The Kilarc Reconstruction Alternative

A Fish Restoration Proposal

for the

Kilarc Hydropower Facility

Part of the

Kilarc-Cow Creek Hydropower Project

Decommissioning

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Table of Contents

Foreword ..... **iii**

The Reconstruction Alternative **1**

Principal Objective **1**

Species Identification for Enhancement *1*
A New Fish Production Facility *2*

Reconstruction **3**

New Habitat Creation *4*
Gravel 5
Jetties 5
Cover 6
Screening 6
Initial Designs 6
Release Pipes 7
Lower Cow Creek Habitat Maintenance *8*

Research **8**

Operation **9**

Changes in Operation *10*

Maintenance **10**

Maintenance Assurance *11*

Institutional Arrangements and Variations **11**

The Kilarc Anadromous Fish and Research Facility *12*
Variation I – A Short License *12*
Variation II – The Recreational Partnership *13*
Variation III – A Lease from PG&E *13*

Derived Studies **13**

Indirect Benefits **14**

Environmental *14*
Recreation *15*
Water / Wetlands *15*
Archaeological / Cultural *15*

Bibliography **17**

Foreword

This is the fifth draft of an alternative reconstruction plan to improve the fishing habitat in the Kilarc hydropower facility. The first draft was released as part of a July 2007 Scoping Document, followed by refinements in September 2007 which focused on fish habitat improvements in both the Kilarc Canal and the South Cow. Subsequent versions, including most of the ideas expressed here, were included in a draft released in January, 2008. These are available on the www.kilarc.info web site. The current version is a work in progress aimed at ways to enhance anadromous fish while generating hydropower. It now includes the initial results of some of the ongoing investigations into how to make the best use of the facility.

This Reconstruction Alternative grew out of the last version, Alternative I (April, 2008). It does not address the South Cow. For now, this proposed Alternative stands by itself as a possible development path in which KC LLC is interested. If other entities become interested in developing the South Cow, we will be pleased to work with them and share data currently in development.

As will be apparent we have had considerable assistance from many individuals, consultants and groups and we thank them for their help in gathering data. They include, among others: Tom Cannon, Fisheries Ecologist, Wildlands; Jan Caster, Forester from Sierra Pacific; meetings with the Cow Creek Watershed Management Group; Kelly Miller and other staff at the Western Shasta Rural Conservation District; Linda Sinnwell, David Jermstad, Principal, Carlton Engineering; Mike Berry, California Department of Fish and Game (CDFG); Don Hansen, Roseburg Timber; Sue Goodwin, Vestra; and many others who have declined to be thanked.

Many of the ideas in this Alternative have been discussed with and reviewed by the following entities, most of which have reports or papers included as references: A. Kawabata, Fisheries Ecologist; M. Bailey, Wetlands Ecologist; D. Moore, Geologist/Aerial Photogrammetry; B. Cavallo and J. Merz, Fisheries Biologists, Cramer Fish Sciences; T. Sloat, Endangered Species Biologist and R. Poore, Stream Restoration Consultant, Stream Wise. These individuals all helped to form and review the idea of restoration. Some are still working on aspects of this Alternative and more research on the biology of the area will unfold this summer.

The Reconstruction Alternative

This Alternative addresses the Kilarc part of the Kilarc-Cow Creek Project. There may or may not be a similar description of an alternative future for the South Cow. This Reconstruction Alternative presents a responsible alternative to demolition of these facilities as proposed by PG&E that will produce the maximum desired fish production.

Principal Objective

The steady production of green power and juvenile steelhead trout.

Carbon-free "Green" power is produced at this facility and as such it produces environmental benefits to the atmosphere and to all living things, especially fish. Green energy production from the Kilarc-Cow Creek facility protects our environment both locally and globally. Replacing it with fossil energy will produce acid rain and other pollutants that will have incremental impacts on fish and other species far beyond the local environment.

Local fish also have to be protected. Specifically there is a concern as to how to restore the Steelhead trout. These are rainbow trout that have gone to sea and returned to fresh water. This behavior is endangered, so the species is of concern locally and nationally. Agencies responsible for the promulgation of this behavior, the National Marine Fisheries Service (NMFS) and California Department of Fish and Game (CDFG, Merz p. 4), are supporting steps to protect and enhance the species, *O. Mykiss*.

On the initiative of PG&E, a plan has evolved to demolish the hydropower facilities at the Kilarc-Cow Creek project and to allow the Creeks to evolve into new *natural conditions*. Barring any evidence to the contrary, it is felt by agency staff that *natural conditions are best (CDFG, Metz p .4)* and that these future "natural conditions" will provide habitat and water flow to increase local populations, and hopefully, seaward migrants. In this document Davis Hydro provides evidence that properly designed and maintained channel features and flow can provide better conditions for fish than demolishing the facilities.

