MEMO

From: D.W. Beaver

To: E.J. Gemperline

Slough Discharge Regression Relations

October 12, 1984

HARZA-EBASCO SUSITNA JOINT VENTURE

INTRA-OFFICE MEMORANDUM

LOCATION Denver/Anchorage DATE Oct. 12, 1984

TO E.J. Gemperline NUMBER

FROM D.W. Beaver

SUBJECT Slough Discharge Regression Relations

In our continuing review of Susitna slough groundwater conditions, we have reexamined statistical relations between slough discharge and other hydraulic parameters (mainstem discharge, mainstem stage, and mainstem stage minus slough stage). In performing these revised calculations, we have used slough discharge data provided by R&M Consultants, mainstem discharge data provided by the U.S. Geological Survey, and stage-discharge relations at selected cross sections inferred from rating curves given in the Harza-Ebasco draft report entitled "Susitna Hydroelectric Project, Lower Susitna River, Water Surface Profiles and Discharge Rating Curves", dated October, 1983.

The derived relationships are summarized on Attachment 1 (slough discharge vs. mainstem discharge), Attachment 2 (slough discharge vs. mainstem stage), and Attachment 3 (slough discharge vs. head difference). In general, these relationships differ but little from relationships previously presented. The differences that do appear can be attributed to minor corrections in the data base, as well as the use of rating curves at different river cross sections.

Some general comments can be made. Regression relations using all values generally have a higher coefficient of determination (R^2) than those which exclude dates when upstream berms were overtopped. This is to be expected, since the sloughs will behave essentially as side channels under overtopping conditions. However, in many instances the correlations are improved when both dates of overtopping and dates when slough discharge is relatively high are excluded, particularly at sloughs 8A and 9. This suggests that other sources, such as localized surface runoff, can be important contributors to slough discharge at some sloughs, such as 8A and 9. (Note that excluding dates when slough discharge is relatively high tends to dramatically increase R^2, while resulting in relatively little change in the slope of the regression line.) Furthermore, these refined analyses confirm previous conclusions regarding the apparent uniqueness of each of the four sloughs studied in detail so far. It remains unlikely that any general relationships applicable to all sloughs can be developed.

The relationships presented in the Attachments should be applied with caution. They are not necessarily accurate predictors of absolute slough discharge under all flow conditions. However, the slopes of the regression lines with higher R^2 values may provide reasonably accurate order of magnitude estimates of changes in apparent groundwater upwelling over the ranges in flow considered. Thus, the indicated relationships may be accurate predictors of relative changes in groundwater upwelling with changes in other parameters, if not accurate predictors of absolute slough discharge.

cc: B.H. Wang, Harza, Chicago
S.O. Simmons, Ebasco, Seattle

ATTACHMENT 1. LINEAR REGRESSION EQUATIONS
FOR SLOUGH DISCHARGE VS. MAINSTEM DISCHARGE

SLOUGH	YEAR	REGRESSION EQUATION	R^2	COMMENTS
8A	1983	S = -3.83 + 0.000526 G	0.103	All values
		S = 5.10 + 0.0000377G	0.001	Excluding overtopping flows, G > 30,000
		S = 0.155 + 0.000117 G	0.086	June 6 - Aug. 7 only; excluding G > 30,000
		S = -0.627 + 0.000128 G	0.631	June 6 - Aug. 7 only; excluding G > 30,000, S > 3
9	1983	S = -149.7 + 0.010008 G	0.264	All values
		S = 2.94 + 0.000307 G	0.089	Excluding overtopping flows, G > 16,000
		S = 1.97 + 0.000351 G	0.805	Excluding G > 16,000, S > 8
11	1983	S = 1.51 + 0.000102 G	0.766	All values
	1982	S = 2.15 + 0.000104 G	0.504	All values
21	1982	S = -7.62 + 0.00105 G	0.543	All values
		S = - 0.570 + 0.000445 G	0.405	Excluding overtopping flows, G > 24,700
		S = -2.71 + 0.000803 G	0.916	Sept. 22 - Oct. 22 only; excluding G > 24,700

Notes: S = Slough discharge, cfs; G = Mainstem discharge at Gold Creek, cfs

ATTACHMENT 2. LINEAR REGRESSION EQUATIONS FOR SLOUGH DISCHARGE VS. MAINSTEM STAGE

SLOUGH	YEAR	REGRESSION EQUATION	R^2	COMMENTS
8A	1983	$S = -2149.8 + 3.698W_1$	0.065	All values
		$S = -92.3 + 0.1683W_1$	0.000	Excluding overtopping flows, G>30,000
		$S = -695.45 + 1.1966W_1$	0.091	June 6 - Aug. 7 only; excluding G>30,000
		$S = -740.96 + 1.2737W_1$	0.626	June 6 - aug. 7 only; excluding G>30,000, S>3
9	1983	$S = -32,801 + 54.380W_2$	0.228	All values
		$S = -769.1 + 1.2871W_2$	0.085	Excluding overtopping flows, G>16,000
		$S = -877.21 + 1.4658W_2$	0.755	Excluding G>16,000, S>8
11	1983	$S = -367.04 + 0.54004W_3$	0.783	All values
	1982	$S = -327.05 + 0.48278W_3$	0.531	All values
21	1982	$S = -4400.2 + 5.8554W_4$	0.491	All values
		$S = -1810.6 + 2.4130W_4$	0.391	Excluding overtopping flows, G>24,700
		$S = -3244.1 + 4.3212W_4$	0.938	Sept. 22 - Oct. 22 only; excluding G>24,700

Notes: S = Slough discharge, cfs; G = Mainstem dischrage at Gold Creek, cfs
W_1 = Mainstem stage at RM 127.1, ft.; W_2 = Mainstem stage at RM 129.3, ft.;
W_3 = Mainstem stage at RM 136.68, ft.; W_4 = Mainstem stage at RM 142.2, ft.

ATTACHMENT 3. LINEAR REGRESSION EQUATIONS
FOR SLOUGH DISCHARGE VS. HEAD DIFFERENCE

SLOUGH	YEAR	REGRESSION EQUATION	R^2	COMMENTS
8A	1983	$S = -11.2 + 1.25\ \Delta H$	0.007	All values
		$S = 26.1 - 1.39\ \Delta H$	0.027	Excluding overtopping flows, $G > 30,000$
		$S = -6.26 + 0.603\ \Delta H$	0.021	June 6 - Aug. 7 only; excluding $G > 30,000$
		$S = -17.3 + 1.31\ \Delta H$	0.564	June 6 - Aug. 7 only; excluding $G > 30,000$, $S > 3$
9	1983	$S = -158 + 19.8\ \Delta H$	0.011	All values
		$S = -0.187 + 0.670\ \Delta H$	0.021	Excluding overtopping flows, $G > 16,000$
		$S = -9.22 + 1.53\ \Delta H$	0.720	Excluding $G > 16,000$, $S > 8$
11	1983	$S = -4.74 + 0.550\ \Delta H$	0.771	All values
	1982	$S = -3.23 + 0.483\ \Delta H$	0.519	All values
21	1982	$S = -35.9 + 5.60\ \Delta H$	0.296	All values
		$S = -11.4 + 2.19\ \Delta H$	0.270	Excluding overtopping flows, $G > 24,700$
		$S = -30.5 + 5.11\ \Delta H$	0.910	Sept. 22 - Oct. 22 only; excluding $G > 24,700$

Notes: S = Slough discharge, cfs; G = Mainstem discharge at Gold Creek, cfs
ΔH = Mainstem stage minus slough stage