FY79 PROGRESS REPORT
FISH SCREENING FACILITY TASK FORCE

CHAIRMAN, DANNY L. KING

Oct '79

PAP-387

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UNITED STATES GOVERNMENT

Memorandum

Memorandum

TO : Chairman, Fish Screening Facility Task Force

Denver, Colorado
DATE: October 11, 1979

FROM : Laboratory Testing Coordinator

SUBJECT: FY79 Progress Report

INTRODUCTION

At the end of FY78, the decision had been made to verify the filtration efficiency of 70-mesh screen with 0.0065-inch wire. Initial tests would be with the standpipe facility. If 100 percent filtration efficiency was shown, sectional model tests would be conducted. Furthermore, the 70-mesh screen was recommended for field testing. Following sectional model verification of the 70-mesh screen, testing would continue to determine hydraulic efficiency, develop the seal design, determine self-cleaning characteristics, develop mechanical cleaning concepts, and examine a basket configuration concept.

OBJECTIVES

The objectives of the laboratory study are:

1. Determine the effectiveness of various size screens to stop the passage of fertilized eggs, eyed eggs, sac fry, and swim-up fry of rainbow smelt, carp, gizzard shad, and Utah chub. Additional species may be studied if warranted. Each species will be studied under various hydraulic conditions.

2. Determine the hydraulic characteristics of the screen design to determine what modifications of the existing structure to accomodate these screens are required.

3. Test the effectiveness of the seal design.

4. Determine the impact of debris on screening effectiveness and hydraulic efficiency.

5. Augment design and operation recommendations for the field test facility and for the prototype structure.

TESTING PROCEDURES

Detailed test procedures are described in attachment I.

Culturing of Eggs and Larvae. - Attachment II gives a more detailed description of the culturing of eggs and larvae. In general, only the eggs and larvae of rainbow smelt were obtained successfully. Attempts to capture, transport, maintain, and spawn gizzard shad, Utah chub, and common carp met with considerable difficulty. A few live Utah chub eggs were supplied by the Utah Cooperative Fishery Unit and preserved larvae of threadfin and gizzard shad (not yet used in the testing) were provided by the Tennessee Valley Authority. At the time of this writing, Utah chub and carp adult fish are being held in the laboratory for later spawning. Attachment III outlines fish culturing plans for FY80.

Characteristic sizes of eggs and larvae. - The following table gives the mean sizes of eggs and larvae used in FY79 testing:

	Smelt	Chub
Egg diameter (mm)	1.14	2.00
Larvae length (mm) 1/	6.45	2/
Larvae head width (mm)	0.83	2/
Widest larvae width (mm)	0.83	2/

1/ One day after hatching
2/ Not available for testing

The maximum dimensions of the eggs and larvae of Utah chub and common carp exceed those of the rainbow smelt. Therefore, their inclusion in the testing is not critical but will serve as final verification of the screen design. On the other hand, gizzard shad are of special interest because their larvae are slightly smaller than the larvae of rainbow smelt. The literature states that its depth, including a continuous fin fold arising on the dorsal surface of the body opposite the posterior margin of the yolk sac and continuing around the posterior end ventral surface until it merges with the yolk sac, is 0.2 mm. No data could be found on the size of the head, which would be somewhat larger.

Characteristic Screen Sizes. - Characteristics of the screens used in the testing are given in the following table:

Type	Mesh	Wire diameter (in)	Nominal aperture size (mm)	Aperture size range (mm)	Nominal percent open area
Johnson well screen	Slotted		0.20	0.19-0.21	11.6
Johnson well screen	Slotted		0.1	0.02-0.10	6.1
Woven wire	70	0.0065	0.198	0.17-0.27	29.8

A visual survey of 16 square inches of 70-mesh stainless steel screen, using a 5.6X microscope, showed an average aperture size from 0.20 to 0.24 mm with a minimum opening of 0.17 mm and a maximum opening of 0.27 mm. These findings imply that closer tolerances may need to be specified for the prototype screen. Also, extreme care will be necessary during cutting, stretching on the frame, etc. Federal Specification E43771 is the industry standard and is stated as:

Wire diameter = 0.0065 inch $\pm$ 0.00025 inch

Mesh: warp (longitudinal) = 70 $\pm$ 1.4
cross weave = 70 $\pm$ 2.8

With these tolerances, the largest allowable aperture size is calculated to be 0.219 mm and the smallest allowable aperture is 0.177 mm. The sample described above exceeds these limits .The task force has decided to use Federal specifications for manufacture of the screen.

Test Facilities. - The full-scale sectional model and the standpipe apparatus were described in the FY78 report. Calking techniques for the sectional model were improved so that complete sealing was assured. A question was raised concerning possible disintegration of larvae in the highly turbulent flow at the upstream end of the collection bag. Recovery tests have been run in which known egg and larvae samples were placed in the turbulent zone and then recovered and counted. With some exceptions, a 90 percent recovery of undamaged eggs and larvae has been noted.

The question of the influence of the collection bag remains unresolved at the time of this writing.

A screen cleaning test apparatus, figure 1, was constructed to evaluate various air and water nozzle configurations. The apparatus consisted of a small section of screen set at the same slope as the sectional model and a device to allow varying the angle of impingement of the air or water jet and the distance above the screen.

Statistical Design. - A consulting environmental statistician, Dr. Thomas Keefe, was retained to design the test schedule to provide appropriate replication. The test schedule is shown as attachment IV. It was not possible to include the cleaning operation mode in this year's testing. The statistician will also provide analyses of data on screen apertures and egg and larvae sizes.

Photography. - Potential changes in the screens, such as wire breakage or aperture enlargement, are monitored by magnified photographs of the screen surface. Figure 2 is an example.

Basket Screen Concept. - The concept was recommended for testing in the FY78 progress report. Serious consideration was given; however, the concept was abandoned when it was determined that flat panels with inflatable seals could be developed into an effective design.

TEST RESULTS

Johnson Well Screen. - Table 1 gives the results of standpipe tests with a well screen having a slot width of 0.1 mm. No material passed the screen. Figure 3 is a photograph of the screen. An earlier test with well screen with a slot width of 0.20 mm passed one damaged egg, three whole larvae, and forty headless larvae. The sample consisted of 100 preserved eggs and 100 preserved larvae of rainbow smelt.

Full Panel With 70-mesh Screen. - Test results, using preserved rainbow smelt eggs and larvae, are shown in table 2. Only one headless larva passed the screen in 21 test runs. With this verification of the filtration efficiency of the 70-mesh screen, subsequent testing concentrated on development of the seal design.

Half Panels With Compression Seals, 70-mesh Screen. - This configuration is shown in figure 4. Table 3 gives the results of testing in the sectional model. In a total of 24 test runs, no whole eggs or larvae of rainbow smelt were recovered. A few damaged eggs and several headless larvae passed the screen. Results of the last recovery run in the table left a fairly large number of specimens unaccounted for. The question of damage caused during the process of washing down the collection bag remains unresolved and will be studied further in FY80.

70-mesh Screen With Flattened Oval Inflatable Seals. - Results of the sectional model tests with preserved rainbow smelt eggs and larvae are shown in table 4. Two whole eggs and three whole larvae collected from one run and one whole larvae collected from another run were identified as being left over from previous recovery runs. The technique of using alternate stains from test to test proved invaluable in identifying the origin of collected materials. Three headless larvae passed this screen in 21 test runs. The flattened oval inflatable seals were used as an interim design pending delivery of rectangular inflatable seals for the final design.

70-mesh Screen With Rectangular Inflatable Seals. - Figure 5 is a schematic of the recommended final design. Results of testing with preserved rainbow smelt larvae and Utah chub eggs (smelt eggs were depleted) are summarized in table 5. No whole eggs or larvae were identified as having passed the screen or seals in 17 test runs. Only one damaged larva was collected.

Screen Cleaning Tests. - The sloping screen was found to be self-cleaning with respect to water-borne debris, with the exception of fine material accumulated in the area of impingement of flow passing over the weir. Mechanical cleaning concepts were examined to remove this material, to remove potential algae growth, and to flush any large accumulations of debris at the downstream end of the screen.

Fluctuating discharge was found to have some effect in moving material in the impingement zone; however, this may not be practical in the field. A squeegee device, consisting of a moveable underflow weir, was also considered. However, this device required building up a head on the upstream side, which makes it effective only when very near the weir.

Spray cleaning was investigated in some detail, using the apparatus shown in figure 1. Screens were placed in waterways at the Denver Federal Center so that biological growths would occur. Also, a gelatinous substances known as agar was used to coat the screens as a representation of materials which might be encountered in the field. Sawdust was used to represent accumulation of loose debris on the screen. Tests were conducted without water flowing on the screen; the results indicated that air jets moved more material faster than water jets, but that water jets more completely cleaned the screen fibers. Data were collected on pressures, flow rates, jet angles, and rate of nozzle movement down the screen. Laboratory test results were used by the Mechanical Branch to design a manifold nozzle arrangement which will be evaluated in the field test facility.

Hydraulic Capacity. - Figure 6 summarizes test data on length of screen required for various unit discharges, using a 70-mesh screen panel with a woven 2-mesh support screen. An identical screen panel was located one foot below. Note that at the design slope of -5° (5° below horizontal), a screen length of 10.5 ft is required to pass the maximum unit discharge of 6 $ft^3/s \cdot ft$. A length of 12 ft, 9 in is included in the field test facility; results there will be used to finalize the prototype design.

Detailed capacity data have not been collected for the present design with flattened expanded metal backup screens. However, observations indicate that a 12 ft long screen will pass 5 $ft^3/s \cdot ft$.

DESIGN, INSTALLATION, AND OPERATION CONSIDERATIONS

1. The present design, with some additional modifications, appears to have the potential to meet our design objectives. The 70 mesh screen supplies adequate filtration. The inflatable seals allow easy screen panel removal and installation with a positive seal.

2. If possible, use of rigid blocks at the splice points in the inflatable seal should be avoided. If the blocks are required, the splices should not be placed in the curved areas of the screen frame.

3. The design of the hold-down groove, rod, and screws should be examined. There is some bowing of the rod, particularly in the curved portion of the groove. This bowing results in incomplete retention and sealing of the screen in the groove.

4. Extreme care must be taken in stretching and attaching the screen to the frame to avoid cutting the screen. Cutting has occurred either when the screen is being pressed into the retaining groove or when the retaining rod is being placed. This degree of care would probably not be ordinarily expected in a production situation.

5. Irregularities in the seating surface may cause leakage past the seal, therefore, machining tolerances must be specified.

CONCLUSIONS

1. Data collected in FY79 indicate that the 70-mesh screen with rectangular inflatable seals will provide 100 percent efficiency in filtering whole eggs and larvae.

2. Special care must be taken in screen frame and panel fabrication to provide good seating surfaces for the inflatable seal.

3. Special care must also be taken in stretching and attaching the screen to the frame.

4. Air or water jet cleaning appears to be effective in removing attached materials from the screen and moving loose material accumulated on the screen.

