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HYDRAULIC MODEL STUDY
ROZA FISH SCREEN, WASHINGTON

BY

PETER JULIUS

PERRY L. JOHNSON

PAP-500

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Memorandum

To: Regional Director, Boise, Idaho
Attention: PN-200, PN-700

From: ACTING Chief, Division of Research and Laboratory Services

Subject: Model Study for Roza Canal Fish Screen Structure - Yakima Project Washington

A report describing the findings of the Roza Canal Fish Screen Structure Hydraulic Model Study is enclosed. As a result of the model study, significant changes were made to the preliminary design of the structure. Structure features were modified to eliminate back eddy and slack water zones, the configuration of the approach to the bypass was modified to improve the velocity distribution approaching the bypass intakes, and it was confirmed that flow patterns through the drum screens were acceptable (within the guidelines established by the fishery agencies) for all potential operating situations. Ken Bates of the Washington Department of Fisheries and Bob Pearce of the National Marine Fisheries Service will be sent copies of this model study report.

GPO 852320

H. Walter Anderson

Enclosure

Copy to: Project Superintendent, Yakima, Washington
(with enclosure)

Blind to: D-241 (Green)
D-270
D-274
D-274 (Starbuck)
D-274 (Edwards)
D-1530
D-1531
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(with enclosure to each)

PLJohnson:flh

HYDRAULIC MODEL STUDY
ROZA FISH SCREEN, WASHINGTON

By

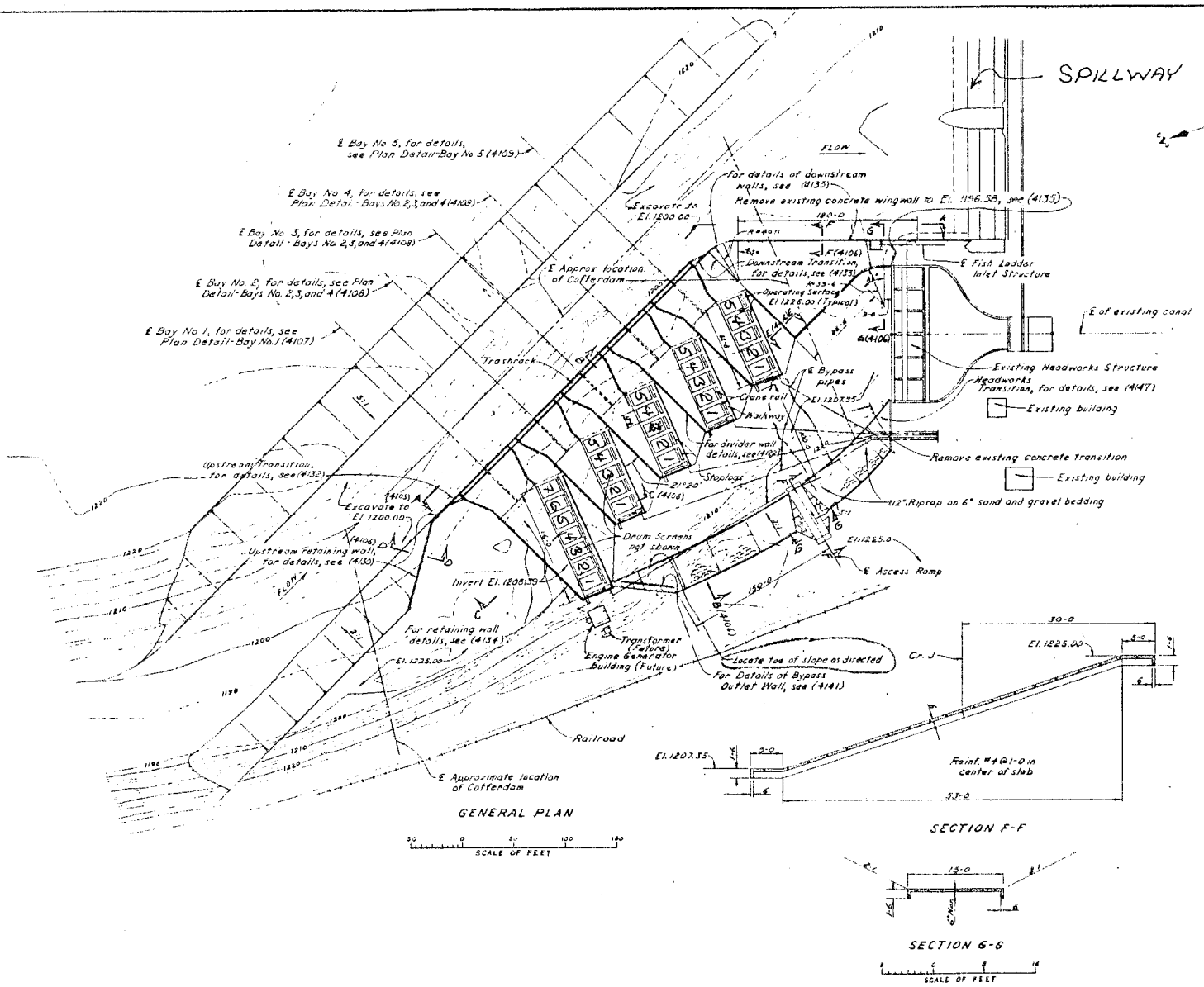
P. Julius and P. L. Johnson

This model study was conducted to optimize and verify the hydraulic performance of a replacement fish exclusion structure for the Roza Canal, Washington State. The structure will intercept downstream migrating juvenile salmon and prevent them from entering the canal. The structure will concentrate and transport the fish around the diversion dam and back to the river by means of a bypass structure. The study was conducted by the Hydraulics Branch of the Engineering and Research Center with review and comments from engineers of the Water Conveyance Branch and from representatives of the National Marine Fisheries Service, the Washington State Department of Fisheries, the Yakima Irrigation District, the Yakima Indian Nation, and the Pacific Northwest Regional Office and the Yakima Project Office of the Bureau of Reclamation.

I. Site and Structure Description

The proposed design consisted of a five bay drum screen structure located in the diversion pool at the headworks of the Roza Canal (figure 1). Roza Canal is an irrigation and power canal which receives water diverted from the Yakima River. The maximum canal discharge is 2,200 ft^3/s. The structure draws water directly from the diversion pool, which has a limited volume (figure 1) and cannot be considered an infinite reservoir. Depending on operating conditions, pronounced velocities will occur at some locations in the diversion pool. For example, if a larger spill is occurring at the dam and maximum discharges are being diverted, substantial flow bypassing the entrance to the screen structure will result (figure 2). In cases where no or limited spill is occurring, but diversion is high, pronounced passing flow (flow passing the bay entrance) with velocities of 1 to 2 ft/s will occur in front of the first of the five bays (the seven-drum bay). The magnitude of these passing flows would decrease from bay to bay down the structure until, for the last bay, withdrawal would be from a fairly quiet low velocity zone (figure 2). Finally, if no spills are occurring and if limited diversions are being made, velocities in the diversion pool could be quite low and the pool might be considered as a large reservoir.

The screen structure will be located on what was the outside of a river bend in a portion of the diversion pool that has been historically free of sediment deposition. In addition, the bottom of the screen structure intake is positioned approximately 10 ft above the excavated diversion pool bottom. This raised intake should function to exclude sediment. Consequently, sediment intake is expected to be minimized and sediment deposition or sediment passage through the screens is not expected to pose operational problems.



GENERAL NOTES

For general concrete outline notes, see 4[illegible]
For reinforcement detailing requirements, see 40-D-6263 unless otherwise shown
Structures to be placed on sound bedrock, consistent earth, or thoroughly compacted fill
Fasten sponge rubber and joint filler securely to one face of concrete.
Reinforcement to be continuous through construction
For details of rubber waterstop, see 40-D-[illegible]
For details of rubber waterstop intersections, see 33-D-4145.
For pipe guardrail and chain details, see 33-D-4[illegible]
Locate pipe guardrail posts as required, not to exceed 8'-0 on centers.
Pipe guardrail requires kickplate unless noted other[illegible]
Provide ¾ inch chamfer on all exposed edges of concrete

DESIGN STRENGTHS

Concrete at 28 days ..... f'_c = 4,000 p[illegible]
Reinforcement ..... fy = 60,000 p[illegible]

11-22-65 D LZF	ADDED TWO DIMENSION AND LOCATE TOE OF SLOPE AS DIRECTED NOTE

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UNITED STATES
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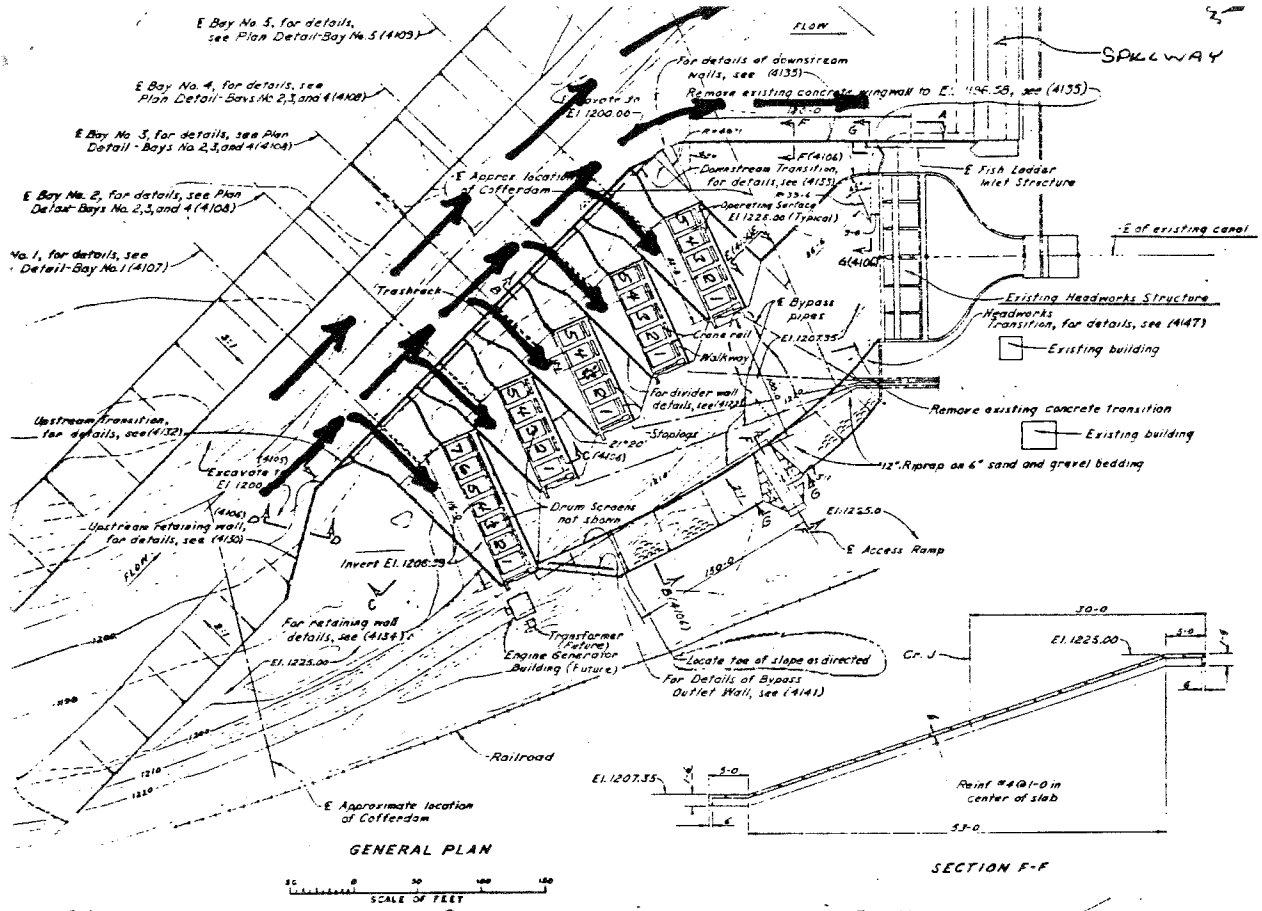
BUREAU OF RECLAMATION
YAKIMA PROJECT - WASHINGTON
FISH PASSAGE AND PROTECTIVE FACILITIES
ROZA DIVERSION DAM
FISHSCREEN STRUCTURE
GENERAL PLAN AND SECTIONS

