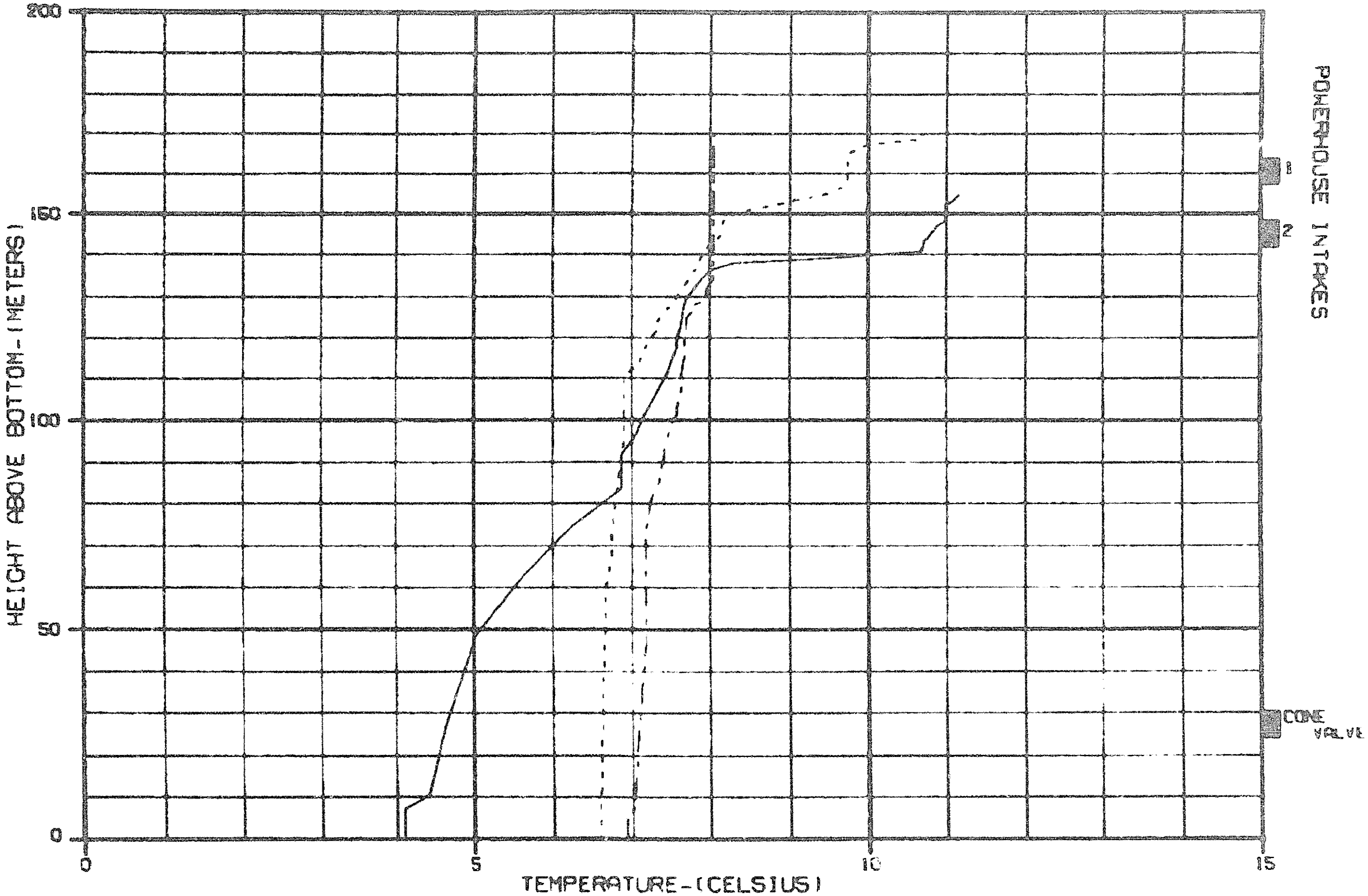
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 42-010-04



CASE: ** DC81200 - DEVIL CANYON OPERATION W/WATANA IN 2020 (CASE E-1) **

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 AUGUST	1981
- - - - - -	1 SEPTEMBER	1981
— - — - —	1 OCTOBER	1981