5. The Johnson well screen with a slot width of 0.1 mm was effective in filtering eggs and larvae. However, the small percent open area and severely reduced capacity, and the fact that the design using woven wire mesh was relatively advanced excluded the well screen from further consideration for this particular application.

RECOMMENDATIONS

1. Insofar as possible, live eggs and larvae for rainbow smelt, gizzard shad, Utah chub, and common carp should be obtained for a complete laboratory verification test of the recommended screen and seal design.

2. Insofar as possible, fertilized eggs should be shipped to Denver for use in testing and for hatching, in lieu of shipping adult fish.

3. The final design should be examined for possible improvement of the screen hold-down features.

4. The seal manufacturer should be asked to modify the splice configuration.

5. Cleaning tests should be made with eggs and larvae on the screen to determine any tendency for eggs or larvae to be forced through the screen by the cleaning process.

Danny J. King

Attachments

Copy to persons on attached sheet

Copy to: Commissioner, Attention: 122 (Seaman), 1900
Regional Director, Billings, Montana, Attention: UM-210 (Verzuh)
Project Manager, Bismarck, North Dakota, Attention: 400 (Knoll)

Blind to: D-1520
D-1522
D-1522 (Grabowski)
D-1522 (Hiebert)
D-1522B (Jackson)
D-1530
D-1530 (King)
D-1531
D-1531 (Johnson)
D-1531 (Eckley)
D-1532
D-274 (Starbuck)
D-252 (DeLapp)

Note for D-1522B (Jackson): Please see that Mills receives a copy of this memorandum.

TABLE 1

Preserved Rainbow Smelt Tests
Johnson Well Screen Standpipe Tests

Screen Size	Date	Discharge (ft^3/s)	Length of Test (min)	Approximate Sample Size		Number of Organisms Recovered in Plankton Net						Stain
				Eggs	Larvae	Whole Eggs	Egg Cases	Damaged Eggs	Whole Larvae	Headless Larvae	Damaged Larvae	
0.1 mm	2/16/79	*	45	100	100	0	0	0	0	0	0	Blue
0.1	2/16/79	.025	45	100	100	0	0	0	0	0	0	Red
0.1	2/16/79	.025	45	100	100	0	0	0	0	0	0	Green
0.1	2/21/79	.025	45	100	100	0	0	0	0	0	0	Blue
0.1	2/21/79	.025	45	100	100	0	0	0	0	0	0	Red
0.1	2/21/79	.025	45	100	100	0	0	0	0	0	0	Green
0.1	2/21/79	.025	45	100	100	0	0	0	0	0	0	Violet

* Reduced discharge, apparently due to initial condition of well screen.

TABLE 2

Preserved Rainbow Smelt Tests
Full Panel

Screen (mesh)	Date	Discharge (ft^3/s)	Length of Test (min)	Approximate Sample Size		Number of Organisms Recovered in Plankton Net						Stain 2/
				Eggs	Larvae	Whole Eggs	Egg Cases	Damaged Eggs	Whole Larvae	Headless Larvae	Damaged Larvae	
70	11/2/78	13.6	45	10,000 1/	10,000	0	0	0	0	0	0	Blue
70	11/3/78	13.9	45	10,000 1/	10,000	0	0	0	0	0	0	Red
70	11/6/78	14.6	45	10,000 1/	10,000	0	0	0	0	0	0	Green
70	11/6/78	14.6	45	10,000 1/	10,000	0	0	0	0	0	0	Blue
70	11/7/78	14.8	45	10,000	10,000	0	0	0	0	0	0	Red
70	11/8/78	15.6	45	10,000	10,000	0	0	0	0	0	0	Green
70	11/8/78	15.9	45	10,000	10,000	0	0	0	0	0	0	Blue
70	11/28/78	3	45	10,000	10,000	0	0	0	0	0	0	Blue
70	11/29/78	3	45	10,000	10,000	0	0	0	0	0	0	Red
70	11/29/78	3	45	10,000	10,000	0	0	0	0	0	0	Green 3/
70	11/30/78	3	45	10,000	10,000	0	0	0	0	0	0	Blue
70	11/30/78	3	45	10,000	10,000	0	0	0	0	1	0	Red
70	12/1/78	3	45	10,000	10,000	0	0	0	0	0	0	Green
70	12/1/78	3	45	10,000	10,000	0	0	0	0	0	0	Blue
70	12/4/78	9	45	10,000	10,000	0	0	0	0	0	0	Red
70	12/4/78	9	45	10,000	10,000	0	0	0	0	0	0	Green
70	12/5/78	9	45	10,000	10,000	0	0	0	0	0	0	Blue
70	12/5/78	9	45	10,000	10,000	0	0	0	0	0	0	Red
70	12/6/78	9	45	10,000	10,000	0	0	0	0	0	0	Green
70	12/6/78	9	45	10,000	10,000	0	0	0	0	0	0	Blue
70	12/7/78	9	45	10,000	10,000	0	0	0	0	0	0	Red

1/ Fertilized eggs, all other eggs unfertilized.
2/ Eggs and larvae were stained to detect and assess contamination by organisms from previous runs.
3/ Two whole eggs were recovered from this sample. They were dyed red and, therefore, were considered as contamination from the previous run. Some splashing may have occurred during screen washing.

TABLE 3

Preserved Rainbow Smelt Tests
Half Panel Seal Tests
(Compression Seals)

Screen Mesh Size	Date	Discharge (ft^3/s)	Length of Test (min)	Approximate Sample Size		Number of Organisms Recovered in Plankton Net						Stain
				Eggs	Larvae	Whole Eggs	Egg Cases	Damaged Eggs	Whole Larvae	Headless Larvae	Damaged Larvae	
70 1/	1/2/79	3	45	* (UN)	*	100	0	0	73	27	2	Red
70	1/3/79	3	45	5,000 (UN)	10,000	0	0	1	0	1	0	Red
70	1/3/79	3	45	5,000 (UN)	10,000	0	0	0	0	0	0	Red
70 2/	1/4/79	3	45	* (F)	*	83	0	10	77	18	0	Blue
70 3/	1/9/79	3	45	1,000 (F)	10,000	30	0	2	31	11	1	Green
70 4/	1/16/79	3	45	5,000 (F)	10,000	0	0	0	0	0	0	Blue
70	1/17/79	3	45	1,000 (F)	10,000	0	0	0	0	0	0	Violet
70	1/17/79	3	45	* (F)	*	98	5	0	82	18	0	Blue
70	1/18/79	3	45	5,000 (F)	10,000	0	0	0	0	0	0	Brown
70	1/18/79	3	45	5,000 (F)	10,000	0	0	0	0	0	0	Green
70	1/19/79	3	45	5,000 (F)	10,000	0	0	0	0	0	0	Red
70	1/19/79	3	45	* (F)	*	99	1	0	71	25	0	Green
70	1/22/79	3	45	1,000 (UN)	10,000	0	0	0	0	0	0	Violet
70	1/22/79	3	45	1,000 (UN)	10,000	0	0	0	0	0	0	Red
70	1/24/79	9	45	5,000 (F)	10,000	0	0	0	0	4	0	Violet
70	1/25/79	9	45	* (UN)	*	100	0	0	85	12	0	Green
70	1/25/79	9	45	1,000 (UN)	10,000	0	0	0	0	0	0	Red
70	1/26/79	9	45	1,000 (UN)	10,000	0	0	0	0	0	0	Green
70	1/29/79	9	45	1,000 (UN)	10,000	0	0	0	0	0	0	Blue
70	1/30/79	9	45	1,000 (UN)	10,000	0	0	0	0	0	0	Red
70	1/30/79	9	45	1,000 (UN)	10,000	0	0	0	0	0	0	Green
70	1/30/79	9	45	1,000 (UN)	10,000	0	0	0	0	0	0	Blue
70	1/31/79	9	45	* (UN)	*	100	0	0	98	3	0	Red

UN = Unfertilized Eggs
F = Fertilized Eggs
1/ * Recovery Test - Introduced 100 eggs and 100 larvae under the screen panel.
2/ Small holes in net above plankton cup.
3/ Test organisms introduced onto seal areas.
4/ Two green eggs recovered from previous test. Resealing of upper portion was done previous to this test.

Preserved Rainbow Smelt Tests
Half Panel Seal Tests
(Compression Seals)

Screen Mesh Size	Date	Discharge (ft^3/s)	Length of Test (min)	Approximate Sample Size		Number of Organisms Recovered in Plankton Net						Stain
				Eggs	Larvae	Whole Eggs	Egg Cases	Damaged Eggs	Whole Larvae	Headless Larvae	Damaged Larvae	
70	2/1/79	15	45	1,000 (UN)	10,000	0	0	0	0	2	0	Violet
70 1/	2/1/79	15	45	* (F)	*	98	0	0	99	2	0	Red
70	2/2/79	15	45	1,000 (UN)	10,000	0	0	0	0	0	0	Blue
70	2/2/79	15	45	1,000 (UN)	10,000	0	0	0	0	0	0	Green
70	2/2/79	15	45	1,000 (UN)	10,000	0	0	0	0	0	0	Red
70	2/5/79	15	45	1,000 (UN)	10,000	0	0	0	0	0	0	Blue
70	2/5/79	15	45	1,000 (UN)	10,000	0	0	0	0	0	0	Red
70	2/6/79	15	45	1,000 (UN)	10,000	0	0	0	0	0	0	Blue
70	2/6/79	15	45	* (F)	*	99	0	0	95	5	0	Red
70 (cup)	2/9/79	3	45	* (UN)	*	60	0	1	54	0	0	Red
70 (net)	2/9/79	3	45			29	0	0	34	2	0	
2/						89	0	1	88	2	0	
70 (cup)	2/9/79	3	45	* (F)	*	32	0	0	19	0	0	Blue
70 (net)	2/9/79	3	45			51	0	0	64	1	0	
						83	0	0	83	1	0	

UN = Unfertilized Eggs
F = Fertilized Eggs
1/ * Recovery Test - Introduced 100 eggs and 100 larvae under the screen panel.
2/ Recovery tests of unwashed net. Introduced 100 eggs and 100 larvae under the screen panel. This test was to determine if washing the net is accounting for a large percentage of headless larvae appearing during a normal recovery run. Only the lower 0.3 m of the net was rinsed.