Species Identification for Enhancement

The following section addresses several systemic questions – not about the facility, but rather about the fish themselves.

The first question is what fish exist?. The problem centers on the large rainbow trout population (Merz, Entrix) that permeates the forebay, canal, headwaters, and bypass

reach. It is clear that the area has been artificially inseminated with multiple installations of hatchery fish (Entrix). Whether there are any non-hatchery fish of various vintages is unclear, and due to cross breeding this may not be easily determined. Are the fish present suitable for migration?

If it is nearly impossible for fish to come upstream to the Kilarc diversion, then any fish that we induce to thrive in the canal and migrate downstream must be the right ones. It is a statistical question how often and how far upstream migrating trout can penetrate the project area. There is little doubt that they can pass the Whitmore Falls at some extreme flows, when the tail water rises significantly and floods the falls enough to allow passage. Because of the occasional nature of this passage, and the difficulties of lesser and more difficult barriers upstream[1] in the bypassed reach, it is not clear if this site can provide upstream passage under any circumstances (Merz p. 3). Are there any suitable non-hatchery fish in the area? If not, then it is a site for fish spawning and juvenile habitat, hopefully with net out-migration downstream.

A question that might be studied is whether, if the whole area contains hatchery fish, i is even possible to produce a strain of fish suitable for anadromy. If all fish in the area are polluted by interbreeding with hatchery fish, what can be the role of a facility that produces more of them? If either PG&E's alternative, or our own, is followed, and habitat were to increase significantly in the Old Cow, will we only produce more hatchery fish? While it is agreed that a good objective is to increase fish in general, a higher goal is to focus on the threatened ones. Given the interbreeding in this population, is that possible?

A New Fish Production Facility

Assuming that the above concern is invalid, no hatchery fish are found, and the area only contains – or can be made to contain - non-hatchery or at least potential migrating anadromous fish, what facilities can be constructed from the present ones to best produce steelhead trout?

This new Reconstruction Alternative presents a potentially better arrangement of Kilarc facilities than the natural conditions, consistent with goals to increase fish habitat and populations. The adverse conditions of the natural channel engender consideration of benefits of an enhanced, designed, and maintained channel. The facilities are described below. The Reconstruction Alternative modifies the Kilarc canal to make about a third of it's length a very productive fish spawning and juvenile habitat area (Kawabata, Poore). It is probable that the lower parts of the bypassed reach can also be made productive, but the consistency and expected fertility of the modified canal may be even more productive, meeting Fish Agency's goals.

[1] The barrier at W 121.83041, N 40.68396 is reported to be considered impassable at any flow (Entrix, Caster). This eliminates upstream migration to the Kilarc diversion.

It is not the objective of this paper to assert or deny that future evolved "natural conditions" are better than this suggested alternative, only that it should be studied as a hypothetical alternative. Several factors lend credibility to questioning whether "natural conditions are best". Specifically:

- Davis Hydro is proposing an aggressive alternative with an active breeding and fish restoration program.
- Much of the bypassed Cow Creek – especially the upper third - is very steep and unsuitable for habitat.
- Much of this bypass is in a steep, U-shaped valley suggesting that more water may actually reduce fish habitat. The top 40 % of the bypass has this characteristic.
- The "alpine" flow duration curve of the river suggests that this area is subject to sudden floods due to its elevation and lack of storage. This decreases bed stability in affected reaches such as the bypass reach, reducing habitat value.

If analysis reveals that the natural channel is indeed superior, all that the fish will have suffered is a brief delay (compared to over 100 years of current diversion conditions, or perhaps no delay at all if studies are commenced immediately instead of waiting until the license surrender is finally approved by the FERC and dismantling is authorized) in restoring flows to the natural channel. There are two potential mechanisms available to maximize the population of anadromous fish:

- increase the productivity of the resident population and
- motivate this population to migrate to sea.

The fish returning upstream are blocked by a natural barrier in the by-passed reach, so no fish that have been to sea can rejoin the resident population above the existing diversion, with or without the dam. The diversion canal can increase the reproduction and survival rate for emission of juveniles and also foster downstream migration of adults. The ability of fish to migrate upstream is controlled primarily by physical barriers. Only minimal physical barriers exist downstream of the Whitmore Falls below the project. From the Whitmore falls upstream, there are a large number of barriers on the Old Cow varying from hydropower diversion dams (including the Olson project, downstream of Kilarc powerhouse) to agricultural diversion structures, and impassable natural falls and cascades. On the other hand, the ability of the Kilarc facilities to emit downstream steelhead of all ages is very much under the control of the facility design and operation, and will be the focus of this Alternative.

