A TRACY DEMONSTRATION FISH FACILITY (TDFF) TO PROVIDE TECHNOLOGY DEVELOPMENT FOR UPGRADING SOUTH DELTA FISH SALVAGE FACILITIES, CALIFORNIA

DRAFT CONCEPT REPORT

SUBMITED BY

U. S. BUREAU OF RECLAMATION

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TO

CALIFORNIA SOUTH DELTA FISH FACILITIES FORUM (SDFF)

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EXECUTIVE SUMMARY

Background

Prior to improving or replacing South Delta fish facilities at the Federal and/or State water projects, the benefits of proposed actions need to be evaluated from both a fisheries and engineering basis. These benefits must be evaluated in the context of fish recovery to guide the development of cost effective South Delta fish protection. The existing fish facilities are large fish collection systems located in essentially a dead end area of the South Delta. Fish drawn to the area are guided via behavioral louvers into large holding tanks for eventual transport to outfalls in the western Delta. Many fish pass through these louvers and are lost in the diversions. Other direct facility fish losses include predation due to the accumulation of fish drawn to the area, as well as collection, handling, transportation and release (CHTR) losses. Indirect losses due to pumping operations may be significant as well. All losses need to be put in perspective when planning for new facilities.

The existing 1950's era fish collection processes and facilities have essentially remained unchanged since they were first constructed. This despite corroding facilities, manually operated systems, increased debris loads, higher pumping rates, reduced outage periods, and the introduction of nuisance species (mitten crabs, etc.). New screening and collection technologies are needed to function in this environment. This technology development requires fisheries and hydraulic testing for agency and stakeholder acceptance. Assurances through on-site investigations will lead to the most economical solutions at a given level of fish protection. This proposal is focused on testing new technologies and facilities in the South Delta environment to compliment on-going research.

New facilities and technologies must be implemented within the context of a larger fish recovery strategy. While improving facilities to reduce direct fish losses is important from a regulatory and legal standpoint, it is not in and of itself a fish recovery solution. Understanding and prioritizing fish recovery strategies is important in guiding the development of cost effective South Delta fish protection facilities. The near and far field effects of drawing fish to the South Delta due to State and Federal pumping or barrier operations is critical to this understanding. The USBR is actively participating in the development of a separate but coordinated proposal on this topic. Both of these efforts should proceed in parallel if decisions are contemplated in the next several years. Each effort will help determine the benefits of various facility or operational actions and their associated costs.

The USBR has been working on a multiyear, interagency effort to improve and/or replace the existing fish protection facilities since the early 1990's. This is driven by Federal legislation (Central Valley Project Improvement Act, 1992) and California Bay-Delta Program Record of Decision. The USBR has been pursuing the application of new fish facility technologies and developing a better understanding of the hydraulic and biological issues at their existing facilities. These investigations have been conducted primarily at the Tracy Fish Collection Facility (TFCF) and at the Water Resources Hydraulic Laboratory in Denver.

To date, the USBR and the CBDA have been heading down a path of developing a prototype fish facility adjacent to the existing Tracy Fish Facility (i.e. the Tracy Fish Test Facility). While environmental documentation for this facility was completed, the high cost and size of this facility have prevented it from being implemented. Limited technology development is continuing through laboratory and existing facility modification evaluations are continuing during this period of project uncertainly.

Recognizing funding limitations, the need to integrate with near field biological investigations to assess project impacts, and the need to continue time consuming tasks of technology development, an alternative field testing facility is being proposed by the Bureau of Reclamation (USBR). This report provides the most recent concept for a Tracy Demonstration Fish Facility (TDFF). Construction costs have been minimized by locating the facility above ground and decreasing the size of some components. Key testing capabilities as recommended by the interagency Tracy Technical Advisory Team (TTAT) have been retained as much as possible. With input from management and the TTAT, this reduced size facility will be further developed to meet the needs of proposed facilities.

A South Delta demonstration fish testing facility would be integrated with any proposed near and far field study. This is important because understanding fish movements in the area along with facility collection data may help in determining the significance of the salvage operations for various species. This in turn could result in simplifying fish facility project features. However, until this information is available and evaluated, technology development on the more complex fish salvage facilities should continue.