TABLE 4
Preserved Rainbow Smelt Tests
Flattened Oval Inflatable Seal

Screen Mesh Size	Date	Discharge (ft^3/s)	Length of Test (min)	Approximate Sample Size		Number of Organisms Recovered in Plankton Net						Stain
				Eggs	Larvae	Whole Eggs	Egg Cases	Damaged Eggs	Whole Larvae	Headless Larvae	Damaged Larvae	
70	5/9/79 1/	15	45	10,000	10,000	0	0	0	0	0	0	Methylene Blue
70	5/10/79 2/	9	45	10,000	10,000	0	0	0	0	0	0	Neutral Red
70	5/11/79	3	45	10,000	10,000	0	0	0	0	0	0	Methylene Blue
70	5/11/79	9	45	10,000	10,000	0	0	0	0	0	0	Neutral Red
70	5/12/79	3	45	10,000	10,000	0	0	0	0	0	0	Janus Green B
70	5/12/79	15	45	10,000	10,000	0	0	0	0	0	0	Toluidine Blue O
70	5/14/79 3/	3	45	10,000	10,000	2	0	0	3	0	0	Neutral Red
70	5/14/79	15	45	10,000	10,000	0	0	0	0	0	0	Toluidine Blue O
70	5/14/79	9	45	10,000	10,000	0	0	0	0	0	0	Janus Green B
70	5/15/79	3	45	*	*	97	0	0	36	0	0	Neutral Red
70	5/15/79	9	45	*	*	99	0	0	96	0	0	Methylene Blue
70	5/16/79	15	45	*	*	8	0	89	95	3	2 pc = 1	Janus Green B
70	5/16/79	9	45	10,000	10,000	0	0	0	1 4/	0	0	Neutral Red
70	5/16/79	15	45	7,000	10,000	0	0	0	0	0	0	Methylene Blue
70	5/16/79	3	45	0	10,000	0	0	0	0	0	0	Janus Green B
70	5/17/79	3	45	0	10,000	0	0	0	0	0	0	Neutral Red
70	5/17/79	9	45	5,000	10,000	0	0	0	0	0	0	Janus Green B
70	5/17/79	15	45	500	10,000	0	0	0	0	0	0	Toluidine Blue O
70	5/17/79	15	45	0	10,000	0	0	0	0	0	0	Neutral Red
70	5/18/79	3	45	0	10,000	0	0	0	0	0	0	Janus Green B
70	5/18/79	9	45	0	10,000	0	0	0	0	0	0	Toluidine Blue
70	5/18/79	9	45	3,000	10,000	0	0	0	0	0	0	Neutral Red
70	5/18/79	3	45	0	10,000	0	0	0	0	0	0	Nile Blue A

1/ We observed another tear in the collection bag in the vicinity of the previous tear. Dan King suggested that we count this run but note that a small 1-inch tear occurred.
2/ Net seemed to hold up well enough; did not rip again.
3/ The eggs and larvae recovered in this run were not stained red and were determined to be from the side of the bucket used to collect and concentrate the material in the plankton net. This same bucket was used to collect material in the 15 ft^3/s run, and the larvae adhering to the sides were noticed after the second bucket of collected material was strained through plankton netting.
4/ The one larva was stained a dark green and was determined to be from the previous run.
5/ * Recovery Test - Introduced 100 eggs and 100 larvae under the screen panel.

TABLE 5

Preserved Rainbow Smelt Tests
Smelt Larvae - Utah Chub Eggs
Rectangular Inflatable Seal

Screen Mesh Size	Date	Discharge (ft^3/s)	Length of Test (min)	Approximate Sample Size		Number of Organisms Recovered in Plankton Net						Stain
				Eggs	Larvae	Whole Eggs	Egg Cases	Damaged Eggs	Whole Larvae	Headless Larvae	Damaged Larvae	
70	7/17/79	16.5	45	10,000	10,000	0	0	0	0	0	0	Neutral Red
70	7/17/79	3	45	10,000	10,000	1 1/	0	0	0	0	0	Toluidine Blue
70	7/17/79	3	45	10,000	10,000	0	0	0	0	0	0	Green
70	7/18/79	9	45	10,000	10,000	0	0	0	0	0	0	Toluidine Blue
70	7/18/79	16.5 4.5 2/	45	7,000	7,000	0	0	0	0	0	0	Neutral Red
70	7/18/79	16.5	45	10,000	10,000	0	0	0	0	0	0	Fast Green
70	7/19/79	3	45	10,000	10,000	0	0	0	0	0	1 3/	Toluidine Blue
70	7/19/79 4/	9	45	10,000	10,000	0	0	0	0	0	0	Neutral Red
70	7/20/79 5/	16.5	45	10,000	10,000	0	0	0	0	0	0	Fast Green
70	7/20/79 6/	16.5	45	10,000	10,000	0	1 12/	0	0	0	4 7/	Toluidine Blue
70	7/20/79	3	45	10,000	10,000	0	0	0	0	0	1 8/	Neutral Red
70	7/23/79	9	45	10,000	10,000	0	0	0	0	0	0	Fast Green
70	7/23/79	3	45	*	*	99	0	4 9/	88	11	0	Neutral Red
70	7/24/79	9	45	*	*	98	0	10 10/	98	2	0	Nile Blue A
70	7/24/79	16.5	45	*	*	100 1 11/	0	0	88	8	0	Fast Green

1/ Green egg apparently from 3 ft^3/s recovery run of 7/16/79.
2/ During injection of organisms into the headbox, the flow suddenly slowed down due to a burned out pump. The estimated flow was therefore 4.5 ft^3/s. Hiebert only injected about 2/3 of stained, prepared egg and larvae samples, but the test run was conducted for the normal 45 minutes, and the net was washed down as usual. No eggs or larvae were recovered from the plankton net. J. Fitzwater indicated later that a defective pump coupling caused the problem.
3/ The one damaged (eyeless) larva found in this run was stained red and was likely from the run of 7/18/79 in which the reduced discharge (4.5 ft^3/s) was used.
4/ A high discharge was scheduled between the high (16.5 ft^3/s) of 7/18/79 and the low (3 ft^3/s) of 7/19/79. Since the pump was not yet repaired we could not get 16.5 ft^3/s so we did the next run in the schedule. This was the 3 ft^3/s run.
5/ This run was to make up for the skipped high run above.
6/ Regularly scheduled.
7/ Four pieces look like pieces of skin from one larva.
8/ One very small piece of possible larva or egg case.
9/ Four pieces of egg cases.

Preserved Rainbow Smelt Tests
Smelt Larvae - Utah Chub Eggs
Rectangular Inflatable Seal

10/ Ten small pieces of debris from egg cases.
11/ This one blue egg was recovered in subsequent 16.5 ft^3/s recovery run. Egg apparently lodged in pocket of net until washed out in next run.
12/ Distorted blue.
13/ * Recovery Test - Introduced 100 eggs and 100 larvae under the screen panel.

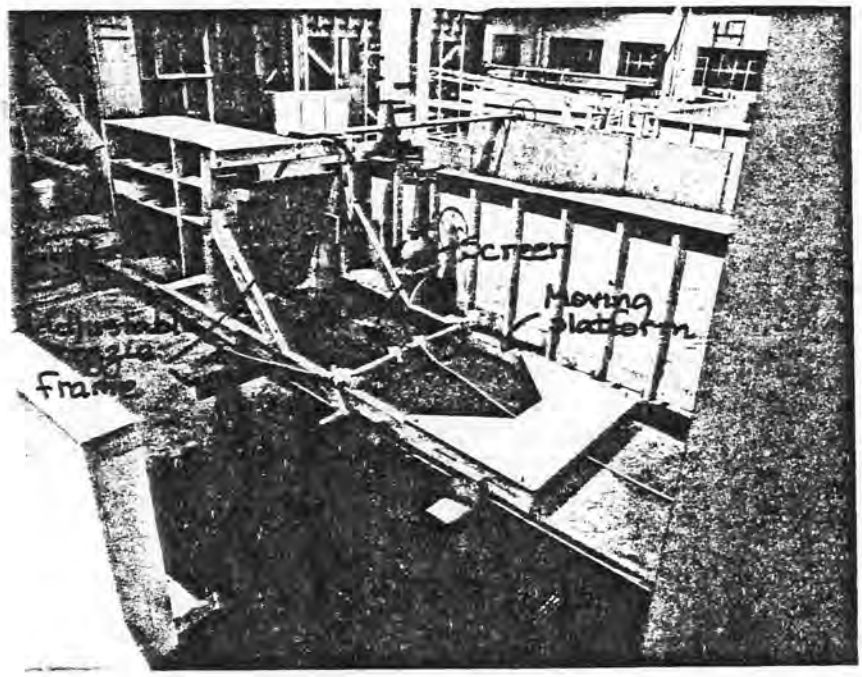


Figure 1. - Screen cleaning test apparatus.

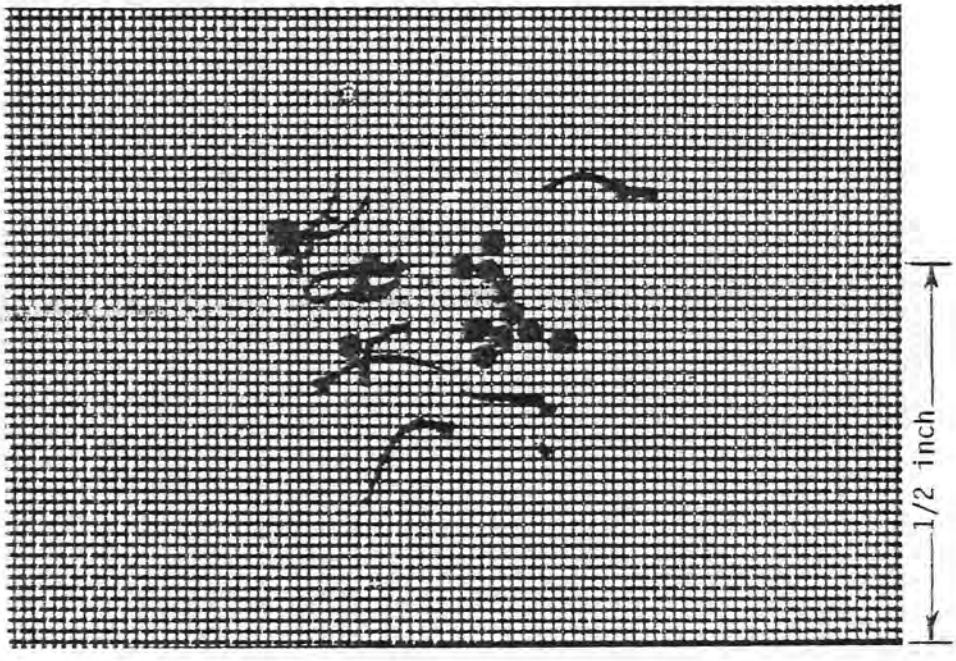


Figure 2. - Magnified photograph of woven wire screen, 70-mesh, with preserved eggs and larvae of rainbow smelt.