Reconstruction

To accomplish the goals of transforming the Kilarc canal into a Fish Production/Green Power facility we need to accomplish two plenary objectives:

- Safely deliver most downstream migrating juvenile and seaward-migrating fish to the Old Cow, and
- Change the character of part of the canal into a fish production habitat and spawning area.

The Reconstruction Alternative redefines the Kilarc canal as a fish production facility by providing the following new features:

- Canal bank and bedding improvements so that fish can spawn in the canal,
- woody debris and vegetative/ wooden cover for stress reduction,
- fish return conduits to allow juvenile fish to migrate down to the Old Cow and on to the sea, and
- screens at the downstream end of the canal directing most fish into the conduits.

Specifically, Figure I.a shows the new fish habitat areas in the Kilarc canal. Figures 1.b and 1.c show the fish screens and the fish return conduits. Further description of the water velocities and depths observed is contained in Kawabata. The screens are to induce fish to drift downstream into the conduits passage down to the Old Cow habitat areas. The screens are not meant to be perfect. They will divert only a portion of the fish. Some fish will be allowed to pass down to the next habitat area. In the current (pre-liminary) design, the first screen will return most fish passing downstream to above the upper end of the good habitat areas in the Old Cow (Figure 1.c). Some fish will pass this barrier and pass down the canal. They may stay in the second or third habitat areas.

At the downstream end of the third area is a second screen and conduit that will lead downward to a small creek the feeds the Old Cow within its best habitat area (Figure 1.b). This second screen also is not intended to be perfect, allowing primarily adults to escape. These fish will pass into the forebay where they – as they do now (Merz, Cannon) grow and over-summer. In the late fall, they come out of the forebay up-canal and possibly upstream to spawn in the canal and in the upper reaches of the Old Cow above the project. This behavior will be encouraged and facilitated by designing the screening nets to allow fish to find ways upstream, possibly by further opening the nets during the upstream migration period.

The remainder of this Alternative summary describes elements recommended for study. The emphasis of this report is not on the final design, for this facility is intended not only for fish production, but as an experimental station to determine which elements of fish enhancement are most effective and most sustainable. With this introduction to the objectives, this description now turns to the methods proposed.

New Habitat Creation

Habitat will be created in the Kilarc canal for two reasons[2]. First, by creating habitat in the canals, we can engineer protected spawning beds and juvenile habitat areas to maximize regular annual production (Kawabata). Second, because the canal beds are not

[2] See Poore for general discussion of the feasibility of these engineering works.

in spring flood flows, the redds will not be washed away or buried by mud, or the habitat destroyed by floods. This will assure a continuous supply of juvenile fish independent of stream conditions in the bypassed region.

How will this be done? The Kilarc canal is about three miles long, of which one mile can be transformed into three smaller habitat areas[3] providing a variety of excellent spawning and juvenile habitats (Kawabata). To create this fish production facility, the following physical measures will be taken:

- Existing streambed spawning gravels (Sloat) will be increased to an average depth of about 5 inches.
- Small jetties and woody debris breaks (Merz) will be put in to produce calm water areas downstream.
- Cover will be placed over many areas of the canal.
- Two different fish screens will partially inhibit fish – especially motile juvenile fish - from passing into the forebay.
- The same screens will allow upstream migration for spawning, and
- fish release pipes will be put in at the downstream ends of the screens to carry fish to small streams and from there down to the main stream of the Old Cow.

Gravel

Riverbed gravel will be imported and placed along the habitat areas to an average depth of 5 or more inches in the spawning areas (Kawabata, Poore). This will also be built up behind barriers and placed differentially among another design features well oxygenated by the flowing current. The existing gravels with their redds (Sloat) will be fairly simple to improve and maintain in that the whole length of the habitat area canal is truck accessible (often after bank and 4-wheel vehicle access barrier removal). If and as necessary, the gravel depth can be increased in depth, but with the steady flow, lack of fines and well-oxygenated water this may not be necessary.

Jetties

Small rock and informal log jetties of various types will be installed along the north side of the canal[4]. These hydraulic obstacles will have to be built and tested to enhance the newly created habitat areas in the swirling pools downstream of the jetties (Poore, Kawabata). These pools are suitable for juvenile habitat, and allow a segregation of bed type so that various types of bedding gravels will be separated and allow the fish to choose what bed they like.

The jetties also provide resting places (Poore) and slow water pockets for sleeping and partial cover (Kawabata). Many of the jetties, gravel beds and other features need to be designed so that power machinery can pass during maintenance periods every few years.

[3] The first habitat area extends from near the measuring flume downstream to the existing wooden bridge, the second extends from the downstream end of the water tunnel past the camping area to where the canal heads out along the escarpment, and the third extends from the next to last flow relief gate to the forebay area. These are all shown in Figure 1.a.