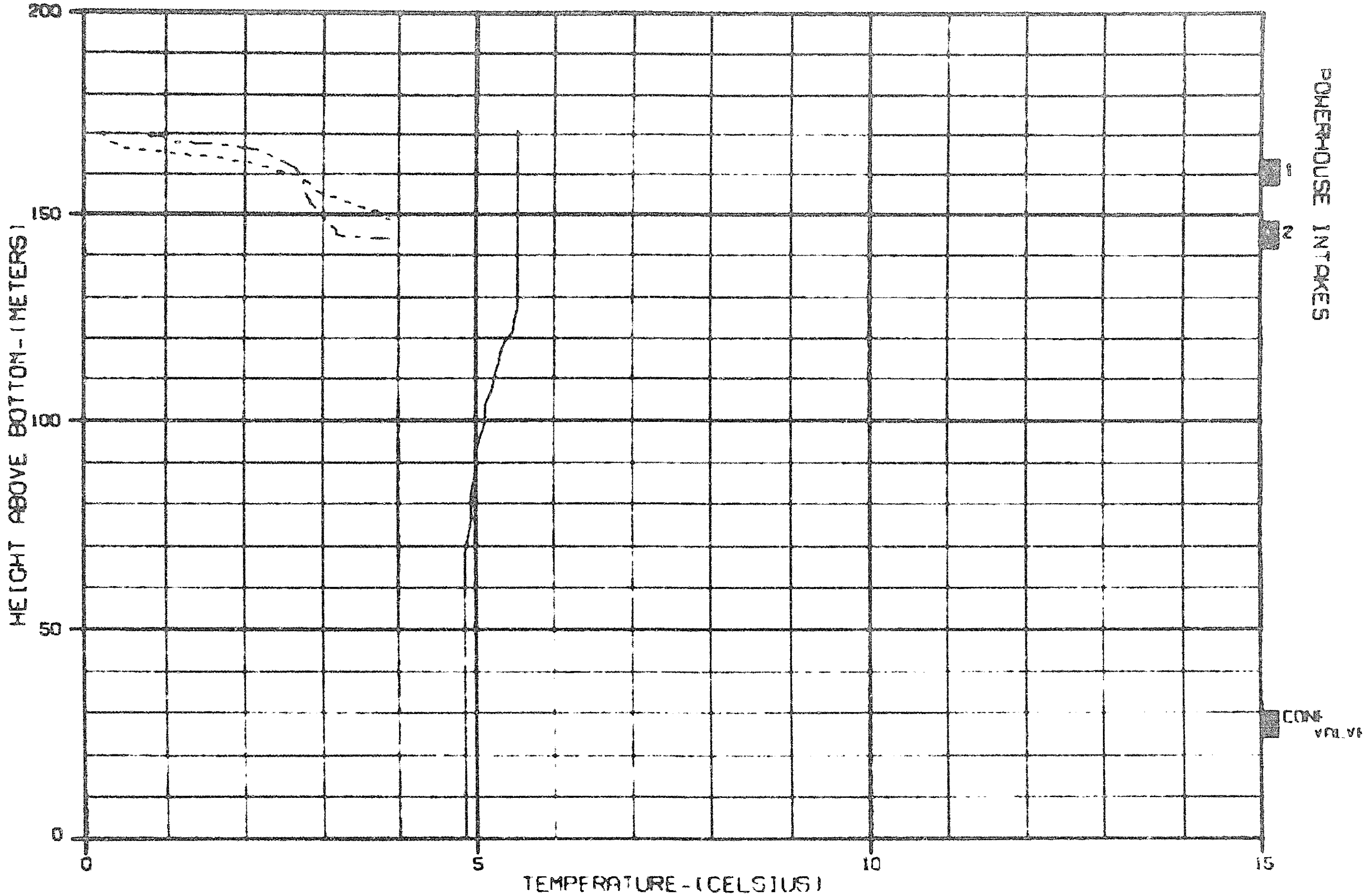
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR
TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | 67-010-04