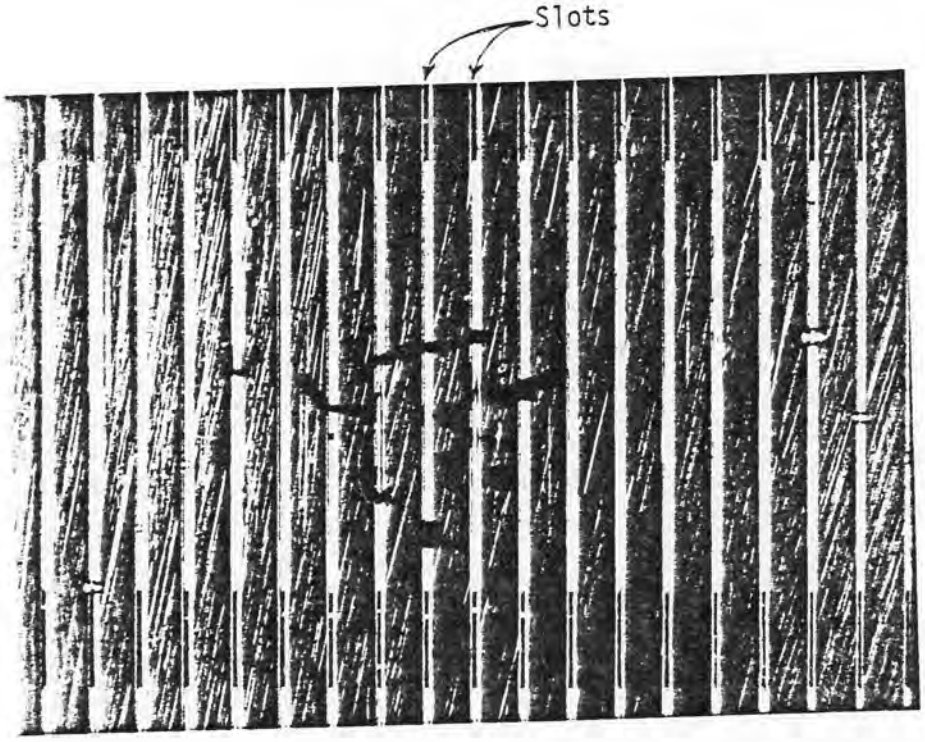
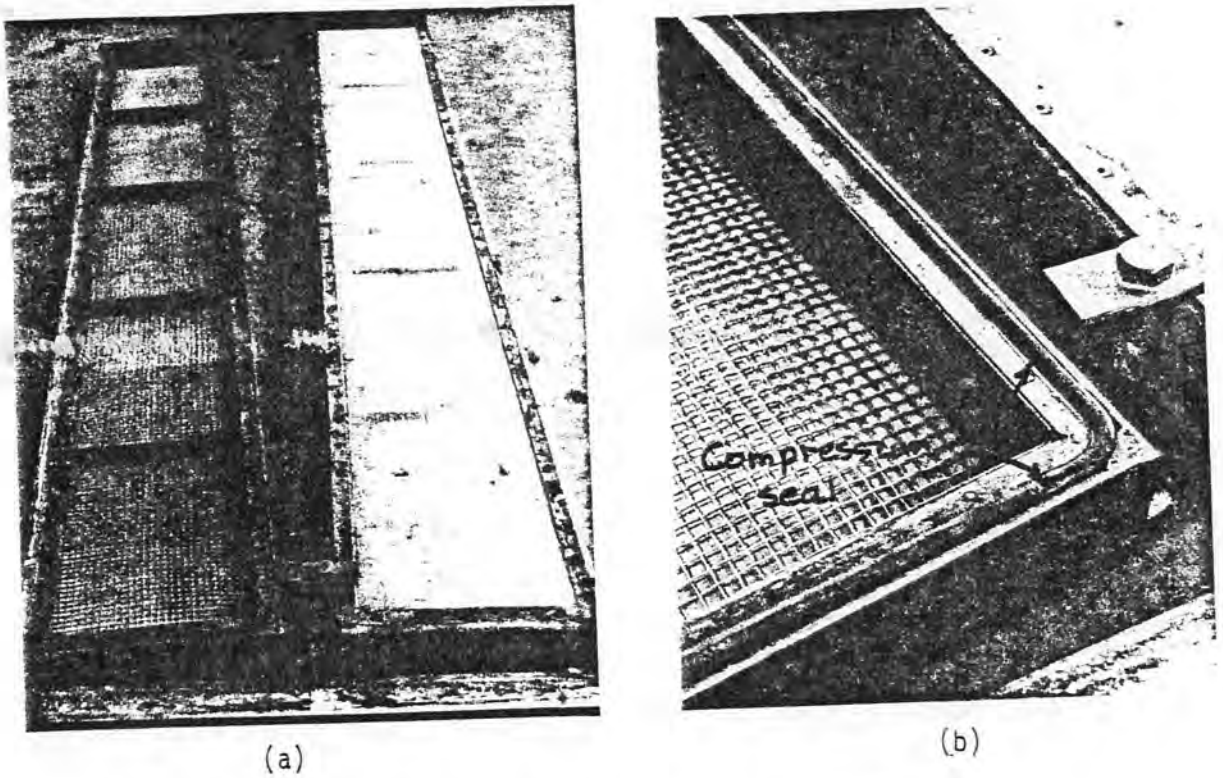


Figure 3. - Johnson well screen with 0.1 mm slot width.



(a) (b)

Figure 4. - Half-panel configuration before installation.
(a) Panel on left is upside down and shows support screen and seal.
(b) Closeup view of bottom of panel with compression seal.

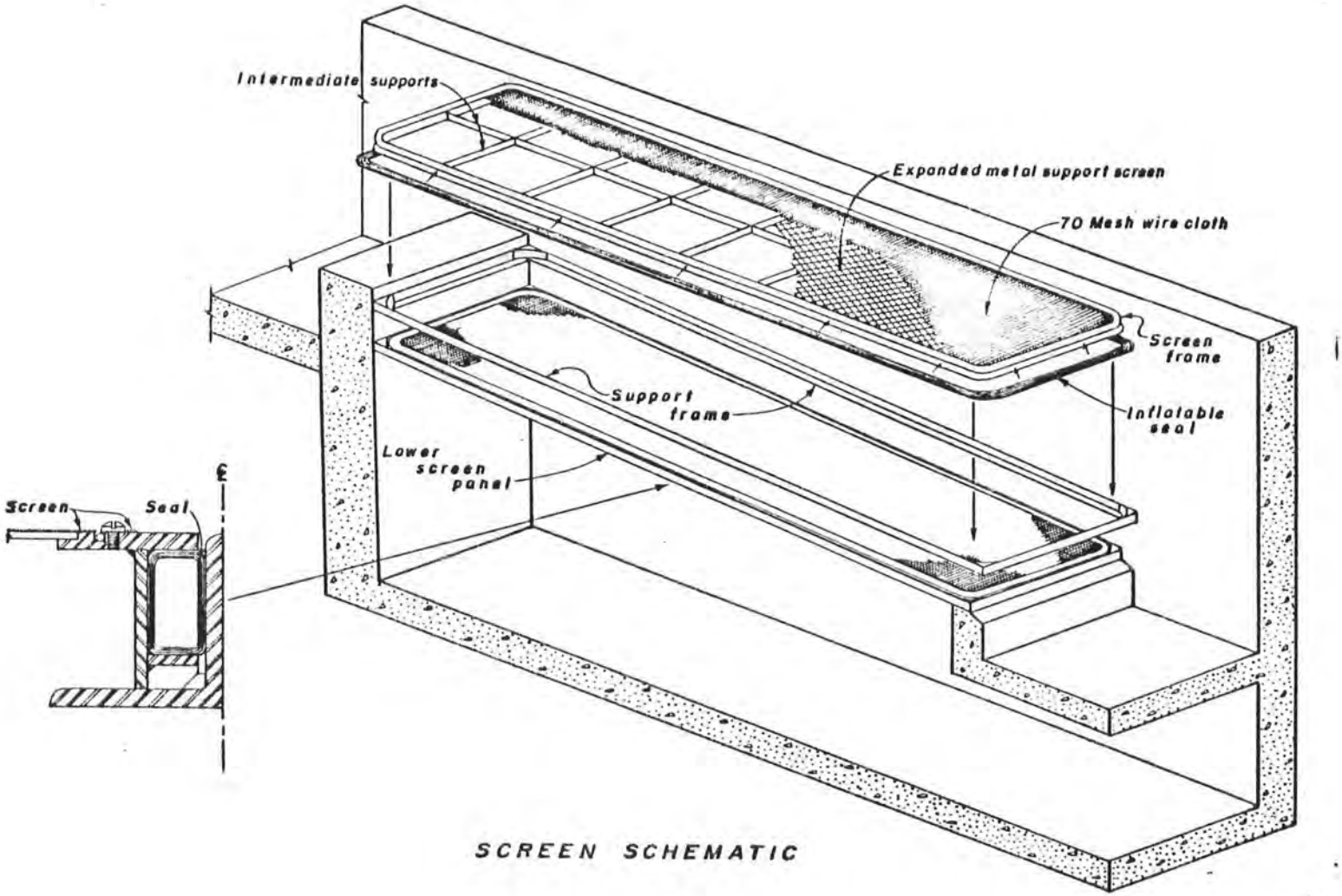


Figure 5. - Schematic of recommended final design.

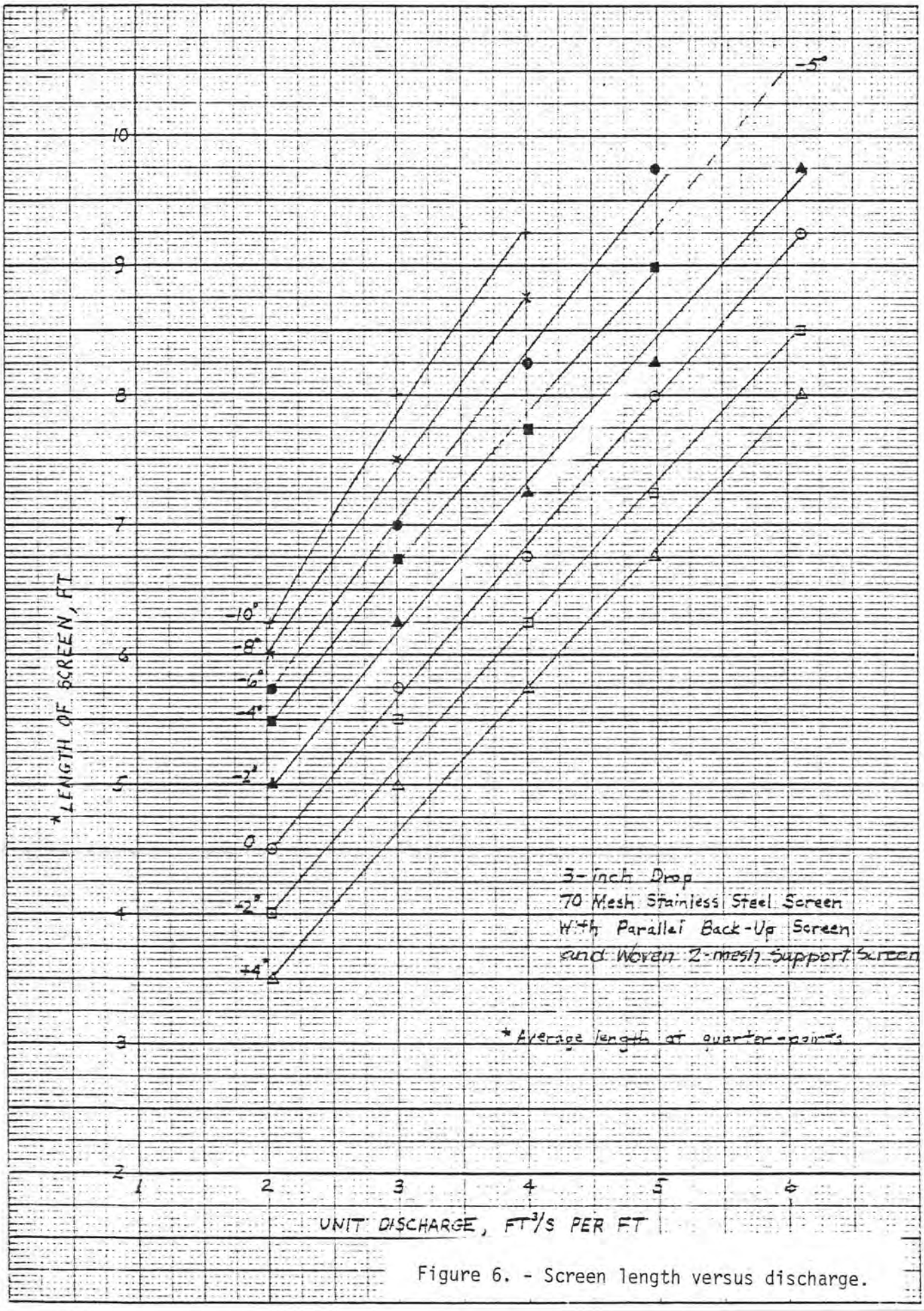


Figure 6. - Screen length versus discharge.