[4] A few of these seem to already exist in smaller form – perhaps from a previous effort.

The limitations of jetty design and placement will be erosion and blockage under flow and ice conditions. These jetties will come from either side depending on erosion concerns. The intent is to design them to balance fish spawning and juvenile habitat. To start with they will be designed from standard designs, but since visual observation is so simple at this facility, they will be slowly modified over the years depending on which designs are most effective. This will be part of the research agenda.

Cover

Various natural and artificial coverings will be installed over parts of the canal (Metz, Kawabata). Habitat area 2 needs the least new cover. The furthest downstream, habitat area 3, needs the most and widest cover materials. Cover will be constructed in such a manner to withstand ice, yet be removable for canal maintenance. The cover will have various designs. In some places it may be heavy rail ties[5], while in other places where access up and down the canal is important a softer "bush" type cover will be created, limited by ice conditions. In other places, new fallen trees will be used. All designs will be adapted to be a balance between cover, naturalness, flow encumbrances, piping prevention, access, bank stabilization, and ice conditions. Once again, research observations will be made on what types of cover are preferred and those types will be used if they are maintainable.

Screening

The canal habitat areas have to be connected at the downstream ends to facilities to carry fish down to the Old Cow bypass reach, and not allowed to be lost into the forebay. Initial design calls for two screen areas with unspecified screen design. It is expected that initially these will be a mixture of fixed and flexible screens that will have the design goal of carrying moving fish down to the Old Cow. The research agenda will be to find an effective balance between maintainability, durability, and efficacy for fish at different life stages (Kawabata).

Initial Designs

The initial screen design is to have an initial screen at the end of the first habitat area[6] that will escort most fish back to the old cow. It is intended to be imperfect. Some fish, especially larger numbers of fry are expected to be screened and conveyed back to the bypassed reach of the Old Cow. Larger fish are less likely to be entrained, and may pass further into the canal (Kawabata). The initial screen geometry will be a long screen at an acute angle to the flow, designed to escort small fish for return directly to the upper regions of the Old Cow bypassed area via a pipe conduit[7]. Its final design will evolve, but is anticipated to be partially fixed and partially netted for maintenance. In the initial

[5] These will be well weathered and may be used for passage, cover, protection from threatening rolling boulders, and similar engineering purposes.

[6] For those familiar with the canal, this will be at the fixed bridge across the canal (N40 41 08.7, W121 48 39.3).

[7] The Old Cow is not very far below the canal at this point, so returning the fish to a pool in (or next to) the Creek can be done directly.

design, we expect to have a few design failures and to make adjustments to achieve a balance between fish moving downstream and those moving further into the canal. The key to success will be the active management of the screens by the hydropower operating personnel, as this is an ice-prone area.

The second screen will be at the end of the last (3rd) habitat area, most likely in the bend area downstream of the existing trash rack. It will also shepherd juvenile fish and downward-migrating adults to the Old Cow. The initial design for this second screen will also be long, gently sloped, and easy to maintain and clean. The design must recognize existence of frazil and solid ice and be built to withstand these problems with maintenance. It will divert most juveniles floating high in the water column to the bypass conduits such that it will be simpler for adults to miss the screen, but it is intended that some will be escorted downstream. The screens' design and operation will be subject to modification as part of the research mission of the facility.

Fish swimming upstream to spawn in the fall will have little trouble, as in the initial design the screen will not cut off all the stream – so that upstream swimming will be possible along the south-eastern side or possibly under or by sections of the net/screen.

Screens require maintenance and this flexible design is no exception. It may be destroyed every winter by ice clogging. This is to be expected and repairs will be made as a matter of regular maintenance prior to the spring downstream migration.

Release Pipes

The current design is to have to release pipes that will return the downward migrating fish to the Old Cow juvenile habitat areas (Cannon, Poore, Kawabata). These pipes[8] are at the end of long screen areas and will be designed for simple maintenance in adverse weather conditions. It is expected that they may be taken out by ice. This is a necessary assumption and part of the design as over-flow of the canal is a major design consideration. Because of the overflow danger, screen design and placement must be such as to allow for safe overflow in that area. Because critical fish movement occurs in the late fall and spring, these will need to be repaired quickly and easily so as to be effective at that time.

The upper screen release pipe will carry the fish to a small pool nearly back to the Old Cow, populating the limited habitat of this steep rocky area. It is *a priori* expected that these pipes will be small (4") with water rapidly moving in laminar flow to reduce stress and oxygen deprivation[9]

The second release pipe near the existing trash rack will carry the fish a few hundred yards to an existing stream below the last relief gate. This conduit from this second

[8] The return or fish bypass pipes are an idea developed with Tom Cannon of Wildlands.