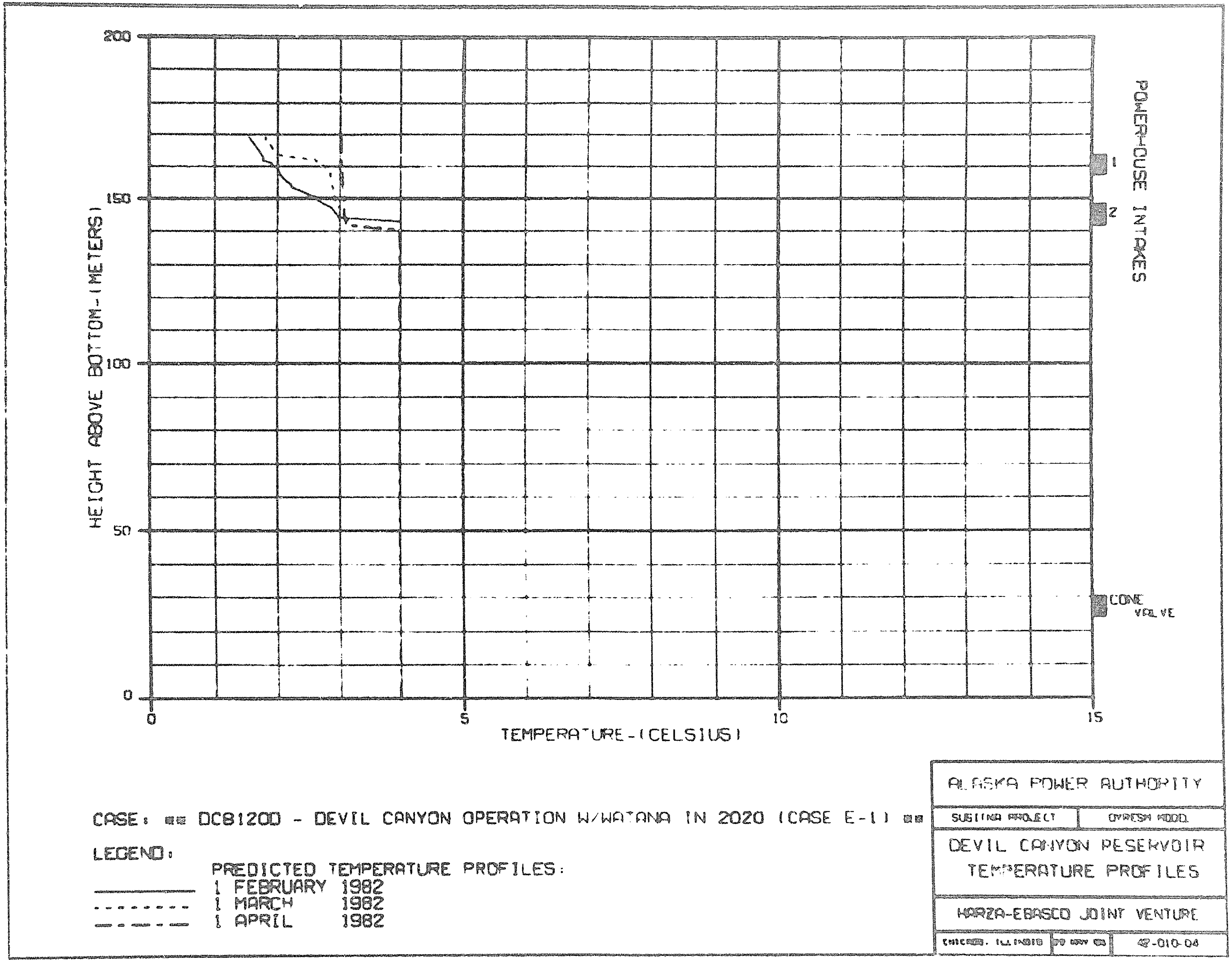
CASE: ** DC8120D - DEVIL CANYON OPERATION W/WATANA IN 2020 (CASE E-1) **

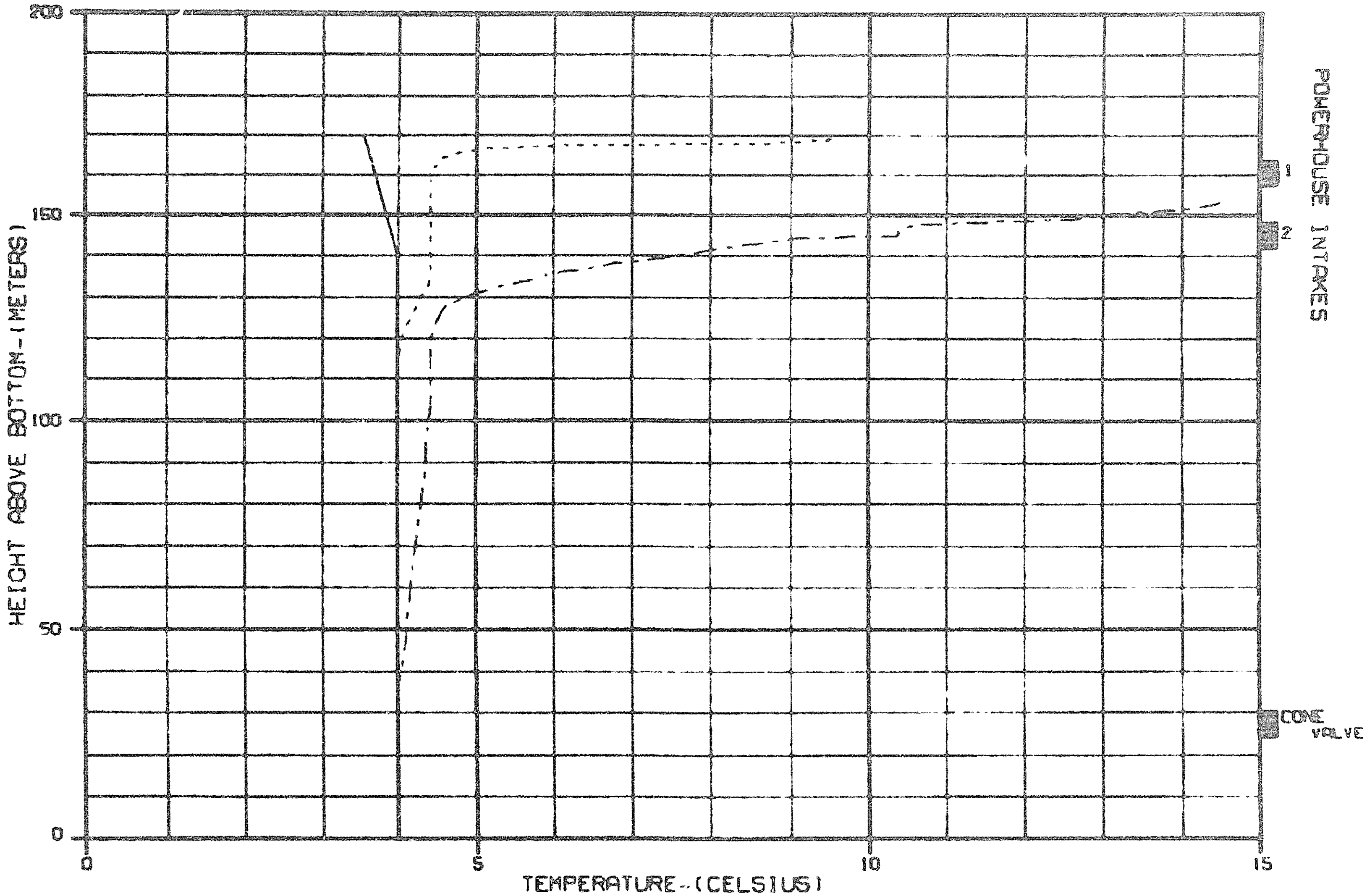
LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 NOVEMBER 1981
- - - - - -	1 DECEMBER 1981
— - — - —	1 JANUARY 1982

ALASKA POWE[illegible]HORITY	
SUSITNA PROJECT	[illegible] MODEL
DEVIL CANYON RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
CHICAGO, ILLINOIS [illegible]	47-010-04


200
150
100
50
0
HEIGHT ABOVE BOTTOM-(METERS)
0
5
10
15
TEMPERATURE-(CELSIUS)
POWER-HOUSE INTAKES
1
2
CONE VALVE
CASE: ** DC8120D - DEVIL CANYON OPERATION W/WATANA IN 2020 (CASE E-1) **
LEGEND:
PREDICTED TEMPERATURE PROFILES:
1 FEBRUARY 1982
1 MARCH 1982
1 APRIL 1982
ALASKA POWER AUTHORITY
SUSITNA PROJECT
DYRESM MODEL
DEVIL CANYON RESERVOIR TEMPERATURE PROFILES
HARZA-EBASCO JOINT VENTURE
CHICAGO, ILLINOIS
42-010-04