Attachment I

STANDPIPE TESTS
OUTLINE OF LABORATORY TESTING PROCEDURES

A. Test preparation:

1. The section of screen to be tested, mounted at the base of the 4-inch-diameter standpipe, is initially washed to remove surface dust.

2. The standpipe testing devices is positioned under the water supply pipe so that the pipe is behind a filter screen. The free end of the support chain (attached at the opposite end to the standpipe box) is wrapped around the top of the water supply pipe and hooked to the standpipe box. Additional support is provided beneath the overflow weir by a removable piece of plywood, of a height required to level the box.

3. The collection bag made of plankton netting is placed around the base of the standpipe (to which the well screen is attached) and securely fastened by means of a circular clamp located about 3 inches above the base. Everything passing the well screen must therefore pass into the collection bag.

4. A bucket is placed under the standpipe so that the lower portion of the collection bag is submerged when the bucket is full. The water in the bucket acts as a stilling pool to reduce turbulence and lessen possible damage to organisms that pass the screen.

5. Fish egg and larva samples of approximately 100 eggs and 100 larvae each are counted out and then stained.

B. Operation of the standpipe:

1. Water is introduced to the standpipe through two rectangular orifices in the standpipe wall. A constant head differential of approximately 2.4 feet is developed across the screen. The resulting discharge through the screen depends on the screen material being tested. The water passes through the screen, the collection bag, and the bucket. It then flows into the recirculation channel directly below the standpipe.

2. Water not entering the standpipe and passing through the well screen flows across an overflow weir and into the recirculation channel below. The total inflow should be sufficient to produce a continuous flow across the overflow weir.

3. Standpipe operation prior to sample injection is minimized in an effort to minimize screen fouling. Fouling reduces the discharge through the screen.

4. The stained sample of fish eggs and larvae is injected into the standpipe through a 1-1/2-inch-diameter PVC pipe, positioned so that the bottom of the PVC pipe is about 2 inches below the orifices in the standpipe wall. In this way it is insured that none of the injected eggs and larvae are lost over the overflow weir. About 1 liter of water is poured through the PVC pipe to insure that all eggs and larvae are rinsed into the water above the screen. The standpipe is then operated for 45 minutes.

C. Removal of test sample:

1. After the water is turned off and the standpipe is allowed to drain, the circular clamp is loosened and the collection bag is carefully removed. The bag is gently washed out into a clean 5-gallon bucket.

2. The contents of the bucket are carefully strained through a 1-foot square piece of plankton netting. Stained eggs and larvae, or pieces thereof, are collected, counted, and preserved in 10 percent formalin.

3. The plywood support is removed from beneath the overflow weir and the support chain is unhooked from the standpipe box. The testing device is carried to a location outside the laboratory for complete washing of the screen and standpipe.

4. The standpipe testing device is repositioned under the water supply pipe immediately after the washdown, and another test is conducted. The stain colors are alternated between tests to check for possible contamination from previous tests. With this procedure, six tests can be made during a normal working day.

Time required for one test, including standpipe preparation, operation, and cleaning, excluding sample preparation and examination . . . 1.25 hours

Total labor required for single test . . . . . 2.50 man-hours

Attachment I (cont'd)

McCLUSKY CANAL FISH SCREEN SECTIONAL MODEL
OUTLINE OF LABORATORY TESTING PROCEDURES

A. Test preparation:

1. The collection bag made of plankton netting is placed inside the plastic collection cup, with the top of the bag folded over the outside of the cup and held tightly in place by a circular clamp.

2. The collection apparatus consists of a large rubberized nylon bag suspended from a rectangular wooden frame, with a cone of plankton netting attached to the downstream end of the bag. The cone is open at the vertex. The open end of the plankton net is placed through a circular clamp and over the outside of the collection cup. A rubber strap is positioned around the circumference of the cup and beneath the clamp, to protect the net from tearing when the clamp is tightened around the strap, net, and cup. The clamp should be positioned flush with the upstream end of the cup to prevent eggs and larvae from lodging between the net and the cup.

3. After securing the collection cup to the net, the nylon bag is positioned beneath the screen by sliding the wooden frame over its steel supports. Grommeted straps sewn to each of the bottom four corners of the bag are fastened to the model floor by hooks, to prevent the bottom of the bag from rising to the water surface during the test. A C-clamp is tightened onto one support at the downstream end of the bag's frame to prevent shifting of the frame during operation of the model. The collection cup is placed on the floor of the model.

4. The desired sample size of fish eggs and larvae are counted or estimated volumetrically and then stained. The eggs tested may be fertilized or unfertilized, depending upon their availability.

B. Operation of the model:

1. Water is introduced to the model headbox through a rock baffle to evenly distribute the flow. It then passes from the headbox over a broad-crested weir and onto the screen. The weir represents the screen headwall in the prototype. The design discharge, which is determined from hydraulic property tests, is used in addition to low and intermediate discharges to represent a range of operating conditions. (See paragraph B-4 for discharges used.)

2. Water flowing over the downstream end of the screen, and not passing through the screen and collection apparatus, flows away from the model through a drain pipe. This water is collected for filtering and disposal of the retained material.

3. Model operation prior to sample injection is minimized in an effort to minimize screen fouling. The screen tends to foul in the area where the flow first impinges on the screen. Fouling reduced the potential for egg and larvae passage and changes the hydraulic flow conditions on the screen.

4. For injection tests, fish eggs and larvae are introduced above the screen using one of two methods, depending on the purpose of the test:

   a. Testing of the different screen mesh sizes requires injection of fish eggs and larvae into the headbox. To insure a representative distribution of eggs and larvae across the screen being tested, three injection locations in the headbox are used. These locations are about 2 feet upstream from the weir, and at the quarter points of the model's width. At each location about one-third of the stained sample of fish eggs and larvae is poured through a 1-1/2-inch-diameter PVC pipe. The pipe is positioned so that the bottom of the pipe is about 1 inch below the water surface for the center location, and at the elevation of the broad-crested weir for the two outer locations. About 1 liter of water is poured through water. The model is then operated for 45 minutes. Discharges used for testing under these conditions are 3, 9, and 18 ft^3/s, or a lesser maximum discharge based on the capacity of the screen.

   b. Testing of the different screen seal designs requires injection of fish eggs and larvae directly into the areas of the seals. Three standard 3/4-inch-diameter hose sections are installed in the sectional model for injection of eggs and larvae at the sides beneath the weir, and at a point between the two half-panels. About one-third of the stained sample of fish eggs and larvae is poured into each hose and rinsed down with about 1 liter of water. The model is subsequently operated for 45 minutes. Discharges used for testing the seals with the two half-panels are 3, 9, and 15 ft^3/s. The maximum discharge is based on the <u>effective</u> screen area outside the seals.

5. Recovery tests are run periodically to evaluate the effectiveness of the collection apparatus, to insure the reliability of the injection test results. Recovery tests require the release of exactly 100 stained eggs and 100 stained larvae into the water below the screen, to be collected in the plankton net and collection bag for later counting. The model is operated for 45 minutes after the organisms are introduced, regardless of the test discharge.

C. Removal of test sample:

1. After the model is allowed to drain, the C-clamp is removed from the frame support and the nylon bag is unhooked from the model floor. The wooden frame is then slid out from beneath the screen.

2. The sides of the nylon bag are hosed down using a spray nozzle, with the wash water collecting at the bottom of the bag. While two persons lift portions of the bag to allow the wash water to drain away through the net, the person operating the hose cleans the exposed bottom of the bag. The spray nozzle is removed from the hose prior to cleaning the net. The net is then washed from the bag towards the collection cup.

3. The collection cup is placed inside a clean 5-gallon bucket while the plankton net, clamp, and strap are carefully removed. The cup is then set aside while the net is gently washed out into the bucket. The collection bag is removed from the cup by loosening the clamp, and both the bag and clamp are washed out into the bucket.

4. After the initial washdown, the contents of the bucket are carefully strained through a 1 foot square piece of plankton netting. Stained eggs and larvae, or pieces thereof, are collected, counted, and preserved in 10 percent formalin.

5. The screen is hosed down to removed debris as well as eggs and larvae (if an injection test has been performed) deposited during the test. The debris and organisms are carried away with the wash water through the drain pipe for filtering and disposal.

6. The nylon bag and plankton net are hosed down a second time, using the procedures outlined in paragraph C-2.

7. The nylon bag and plankton net are repositioned under the screen immediately after the second washdown, and another test is conducted. A different stain color is used on the organisms for each test, serving to identify eggs and larvae from previous tests. The net is elevated to dry thoroughly overnight by attaching ropes from a hoist to each corner of the nylon bag's frame and lifting the bag above the model floor. Complete drying will cause a permanent change in the appearance of any organisms that inadvertently remain within the collection apparatus, allowing positive identification if recovered in a succeeding day's test. Organisms detected in a test other than that in which they were first introduced will be noted in the test results. With this procedure, four tests can be made during a normal working day.