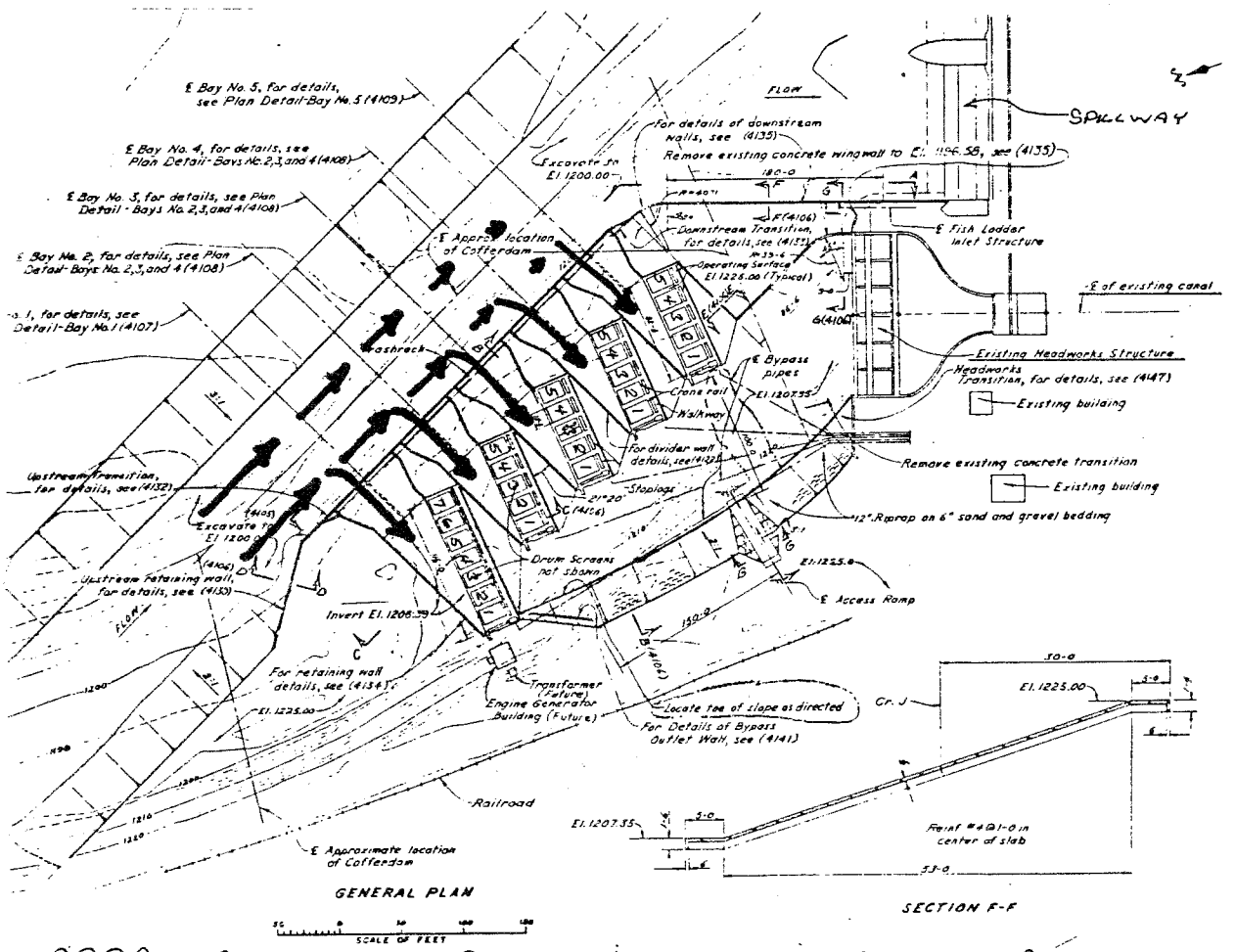
DESIGNED [illegible] TECHNICAL APPROVAL [illegible]
DRAWN [illegible] SUBMITTED [illegible]
CHECKED [illegible] APPROVED [illegible]
DENVER, COLORADO

GENERAL PLAN OF FISHSCREEN STRUCTURE

FIGURE 1



APPROXIMATE FLOW PATTERN WITH LARGE SPILLWAY RELEASE



APPROXIMATE FLOW PATTERN WITH NO SPILLWAY RELEASE

FIGURE 2

II. Study Objectives

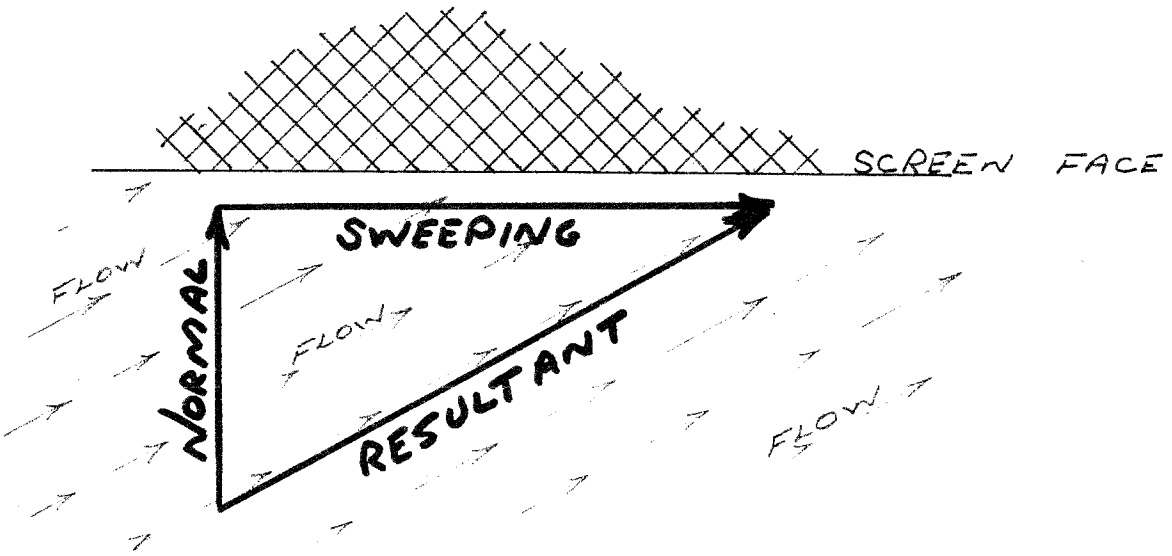
The objectives of this model study were to develop a screen structure configuration that would yield flow patterns which efficiently divert the fish into bypasses which would in turn be used to transport the fish around the diversion dam and back to the river. This would be done while preventing fish impingement on the screens and while keeping structure cost to a minimum. To efficiently divert and guide the fish required identifying and eliminating areas in the structure where back eddies and low flow velocities would occur. Such areas inhibit fish passage and are regions in which predators can hold and feed on the young salmon as they come downstream. The velocity magnitude, direction, and distribution passing through the screens were also studied. Criteria to minimize fish impingement against the screens require that the component of the velocities normal to the screen be less than 0.5 ft/s (figure 3). The criteria also require that the sweeping component of the velocity which is parallel to the screen faces have a magnitude equal to at least twice the magnitude of the normal component (figure 3). This ensures a flow pattern that will sweep the fish off of the screens and into the bypass. Various stoplogging patterns behind the drum screens were studied in an effort to optimize the flow distribution through the screens. Also studied were the fish bypass intakes where steady or slightly accelerating velocities were considered desirable. The performance of the modifications were tested at maximum discharge and at one-half of the maximum discharge both with the approach flow in the diversion pool passing the structure intake and entering straight into the intake.

III. Model

The Roza fish screen model was a 1 to 12 scale representation of one bay of the five bay structure. The model could be adjusted to include five or seven drum screens, and thus any one of the five bays could be studied. The model also included the trashrack, entrance transition, center pier wall, and fish bypass intake (figure 4).

Areas of major concern in the study were the effects of the diversion pool flow regime and the effects of the trashrack as a flow straightener on the flow to the drum screen and fish bypass. Since the model did not include the entire structure and likewise did not include an accurately represented diversion pool with topography, the approach flow to the screen structure intakes was not correctly represented. Consequently, each structure modification considered was tested with straight-in approach flow and with passing approach flow (figure 5). These represent the extremes of possible approach flow. Thus, if flow patterns through the drum screens and fish bypass were found to be satisfactory for both approach flow conditions the structure should function satisfactorily under all possible operating conditions.