Project Goal and Objectives

- ***Develop Improved Fish Protection Technologies for South Delta Fish Salvage Facilities to Support Environmentally and Economically Sound Water Diversions and Use***

The program would address the following objectives to accomplish this goal:

- Develop more efficient fish friendly methods to handle and minimize debris and sediment interference on facility components including screens, louvers, fish separation systems, and holding tanks;

- Determine feasibility of using positive barrier screens for recovering fish and retaining them in holding tanks prior to transport;

- Determine the feasibility for long-term use of fish friendly lifts for providing bypass flows to above ground fish separating/holding facilities;

- Determine the feasibility of gravity-fed bypass systems for providing flows from the main experimental flume to fish separation/holding facilities;

- Development of efficient, fish friendly transfer systems from holding tanks to transport tanks and vehicles;

- Develop enhanced predator control abilities through:

    - ✓ Developing abilities to sort fish by size up front by using a combination "leaky louver" and positive barrier screen in the main experimental flume;

    - ✓ Determining effective use of fish crowders in flumes and holding facilities for moving fish rapidly to bypasses or through sorters;

    - ✓ Developing fish sorting systems in flows emanating from bypasses driven either by fish lifts or gravity;

    - ✓ Maintaining fish segregated by size in holding tanks for transfer to designated transport means;

- Developing and assuring that all systems are user friendly, reliable, and economical for future operations and maintenance staff;

- Carrying out all developments using existing fish screening facility design criteria whenever possible, plus testing components using different criteria (variances from criteria) as deemed needed to establish workable and economical future salvage facilities

<u>Project Integration</u>

The TDFF will be designed as a multi-disciplinary and cooperative project. As was envisioned in the previous Tracy Fish Test Facility project, the interagency Tracy Technical Advisory Committee will continue to provide project oversight. Cooperative projects by the Department of Water Resources, University of California, Davis, and others will be cooperatively executed to meet program goals.

Integrating the TDFF into an overall biological and hydraulic investigation on South Delta operations, including proposed barrier and diversion changes, is also critical. Understanding the near and far field effects will ultimately be used to determine the level of fish protection necessary for a sustained or improved fishery. Facilities should be developed in the context of the following management questions:

Near Field (Zone of Entrainment)

- How does the composition and abundance of fishes vary in the channels leading to the fish facilities during various water operation regimes?
- What are the relationships between occurrence of fishes at important points outside CCF and the TFF and salvage?

Far Field (Zone of Influence)

- How does the distribution of fishes respond to water operation regimes in the greater South Delta region?
- What fish behaviors could affect vulnerability to project effects?
- Under what circumstances do the fishes move with the flow and when not?

TDFF Proposal Specifics

The TDFF is presented as three versions on a common theme. Differences relate mainly to choices between types of pumps and lifts used for source water or bypasses (i.e., “fish friendly” or conventional pumps). TDFF would be sited immediately north of the existing Tracy Fish Collection Facility and would draw test water from the Delta Mendota Intake Channel, immediately downstream of existing louvers. TDFF would be over 300 feet long, with the main flume 10 feet wide and 6.5 feet deep. Up to 250 cfs of water could be delivered to the flume for tests. Louver/screen combinations could be tested to assist predator segregation from prey, and to study louver efficiencies. A combination of hydraulic conditions could be tested with associated fish and debris insertions and naturally entrained materials. Conditions could range from 2.0 to 4.0 ft/s flume velocities and 0.1 to 0.4 ft/s screen approach velocities. Exposure times of fish moving along the screens would range from about 30 to 113 seconds. Innovative methods for debris handling would be tested throughout. New designs for fish separating and holding facilities downstream of flume bypasses would facilitate tests for much improved systems to minimize predator exposure and debris interference for held fish prior to transport. TDFF would integrate and coordinate extensively with fish holding, transportation and fish release research conducted concurrently by California Department of Fish and Game and California Department of Water Resources.

