FIELD TIDE NOTE
OPR-P132-DA-83
ORCA INLET, ALASKA

Predicted tides for Cordova, AK (Reference Station 945-4050) were used to reduce survey sounding data for OPR-P132-DA-83, the Basic Hydrographic Survey of Orca Inlet, to the Mean Lower Low Water (MLLW) chart datum.

ASCII and BINARY predicted tides tapes based on daily tidal predictions for Cordova were generated on the shipboard PDP8/e computer system using standard NOS software. Version 11/10/72 of AM500, "Predicted Tides Generator," was used to create paper tapes for field and processing use.

Height correction factors were applied to daily Cordova tidal predictions (times were applied direct on Cordova). Tide tapes incorporating the different height correction factors were applied to field sheets and final sounding plots in accordance with the zoning diagram outlined in the Project Instructions.

A correction factor of 0.94 was applied to Orca Inlet sounding data gathered on JD 159-182 and JD 205 for the area between one and six nautical miles SW of Spike Island. ✓

A factor of 0.90 was applied to soundings from the area between six and seventeen nautical miles SW of Spike Island, bordered on the north and south by Hawkins Island and Mummy Island, respectively. Hydrography in this area was run on JD 191-201.

A factor of 0.86 was applied to soundings from the area bordered by Mummy Island on the north, Egg Island on the south, and Point Whitshed and Cape Hinchinbrook on the east and west, respectively. Hydrography in this area was run on JD 191- 193.

Soundings in the Cordova Small Boat Harbor and along pier faces at St. Elias Ocean Products and North Pacific Processors were obtained by lead line, dead reckoning, and range azimuth methods. Soundings were reduced to MLLW using predicted tides based direct on Cordova. Velocity corrections were applied to echo soundings in the Small Boat Harbor.

CORDOVA (945-4050)

The Cordova tide station was the primary reference station used to control sounding data in Orca Inlet. The tide station

is located in a small building on the SE corner of the Municipal (Ferry) Dock approximately 0.8 n.mi. north of the city of Cordova. A Leupold-Stevens (L&S) analog to digital recording (ADR) tide gage operated continuously during the survey. DAVIDSON personnel inspected the station on 10 June 1983 and found the backup gage (Metercraft gas-purged type, S/N 7603715164) inoperative. It was replaced the same day with Bristol gage S/N 71A21485. A 3-hour gage acceptance test was performed on the Bristol gage on 13 June 1983. DAVIDSON divers inspected and cleaned the floatwell, orifice, and staff on 16 June 1983 (see attachment 1). LT. A. Snella, Chief, Pacific Tides Party (PTP) inspected the station on 27 June 1983, repaired the Metercraft gage and replaced the Bristol gage with the former.

The Cordova tide station is maintained by a contract observer, Mr. Jim Cunningham (P.O. Box 1139, Cordova, AK, 99574).

Levels were run from the Cordova tide staff to six permanent bench marks, including the primary bench mark, before and after hydrography. Third-order Class I results agreed favorably with DAVIDSON and PTP historic levels. Elevation differences between bench marks determined during the open and closing level runs of 5 June 1983 and 25 July 1983, respectively, differed by 0.005 m or less. There was no evidence of staff or crustal movement. It is recommended that a new primary bench mark be designated. To level to the present primary mark (BM No. 9, 1964) it is necessary to set up on a shakey (and usually congested) pier.

SHAG ROCK (945-4125)

The Shag Rock tide station was installed on 3 June 1983 to control hydrography in Orca Inlet south of Cordova and north of 60°23.5'N, as per Project Instructions. Shag Rock is located approximately 2.9 n.mi. WNW of Point Whitshed, 0.6 n.mi. ENE of Mummy Island Light, and 7.7 n.mi. SW of Cordova. The Shag Rock gage was mounted on a small rock step near the highest point of the rock, partially protected from the elements. The tide staff was mounted against the west side of the rock facing a heavily transited shallow channel into Orca Inlet. The staff was braced with lumber and guyed in place with wires secured to eyebolts set in bedrock.