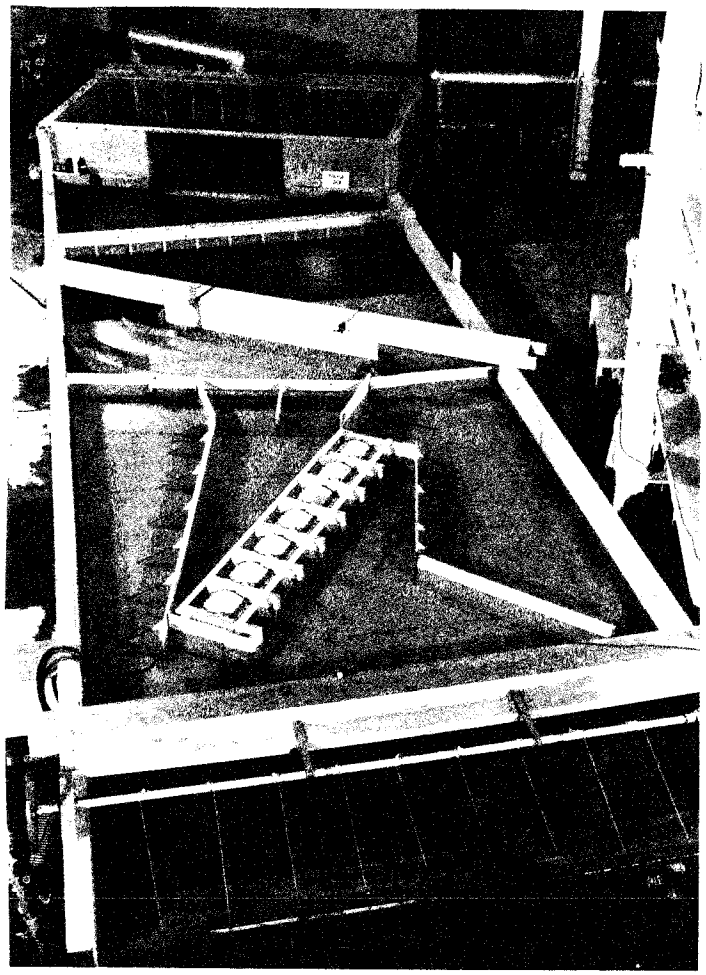
For reasons of economy, a commercially available grating was used to model the trashracks. The modeled trashracks correctly represented bar spacing and thickness but scaled to a 4.5-in bar depth versus the 2.5-in actual prototype bar depth. It was noted that, in particular for the passing

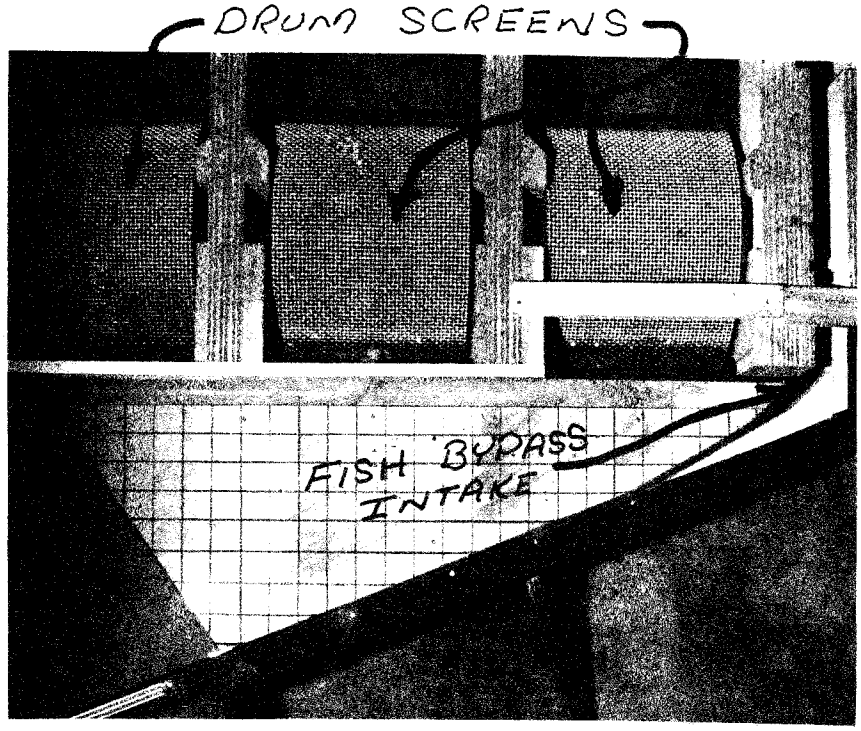


DEFINITION OF VELOCITY COMPONENTS

FIGURE 3

1:12 HYDRAULIC MODEL





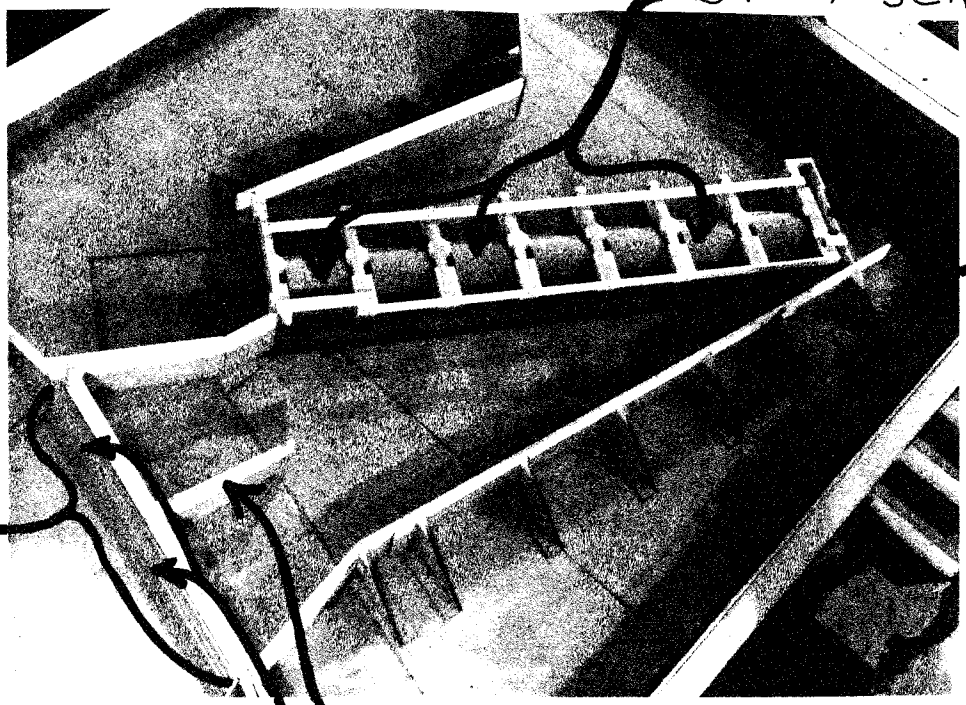
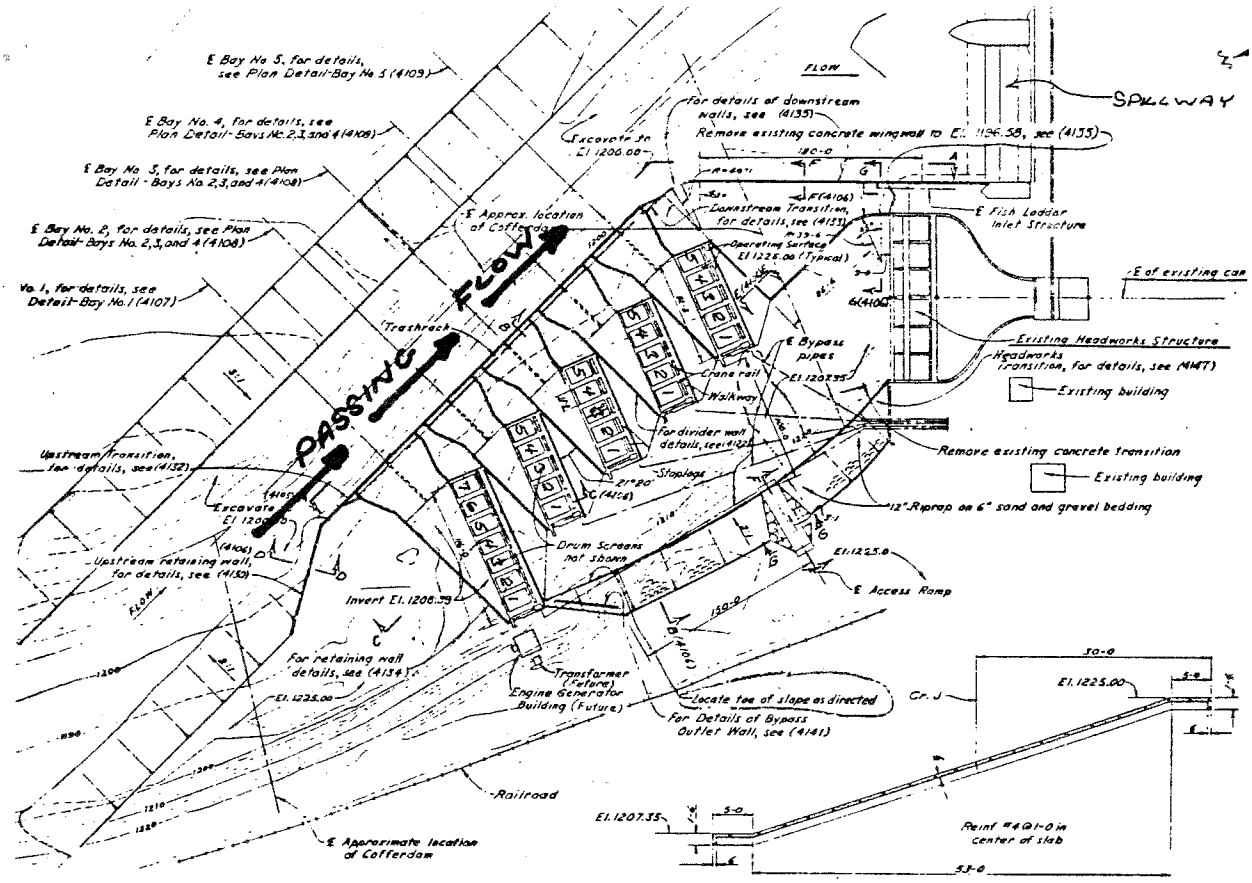
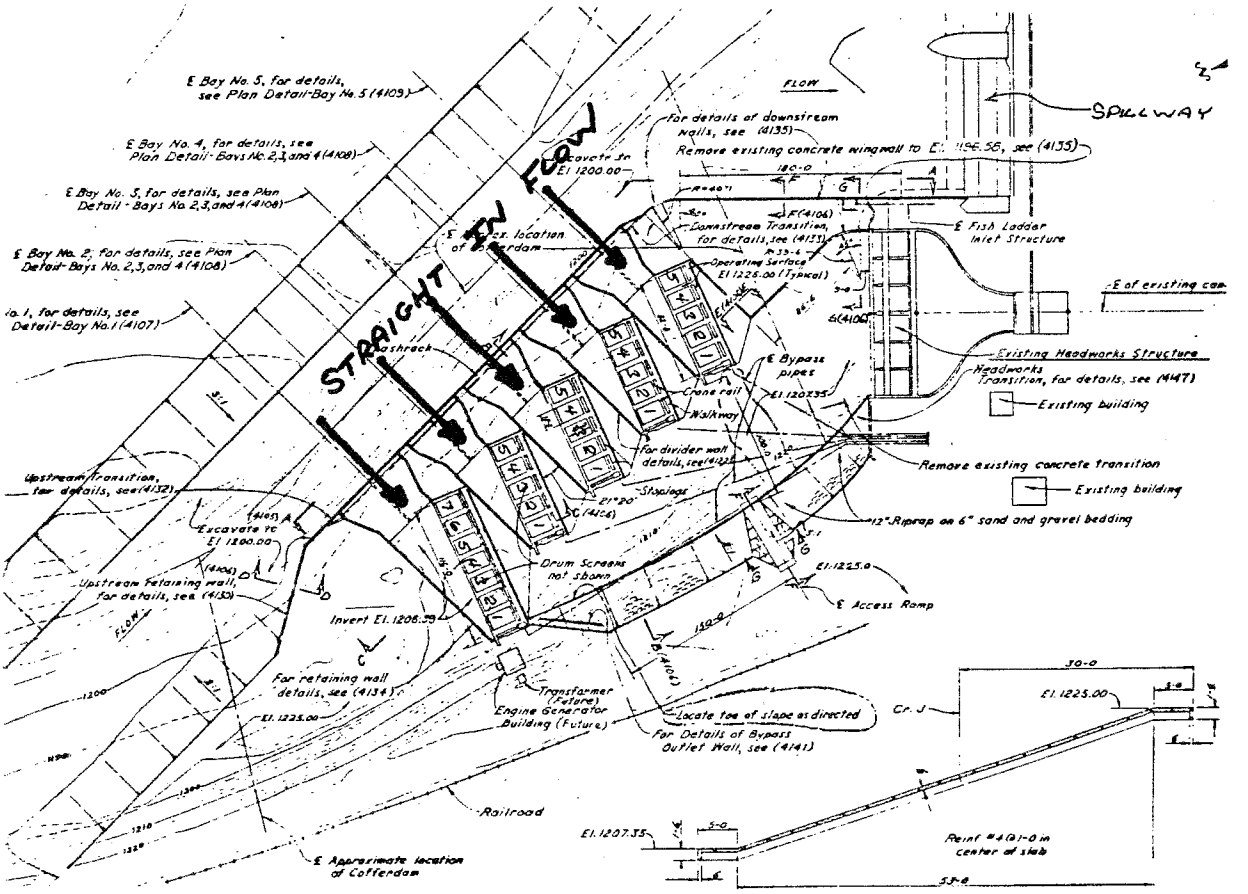