Time required for one test, including model preparation, operation, and cleaning, excluding sample preparation and examination . . . 1.5 hours

Total labor required for single injection test . . . . . 4.0 man-hours

Total labor required for single recovery test, including additional time for counting recovered sample . . . . . 5.0 man-hours

OPTIONAL FORM NO. 10
JULY 1973 EDITION
GSA FPMR (41 CFR) 101-11.6

UNITED STATES GOVERNMENT

Memorandum

Attachment II

Memorandum

TO : Chief, Applied Sciences Branch

Denver, Colorado
DATE: October 19, 1979

FROM : Head, Environmental Sciences Section

SUBJECT: Fish Acquisition and Culture for McClusky Canal Fish Screen Studies - FY79

Applied Sciences Referral Memorandum No. 80-2-2

Investigated by: S. J. Grabowski

INTRODUCTION

The McClusky Canal, the principal supply works for Garrison Diversion Unit in North Dakota, has been constructed. This canal would supply water from the Missouri River (Lake Sakakawea) for irrigation, municipal and industrial water supplies, recreation, and fish and wildlife purposes in parts of eastern North Dakota. This canal provides a direct link from the Missouri River drainage to the Hudson Bay drainage. The IJC (International Joint Commission) has expressed the concern that this interbasin link will provide an avenue for transfer of undesirable biota, especially fish and fish pathogens. To address the problem of interbasin transfer of fish, USBR has designed and constructed a fish screen structure on the McClusky Canal. The primary objective of this fish screen is to filter all water flowing through the canal to filter out eggs and larvae of the four fish species determined to be of major concern by the IJC.

Laboratory tests currently in progress on the sectional model of the McClusky Canal fish screen at the USBR E&R Center, Denver, Colorado, require that four species of fish be tested to assess the adequacy of the wire-cloth mesh size and the seal design for preventing the interbasin passage of fish, fish eggs, and fish larvae. The eggs and larvae constitute the critical size of interest of the four fish species, and tests are, therefore, conducted with eggs and larvae. To differentiate eggs and larvae used in each of the several tests conducted on any one day, each test lot of 10,000 eggs and 10,000 larvae is stained a different color. It is difficult to stain living eggs and larvae without toxic effects, but neutral red stain seems the least toxic of the stains used.

We were not able to test eggs and larvae of all four species on the sectional model due to the inability in some cases to obtain sufficient

eggs to fertilize and incubate for larvae. I will discuss acquisition, culture, and results for each species separately. The four species of fish required for testing on the sectional model of the McClusky Canal fish screen are: rainbow smelt (Osmerus mordax), Utah chub (Gila atraria), common carp (Cyprinus carpio), and gizzard shad (Dorosoma cepedianum).

The refrigeration units supplied with the three glass aquaria were not dependable so we installed two 1-hp Min-O-Cool refrigeration units as backup on two of these aquaria. These two units were used almost constantly to maintain suitable low water temperature for the smelt. Mr. T. Jackson, Fish and Wildlife Service cooperator in the Envronmental Sciences Section, lent invaluable assistance in fish acquisition through his contacts and suggestions.

Rainbow Smelt

Rainbow smelt (Osmerus mordax) were obtained from several sources including commercial fishermen and state fish and game departments. Smelt acquisition was hindered this year due to an airline strike and the restrictions other airlines imposed on shipment of perishable goods. Consequently, in two cases we chartered planes to fly smelt to Denver.

On March 12, 1979, we obtained about 200 smelt from George Johnson, a commercial fisherman in Escanaba, Michigan. Jerry Peterson, fishery biologist with the Michigan Department of Natural Resources, took care of shipping these smelt to Denver. Mr. Johnson collected the smelt in pound nets set through the ice. About one-half of this lot of smelt were placed in each of two aquaria maintained at 33 to 36 °F. We planned to acclimate fish at this low temperature, place about 20 fish in a separate fiberglass tank at 34 to 35 °F, then gradually raise the temperature to 55 °F. This is about the temperature required for spawning in smelt. I will refer to this fiberglass tank as the spawning tank. This attempt to collect fertilized eggs was partially successful in that we usually obtained sufficient eggs for a test run, but we had negligible larval production from these eggs.

Mortality of this lot of smelt was about 15 to 20 percent after the first day, and we attribute this mortality to the stress of handling and shipping. We observed similar smelt mortality in other lots of adult smelt we received. Smelt mortality then declined to a low level, usually only one or a few fish each day. A few smelt died in the spawning tank, but this amounted to only a few percent. We added smelt to the spawning tank to keep a suitable spawning population there. On some occasions, we placed smelt directly into the 55 °F spawning tank from the 36 °F holding tank and did not observe any adverse effect on the smelt. We could not attribute mortality to direct placement of smelt into water maintained at spawning temperature. This procedure

and these observations were not quantified and should be repeated under controlled conditions with other adult smelt as time and available fish permit.

On April 27, 1979, we received a shipment of about 80 smelt from Cahill Fisheries, Oswego, New York. These fish were flown by charter aircraft and had been in transit about 12 hours. The pilot had stopped at LaCrosse, Wisconsin, to deliver some smelt to the LaCrosse National Fishery Research Laboratory, which conducted acute toxicity tests of seven chemicals on smelt eggs and larvae for the Upper Missouri Regional Office. These fish were shipped in iced water, and we placed them in a holding tank at 36 °F. Shipping mortality for this shipment of Oswego smelt was three fish. In this lot of smelt, as with the Lake Michigan smelt, we observed daily mortality of a few percent. We attempted to spawn these fish in the spawning tank as previously described. With these smelt, we obtained eggs but were unsuccessful in obtaining larvae.

On April 30, 1979, I traveled to Concord, New Hampshire, to confer with fishery biologists from the New Hampshire Fish and Game Department regarding smelt culture and observe their smelt egg taking operation. Details of their operation are described in my travel report of May 22, 1979. Briefly, rainbow smelt in Black Brook spawn over burlap mats, which are removed from the stream after they hold about 200,000 eggs and incubated. I obtained three of these burlap mats of smelt eggs which amounted to about 600,000 eggs. These were placed in a plastic bag in a styrofoam container and covered with a dome of oxygen. Upon returning to Denver, I placed these burlap mats in a Heath incubator for incubation. These eggs began to hatch May 4 and we continued to obtain larvae for about 10 days. These larvae were used with the eggs collected in the spawning tank to conduct tests on the fish screen model. We had devised a collecting trap for smelt larvae, to allow easier harvesting of newly hatched smelt and to prevent any smelt larvae from entering the channel in the Hydraulics Laboratory when we incubated eggs in the aquarium enclosure. All the larvae we used for testing on the fish screen model were from the New Hampshire eggs. Hatching success was very high; we obtained enough larvae to conduct 24 screen tests and preserved a sufficient number to conduct about 30 additional tests. I plan to pursue acquisition of rainbow smelt eggs from New Hampshire for testing in FY80, since I feel these eggs offer the best prospects for a large supply of larvae. Eggs most likely will be obtained from different populations of adult smelt placed in a spawning tank.

On May 11, 1979, we obtained about 140 rainbow smelt from Lake Superior. These smelt were collected on their upstream spawning run in the French River by Mr. E. Peiring, fishery biologist at the French River Hatchery. These smelt were again shipped in plastic bags inside styrofoam cartons with a dome of oxygen and with lake ice to maintain a low temperature.

The Upper Missouri Regional Office plane flew these smelt from Duluth, Minnesota, to Denver, Colorado. Shipping mortality amounted to six fish. After a total mortality of 20 smelt, mortality virtually ceased. We placed about 15 of these smelt in the spawning tank and increased the temperature appropriately in an attempt to induce spawning. We observed no egg production from these smelt nor from other smelt placed in the spawning tank later. We tried to obtain eggs manually by handstripping fish and found only male fish in the spawning tank. All other smelt in the holding tank were checked manually and we found that all remaining fish were males. This unusual and undesirable circumstance was probably due to sexual segregation of smelt on the upstream spawning run. It was unfortunate that we had all males surviving in the holding tank, but other species are known to segregate sexually on upstream spawning runs. Had the smelt been collecting by trawling in Lake Superior, we would assume a more even distribution of male and female smelt. These male smelt were destroyed on June 25, 1979.

Despite problems encountered with shipment of smelt and the variable degree of success in obtaining and incubating eggs from adult smelt here in the laboratory, we were more successful this year with the smelt than with other species.

Results of fish screen tests with rainbow smelt eggs and larvae are reported in the FY79 progress report of the testing coordinator.

Gizzard Shad

Gizzard shad (Dorosoma cepedianum) are relatively fragile fish and usually do not survive handling and transporting very well. This species is usually used as a forage base for game fish but is not traditionally cultured in hatcheries and not often worked with by fishery biologists. To produce young shad for forage, fishery biologists stock adults in the lake of interest and allow these to spawn naturally. This is the procedure the Colorado DOW (Division of Wildlife) uses to produce shad for forage in lakes and reservoirs where the species does not survive the winter. I contacted Mr. J. Whittaker, a fishery biologist with the Colorado DOW, who indicated that we could obtain prespawning gizzard shad adults from them in May 1979. On May 22, 1979, we obtained 10 adult gizzard shad from the DOW. These shad were collected in three trap nets, set in a large private lake near Longmont, Colorado. We transported these 10 shad to the E&R Center in a fish hauling tank to which we added enough salt to make about a 1 percent solution with the lake water. The DOW had previously found that transporting shad in a mild salt solution reduced shipping mortality. Fishery workers have used this method of transporting fish in the past, especially with salmonids. A salt solution reduces osmoregulatory stress on the fish and enhances survival of transported fish. One of the 10 shad seemed to be in distress when we arrived at the E&R Center,

but all 10 shad survived hauling. The first mortality was a 350-mm female found on May 26, 1979. A second mortality was found on May 27, 1979, a 355-mm male.

On May 29, 1979, we attempted to spawn the remaining eight shad. We could obtain only a few hundred eggs from two females and had to sacrifice the only male producing milt to fertilize these eggs. By May 30, 1979, about 90 percent of the eggs were dead as indicated by their opaqueness. The remaining eggs gradually died and we obtained no larvae. None of the remaining seven shad handled in this spawning attempt died; they seemed as active as usual. The shad did show signs of a fungal infection and we treated the shad with 1:14,000 formalin for 1 hour on May 31, 1979. No immediate effect was seen, but on June 1, 1979, five shad were dead. A sixth shad was dead on June 2, 1979. The last shad remained alive until June 25, 1979. Mortality was probably due to the formalin treatment.

On June 8, 1979, we obtained nine gizzard shad from the Colorado DOW. These were trap netted near Longmont, Colorado, transported to the E&R Center in a 1 percent salt solution, and placed in a holding tank behind the greenhouse. These shad likewise survived transportation very well. We attempted to spawn these shad on June 27, 1979, but obtained less than 100 eggs. The attempt was unsuccessful but the shad survived the handling. One shad was dead on July 3, 1979, and three more were dead on July 5, 1979. We later attempted to collect eggs from the remaining shad but obtained no viable eggs. We destroyed these shad on July 11, 1979.

The attempt to obtain shad eggs for larval production was unsuccessful this year. Other fishery workers have also experienced extreme difficulty in handling shad and in obtaining viable eggs. We have had some success in transporting shad and will attempt to obtain shad for egg and larval production again in FY80. Mr. D. Tomljanovich of TVA (Tennessee Valley Authority), Norris, Tennessee, sent us three containers of preserved mixed gizzard shad and threadfin shad larvae that TVA had collected. The size of these preserved larvae ranged up to 1 inch and would not be suitable for a rigorous test of the fish screen and seal. We do, however, appreciate the efforts TVA made to supply preserved larvae.