The first gage installed at the site (S/N 67A16205) on 3 June 1983 failed to pass the acceptance test (5 June 1983). Oil was subsequently discovered in the constant pressure regulator. Replacement gage S/N 68A14940, installed on 6 June 1983, provided continuous good data through the remainder of the survey period. The gage required only infrequent time adjustments. On the basis of 26 staff to gage comparisons throughout the survey period including a mean value for the

3-hour gage acceptance test (7 June 1983), a marigram reading of 6.5 feet ± 0.1 (standard deviation) corresponds to a staff value of 0.0 feet.

Third-order Class I levels run before and after hydrography, on 3 June 1983 and 25 July 1983, respectively, were in excellent agreement with historic values. Elevation differences determined between bench marks on opening and closing level runs agreed exactly. There was no indication of staff or crustal movement.

The orifice for the Shag Rock gage was secured to the top of a 4.5 foot length of ½-inch iron rod driven about three feet into the sandy channel bottom. This was done to prevent the orifice from being covered by shifting sands. There was no evidence of the latter or of orifice movement. However, an unexplained anomaly was noted on the marigram between 0945-1430 UTC, 11 June 1983 (see Attachment 2). Staff-to-gage differences before and after the event are not significantly different, and gage performance appeared normal.

As per Change No. 3 to the Project Instructions, the requirement for leveling to five permanent bench marks was waived for the Shag Rock station in consideration of the small size of the rock and the close proximity of the existing bench marks. Accordingly, levels were run from the staff to the three historic marks and no additional marks were established. ✓

BOSWELL ROCK (945-4149)

A tide station was established at Boswell Rock to control hydrography in Orca Inlet south of 60°28.0'N as per Project Instructions. Boswell Rock is located approximately 6.8 n.mi. WSW of Point Whitshed, 4.5 n.mi. SW of Mummy Island Light, and 1.5 n.mi. NW of Point Bentinck on the west side of the entrance to Boswell Bay. The staff was installed on the SE tip of the island, mounted on a large and stable round-top boulder and guyed in place with wire secured to eyebolts set in the rock. The orifice was placed in the channel south of Boswell Rock, secured to a 15-lb. concrete anchor. The gage was set in the approximate center of the island, about ten feet above the Mean High Water (MHW) line and was well protected from the elements by a rock wall and boulders on three sides.

Gage S/N 68A14940 was installed on Boswell Rock on 4 June 1983. It was removed and reinstalled at Shag Rock on 6 June 1983 where it operated satisfactorily through the remainder of the survey. The Boswell replacement gage S/N 64A11033 passed a 3-hour acceptance test on 8 June 1983. This gage had previously been installed at Shag Rock, had malfunctioned and been repaired aboard ship (oil was found in the constant

pressure regulator). The gage operated satisfactorily through 13 June 1983. Based on 18 staff to gage comparisons, including three hours of comparisons at 12-minute intervals, a reading of 8.6 feet ± 0.1 corresponds to staff zero. On 13 June a shift in the staff to gage difference was noted. Five subsequent comparisons made between 13-18 June 1983 resulted in a mean value of 9.0 feet ± 0.1 equivalent to staff zero. The gage was replaced on the assumption it was malfunctioning. In reality, the orifice was probably disturbed by a fishing boat dragging anchor (see Attachment 3). Replacement gage S/N 64A11032 operated satisfactorily through completion of the survey with the exception that another abrupt shift in the mean staff to gage difference occurred on 9 July 1983. Based on 12 observations between 18 June-5 July 1983, a marigram value of 9.6 feet ± 0.05 corresponds to staff zero; based on 11 observations between 9 July-25 July 1983, a marigram value of 9.0 feet ± 0.1 feet corresponds to staff zero. The shift is attributed to a pen malfunction (see Attachment 4) as the gage appeared to function properly before and after the event. Another anomaly was noted on the Boswell Rock marigram (see Attachment 5). A curious rippling or undulating effect was observed, particularly at low tides, that persisted from 16 July 1983 (1900 UTC) to 18 July 1983 (0200 UTC). The effect was not seen before or after the stated times, and staff to gage differences before and after the event appeared normal.