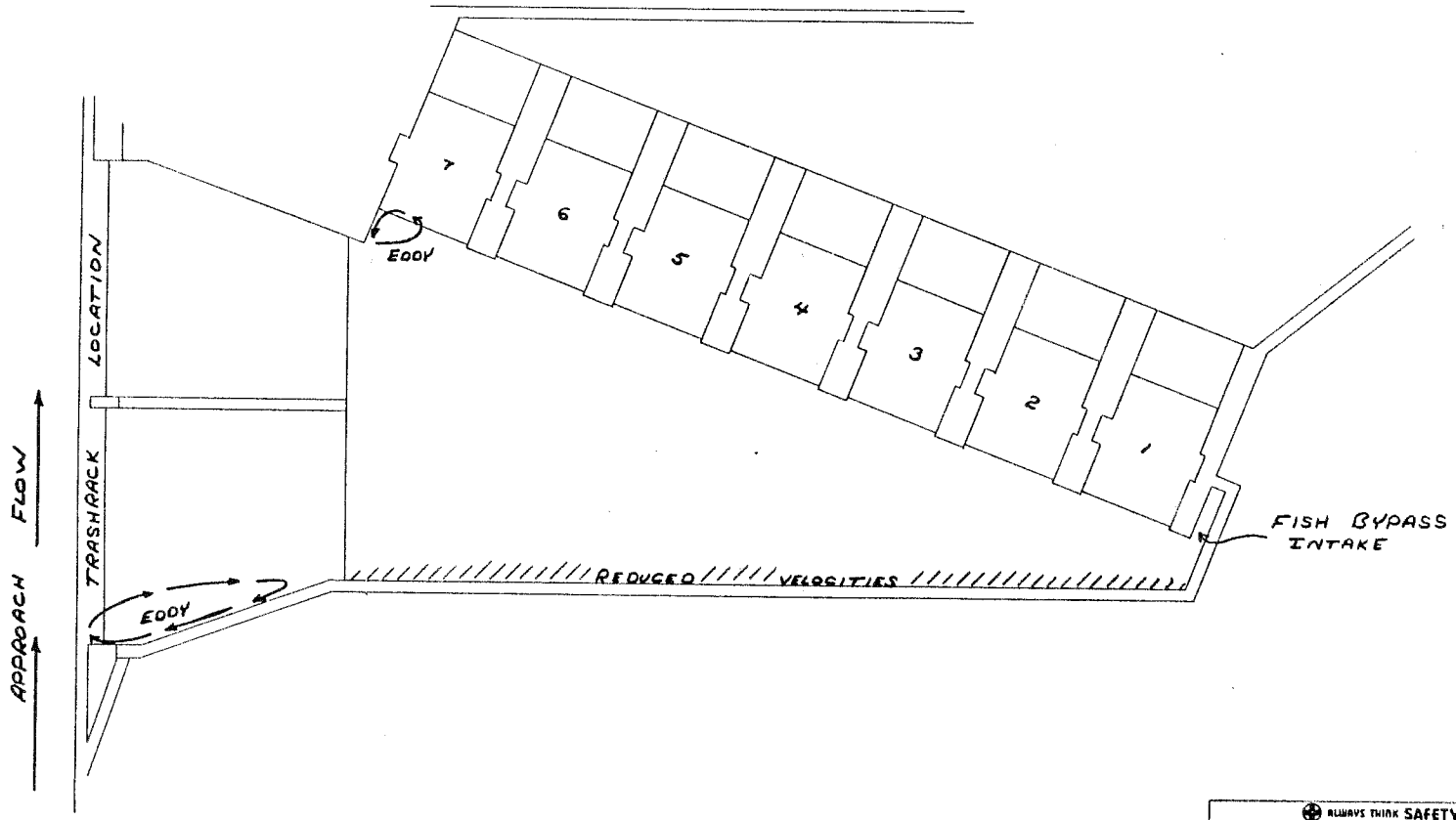
FIGURE 4





ALTERNATIVE APPROACH FLOW CONDITIONS TESTED

FIGURE 5



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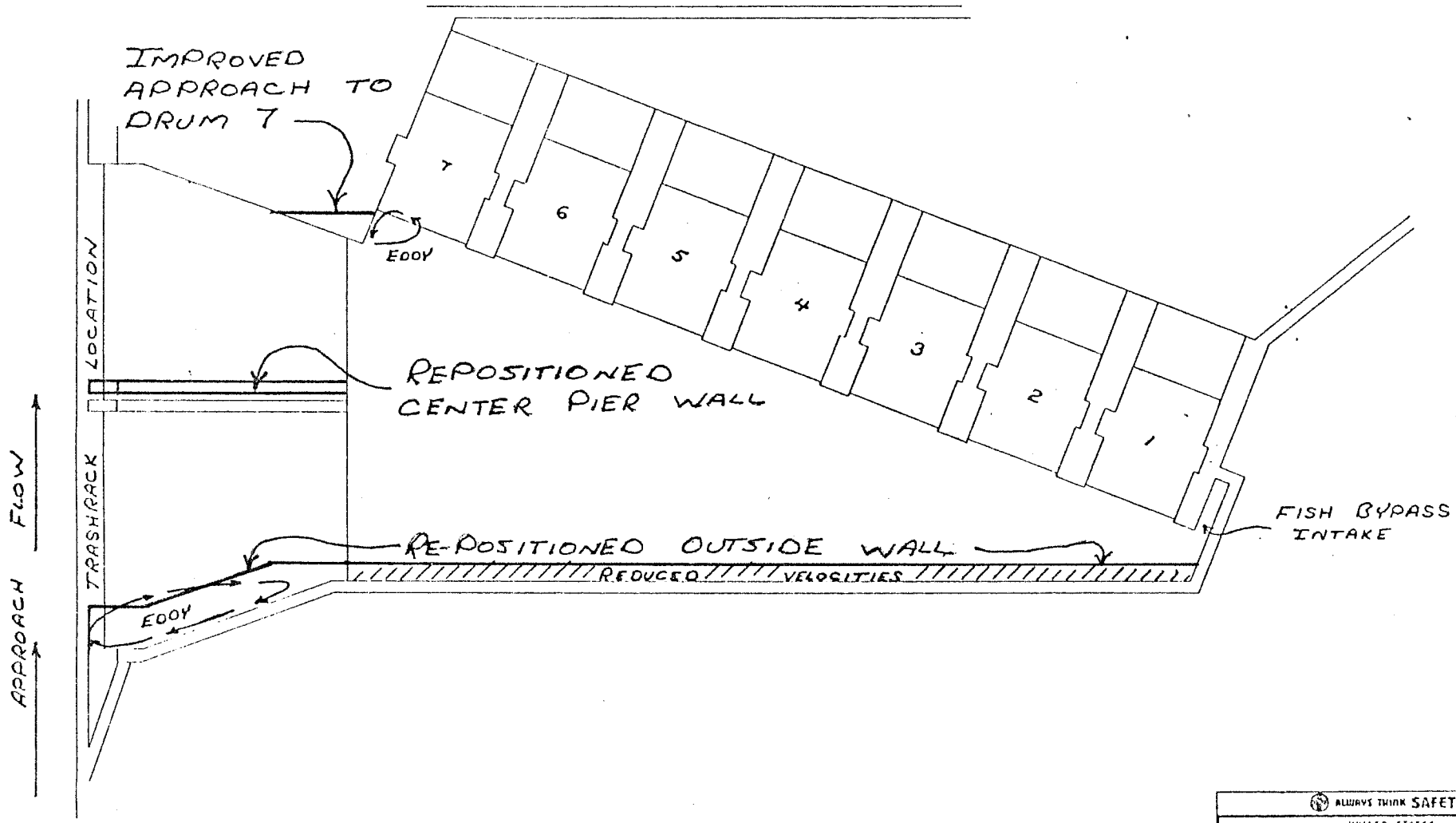
DESIGNED ..... TECHNICAL APPROVAL .....
DRAWN ..... SUBMITTED .....
CHECKED ..... APPROVED .....
DENVER, COLORADO