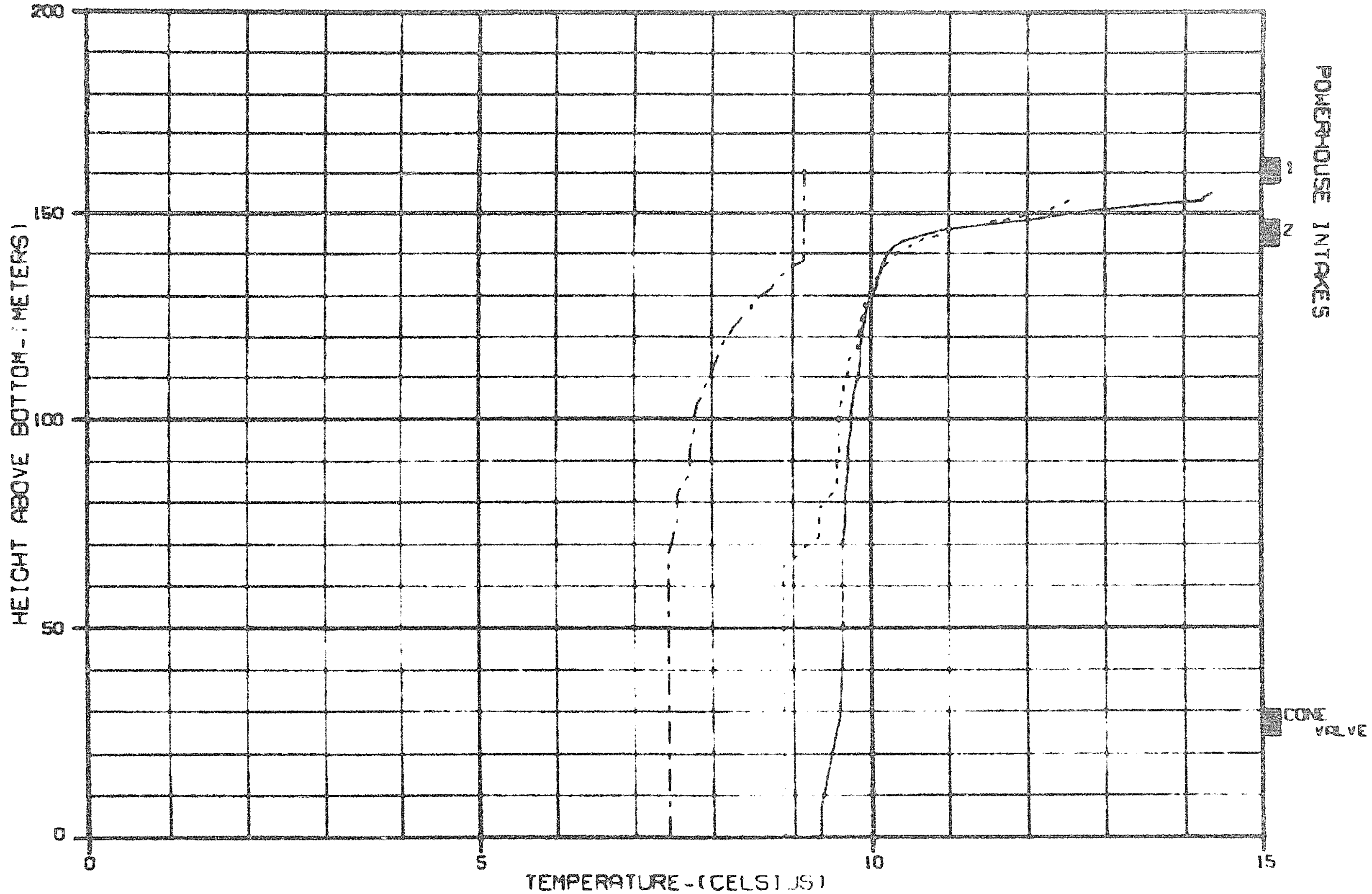
CASE: DC8120D - DEVIL CANYON OPERATION W/WATANA IN 2020 (CASE E-1)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————————	1 MAY 1982
- - - - - - - -	1 JUNE 1982
—·—·—	1 JULY 1982

ALASKA POWFR AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
DEVIL CANYON RESERVOIR TEMPERATURE PROFILES	
HARZA-EBASCO JOINT VENTURE	
CHICAGO, ILLINOIS [illegible]	82-010-04



CASE: DC8120D - DEVIL CANYON OPERATION W/WATANA IN 2020 (CASE E-1)

LEGEND:

PREDICTED TEMPERATURE PROFILES:

————	1 AUGUST	1982
- - - - - - -	1 SEPTEMBER	1982
— - — - —	1 OCTOBER	1982

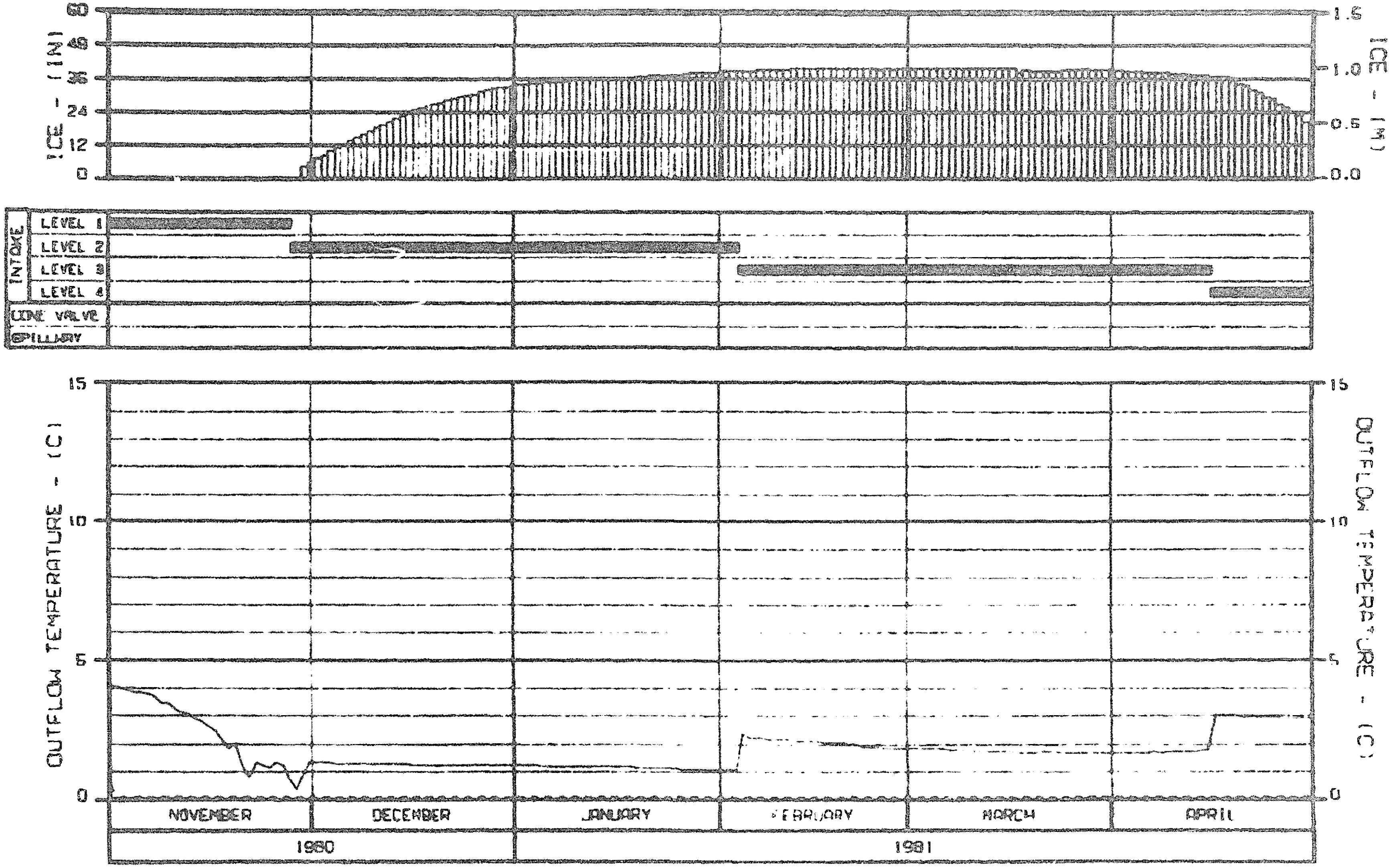
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

DEVIL CANYON RESERVOIR TEMPERATURE PROFILES

HARZA-EBASCO JOINT VENTURE

CHICAGO, ILLINOIS | [illegible] | 42-010-04



LEGEND: CASE: [illegible] WA8120E - WATANA OPERATION W/DEVIL CANYON IN 2020 (CASE E-6)

——————— PREDICTED OUTFLOW TEMPERATURE
- - - - - - - INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT LEVEL 1 AT ELEVATION 2183 FT (666 4 M)
2. INTAKE PORT LEVEL 2 AT ELEVATION 2109 FT (642 7 M)
3. INTAKE PORT LEVEL 3 AT ELEVATION 2066 FT (629 9 M)
4. INTAKE PORT LEVEL 4 AT ELEVATION 2024 FT (617 1 M)
5. CONE VALVE AT ELEVATION 1929 FT (598 0 M)
6. SPILLWAY CREST AT ELEVATION 2297 FT (700.0 M)

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	DYRESM MODEL
WATANA RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH	
HARZA-EBASCO JOINT VENTURE	
CHICAGO, ILLINOIS	[illegible]
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