[9] See Kawabata for initial references on this design, which is a work in progress. Each biologist to date has had a different opinion on its best design.

screen drops gently down about 40 feet of elevation to the small stream[10] and ditch that have been formed below the last waste gate located about 200 yards upstream of the trash rack (Figure 1.b). There may be an intermediate concrete resting pool on the way down-stream[11]. This small stream is barely trickling this time of year (June) and will be augmented with about 2 cfs of water from the fish screen area. This release place is chosen because the cover is good from there to down to the main stem of the Old Cow.

Lower Cow Creek Habitat Maintenance

The Old Cow joins the South Cow well below the powerhouse and Whitmore falls. This lower area and much of Cow Creek is prime habitat area for multiple species of anadromous fish. Several limiting factors impact this area. Chief among them are high water temperatures from direct solar heating, and thermal and chemical pollution from the fields.

In this Reconstruction Alternative, the water will be cooler as a result of the cover over the canal, and more importantly, because water that is diverted into a rapidly moving canal is transported at a high, cool altitude to the powerhouse (Merz, Wetmore). Except for the last half mile, the canal runs in the shade along the north slope of a hill, out of the sun. This leads to rapid delivery of cold water to the powerhouse in a fraction of the time it takes water to traverse the Old Cow bypassed channel. Complicating these effects is the effect of air temperature; while cooler at the high altitude of the canal, if the air is cooler than the water, it will cool the water more in the bypass reach where it is exposed to the water far more[12]. However, in the summer this effect is reversed, with the babbling by pass reach exposing water far more to the warm atmosphere than the faster direct canal and pipeline. Thus, the water downstream will be colder with the powerhouse in operation. Since the limiting factor for much of the very large Cow Creek habitat is the high summer temperatures, this temperature effect may be significant.

Research

The motivation of trout to migrate downstream and become steelhead is not well understood. The Kilarc hydropower facility is already built and can be modified at little cost into an excellent near-natural field laboratory to study all aspects of the spawning and juvenile beds, stream conditions, and migrating behavior. This would be impossible in the open stream. Many engineering features are to be incorporated within the facility, and because of the easy access during spawning and migrating seasons, the efficacy of these measures will be easy to study. Questions might range from, “Do more juvenile survive in the natural bypass, or in the canal?” to “what are the exactly preferred types of gravels for spawning?” and “what triggers will work to induce seaward migration?”

[10] This will be upstream of the existing bridge at N40 40 21.6, W121 51 23.1, well below the canal.
[11] See Kawabata for an extensive discussion of predation prevention in these types of facilities.
[12] As it exits the powerhouse, the water is also cooler than bypass water due to the physics of hydropower. The effect is small. If 2 Megawatts of energy are being exported as electricity, that same energy is not wasted heating the water in viscous turbulence.

This facility is ideal to do experiment with fish behavior. All of the three habitat areas are accessible by vehicle much of the year. All downstream migrating fish can be counted in the transfer pipes, allowing detailed studies of migration as a function of various parameters. Studies can be easily made of bed design, bank and pool designs, covers, as well as the effects of hard and frazil ice. Fish behavioral studies can be done day or night as there is power in part of the habitat area for infrared lights, camps, and equipment. It is the migrating behavior that is endangered in the fish. This facility with the ability to adjust many habitat variables is a prime place to study this behavior.

A research agenda could be built into the operation of the facility and be overseen by all the vested agencies.

Operation

The operation will be such that episodic upstream and downstream migration within the canal facility will be possible. This will be done with some minor modifications in the diversion area (such as the surface weir notch suggested by Kawabata) and operation in the early morning[13] during the spawning season the canal will be greatly slowed for a two-three hour period in the early mornings so that fish can migrate upstream. This will allow natural upstream migration behavior and spawning in the canal and into the reaches above, specifically, the facility will also allow[14] for upstream passage from the canal up to Buckhorn Lake and beyond for spawning, juvenile habitat, and resident adult populations. With a steady supply from the new facilities in the canal, we will produce a steady stream of juvenile fish coming downstream – some diverted into the canal and others more directly returned through the present facilities to the Old Cow.

Downstream migration will be encouraged both into the canal and directly down the Old Cow. Proposed operation will allow more water to go down to the Old Cow – primarily at night when downward migration is more likely[15]. Almost all juvenile fish that enter the canal either will stay in the canal or will be allowed to pass downstream via pipe/small creek facilities. Most of the young juvenile fish will later be directed back into the Old Cow via conduits to the top of small Creeks that lead to the Old Cow above the Powerhouse. In consultation with CDFG and NMFS some adult fish will be allowed to pass into and out of the forebay. The mechanism to do this will be active screen management[16].

[13] Early morning is chosen as a balance. The light is needed for upstream migration, and at that time fewer humans are present. Further it leaves the day to make redds in the light. Power is also less valuable at this time.