INITIALLY OBSERVED FLOW PATTERNS

FIGURE 6



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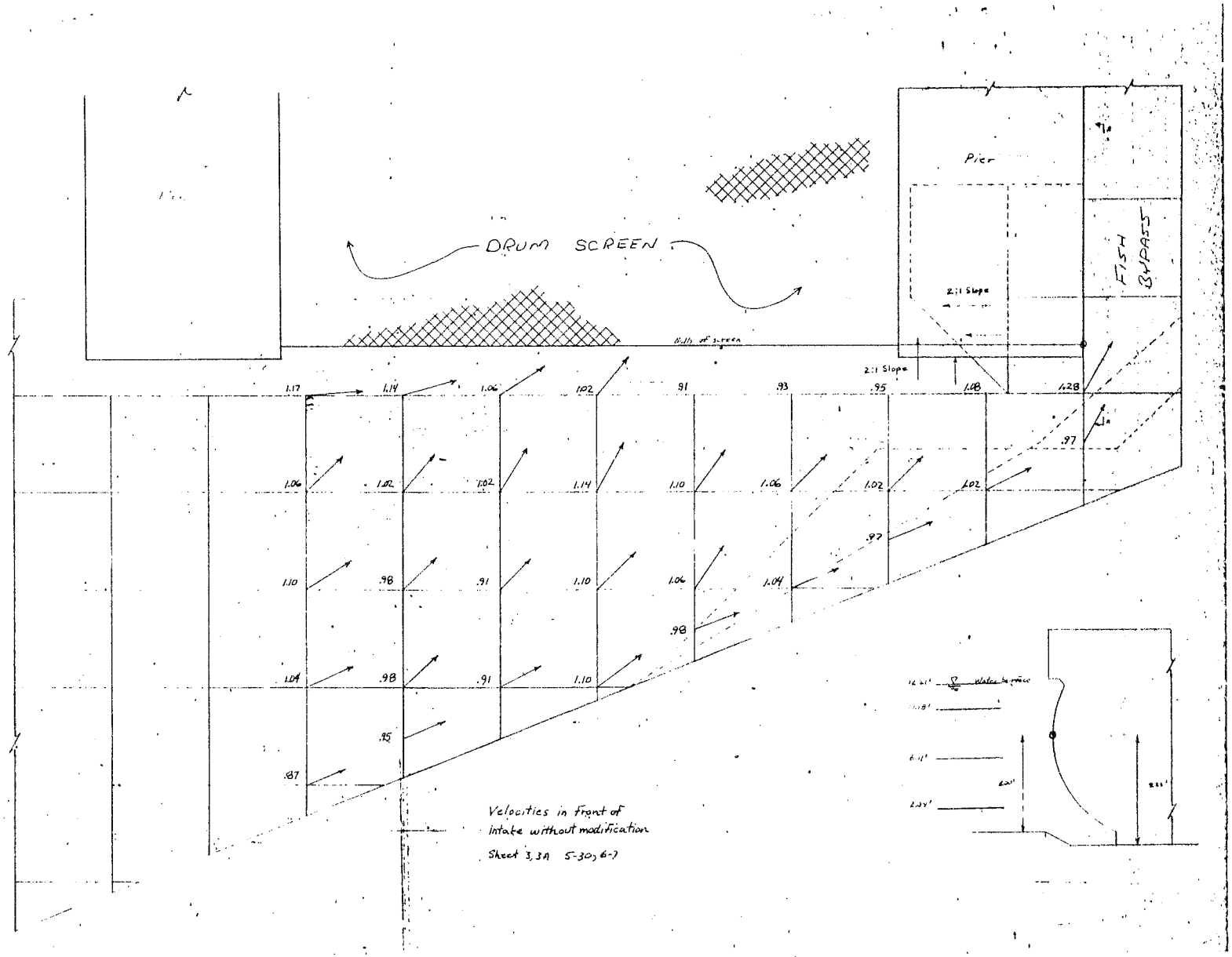
DENVER, COLORADO

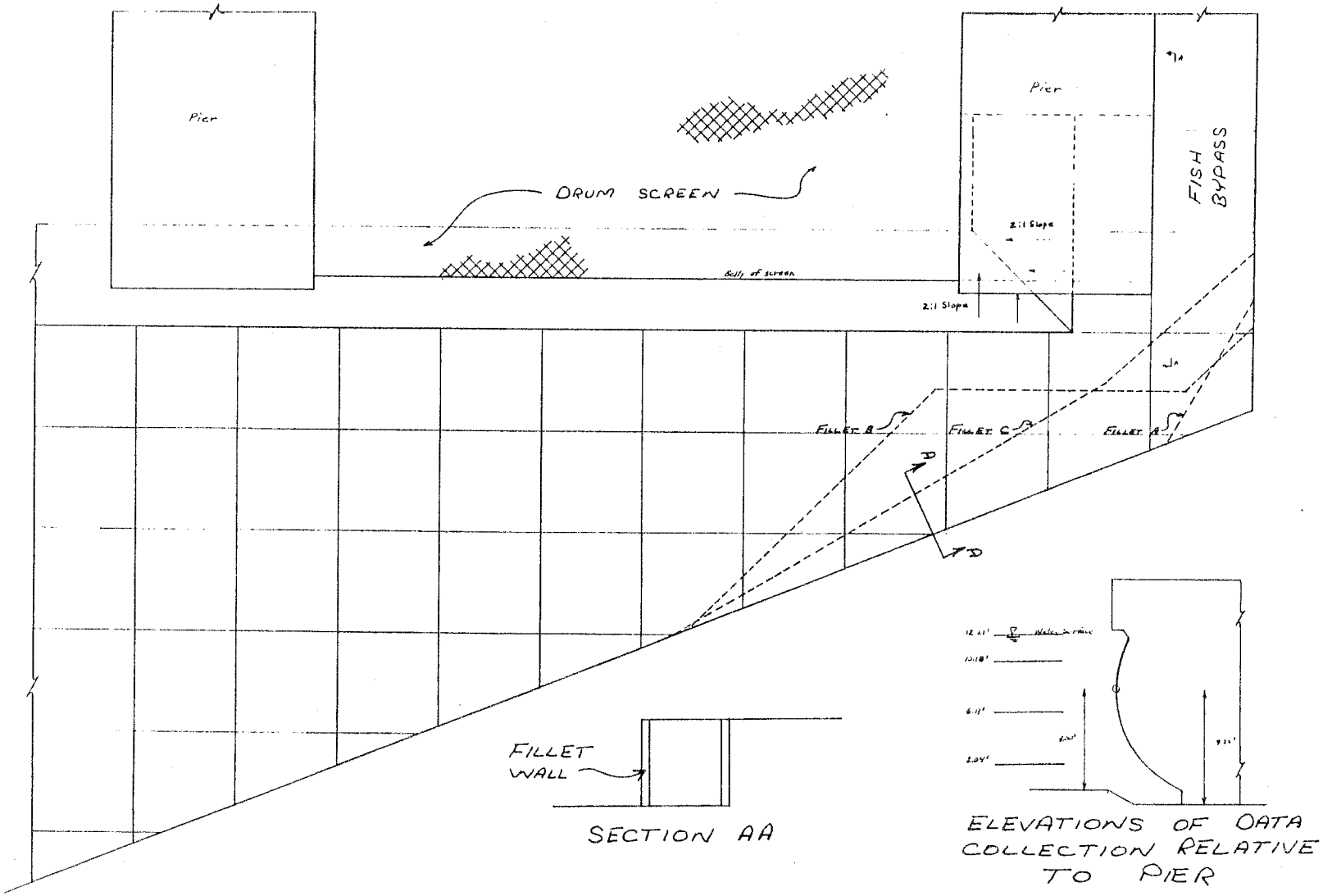
MODIFIED BAY GEOMETRY

FIGURE 7



BYPASS APPROACH FLOW
-INITIAL DESIGN

FIGURE 8



ALTERNATIVE BYPASS INTAKE FILLETS

FIGURE 9

approach flow, the trashracks function as guide vanes, turning and redirecting the flow down the bay. Because of uncertainties about modeled trashrack influence, data were taken both with and without the trashracks in place. Again it was felt that if satisfactory performance was obtained both with and without the trashracks an adequate design would be assured.

The model drum screens were fabricated from 4-mesh, 12-gauge wire screen fabric. This is similar material to what is called for in the prototype design. Model design analysis showed that using large mesh screen fabric with the same percentage of open area as the prototype material will yield the best representation of hydraulic losses across the screen and thus the best representation of screen influences on flow distribution.

Velocities were measured with an electromagnetic current meter. Discharges were measured with the laboratory Venturi system and with a weigh-tank. Flow patterns were monitored visually, photographically, and through use of video tape.

IV. Findings

Initially, the seven-drum first bay of the structure (figure 1) was studied. All tests were run with the screens oriented at an angle of 21° 20' to the walls of the structure. Likewise, all tests were run with the water surface at elevation 1220.60. The initially proposed design was first operated over the full range of potential operating conditions and resulting flow patterns were visually observed. The seven-drum bay was operated at 560 ft^3/s (the maximum discharge) both with passing and straight-in approach flow and both with and without trashracks. In general, for all cases the flow was well directed down the bay. Localized exceptions were noted, in particular across the first half of drum 7 (figure 6) where the offset of the drum screens from the intake caused an eddy zone, along the outside wall of the bay where a low velocity zone occurred, and near the fish bypass intake. To improve the flow across drum 7, the offset was eliminated as much as possible by cutting back the wall to the position shown in figure 7. This resulted in a substantial reduction of the eddy size. It also resulted in an unsymmetrical inlet from the diversion pool, with the portion of the intake to the left (looking in the direction of flow) of the center pier wall being 3 ft wider than the portion to the right.