Project Cost

Construction costs for TDFF are estimated at around $10,000,000. State funding for the previous test facility has already been transferred to the USBR and could potentially be used for this purpose. Federal cost sharing using CVPIA funding could also be used to construct and operate the reduced cost facility. Unlike previous test facility designs, the

TDFF would fit more comfortably within Reclamation properties at Tracy and right-of-way issues and additional costs would minimal (see figure 1).

Evaluation costs are within an expected range of 2-3 million dollars annually. CVP operations impacts and associated costs will be minimal since the proposed TDFF is not expected to impact project operations.

Schedule

Given direction to proceed with development by the South Delta Fish Facilities Forum in September 2003, the following schedule for TDFF design and construction is envisioned:

Event	*Date*
Cost Estimate and Initial Concept Drawings (done)..........................	August 20, 2003
TDFF Design and Study Plan Development.....................................	October/Nov, 2003
Updated TDFF Report	December, 2003
* Study Plan Development for TDFF	January - May, 2004
Decision to Proceed with Final Design of TDFF..............................	February 15, 2004
SpecD (drawings out for final spec reviews)....................................	August 15, 2004
ReviewC (final spec review)...	September, 2004
SpecB (specs sent to Region for printing)	October, 2004
BookC (specifications published)..	December 1, 2004
Award...	March 1, 2005
Notice to Proceed..	March 15, 2005
CBDA Science Review Completed	July 15, 2005
Complete Construction	December 20, 2005
TDFF Evaluations and Demonstrations...	January 06 – Dec 08

Fisheries and Hydraulic study plans will be prepared for CBDA Science review following initial input from the TTAT around the facility objectives. TDFF operations and evaluations would begin in January 2006, with early focus on prioritized studies.

It is anticipated that results useful to facility design engineers will be available as early as December 2006. An initial study program is expected to encompass three years, with annual interagency and CBDA Science reviews.

Scalability Issues

Precedence for using on-site large flume type test facilities to develop larger, production level systems to serve combined engineering and fish protection needs is noted in the report. Though not inclusive, noted are the Tracy Fish Collection Facility development (1950s), San Onofre Nuclear Generating Station Intake (1970s), Modular Inclined and Eicher Closed Conduit Fish Screens (EPRI, 1990s), and the U.S. Army Corps of Engineers Improved Wet Fish Separator on the Columbia River (1990s).

Project Benefits

Further clarifications of the benefits of constructing and testing a TDFF are as follows:

- TDFF can be constructed and tested with reduced funding;

- Simplified construction expedites schedule – facility will be online in 2005;

- Modular design can minimize required shakedown time – as a result significant study findings will be generated within a few months of startup;

- Operational changes can be made quickly which should expedite testing sequences;

- Placement of the TDFF behind the TFCF minimizes listed species influences on operations;

- TDFF will not impact existing Tracy Pumping Plant operations;

- Siting on USBR property minimizes environmental impacts;

- TDFF will be tested in south Delta conditions (water quality, debris, sediment, biological organisms) which results in heightened confidence of findings over results from off site lab studies;

- Siting the TDFF at the TFCF allows use of existing Tracy fish sources and holding capabilities, and experienced fisheries-engineering staff, which reduces cost and setup time, and assures continuity of fish salvage related studies on-going since the late 1980s.

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INTRODUCTION AND BACKGROUND

The Tracy Demonstration Fish Facility (TDFF) represents a smaller version of Tracy Fish Test Facilities considered during the past decade by CALFED interagency efforts to develop technologies for fish salvage upgrades in the South Delta. Since 1998, significant interagency staff time and funds have been expended at planning and designing pioneering test facilities to meet new fish protection demands at large water diversions.

Fish salvage technologies using behavioral louvers developed in the 1950s are still being implemented at State and Federal salvage facilities. Deficiencies of the existing facilities (see Appendix A) were generally recognized and improvements were identified for CALFED Stage 1 implementation actions as part of the Conveyance Program. CALFED and USBR together also recommended an Interagency Tracy Technical Advisory Team (TTAT) to guide development of the facilities and assist development of the research. The TTAT is comprised of Reclamation (lead agency), CDFG, CDWR, USFWS, NMFS, CALFED, and water authorities. Technical advisory staffs from Universities and consultants were also included. TTAT has met monthly since November, 1998, and has developed design options for a test facility.