Time constraints and adverse sea conditions precluded diver inspection of the gage orifices immediately prior to their removal. The Shag Rock orifice was not located; divers following the orifice tubing back from the gage reported the weighted tubing was deeply buried under sand. High current and poor visibility caused a cessation of the orifice recovery effort; the tubing was cut and the orifice abandoned. At Boswell Rock, the orifice was simply lifted from the bottom by hauling up on the tubing from a boat. The orifice came free from the anchor while lifting it off the bottom (apparently the wires securing it to the anchor had rusted through). It is possible that the wires had previously rusted through and the orifice was swaying with the currents, causing the anomalous rippling effect on the marigram. It is recommended that in future hydrographic operations involving temporary tide gage installations, visual inspections of anchored orifices be made by divers prior to orifice removal. Additional diver inspections could be made throughout the survey if marigrams exhibited unusual or anomalous features.

Opening levels were run at Boswell Rock on 4 June 1983 between the staff and five permanent tidal bench marks established by DAVIDSON in 1982. Levels closed within Third-order Class I standards but did not agree with the previous year's closing elevation differences for the leg between bench marks 4149C

and 4149D. The discrepancy probably arises from compensating misreads during the 1982 season (observations over approximately 100 m of open water are necessary to tie bench mark 4149C to 4149D). Elevation differences for the C-D leg determined on three independent level runs (4 June, 18 June, 25 July) agreed within 0.002 m. Elevation differences between the remaining bench marks on opening and closing level runs agreed within 0.004 m of each other and 1982 results. There was no evidence of staff or crustal movement.

The following table summarizes tide gage distribution during OPR-P132-DA-83:

Site and Reference Station Number	Location	Gage S/N	Period of Operation
Shag Rock (945-4125)	60°27.9'N 145°59.3'W	67A16205	3-6 June 1983
		64A11033	6 June 1983
		68A14940	6 June-25 July 1983
Boswell Rock (945-4149)	60°24.8'N 146°06.2'W	68A14940	4-6 June 1983
		64A11033	7-18 June 1983
		64A11032	18 June-25 July 1983

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Gage Problems

The DAVIDSON carried to Alaska six Bristol bubbler-type tide recording gages from Pacific Marine Center; five had varying amounts of oil in their constant pressure regulator. PTP was informed and immediately sent four replacement gages. Three of the latter also had oil in their constant pressure regulator, though they had apparently been examined prior to shipment. The following gages were received from PTP in oil-damaged condition: 73A231, 68A9335, 67A16209, 64A11033, 67A16205, 67A10294, 67A10292, 64A11032. As per PTP suggestions, several of the gages were repaired aboard DAVIDSON for immediate and backup use; the remainder were returned to PTP on 21 June 1983.

All gages were operated by DAVIDSON personnel and annotated in Universal Coordinated Time (UTC) except the contract-observer maintained Cordova gages which were kept on Alaska Standard Time (AST).

When abstracting hourly heights of tides from the marigrams, time errors were distributed linearly throughout the period between observations.

As observed during the 1982 field season, the marigrams from Shag Rock and Boswell Rock exhibited a characteristic flattening at the lower portion of the tidal cycle (see Attachments 6 and 7). The effect was not noticeable at high water. The orifices at both sites were set in channels with relatively unrestricted tidal flow. Since the gages appeared to function properly, the flattening effect is probably real and a function of the morphology of the tidal basin. The effect is probably only significant at low water when the extensive mud flats largely expose with consequent restriction to narrow channels of the tidal flow into and out of the basin. The flattening effect is more pronounced the lower the stage of the tide. When greater than 7-8 feet of water covered the orifices, the effect was not noticeable. At higher tides the mud flats cover and the restrictive effects of channels on tidal flats are minimized, hence the upper portion of the tide curves appear normal.

The times of tidal extrema were compared for Shag Rock and Boswell Rock to determine if any differences existed. Thirty-three differences were taken between actual times of high and low tides at each station, from the scaled and abstracted hourly heights of tides (NOAA Form 77-29) for each station between 9 June-11 July 1983. The mean difference between 17 times of low tides at Shag Rock and Boswell Rock was 3.4 ± 7.2 minutes, i.e. low tides at Boswell generally occur slightly earlier than at Shag. The mean difference between 16 times of high tides at Shag Rock and Boswell Rock was 3.4 ± 7.7 minutes, i.e. high tides at Boswell generally occur slightly earlier than at Shag. The closer proximity of Boswell Rock to the Gulf of Alaska and relatively unimpeded tidal flow into Orca Inlet through Strawberry Channel may account for the slight time differences.

Respectfully submitted,

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Approved and forwarded,

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b. Tide level values are from observed tides, see Form 712.