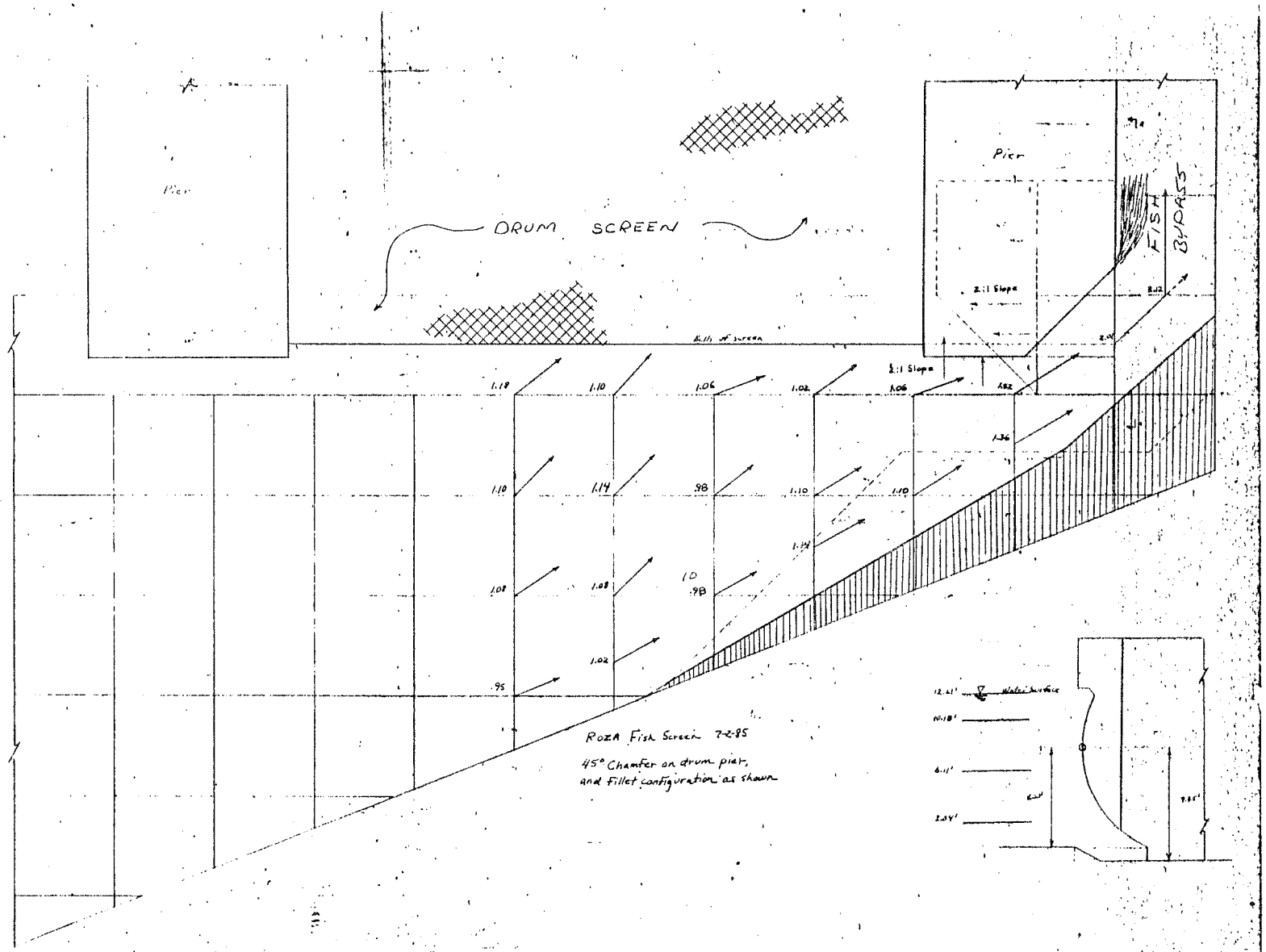
It was observed that with passing approach flow, velocities along the bay wall opposite the drums, or the outside wall of the bay, were reduced. This resulted from the corner separation (eddy) that occurred at the entrance (figure 6). This was corrected by reducing the width of the intake bay by 3 ft which again made the intake symmetrical and reduced the size of the low velocity zone (figure 7).

Finally, using the seven-drum bay and with confirmation from the five-drum bay the design of the fish bypass intake was investigated. With the initial design a low velocity zone occurred near the outer wall of the bay opposite the fish bypass intake (figure 8). Three different vertical wall fillet configurations were tested to eliminate this zone and thus to accelerate the flow approaching the bypass intake. The longer concave fillet (figure 9,

fillet C) was found to be the most effective in creating gradual uniform acceleration of the flow with no flow separation or eddy zones. It should be noted that care had to be taken to keep the bypass intake at least 2 ft wide. To install the fillet, required beveling the corner of the pier between drum 1 and the bypass intake (figure 10). Figure 10 also shows a typical observed flow field for this design. These data were taken on the seven-drum bay, with the design diversion discharge, passing approach flow, and no stoplogging. Velocities shown are averages of velocities taken at 17, 50, and 83 percent of total water depth. Note that in general a fairly uniform accelerating flow field has been created (figure 10). Note also that within the bypass intake itself a separation or eddy zone occurs just downstream of the beveled corner. Consideration was given to ways to eliminate this zone. However, it was concluded that due to space limitations a transition of adequate length to eliminate the separation could not be installed.

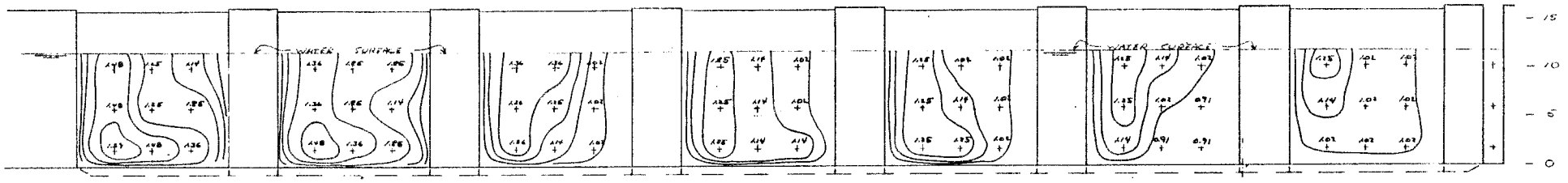
With the previously mentioned modifications in place, efforts were directed at obtaining detailed evaluations and refinements of flow patterns at the drum screens. Velocity data were taken in a vertical plane 1 ft in front of the drums at approximately 20, 60, and 80 percent of the total water depth. All initial tests were conducted with no stoplogging behind the drums. Observed drum screen flow conditions for the various approach flow conditions tested are shown in figure 11. Note that with passing approach flow and with trashracks in place, average resultant (figure 3) velocities at the drums varied from 1.36 ft/s at drum 7 to 1.06 ft/s at drum 1 (figure 11a). Likewise there tended to be a horizontal velocity gradient across each drum. Vertically, velocities were quite uniform. Corresponding normal velocity components range from 0.39 ft/s at drum 7 to 0.19 ft/s at drum 4 to 0.36 ft/s at drum 1 (table 1). Velocity component ratios ranged from 3.38 at drum 7 to 5.84 at drum 4 to 2.44 at drum 1 (table 1). This component ratio data shows that the angle of flow attack flattens over the middle drums and is sharper at both ends of the structure. Again with passing approach flow, but with the trashracks removed, average resultant velocities at the drum screens varied from 1.59 ft/s at drum 7 to 1.02 ft/s at drum 1 (figure 11c). As with the trashracks in place there were horizontal gradients across each drum with vertical velocity variations tending to be small. As can be seen by comparison of figures 11a and 11c, the model trashracks do have a significant influence on the flow. The trashracks tend to intercept and turn the flow into the bay, reducing separation and flow concentration zones. Performance of the prototype with trashracks should be someplace between these two observed model conditions. It is speculated that the prototype trashracks will have significant influence on flow direction and distribution and that resulting performance will be more like the model with trashracks than the model without.

The seven-drum bay was also observed with straight-in approach flow. This was done with the trashracks in place. However, with straight-in approach flow trashrack influence is negligible. The observed flow distribution is shown in figure 11b. Note that for the maximum discharge average resultant velocities range from 1.07 ft/s at drum 7 to 0.95 ft/s at drum 4 to 1.00 ft/s at drum 1. Thus, with straight-in approach flow, velocities at the drum screens are quite uniform in both the horizontal and vertical. Figures 11a and 11b represent the most likely extremes of drum screen



RECOMMENDED BYPASS INTAKE FILLET
WITH OBSERVED APPROACH FLOW

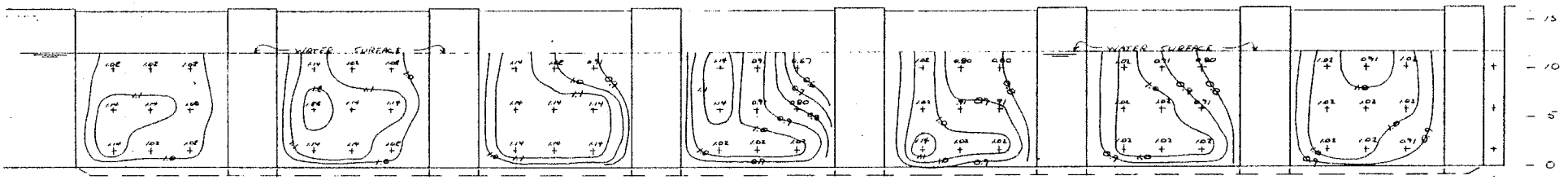
FIGURE 10



AVERAGE VELOCITY FT/S 1.36 1.30 1.21 1.15 1.14 1.06 1.06

11a

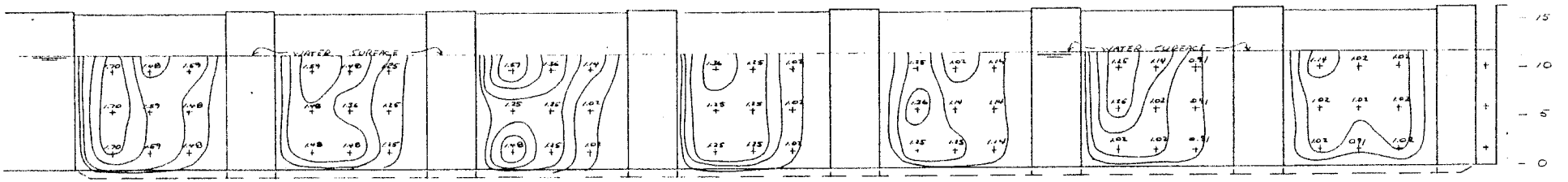
DISCHARGE = 560 FT³/S
PASSING APPROACH FLOW
WITH TRASHRACKS
NO STOPLOGS



AVERAGE VELOCITY FT/S 1.07 1.11 1.10 0.95 0.96 0.97 1.00

11b

DISCHARGE = 560 FT³/S
STRAIGHT IN APPROACH FLOW
WITH TRASHRACKS
NO STOPLOGS



AVERAGE VELOCITY FT/S 1.59 1.40 1.26 1.19 1.19 1.05 1.02

11c

DISCHARGE = 560 FT³/S
PASSING APPROACH FLOW
NO TRASHRACKS
NO STOPLOGS

FIGURE 11

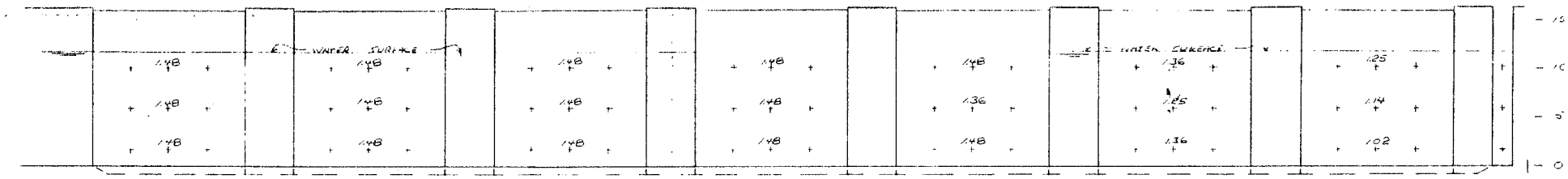
OBSERVED RESULTANT VELOCITY DISTRIBUTION
SEVEN DRUM BAY - NO STOPLOGS

flow distribution that result due to approach flow variations when no stoplogging or no effort to force a modified distribution is made. Thus, potential distributions range from a marginal condition for which the localized component criteria are satisfied but for which the overall flow pattern yields a deceleration of flow across the drum screens instead of the desired steady or gradually accelerating flow to an acceptable flow pattern which both satisfies local flow criteria as well as desired general flow patterns.