Funding constraints have required a scaleback in facility complexity and size. Though TDFF is a smaller version, critical elements planned for earlier, larger systems are retained. For instance, the proposed TDFF will be of sufficient scale to test long screens and agency fish screening criteria. In addition, further capabilities for testing novel approaches to fish salvage structures, hydraulics and general operations are attainable (refer to Appendix B for a list of main facility criteria guiding much of past Tracy test facility designs). TDFF should have increased flexibility due to it's accessible modular design. TTAT will continue to refine the TDFF as necessary to meet the technology development objectives.

GOAL AND OBJECTIVES

TDFF operations and evaluations are being planned to lessen uncertainties in developing future, modern fish salvage facilities in the South Delta. The TDFF will evaluate technologies that minimize fish loss in conjunction with large diversions of water. This environment represents a difficult situation for fish protection facilities to operate effectively while not creating unacceptable resource expenditures for both construction and long-term operations. TDFF should produce sound technical guidance on economically feasible alternatives useful for constructing much larger facilities with the confidence that they will work acceptably throughout all seasons and during different water years.

The overall goal of the TDFF is the same as for previous Tracy Fish Test Facility options: "to develop improved fish protection technologies for South Delta fish salvage facilities to support environmentally and economically sound water diversions and use".

Objectives for reaching this goal are:

- Develop more efficient fish friendly methods to handle and minimize debris and sediment interference on facility components including screens, louvers, fish separation systems, and holding tanks;

- Determine the feasibility of using positive barrier screens for recovering fish and retaining them in holding tanks prior to transport;

- Determine the feasibility for long term use of fish friendly lifts for producing bypass flows to above ground fish separating/holding facilities;

- Determine the feasibility of gravity-fed bypass systems for providing flows from the main experimental channel to fish separation/holding facilities;

- Develop efficient, fish friendly transfer systems from holding tanks to transport tanks and vehicles;

- Develop enhanced predator control abilities through:

    - Developing abilities to sort fish by size up front by using a combination "leaky louver" and positive barrier screen in the main experimental channel;

    - Determining effective use of fish crowders in channels and holding facilities for moving fish rapidly to bypasses or through sorters;

    - Developing fish sorting systems in flows emanating from bypasses driven either by fish lifts or gravity;

    - Maintaining fish collections segregated by size in holding tanks for transfer to designated transport means;

- Developing and assuring that all systems are user friendly, reliable, and economical for future operations and maintenance staff;

- Determining appropriate hydraulic and operational conditions to maximize fish protection; existing criteria will be tested in addition to variances deemed needed to establish workable and economical future fish salvage facilities;

In addition to the above, the overall goal of improving fish salvage facilities and operations requires improvements in trashracks and associated issues (debris, fish passage, predation) and improvements in fish transport and release systems (fish stocking back into the Delta). Both the Department of Fish and Game and Department of Water Resources are addressing those needs. The TDFF program would integrate with these programs in a supporting and coordinating role.

CONCEPTUAL DESIGNS FOR THE TDFF

Three different types of pump intake designs and two different bypass phases (pumped and gravity) are being considered as design options for the TDFF . All options would result in a facility located just to the north of the Delta Mendota Intake Channel, immediately downstream of the existing Tracy Fish Collection Facility. Anticipated construction costs of the proposed facilities are estimated around $10,000,000.

Differences between options and costs are related primarily to the types of pumps chosen for lifting water to the facility from the intake channel, and the method of delivering bypass water from the experimental channel to the fish separator and holding tanks downstream.