[14] Physical modifications will have to be made in two places in the canal to facilitate upstream passage – the diversion gate area and the lower canal inlet gate profile.

[15] The power is also worth more, helping project economics.

[16] Since juvenile fish moving downstream stay near the surface, this affords an engineering path to deflect the majority of the downward young fish while allowing a higher percentage of adults to pass more easily into the forebay.

Because the screen/nets will "capture" most juveniles and some adults passively going downstream, the whole facility will emit fish on a regular annual basis unaffected by droughts, floods, or other conditions. By allowing some imperfect screens, some fish will prosper in the canal and forebay to be a quasi-resident population as they are now. This may or may not be sustainable without hatchery supplementation. How this anadromous fish restoration activity interacts with the present recreational fishing objectives and it associated stocking will have to be researched. Since the forebay may be stocked with fish that we may not want to interbreed with the migrating/spawning target fish, this facility will have to be designed carefully in concert with agency biologists. Clearly, if the forebay is, or can be, stocked with the specific sub-species that is targeted to migrate the entire job is simple. The subject of what fish are being promoted here has to be evaluated prior to determining whether this facility has any significant value as a steelhead production facility. Producing more hatchery fish will have a diminished value at the head of stream with a negligible return potential.

Changes in Operation

Operation will be much as it is today with a couple of proposed differences:

- More water will be returned to the Cow Creek during some spring nights and more steadily through the fish return bypasses.
- During upstream (spawning) periods, in the late fall, the water speed in the canal will be greatly reduced occasionally in the early mornings allowing upstream migration from the forebay to the head of the canal and beyond.
- With modification, the diversion inlet (where the Kilarc Canal leaves the Old Cow) will also be modified to periodically allow fish to migrate upstream back in the Old Cow, and
- screens, jetties, cover, bypasses, and ancillary features will be maintained – especially carefully during seaward migration periods.

These measures promote balancing of fish and habitat by providing a mechanism for upstream migration that is not now available due the Creek's falls and cascades. The created highlands quasi-isolated ecosystem proposed here will produce a steady stream of anadromous fish flowing down out of the Old Cow.

Maintenance

Equally important, beyond feature efficacy, is sustainability, cost, and maintenance. Hydropower provides funds and onsite staff to maintain fish production facilities. This is a joint use, and joint objective facility. Either both objectives can be accomplished – or, by license condition, neither can be.

This facility is at about 4,000 feet of elevation. Winter precludes access; ice is common in the canal; and frazil ice will plague any screening process. Ice and natural erosion of bank in, below, and above the canal all impact the engineering features. Some of these features are applicable to other places. Instream gravel and juvenile habitat areas can be studied. With simple access, changes in these physical parameters can be made at reasonable cost; the facility becomes, and can be maintained as, an excellent research facility.

The screens at the lower end of the habitat areas 1 and 3[17] in the canal, which are designed to escort downstream mobile fish into the bypass conduits down the Old Cow, are going to be especially vulnerable to ice clogging. This project will continually study screen operation to study efficacy, cost and maintenance requirements. It is intended that the results of this work will be applicable to other sites.

No one minimizes the difficulty of operating a fish production /research/hydropower facility at this elevation at this latitude. While the operation and maintenance is expected to be significant, it will also be exploratory. Many of the measures to be studied can be used at other facilities and an important element of the research is to see how the measures can be maintained under these conditions. It is expected that there will be design revisions and improvements of screens, pipes, covers, and jetties. Flexibility and learning will be a secondary goal of the facility. With flexibility, maintenance is an inseparable part of the research agenda of the facility.

Maintenance Assurance

The hydropower will provide money, and on-site manpower to maintain the facilities. All screens, whether netting or metal, need to be cleaned regularly to be viable. This facility with its high altitude will catch woody debris, ice and leaves, as well as downward migrating fish. Thus, maintenance is required at a much higher level than a normal single purpose hydropower facility.

FERC now has a process that allows for operating agreements, environmental settlements, and adaptive management plans that go far beyond just operating hydropower gates. Operation of this hydro/fish production and research facility requires and can make use of such arrangements.

Institutional Arrangements and Variations

Who will operate the Facility? For the moment, resolution of this is not relevant to NEPA consideration of Alternatives. The important first question is whether we as a

[17] Screening is not suggested at the end of habitat 2 due to the access difficulties for maintenance. In areas 1 & 3 access is simple as there are roads close to the conduit features and release points.

group want a funded anadromous fish production and research facility. The question of exactly who will own and operate it can, and will, be worked out if there is a collective will to save the facility. That aside, since this document is to be widely circulated for comments and suggestions, possible ownership structures are suggested next, purely for discussion.