Numerous efforts were made through use of stoplogs placed behind the drums to force improved flow distribution. Numerous stoplogging patterns were tested. All velocity data, with stoplogging, presented in this report are with what was found to be the optimum pattern (pattern A). This arrangement had 80 percent stoplog blockage behind drums 5, 6, and 7; 50 percent stoplog blockage behind drums 3 and 4; and 20 percent stoplog blockage behind drums 1 and 2. The resulting velocity distribution for the maximum discharge with a passing approach flow is shown on figure 12a. Note that average velocities ranged from 1.48 ft/s at drum 7 to 1.14 ft/s at drum 1 and that velocities were extremely constant across drums 7 to 3.

A number of tests were directed at increasing velocities at drums 1 and 2. Decreasing velocities, in particular when approaching the bypass intake, were undesirable. However, efforts to increase these velocities with additional stoplogging were unsuccessful. The angles of velocity approach to the drum screens were evaluated and used with corresponding velocity magnitudes to compute the normal components of the velocities and the ratios of sweeping component magnitudes to normal component magnitudes. The results are shown in table 1. Note that for the seven-drum bay operating at the maximum diversion discharge with passing approach flow and stoplogging option A, normal velocity components to the drums were all equal to or less than 0.50 ft/s and sweeping to normal component ratios were all greater than 2. Thus, the general velocity criteria for the screens were met. Therefore, with respect to normal component and velocity component ratio criteria, the seven-drum bay with stoplogging is as acceptable as the seven-drum bay without stoplogging. The resultant velocity distribution with stoplogging is more uniform but whether the stoplogging yields sufficient improvement to warrant its use can be argued.

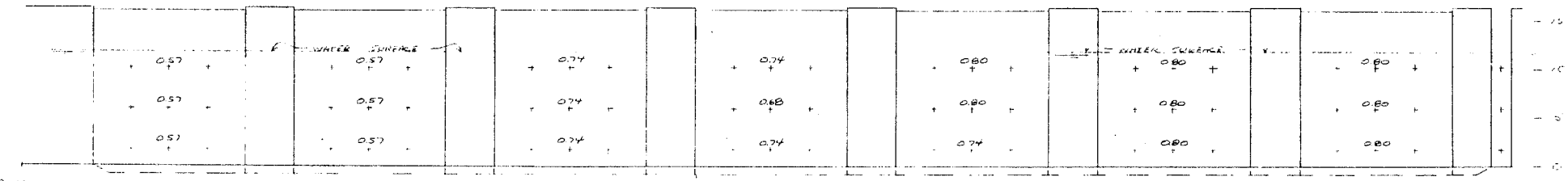
The seven-drum bay was also studied operating with a diversion discharge of 280 ft^3/s, 50 ft^3/s of which was discharged through the fish bypass. The drum screen velocity distribution with stoplogging and with passing approach flow is shown on figure 12b. The drum screen velocity distribution with stoplogging and with straight-in approach flow is shown on figure 12c. Corresponding normal velocity components and sweeping to normal component ratios are shown in table 1. Note that for both cases the magnitude of the resultant, normal, and sweeping velocities increased as the flow passes from drum 7 to drum 1 and then into the bypass. Velocities are all reduced from the levels observed with the 560 ft^3/s discharge. Normal velocity components ranged from 0.09 ft/s to 0.26 ft/s with stoplogging and passing approach flow, and from 0.10 ft/s to 0.27 ft/s with stoplogging and straight-in approach flow. These conditions are all acceptable with respect to the hydraulic criteria and actually represent very desirable flow patterns for guiding fish into the bypass intakes.



AVERAGE VELOCITY FT/S 1.48 1.48 1.48 1.48 1.44 1.32 1.14

DISCHARGE = 560 FT³/S
PASSING APPROACH FLOW
WITH TRASHRACKS
WITH STOPLOGGING PATTERN A

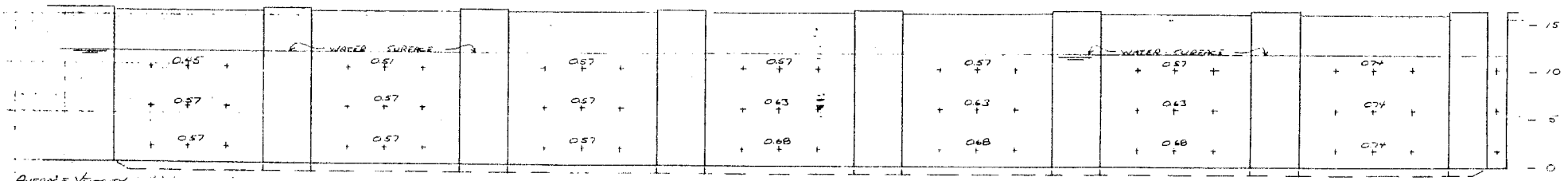
12a



AVERAGE VELOCITY FT/S 0.57 0.57 0.74 0.72 0.78 0.80 0.80

DISCHARGE = 280 FT³/S
PASSING APPROACH FLOW
WITH TRASHRACKS
WITH STOPLOGGING PATTERN A

12b



AVERAGE VELOCITY FT/S 0.53 0.55 0.57 0.63 0.63 0.63 0.74

DISCHARGE = 280 FT³/S
STRAIGHT IN APPROACH FLOW
WITH TRASHRACKS
WITH STOPLOGGING PATTERN A

12c

FIGURE 12

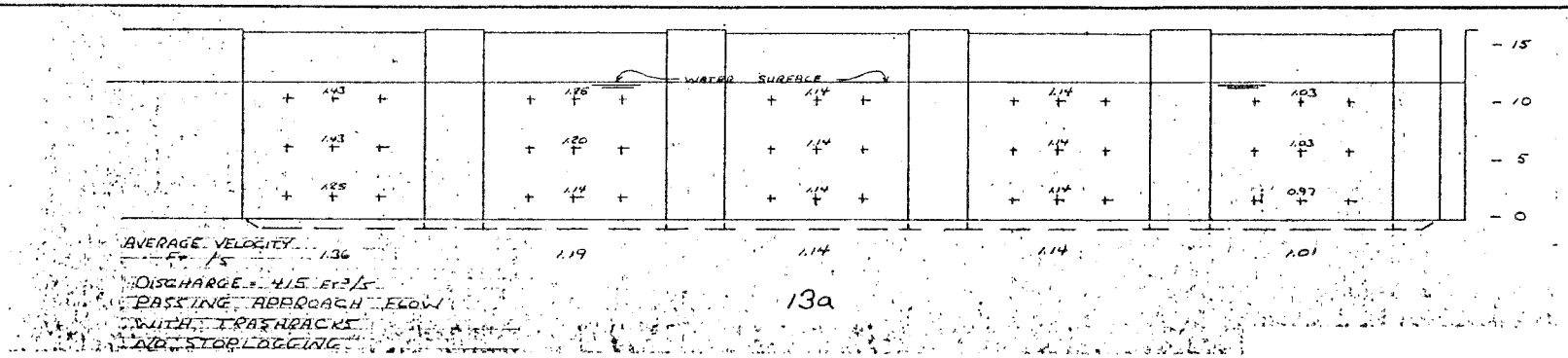
OBSERVED RESULTANT VELOCITY DISTRIBUTION
SEVEN DRUM BAY - WITH STOPLOGS

With completion of testing of the seven-drum bay, a five-drum bay was installed in the model. The five-drum bay was tested for similar approach flow, discharge, and stoplogging conditions as the seven-drum bay. With no stoplogging and at the maximum discharge (415 ft^3/s including 50 ft^3/s bypass discharge) flow patterns were evaluated both with passing and straight-in flow. With passing flow and no stoplogging, resultant velocities ranged from 1.36 ft/s at drum 5 to 1.01 ft/s at drum 1 (figure 13a). Corresponding normal velocity components range from 0.45 ft/s at drum 5 to 0.21 ft/s at drum 4 to 0.39 ft/s at drum 1 (table 1). Likewise, the component ratios ranged from 2.84 at drum 5 to 5.57 at drum 4 to 2.36 at drum 1 (table 1). The flow decelerates as it approaches the bypass, which is not an ideal flow condition. However, with respect to the normal component and component ratio criteria, the flow conditions are acceptable. With straight-in flow, resultant velocities range from 1.21 ft/s at drum 5 to 1.08 ft/s at drum 3 to 1.23 ft/s at drum 1 (figure 13b). Corresponding normal components ranged from 0.43 ft/s at drum 5 to 0.33 ft/s at drum 3 to 0.45 ft/s at drum 1 (table 1) and component ratios ranged from 2.63 at drum 5 to 4.77 at drum 4 to 2.53 at drum 1 (table 1). Thus with straight-in approach flow and no stoplogging at the maximum discharge, observed flow conditions were generally good.