The TDFF could be constructed and evaluated in several phases. Phase 1 would include all components required for testing a basic layout, and additional items could be constructed as needs arise. Main components for a **Phase 1** would be:

1. Demonstration flume

a. Flume foundation at ground level on the levee
b. In-flume facilities accommodating future leaky louvers in a "V" shape with central bypass
c. Positive fish screen in straight line with bypass
d. "Sweep cleaner (brush) apparatus to clean screen
e. Side bypass from screen to fish separator/holding facilities
f. Flow regulating weir in return flow flume to canal

2. Pumps in canal providing up to 250 cfs to the demonstration flume

Three types of pump inlet versions are being investigated:

a. Version 1 – Vertical pumps (non-fish friendly) on a pier in canal; four 50.cfs and three 16.7 cfs pumps; no variable speed controllers (see figure 2)

b. Version 2 – Three "Fish friendly" pumps in a structure on side canal; no variable speed (see figure 3)

c. Version 3 - Large volume sewage type pumps in a structure on the canal side; three 62.5 cfs and two 31.2 cfs pumps; no variable speed controllers (see figure 4)

3. Return flow channel of 250 cfs back to canal (behind the louvers)

4. Separator/holding tank facility for fish screen bypass

a. Phase 1 – Pumped flow with fish lift just downstream from the bypass; flow goes to elevated active/passive fish separator and into tanks (see figure 5)
b. Phase 2 – Gravity flow with active/passive separator just downstream from the bypass
c. Flow to separator/holding facility is 12 cfs for each option
d. Two circular holding tanks and one elliptical tank for each option
    - Elliptical tank receives small fish from passive separator
    - One circular tank receives small fish from active separator; Other circular tank receives large fish from active separator

5. Water supplies –

a**.** Untreated canal water for test fish, 100-200 gpm
b**.** Treated canal water for test fish holding
c. More tanks to hold fish prior to and following testing
d. Temperature controlled and treated groundwater for fish
e. Truck fill water supply
f. Non-temperature controlled and treated ground water for fish
g. Service water
h. Potable water
i. Untreated canal water to large fish circular tank

6. Tanks for holding fish prior to testing

7. Two storage sheds

8. Relocate existing facilities – fiber optic cable

9. Security fencing

10. Area lighting

11. Modular office trailer/building

Potential Additional TDFF Components/Items Following Phase 1

1. Add leaky louvers with center bypass; include side holding tanks
2. Incorporate fish crowders
3. Mechanical equipment with automated controls (i.g., sediment and debris handling; traveling screens
4. Equipment to convert to gravity bypass system
5. Generally: Results from initial testing will indicate further requirements for future testing

LOUVER/POSITIVE BARRIER FISH SCREEN TDFF FLUME

The louver/screen flume (the "flume") will be built above ground. A maximum of 250 cfs of water will be pumped into the upstream end from a canal source located immediately below the existing Tracy Fish Collection Facility (i.e. downstream of fish collection louvers). The flume will be 10 feet wide with flow depth of approximately 5 feet. Leaky louvers would not be installed initially. When installed, they would be at the most upstream end of the flume, and flow would proceed in two directions: 1) main flows would go through the leaky louvers to the screen; and, 2) bypass flows ("louvered" flows) would proceed to a side holding tank.

The main flume section would include a wedgewire screen as long as 195 feet. Flow moving through the screen (majority of the flow) would be returned to the canal through an outlet channel. The screen bypass channel, which is two feet wide and 45 feet long, will have dewatering screens and an inclined ramp to reduce the bypass flow before continuing on to the separator/holding facilities.

The TDFF will focus on testing the following hydraulic conditions:

	Condition 1	**Condition 2**	**Condition 3**[2]	**Condition 4** [2]
Channel Velocity (ft/s) at Upstream End of Flume	4.0	2.0	4.0	2.0
Flow (cfs) Upstream of Fish Screen	200	100	200	100
Main Screen Approach Velocity (ft/s)	0.2	0.1	0.4	0.2
Exposure Time (Seconds)[1]	60	113	30	50
Bypass Entrance Flow/Velocity (cfs/ft per s)	40/4	20/4	40/4	20/2
Bypass Exit Flow/Velocity (cfs/ft per s)	12/4	12/4	12/4	12/4

1 Exposure time includes bypass dewatering screen section
2 Reinstall main fish screens in channel utilizing approximately half of the screen