On September 11, 1979, Mr. J. Whittaker called and indicated that the DOW could supply us with gizzard shad on that day. S. Hiebert and G. Skalla drove to Longmont, Colorado, and picked up 73 gizzard shad. These were transported back to Denver in a 1 percent salt solution. We found three mortalities on September 12, 1979. Unfortunately, sometime September 15, 1979, the flexible line from the air pump separated at the gang valves and the shad were without air. By 6 p.m. when I arrived at the E&R Center to check the fish, all had died. This mechanical failure was probably due to an initial poor connection or tampering by unauthorized persons in the wet lab.

We were attempting to hold gizzard shad over the winter to have mature fish on hand for the spring. We may not be able to accomplish this.

Utah Chub

We arranged with Wyoming Game and Fish Department to trap net Utah chub (Gila atraria) in early June 1979 in Flaming Gorge Reservoir, Green River, Wyoming. We set a New Hampshire style fyke net in a bay near Buckboard Marina on June 12, 1979, and on the morning of June 13, 1979, found over 1,000 fish in the trap net. Most of these fish were Utah chub. We loaded about 500 Utah chub in our hauling tank for transport to the E&R Center. We had added about 25 pounds of salt to each half of the fish hauling tank. This amount of salt would produce approximately a 2 percent solution, the concentration recommended for hauling by Dr. C. Berry of Utah State University. We also supplied the chub with oxygen. After several hours in transit, we began to observe mortality, and by the time we arrived in Denver, we had about 90 percent mortality. Some of these recently dead fish were in spawning condition and we stripped and fertilized eggs for incubation. This proved to be a futile attempt since we obtained only one larva from the many thousands of eggs incubated. Live chub were placed in a holding tank. On June 15, 1979, we placed five Utah chub in a spawning tank maintained at 58 °F. We slowly raised the temperature to 64 °F. We could not observe any natural spawning of chub. One dead male chub was found in the spawning tank June 22, 1979, and one female chub on June 23, 1979. Four other female chub in the spawning tank produced no eggs and were dead on June 25. The tank was drained, cleaned, and refilled. On June 26, we attempted to hand strip eggs from three chub but could not obtain eggs or milt. These were placed in the spawning tank along with six more on June 27. One of these chub released a few hundred eggs but we could not obtain milt to fertilize them. On July 2, 1979, we again tested the remaining 20 chub from the holding tank. Three females released many eggs easily but we had to sacrifice a male to obtain milt. The male possessed very little milt and we did not achieve fertilization of these eggs. We placed all these chub in the spawning tank and attempted to strip eggs and milt again on July 10, 1979. This attempt was not successful. In an attempt to induce spawning of chub, we injected eight chub with about 250 units of HCG (human chorionic gonadotrophin) and 0.05 mg clomid on July 24, 1979. Dr. Berry and his graduate student at Utah State University recommended using a mixture of carp pituitary and clomid to induce spawning in Utah chub, but we only learned of this technique the day before we left for Flaming Gorge. Carp pituitary would not be available for several months, so we decided to use HCG instead. This has been used by fishery workers to induce spawning in some species of fish, with different degrees of success. To my knowledge, HCG had not been tried with chub. We could obtain no eggs from the chub injected interperitoneally with the mixture of HCG and clomid. I spoke with Dr. Berry who indicated that our chub were probably overripe by that time and the eggs were probably

being reabsorbed. They had a problem with overripe female chub in work they are conducting for USBR. He suggested that we should have injected chub immediately after bringing them to the laboratory. Since we are now familiar with the experimental procedure, we will attempt injecting chub in FY80. The chub do not seem to spawn in the spawning tank as readily as do smelt and apparently must be injected and hand stripped and fertilized to obtain larvae. Remaining adult chub were destroyed August 2, 1979.

On August 7, 1979, Dr. Berry airfreighted about 1,000 Utah chub larvae to the E&R Center. Shipping mortality was about 90 percent. We placed live chub larvae (about 2 weeks old) in an aquarium and fed them with finely ground trout chow. About 20 of these larvae still remain.

We arranged with Dr. Berry to pick up adult Utah chub at Logan, Utah, on August 14, 1979. He had collected chub from five different locations and maintained these in a hatchery. We obtained about 100 Hebgen Lake chub and about 100 Flaming Gorge Reservoir chub and transported these to the E&R Center. We used the salt concentration for hauling recommended by Dr. Berry, but observed high mortality during transit. Only eight Flaming Gorge chub and six Hebgen Lake chub survived the 12-hour trip from Logan. In a subsequent conversation with Dr. Berry, we concluded that 2 percent salt may be too high for long-term hauling of chub and on subsequent hauls will reduce the salt concentration. We brought chub to the laboratory in an attempt to hold them over until next spring and cycle them through a shorter and earlier winter to bring about earlier maturation in the spring. Dr. Berry has done this with some chub populations. Dr. Berry plans to bring Locomotive Springs chub to the E&R Center October 9, 1979, and we will hold these over the winter.

We also brought back about 1,000 chub larvae which survived the trip in fine shape. We had hoped to obtain enough chub larvae for several test runs on the fish screen model, but the number of larvae Dr. Berry could supply was too small to conduct any tests.

For FY80 we plan to collect chub again earlier in May in Flaming Gorge Reservoir and be prepared to inject these fish with the carp pituitary and clomid mixture recommended by Dr. Berry and his graduate student.

Common Carp

Common carp (Cyprinus carpio) are widely distributed and we planned to collect spawning carp by seining local ponds and lakes. I contacted Bruce Rosenlund, FWS fishery biologist in Denver, who suggested using a 2-1/2-inch mesh gill net in the lake at the Federal Correctional Institution in Lakewood, Colorado. He indicated that he experienced difficulty in seining carp in that lake, but collected many carp using

a gill net. Since a carp population will spawn throughout the summer, we felt that gravid carp could be collected easily to obtain eggs throughout the summer.

On June 28, 1979, we used a 50-foot by 6-foot 1/2-inch mesh seine to seine several shoreline areas of the lake at the Federal Correctional Institution. We had seen carp along the shoreline before seining but were not successful in collecting carp. That afternoon, we set Mr. Rosenlund's gill net and within 15 minutes captured seven carp. We picked these from the gill net, reset the net, and transported the seven carp to the E&R Center. On the morning of June 29, 1979, we found 20 carp in the gill net and transported these back to the E&R Center. We reset the net but found no carp later that afternoon. Carp seemed to move about more during hours of darkness. Of the 20 carp collected that morning, we had 17 mortalities later in the day, 11 females and 6 males. The eggs of the females were not quite ripe and were preserved in formalin.

On July 2, 1979, we collected only one carp in the seine and set the gill net. We found 11 carp that afternoon and transported these to the E&R Center. We left the gill net set overnight in the southeast area of the lake, but during the night vandals had pulled the net towards shore and left it in a heap in shallow water. The five carp in the net were in poor condition. These five carp rapidly became covered with fungus and all died by July 9, even though three had received a 30-second treatment of 1:15,000 malachite green.

We attempted to spawn the carp we picked out of the gill net but without success. Female carp did not appear to be ripe enough to release eggs easily.

Hormone injections are sometimes used to induce spawning in sexually mature fish. We prepared a mixture of HCG and clomid so that 1 mL of the mixture would contain about 500 units of HCG and 0.5 mg clomid. On July 23, 1979, we injected 11 carp with 0.75-1.1 mL of the mixture intramuscularly. We tested these carp for evidence of eggs and milt July 24, and obtained less than 100 eggs and virtually no milt. We injected an additional five carp with the HCG and clomid mixture interperitoneally.

On July 25, 1979, we injected 15 carp interperitoneally with the HCG and clomid mixture; no eggs were obtained on July 26, so we reinjected nine carp with HCG only. These carp produced no eggs by July 27. We reinjected another five carp with HCG. None of these injected fish produced eggs, and we decided to abandon this approach for the time being. Many of the females injected contained eggs, but they were apparently not mature or overripe.

On August 2, 1979, we seined the lake again and collected three carp. We sacrificed all carp to obtain eggs and milt. This attempt at

fertilization was not successful. Fourteen carp held at the greenhouse were brought down to the wet lab in building 56 on August 3, 1979. All seemed to be in good shape but not producing eggs and milt.

Personnel from the Federal Correctional Institution indicated that they were going to drain their lake, seine it to collect most fish, then rotenone the lake to kill all remaining fish. Mr. Rosenlund would coordinate the rotenoning operation. They suggested that we would have better luck seining the lake for carp after it was drawn down. We seined the lake again on August 23 but collected no carp.

Messrs. Hiebert and Skalla seined this lake again on August 28, 1979, and collected only one carp. Rotenoning of the lake was to take place August 31, after which time all fish should be eliminated.

I received permission from Lakeside Park in Denver to collect carp in their lake. On September 13, 1979, we collected 28 carp near their dock. Four males appeared ripe but we found no ripe females. We will hold these fish over the winter and attempt to spawn them in the spring.

In summary, we have 28 carp from Lakeside Park and 10 carp from several seining efforts over the summer.

Copy to: D-915
D-1520
D-1522
D-1522 (Hiebert, Grabowski)
D-1530 (King)

OPTIONAL FORM NO. 10
JULY 1973 EDITION
GSA FPMR (41 CFR) 101-11.6

Attachment III

UNITED STATES GOVERNMENT

Memorandum

Memorandum

TO : Chief, Hydraulics Branch

Denver, Colorado
DATE: October 1, 1979

FROM : Stephen J. Grabowski, Research Fishery Biologist

SUBJECT: Proposed Schedule for Acquiring Fish for McClusky Canal Fish Screen Testing Program - FY80

In FY80, four species of fish must be tested on the McClusky Canal fish screen model at the E&R Center to verify the final screen mesh size and seal design for the McClusky Canal fish screen. The four species of concern are rainbow smelt (Osmerus mordax), common carp (Cyprinus carpio), Utah chub (Gila atraria), and gizzard shad (Dorosoma cepedianum).

Some problems in fish acquisition were encountered in FY79. To alleviate some of these problems in FY80, I will arrange for fish acquisition as early as practical and possible, including acquiring fish in the fall to hold over the winter. If we (Steve Hiebert and myself) succeed in holding fish over the winter, we will manipulate the environmental holding conditions early in the spring to bring fish up to spawning condition earlier than would occur naturally.

I will discuss acquisition of each of the four species separately.

RAINBOW SMELT (OSMERUS MORDAX)

Mr. Bill Ingham, fishery biologist with the New Hampshire Fish and Game Department, has indicated that the department will probably be able to supply USBR with sufficient rainbow smelt eggs in April 1980 for our testing program. Mr. Ingham visited the E&R Center September 27, 1979, during which time I explained the Garrison Diversion Project in detail and provided him with a map of the project area. I also showed him the fish screen model. He indicated that he could use all this information to explain our need for smelt eggs to Fish and Game Commissioners in New Hampshire. I plan to travel to Concord, New Hampshire, in April 1980 to pick up rainbow smelt eggs.