The Kilarc Anadromous Fish and Research Facility

Since this is a joint fish production/research/power production facility, management must respect the needs of all entities, and be directed by a management structure composed of all three. The facility must run on income from the hydro, which requires the hydro to operate profitably. It also must produce more fish over a reasonable review period – otherwise it will be demolished by agreement, and it must allow research on fish restoration issues for which it should receive credit. It will be a balance.

Under this Alternative, Davis Hydro suggests creating a new corporate entity, The Kilarc Anadromous Fish and Research Facility. This would be funded by a percentage of new Income from hydro operations. KC LLC will own and operate the facilities under the direction of the management committee operating within a FERC mandated Adaptive Management Plan.

PG&E will retain a reclamation bond to eventually demolish the facilities. This is necessary because the removal costs may exceed a figure that dwarfs the expected future value of the recoverable power. Without a reclamation bond in place by an entity capable of eventual facility removal, the FERC will never allow the License to be transferred. With luck and cooperation, PG&E may never have the bond called, saving the ratepayers the expense of demolition.

With this simple ownership structure, it is not clear whether there would be revenue to protect Davis Hydro from lawsuits stemming from risks from public recreation, and the public access to recreation would probably have to be reduced. A separate entity may be needed to operate the recreational aspects of the project and absorb the labiality risks of public access. This might be Shasta County, State Parks, or perhaps National Forest.

Variation I – A Short License

Variation I of this structure would be to allow Davis Hydro to operate the facility – say for 10 years - in an experimental mode. The operation and the research would operate under the guidance of a board of stakeholders such as (but not limited to) NMFS, CDFG, and KC LLC. The Kilarc Anadromous Fish and Research Facility would not formally come into existence.

In this mode continued facility operation would be reviewed every 10 years to see if the appropriate balance between Green Power and total Local, State and National fish benefit

is maintained. In effect, this would be a 10-year hydropower license under the FERC. The downside of this alternative is that less revenue would be available for investment in fisheries capital intensive enhancements and recreation would probably have to be limited or reduced.

Variation II – The Recreational Partnership

Variation II is that that parts of the facility would be taken over by a recreation oriented entity (such as Shasta County, National Forest, or California State Parks) that would continue the operation as it is now. The entity would own the public areas and deliver water to the hydropower plant, and in return be paid a hefty fee for delivery of the water. The recreation entity would take fee title to the lands. The recreation entity would continue the recreation benefits that the site is currently providing, and it would also support the hydro operation by absorbing the legal risks of the canal. The recreational facility would do this at no net average cost, because it would be paid a fee by KC LLC for water delivery to the powerhouse.

To date (June, 2008) no recreation entity has come forward to take over the non-hydropower facilities. PG&E has spoken publicly and privately with the obvious entities, Shasta County and the California State Parks, strongly dissuading them from being interested in continuing recreation at this facility. Joint recreation and hydropower facility has been discussed by Davis Hydro with County and State officials, but to date PG&E's private persuasion for demolition has prevailed with both groups. The discussions continue.

Variation III – A Lease from PG&E

Variation III is to have PG&E lease the site (at a nominal rate) to KC LLC or to the new entity, The Kilarc Anadromous Fish and Research Facility, Inc. Davis Hydro would lease the hydro facilities from this entity. This would leave the eventual responsibility for the facilities in the hands of PG&E, but it would remove the daily operation and operational responsibilities. More important it would allow the facility to continue as a fish restoration facility under the guidance of appropriate agencies. The lease fee paid by Davis Hydro would be designed to cover maintenance and indemnity of the canal and forebay.

Derived Studies

The basic derived study will ask the question whether this facility can be used to enhance steelhead trout. This proposed Alternative suggests that there is good reason to believe that it can and will. Further, the benefits of the site through its outreach in terms of decreased acid rain and research into steelhead behavioral response to different conditions may prove to be of global benefit.

The effect of demolishing a 100-year-old ecosystem has to be compared to the possible benefits of a new fish production facility – one capable of generating green energy reducing water pollution across the county. The original statement that *natural conditions are best* needs to be tested in this area of severe upstream barriers and where *natural conditions* have not existed for over 100 years. The rock bottom U shaped valleys and sporadic floods denuding the rocky Old Cow reaches of much habitat and productivity have to be evaluated against a completely controlled juvenile fish production and research facility. In either case, we are creating new habitat. The question is which way is most likely to be most productive.

Indirect Benefits

The Restoration Alternative has multiple incidental effects that should be mentioned but are not derived from our engineering features. These should be considered when evaluating alternatives. The focus of our alternative is Green Power and fish enhancement both directly from the operation of our fish habitat creation in the Kilarc canal and the indirect effects of the Green Power on our atmosphere and waters across the US. These have been brought to our attention primarily by the work of others, but are presented here briefly for completeness.