PROPOSED SCHEDULE FOR TDFF DESIGN AND CONSTRUCTION

Event	Date
Cost Estimates and Initial Concept Drawings	August 20,2003
TDFF Design Meetings with TTAT	October/Nov 2003
Second Updated Draft TDFF Report	December, 2003
TTAT Meeting[1]	January, 2004
Decision to Proceed with Final Design of Option	February 15, 2004
SpecD (drawings out for final spec reviews)	August 15, 2004
ReviewC (final spec review)	September 15, 2004
SpecB (specs sent to region for printing)	October 15, 2004
BookC (specifications published)	December 1, 2004
Award	March 1, 2005
Notice to Proceed	March 15, 2005
Complete Construction	December 20, 2005
TDFF Evaluations and Demonstrations	January 06 – Dec 08

[1] Following a decision to proceed with a TDFF Option, TFRED will meet a number of times to assist development of an initial three year evaluation plan; a draft of the TDFF study plan will be distributed for further technical review by September, 2004

INITIAL TDFF EVALUATION PLAN

The interagency Tracy Facility Research and Evaluation Document Team (TFRED), a spin off from the TTAT, has met numerous times the past three years to focus on planning and review of Tracy research activities. While focusing on earlier, larger designs for test facilities, draft documents were prepared detailing study objectives and processes for initial three-year studies. Much thought was given to facility pretest "shakedown" planning, and subsequent testing with an operating test facility. These experiences and documents retain high value for planning and carrying out tests with the TDFF. Further, fish salvage studies with the existing TFCF facilities and future facilities have been on-going for many years, both on-site and in experimental flumes at Denver's Technical Service Center. A significant amount of promising new technologies and concepts has resulted in providing much valuable information. These experiences, data, and support facilities will be invaluable for efficient designs, refinements, and testing of a new TDFF.

Following a decision to proceed with design and construction of a TDFF, the TFRED will be reassembled and will assist drafting of an evaluation document to be distributed for reviews by September 2004. Following technical reviews, a final evaluation document will be prepared.

The TDFF evaluations will be approached in two general ways: 1) controlled releases of fish and debris will be used to experimentally determine performance of TDFF; and, 2) performance of facilities exposed to fish and debris entrained from the source waters will be observed. All studies will follow strict scientific regimens, with experimental designs determined beforehand to provide statistically valid data with replicated data sets.

The TDFF will eventually address all objectives outlined earlier under the section "Goal and Objectives". The study priorities for an initial three-year program will be determined through interagency meetings with the TFRED, and from inputs from all interested parties dealing with both State and Federal South Delta fish salvage facilities. However, a number of study demands are already known as being high on the list for early evaluations. These may include, among others:

- ✓ Determining if a positive barrier screen can be operated effectively in the South Delta. [A variety of hydraulic conditions, fish species and fish sizes need to be examined]

- ✓ Determining if fish can be effectively sorted (small from large) early on to minimize "in-facility" predation

- ✓ Determining if the holding tank environment can be maintained for high fish health and survivorship, while receiving loadings of fine debris and fish constituents.

- ✓ Determining best methods for debris and sediment removal and handling from all facility components

Evaluation costs for on-going fish salvage facilities studies, associated with both CVPIA requirements and new testing facilities, range between 2-3 million dollars annually. With development of the TDFF, efforts would be shifted to focus on the TDFF evaluations and total annual costs should not differ significantly from existing expenditures.

ADDITIONAL NOTES ON TDFF JUSTIFICATION (PRECEDENCE)

Use of an on-site large flume as valid testing for developing effective production sized facilities for hydraulics, fish protection, fish handling, operation and maintenance, debris and sediment handling, is certainly not unprecedented. These large flume facilities have offered sufficient size to generate findings representative for full size production facility performance. Examples of large flume studies that have lead to functional production fish facilities include:

- ➢ Tracy Fish Collection Facility (Bates and Vinsonhaler 1957; Rhone and Bates 1960) – A 36 ft long by 5 ft wide by 2 ft deep flume was used to guide development of the louver systems for the TFCF. This lead to the construction of a 60 ft long by 6.33 ft wide deep test flume the following year. Findings lead to development of a prototype louver installation and then the final TFCF facility. These studies verified that evaluation of louver fish exclusion performance with a 4 ft flow depth was representative of the 16-20 ft flow depth louver performance at Tracy. The TFCF developed through these studies has functioned for 50 years.