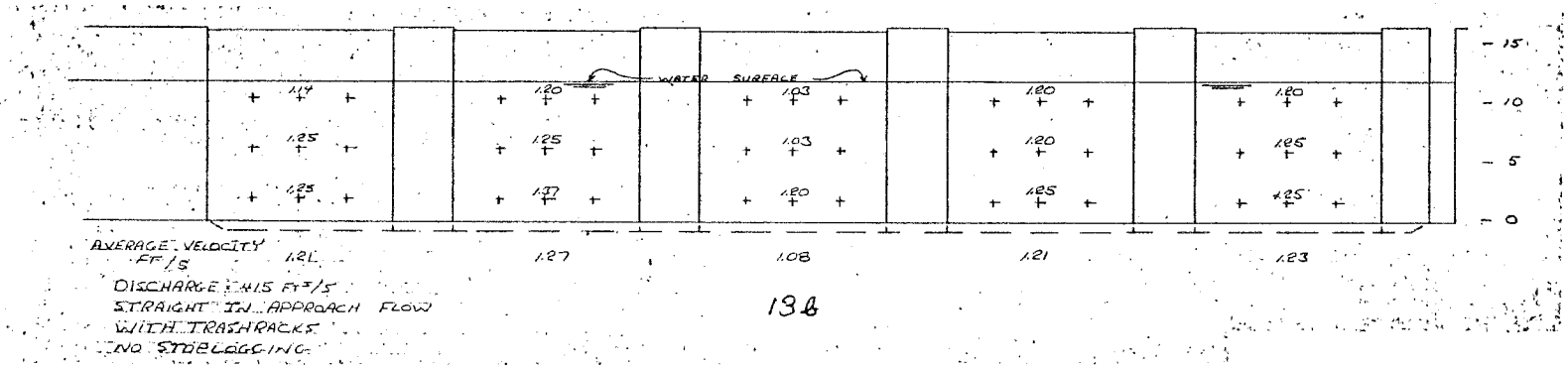
Stoplogging was then used to try to improve flow distribution. The stoplogging pattern used reflects a modified version of the optimum stoplogging pattern developed for the seven-drum bay (pattern A). This consisted of 80 percent blockage behind drums 4 and 5, 50 percent blockage behind drum 3, and 20 percent blockage behind drums 1 and 2. With passing approach flow and the maximum discharge this stoplogging yielded resultant velocities ranging from 1.53 at drum 5 to 1.40 at drum 2 and 1.14 at drum 1 (figure 13c). Corresponding normal components ranged from 0.39 at drum 5 to 0.47 at drum 2 to 0.33 at drum 1 (table 1) and corresponding component ratios ranged from 3.79 at drum 5 to 4.59 at drum 4 to 3.30 at drum 1 (table 1). Thus flow conditions are generally good across the first four drums. However, the pronounced deceleration across drum 1 is not desirable. The stoplogging therefore improves the flow distribution but does not yield the best possible conditions. The stoplogging tended to increase the magnitude of the resultant velocity but not of the normal component. This is because, with stoplogging, the angle of attack of the flow to the screens is flattened.

With straight-in approach flow resultant velocities were very uniform ranging between 1.21 ft/s and 1.33 ft/s (figure 14a). Normal components ranged from 0.45 ft/s at drum 5 to 0.27 ft/s at drum 4 to 0.47 ft/s at drum 1 (table 1) and component ratios ranged from 2.49 at drum 5 to 4.81 at drum 4 to 2.47 at drum 1 (table 1). Thus with stoplogging the observed flow patterns were very good; however, they were also quite good without stoplogging.

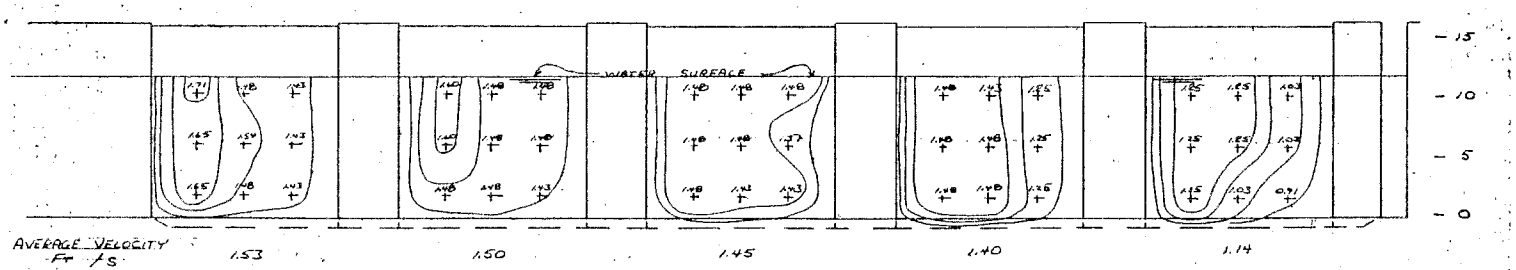
Finally, the five-drum bay was also studied operating at half discharge (208 ft^3/s). This included a 50 ft^3/s discharge through the fish bypass. As with the seven-drum bay, velocities at half discharge were substantially reduced (figure 14b). Normal velocity components were generally below 0.3 ft/s and all were within acceptable limits (table 1). Likewise observed



13a



13b



13c

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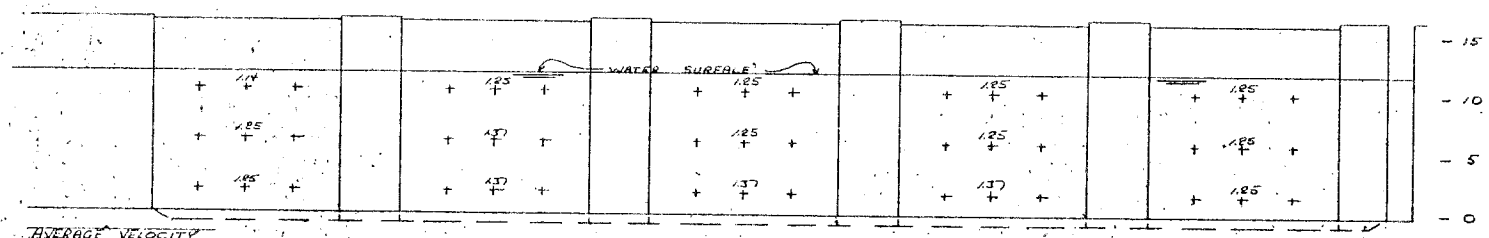
OBSERVED RESULTANT VELOCITY DISTRIBUTION – FIVE DRUM BAY

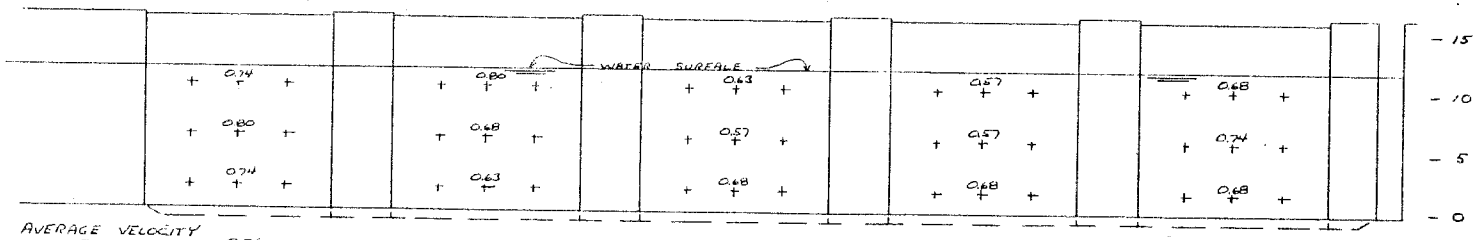
FIGURE 13



AVERAGE VELOCITY FT/S 1.21 1.33 1.29 1.29 1.25

DISCHARGE = 415 FT³/S
STRAIGHT IN APPROACH FLOW
WITH TRASHRACKS
WITH STOPLOGGING PATTERN A

14a



AVERAGE VELOCITY FT/S 0.76 0.70 0.63 0.61 0.70

DISCHARGE = 208 FT³/S
PASSING APPROACH FLOW
WITH TRASHRACKS
NO STOPLOGGING

14b

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FIGURE 14

component ratios were generally acceptable (table 1). However, at drum 5 with passing flow and stoplogging and with straight-in flow with no stoplogging the required ratio value of 2.0 was not met.

As with the seven-drum bay, it appears that only limited improvement in flow distribution in the five-drum bays can be made through use of stoplogs.

Table 1. - Seven-drum screen bay

Screen No.	Passing flow								Straight-in flow							
	Maximum Q 560 ft^3/s				1/2 Maximum Q 280 ft^3/s				Maximum Q 560 ft^3/s				1/2 Maximum Q 280 ft^3/s			
	Stoplogging		No stoplogging		Stoplogging		No stoplogging		Stoplogging		No stoplogging		Stoplogging		No stoplogging	
	Normal velocity	Passing ratio	Normal velocity	Passing ratio	Normal velocity	Passing ratio	Normal velocity	Passing ratio	Normal velocity	Passing ratio	Normal velocity	Passing ratio	Normal velocity	Passing ratio	Normal velocity	Passing ratio
1	0.50	2.04	0.36	2.44	0.26	2.92			0.42	2.10			0.27	2.61		
2	0.36	3.53	0.38	2.71	0.21	3.67			0.42	2.32			0.23	2.56		
3	0.40	3.45	0.32	3.40	0.16	4.75			0.21	5.66			0.24	2.41		
4	0.37	3.86	0.19	5.84	0.14	5.07			0.28	4.32			0.17	3.61		
5	0.15	9.80	0.30	3.97	0.15	4.80			0.16	7.61			0.10	5.67		
6	0.24	6.08	0.38	3.37	0.09	6.22			0.33	3.02			0.18	2.96		
7	0.41	3.46	0.39	3.38	0.12	4.67			0.32	2.85			0.18	2.83		

Five-drum screen bay.

Screen No.	Passing flow								Straight-in flow							
	Maximum Q 415 ft^3/s				1/2 Maximum Q 208 ft^3/s				Maximum Q 415 ft^3/s				1/2 Maximum Q 208 ft^3/s			
	Stoplogging		No stoplogging		Stoplogging		No stoplogging		Stoplogging		No stoplogging		Stoplogging		No stoplogging	
	Normal velocity	Passing ratio	Normal velocity	Passing ratio	Normal velocity	Passing ratio	Normal velocity	Passing ratio	Normal velocity	Passing ratio	Normal velocity	Passing ratio	Normal velocity	Passing ratio	Normal velocity	Passing ratio
1	0.33	3.30	0.39	2.36	0.18	4.33	0.17	4.00	0.47	2.47	0.45	2.53	0.29	2.49	0.23	3.45
2	0.47	2.81	0.33	3.30	0.16	4.50	0.14	4.21	0.49	2.43	0.37	3.11	0.21	2.62	0.20	3.05
3	0.37	3.78	0.34	3.21	0.18	3.67	0.17	3.59	0.38	3.24	0.33	3.12	0.17	3.59	0.14	3.79
4	0.32	4.59	0.21	5.57	0.13	5.77	0.13	5.31	0.27	4.81	0.26	4.77	0.10	6.00	0.10	6.00
5	0.39	3.79	0.45	2.84	0.39	1.72	0.23	3.17	0.45	2.49	0.43	2.63	0.21	2.52	0.28	1.79

All data presented with stoplogging were for stoplogging pattern A.