Mr. Ed Piering, Assistant Manager of the French River Hatchery, Duluth, Minnesota, indicated that the hatchery has sufficient space to hold rainbow smelt for a time and that he could oversee the shipment of the adult smelt to the E&R Center. I have not yet been able to contact Mr. Stanley Sivertson, a commercial fisherman from Duluth, about the availability of smelt this fall. However, his secretary indicated that

they do fish for smelt in the fall in Lake Superior, but that the season is just beginning. I plan to contact Mr. Sivertson later in October 1979 to coordinate acquisition of smelt and shipment of smelt with him and Mr. Piering.

Mr. Howard Kunesh, Manager of the Garrison Dam National Fish Hatchery, Riverdale, North Dakota, also indicated that his hatchery has some space available to hold any smelt collected in Lake Sakakawea. He could also oversee shipment of smelt to the E&R Center. I have not been able to contact Mr. Emil Berard, area fishery biologist for the North Dakota Game and Fish Department in Riverdale, concerning his fish sampling and collecting program for this fall. I, therefore, do not know if he will be collecting smelt this fall. In spring 1979, Mr. Berard had planned to provide USBR with smelt, but by the time the ice went off Lake Sakakawea and he could safely set his nets, the smelt had spawned.

Mr. Jerry Peterson of the Michigan Department of Natural Resources, Escanaba, Michigan, informed me on September 17, 1979, that local commercial fishermen do not fish for smelt in the fall in that area of Lake Michigan but rather set pound nets for smelt in the winter after ice forms and shipping on the lake ceases. He said that he would check on the fall smelt fishing situation in other areas of Lake Michigan and let me know, but as of September 28, 1979, he had not contacted me. I learned that he was out of town that week. I will try to contact Mr. Peterson again in early October.

UTAH CHUB (GILA ATRARIA)

In August 1979 we obtained about 200 Utah chub from Dr. Charles Berry, Assistant Leader of the Utah Cooperative Fishery Unit at Utah State University, to hold over the winter. Unfortunately, we had high mortality during transit to Denver and presently have only six Flaming Gorge chub and six Hebgen Lake chub from this venture. Dr. Berry plans to transport about 200 Locomotive Springs, Utah chub to Denver in late October or early November 1979. Since we experienced high mortality rates when hauling chub in Dr. Berry's recommended 2 percent salt solution, he plans to reduce the salt concentration for this trip. We will attempt to hold these fish over the winter in the wet laboratory and spawn them in the spring.

In addition, we also plan to collect Utah chub in Flaming Gorge Reservoir in late May or early June 1980 contingent upon approval of the Wyoming Game and Fish Department. In June 1979, we were able to collect chub rather easily, but the mortality rate during transit to Denver was high. We plan to use a much reduced salt concentration for fish transportation in 1980 and haul fewer fish per tank to lessen crowding stress. A mild salt solution is often used in fish transporting to reduce osmoregulatory stress. Field collection of eggs will be considered if opportunities arise.

COMMON CARP (CYPRINUS CARPIO)

In 1979, we collected common carp from the lake at the Federal Correctional Institution in Englewood, Colorado. These carp were collected by gill netting and seining, but it appears that the stress of gill netting affected the viability of the eggs. We were not successful in obtaining larvae from these eggs.

We now have about 62 carp in a plastic-lined pond behind the Environmental Sciences Section greenhouse. Twenty-eight of these carp are from Lakeside Park and were collected on September 13; the remaining carp are from the Federal Correctional Institution. We plan to maintain these carp over the winter and spawn them in the spring. In addition, we will seine local waters for carp in the early spring. We began collecting carp rather late in 1979, but we will begin collection of carp earlier in the spring of 1980 to insure that we have gravid carp available.

GIZZARD SHAD (DOROSOMA CEPEDIANUM)

Gizzard shad are relatively fragile fish that are reportedly extremely sensitive to handling. We obtained 19 gizzard shad from the Colorado DOW (Division of Wildlife) in May 1979. We successfully maintained these shad but were unsuccessful in obtaining spawn. On September 11, the DOW provided USBR with an additional 73 gizzard shad. Only three shad died during handling and transporting. On September 15, a mechanical malfunction of the aeration system caused the death of the remaining 70 shad. Mr. Jerry Whittaker, fishery biologist with the DOW who provided these fish, said that the prospects for collecting more gizzard shad this fall are very poor. Mr. Whittaker will keep us informed about his fish collecting activities in spring 1980 and let us know when he finds sufficient numbers of shad. Shad are cold-sensitive fish and do not overwinter well in some reservoirs in Colorado. The DOW collects prespawning shad in the spring for stocking in lakes and reservoirs where they desire to reestablish shad as a forage fish.

We will keep in touch with Mr. Whittaker concerning shad acquisition in spring 1980.

Since the status and nature of fish populations are linked to environmental conditions and since no one can predict the severity of the approaching winter accurately, it is not possible to provide a more detailed schedule for acquisition of rainbow smelt and gizzard shad at this time. I feel that Utah chub can be collected easily in Flaming Gorge Reservoir using a trap net in late May or early June 1980 and that carp should be available from local waters earlier in the season

than last year. An airline strike in 1979 hampered shipment of adult rainbow smelt to Denver. If no airline strike is in progress in 1980, shipment of fish to the E&R Center should be less of a problem.

Table I summarizes potential sources of eggs and larvae for the various species.

Copy to: Commissioner, Attention: 122 (Seaman)
Project Manager, Bismarck, North Dakota, Attention: 400 (Knoll)

Blind to: D-1520
D-1522
D-1522 (Hiebert)
D-1522B

Grabowski
26 Oct 79

10/29/79

10/29/79

Table I. Approximate dates for acquisition of adults and eggs of rainbow smelt, gizzard shad, Utah chub, and common carp.

SPECIES	SOURCE	DATES	REMARKS
Rainbow smelt (*Osmerus mordax*)	New Hampshire (Bill Ingham)	Early April 1980	600,000 eggs
	Maine (Bill Andrews)	April - May 1980	500,000 eggs
	Wisconsin (Fred Binkowski)	Early-mid April 1980	Could collect adults, spawn onsite, ship fertilized eggs to E&R Center. May need to provide support.
	Michigan (Jerry Peterson)	February-March 1980 after ice forms and fishermen set nets	Adults
	Minnesota (Stan Sivertson)	November 1979 March-April 1980	Can supply adults. Poor fishing in October 1979. Cannot predict success for Fall 1979. Can supply fish in spring.
Gizzard Shad (*Dorosoma cepedianum*)	Nebraska (Monty Madsen)	Late April 1980	Game and Parks Commission personnel would call E&R Center after they have collected sufficient number of pre-spawning adults.

SPECIES	SOURCE	DATES	REMARKS
	Kansas (Mike Cox)	Early-mid March 1980	Can provide 100 prespawning adults if we assist in collection. Fish numerous in Webster Reservoir.
	Colorado (Jerry Whittaker)	May 1980	Can provide prespawning adults if sufficient numbers are collected.
	New Mexico (Bob Parish)	Mid-March to early April 1980	We could collect prespawning adult gizzard shad in Ute Lake.
	Texas (Joe Kraii)	Early-mid May 1980	We could collect prespawning adult gizzard shad in Lake Meredith.
	Oklahoma (John Stahl)	April 1980	They could supply prespawning adult gizzard shad during their electrofishing operation at Fort Supply Reservoir.
Utah Chub (Gila atraria)	Utah (Charles Berry)	November 1979	100-200 adult chub

SPECIES	SOURCE	DATES	REMARKS
	Wyoming (Steve Faccianni)	mid-late May 1980	Can supply sufficient adults from their purse seining operation. If too late in the season, we would have to trap net for prespawning adults.
		October 1979	About 12 adult chub on hand in lab.
Common carp (Cyprinus carpio)	Colorado	Fall 1979	About 60 adult carp now on hand.
		May-June 1980	Collect adult carp from local waters.

Attachment IV

EXPERIMENTAL DESIGN FOR FISH SCREEN TESTING OF PASSAGE OF LARVAE AND EGGS WITH UP TO NINE REPLICATES INVOLVING TWO OPERATION MODES AND THREE FLOW RATES: SMELT

Replicate	Day	Operation Mode	Flow Rates		
			1st Run	2nd Run	3rd Run
I*	1	Normal	H	M	L
	2	Cleaning	H	M	L
II	3	Cleaning	L	H	M
	4	Normal	M	L	H
III	5	Normal	L	H	M
	6	Cleaning	M	L	H
IV*	7	Normal	M	H	L
	8	Cleaning	M	L	H
V	9	Normal	L	M	H
	10	Cleaning	H	M	L
VI	11	Cleaning	L	H	M
	12	Normal	H	L	M
VII*	13	Cleaning	H	M	L
	14	Normal	M	L	H
VIII	15	Normal	L	H	M
	16	Cleaning	L	H	M
IX	17	Cleaning	M	L	H
	18	Normal	H	M	L

*Replicates with recovery runs included.

EXPERIMENTAL DESIGN FOR FISH SCREEN TESTING OF PASSAGE OF LARVAE AND EGGS WITH UP TO NINE REPLICATES INVOLVING TWO OPERATION MODES AND THREE FLOW RATES:

CARP

Replicate	Day	Operation Mode	Flow Rates		
			1st Run	2nd Run	3rd Run
I*	1	Cleaning	M	L	H
	2	Normal	L	H	M
II	3	Normal	M	L	H
	4	Cleaning	H	M	L
III	5	Normal	H	M	L
	6	Cleaning	L	H	M
IV*	7	Cleaning	H	L	M
	8	Normal	M	L	H
V	9	Normal	H	M	L
	10	Cleaning	M	H	L
VI	11	Cleaning	L	M	H
	12	Normal	L	H	M
VII*	13	Normal	H	M	L
	14	Cleaning	M	H	L
VIII	15	Cleaning	L	M	H
	16	Normal	L	H	M
IX	17	Normal	M	L	H
	18	Cleaning	H	L	M

*Replicates with recovery runs included.

Attachment IV (cont'd)

EXPERIMENTAL DESIGN FOR FISH SCREEN TESTING OF PASSAGE OF LARVAE AND EGGS WITH UP TO NINE REPLICATES INVOLVING TWO OPERATION MODES AND THREE FLOW RATES:

UTAH CHUB

Replicate	Day	Operation Mode	Flow Rates		
			1st Run	2nd Run	3rd Run
I*	1	Cleaning	H	M	L
	2	Normal	H	L	M
II	3	Cleaning	M	L	H
	4	Normal	M	H	L
III	5	Normal	L	M	H
	6	Cleaning	L	H	M
IV*	7	Cleaning	M	H	L
	8	Normal	M	H	L
V	9	Normal	L	M	H
	10	Cleaning	H	L	M
VI	11	Cleaning	L	M	H
	12	Normal	H	L	M
VII*	13	Normal	M	H	L
	14	Cleaning	M	L	H
VIII	15	Normal	H	L	M
	16	Cleaning	H	M	L
IX	17	Cleaning	L	H	M
	18	Normal	L	M	H

*Replicates with recovery runs included.