- San Onofre Nuclear Generating Station cooling water intakes (Schuler and Larson 1975) – A 50 ft long by 6 ft wide by 4 ft deep flume was used to develop fish exclusion and guidance facilities for the offshore intake. Both louver and screen systems were considered with alternative bypass channel widths and configurations. Performance was evaluated with various marine species and flow velocities. Self cleaning characteristics were considered.

- Modular Inclined and Eicher Closed Conduit Fish Screens (EPRI 1994) – 2 ft diameter Eicher screen development facilities and a 2.5 ft by 3.0 ft rectangular closed conduit MIS facility were used to develop both screen concepts in detail. Hydraulic performance, debris handling and cleaning, and fish passage characteristics for a wide range of fish species and sizes were evaluated. Detailed design features including screen design, porosity, seal designs, and bypass operations were refined to optimize performance. Hydraulic and fish passage characteristics with various types and extent of debris fouling were considered. Based on these studies, prototype and production screens were developed and applied at field hydropower installations. Field evaluation of fish passage performance and field operations experience has validated the development facility findings.

- Improved Wet Fish Separator, U. S. Army Corps of Engineers Columbia River Dams (McComas et al. 1998, 1999) – A 62 ft long by 2.5 ft wide flume was used at McNary Dam, Washington, to develop an improved fish separator that is used to reduce predation at fish collection and barging facilities. The studies considered the influence of alternative hydraulic operations, separator bar configurations and length, and secondary flow features. Descaling effects and separation efficiencies for salmonids of various lengths were evaluated. Issues associated with fish holding and fish avoidance responses were addresses. A preferred separator design was developed.

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APPENDIX A
GENERAL DEFICIENCIES OF EXISTING FISH SALVAGE FACILITIES IN THE SOUTH DELTA

- ORIGINAL, RATHER SIMPLISTIC OBJECTIVES FOCUSED ON PROTECTING TWO SPECIES (JUVENILE STRIPED BASS AND SALMON) ARE TOO NARROW

- PASSAGE OF ESA'S STARTING IN 1973, CONCERNS OVER ADDITIONAL NATIVE SPECIES (I.E., DELTA SMELT; SPLITTAIL) AND FOR THE OVERALL FISHERY RESOURCES HAVE SHOWN FACILITIES ARE OUTDATED

- LARGE AMOUNTS OF NEW DEBRIS TYPES HAVE INVADED SINCE FACILITIES BEGAN, INTERFERING GREATLY WITH SALVAGE OPERATIONS AND RENDERING OLD DEBRIS REMOVAL METHODS INADEQUATE.

- CONTINUED INVASIONS OF THE DELTA BY EXOTIC SPECIES SUCH AS MITTEN CRAB ADD TO OPERATIONAL CHALLENGES

- STRIPED BASS ADULTS AND SUBADULTS READILY TOOK UP RESIDENCE NEAR AND WITHIN FACILITIES, MAKING FISH PREDATION A MAJOR SHORTCOMING OF FACILITIES

- WATER DIVERSION PATTERNS AND AMOUNTS HAVE CHANGED, AND THE TRACY FACILITY MUST OPERATE ALMOST CONTINUOUSLY NOW THOUGH SEASONAL SHUTDOWNS WERE CHARACTERISTIC OF INITIAL OPERATIONS

- FACILITY MATERIALS ARE AGING. WITH INCREASING PROBABILITIES FOR SYSTEM BREAKDOWN FROM NORMAL WEAR

- MODERN FISH FACILITY DESIGN CRITERIA PROMULGATED BY STATE AND FEDERAL REGULATORY AGENCIES ARE NOT MET BY EXISTING FACILITIES

- TRANSPORTATION AND RELEASE OF FISH FROM HOLDING TANKS HAS CHANGED LITTLE SINCE INITIAL OPERATIONS (1950'S) THOUGH MULTIPLE SPECIES REQUIREMENTS DEMAND IMPROVEMENTS IN BOTH.