Environmental

This site generates Green Power. Because of the massive effort in California to generate Green Power, there is no competitive renewable energy available to replace the energy lost from these facilities[18]. All power lost here will be made up with fossil based energy. The effects of on the environment from the emissions from these sources will be local, national, and global. Locally, water in the igneous California mountains is poorly buffered and close to neutral pH. This makes it excellent for fish, and unfortunately therefore habitat to pH sensitive species such as salmonids. The poor buffering (due primarily to the lack of contaminants) makes any small change in acidity have an incremental statistics effect on fish viability. Because these waters host large populations, it is on these large populations that the acidity will have incremental effects[19] and will therefore affect many fish detrimentally.

Any imposition of acid rain generated from the make-up energy will lower water pH. Thus, as we destroy Green Energy sources locally, we are incrementally destroying fish habitat over all areas affected by these fossil emissions. On a national scale, the

[18] See any recent CPUC PURPA hearings for rulings on new marginal generation in the state such a R04-040-25, R04-04-003, or any of its sister proceedings. All marginal generation for the foreseeable future will be fossil – mostly natural gas because large premiums are presently being paid for Green Power.

[19] If the water were poor habitat and there were few fish, fewer fish would be affected as there are fewer of them. Because the waters are generally in good condition, populations are large, so that on a statistical basis a very small change in pH acting on large populations means that there will be many fish affected by small changes in the environment.

prevailing westerlies will carry the pollution from the make-up energy east across the United States, incrementally degrading fish habitat downwind. Likewise, on an even larger scale the destruction the global warming combining with the acid rains provides a doubly negative impact for temperature sensitive fish such as steelhead and other salmonids over the whole planet.

It might be argued that at any one point, lake, or stream this effect is small. Without question, the effects will be small in any one body of water. However, the cumulative incremental impacts of local actions are what agencies, and in a larger sense all of us, are responsible for. Promoting local environmental benefits while incrementally destroying State, National, and planet wide ones is inconsistent with the scope of National and State agencies. There is no more certain way to destroy fish over a large scale than by destroying Green Power sources such the Demolition Alternative proposed by PG&E. Unless it can be shown that acid rain will not be created from the CO_2 emissions from the make-up fossil energy, one has to assume that the tiny impacts over millions of acres of habitat will dwarf the small possible gain from the Demolition Alternative.

Recreation

Recreational fishing is a prime activity in this area. Kilarc Reservoir is the best known handicapped trout- fishing for wheelchair-bound individuals. The setting is beautiful and with CDFG continuing to stock the forebay, the fishing is excellent. The area also is used for picnicking and hiking, 4 & 2 wheeling with many trails for exploring along the canal. These would all be eliminated without a recreational element associated with the facility.

Water / Wetlands

The area supports considerable wetlands with wetlands species that should be studied to see if this unique environment that has been stable for a hundred years contains at risk resources that warrant preservation (Sloat). It is not known if the wetlands are significant, but it is clear from their extensive presence surrounding the forebay and a few small areas along the canal that wetlands are present and create a local habitat.

Archaeological / Cultural

The Kilarc-Cow Creek facility is over 100 years old and as a system represents an engineering marvel at the turn of the last century. It was assembled by teams of horse drawn equipment and men working with primitive tools. The most important artifacts are the canals and the associated water works. The canals – particularly the Kilarc canal - are a marvel of hydropower engineering, and unmatched at this scale in those times. While the original wooden flumes of the Kilarc canal are lost, much of the early stone and later cement work is in excellent condition. This very thin-section concrete canal work is not done today, and such artistry is only seen in ferrocement boat construction.

The soils engineering in the canal bottom in the “at grade” sections appears to be a mixture of original naturally impermeable clay layers with interleaving of more modern clay layers during construction. These clays leave the bottom impermeable as it passes over sections of porous soil, forming a base for the large patches of existing sand and gravels and a natural impermeable base for river gravel enhancement. These were clearly not perfect in lasting successfully for a hundred years; not only the wooden flumes rotted away, but some sections of the “at grade” sections failed and had to be either constructed in cement or relined.

The spectacular forebay and canal sections are the very first high head sites in California and a marvel of turn of the century engineering. These might be worth preserving for their historical value – if not utility.

Bibliography

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Caster Personal Communications, reported on visiting the Old Cow barriers by helicopter with CDFG and other people. She reports the CDFG representative reporting that the upper cascade was probably impassable (The statement was also reflected in report prepared by Entrix on behalf of PG&E). Pictures of this cascade are available in the pictures section of WWW.Kilarc.info.

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The written reports are available in the Documents section of www.kilarc.info. Work is ongoing, and some of these will be revised and expanded over the 2008 summer, as the ecology is better understood.