APPENDIX B
FISH FACILITY DESIGN CRITERIA[1] RECOMMENDED FOR INCORPORATING AND TESTING WITH A FISH SALVAGE TECHNOLOGY DEVELOPMENT PROGRAM

- SIZES OF FISH TO BE SCREENED AND SALVAGED ARE 20 MM AND LARGER
- APPROACH VELOCITY TO A POSITIVE BARRIER SCREEN SHALL NOT EXCEED 0.2 FT/S (HIGHER APPROACH VELOCITIES CAN BE INCLUDED FOR FURTHER EVALUATIONS)
- VELOCITY PARALLEL TO THE SCREEN FACE (SWEEPING VELOCITY) WILL BE GREATER THAN THE APPROACH VELOCITY
- SCREENS MAY BE CONSTRUCTED OF PROFILE BAR (WEDGEWIRE, PROFILE WIRE, OR VEE WIRE) WITH SLOT OPENINGS NOT TO EXCEED 1.75 MM IN WIDTH, WOVEN WIRE WITH OPENINGS NTE 2.38 MM MEASURED DIAGONALLY, OR PERFORATED PLATE OPENINGS NTE 2.38 MM IN DIAMETER; SCREENS MUST HAVE CORROSION RESISTANT MATERIAL
- SCREEN POROSITIES WILL PROVIDE AT LEAST 27% OPEN AREA (AREA OF VERTICAL GUIDES AND OTHER STRUCTURAL SUPPORT MEMBERS CANNOT BE INCLUDED IN COMPUTING REQUIRED SCREEN AREA)
- FISH SCREENS WILL HAVE CONTINUOUSLY CLEANING MECHANISMS
- FISH SCREENS WILL HAVE SEALS WITH OPENINGS NO LARGER THAN THE MAXIMUM SCREEN OPENING
- BAFFLES OR POROSITY PLATES ARE NEEDED DOWNSTREAM FROM THE SCREENS WHEN NECESSARY TO ATTAIN A UNIFORM APPROACH VELOCITY THROUGH SCREENS
- DIFFERENTIAL WATER LEVEL SENSORS MUST BE INSTALLED UPSTREAM AND DOWNSTREAM FROM TRASHRACKS, LEAKY LOUVERS, AND FISH SCREENS

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[1] CRITERIA RECOMMENDATIONS MADE FROM REGULATORY AGENCY STAFF PARTICIPATING IN THE MONTHLY TRACY TECHNICAL ADVISORY TEAM (TTAT) DURING 1998 – 2002

APPENDIX B (CONTINUED)

- MULTIPLE BYPASS ENTRANCES SHALL BE EMPLOYED IF SWEEPING VELOCITIES WILL NOT MOVE FISH TO THE BYPASS WITHIN 60 SECONDS, ASSUMING FISH ARE TRANSPORTED AT THIS VELOCITY; WHERE LOW APPROACH VELOCITIES ARE USED (NOT GREATER THAN 0.4 FT/S), LONGER EXPOSURE TIMES FOR TESTING MAY BE APPROVED

- SUFFICIENT BYPASS VELOCITY NEEDS TO BE SUPPLIED TO PROVIDE BYPASS RATIOS (RATIO OF BYPASS VELOCITY TO CHANNEL TRANSPORT VELOCITY) AT OR EXCEEDING 1.0

- IN THE BYPASS PIPELINES, THE MINIMUM REQUIRED VELOCITY IS 3 FT/S, AND THE MAXIMUM VELOCITY IS 10 FT/S

- THE MINIMUM BYPASS DIAMETER IS 2.0 FT

- BYPASS PIPELINE BENDS SHOULD BE DESIGNED TO MINIMIZE DEBRIS CLOGGING AND TURBULENCE, BYPASS RADIUS ON CURVATURE SHALL BE GREATER THAN OR EQUAL TO 5 PIPELINE DIAMETERS

- THE BYPASS PIPES SHOULD BE DESIGNED TO BE “FISH FRIENDLY”, I.E. NO PROTRUSIONS OR ABRUPT OR SHARP SURFACES

APPENDIX C
FIGURES