Appendix K
Water Temperature and Aquatic Habitat in Battle Creek

Appendix K, "Water Temperature and Aquatic Habitat in Battle Creek," is a new appendix that will be included in the Final Environmental Impact Statement/Environmental Impact Report (EIS/EIR) in response to comments received from the California Department of Fish and Game, National Oceanic and Atmospheric Administration National Marine Fisheries Service, and Pacific Gas and Electric Company during public review of the June 2003 Draft EIS/EIR (Jones & Stokes 2003).

In this appendix, the temperature regime is predicted using SNTEMP, which is the analysis the Battle Creek Working Group Biological Technical Team used to develop the Restoration Project action alternatives and to select the proposed action, as presented in the Draft EIS/EIR (Jones & Stokes 2003) and the Action Specific Implementation Plan (Jones & Stokes 2004). Appendix K was created to fulfill the need to disclose decision-making tools for the proposed action and address comments received during the public review of the Draft EIS/EIR. The temperature regime used in this appendix provides information pertaining to the magnitude of beneficial effects provided by cooler water temperatures. This beneficial effect is described in more detail under Impact 4.1-12 in Section 4.1, Fish, of the Draft EIS/EIR.

The U.S. Department of the Interior, Bureau of Reclamation, and the State Water Resources Control Board have deemed that this new appendix constitutes significant new information. As a result, the lead agencies have included Appendix K in this document (the Draft SEIS/REIR) for public comment.

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Introduction

Water temperature affects the quality of habitat used by river life stages of anadromous fish. In Battle Creek, water temperature is influenced primarily by hydrological and meteorological conditions, water diversions, flow releases below diversion dams, and the diversion of cold spring water from the stream channel. Fish populations are influenced by the distribution of water temperatures in the stream habitat.

In this appendix, the temperature regime under the Battle Creek Salmon and Steelhead Restoration Project (Restoration Project) is predicted using SNTEMP (Pacific Gas and Electric Company, Land and Water Quality Unit 2001), which is the analysis method the Battle Creek Working Group (BCWG) Biological Technical Team (Kier Associates 1999) used to develop the Battle Creek project alternatives and select the Proposed Action, as presented in the environmental impact statement/environmental impact report (EIS/EIR) (Jones & Stokes 2003) and the action specific implementation plan (ASIP) (Jones & Stokes 2004). The temperature analysis is presented for habitat under the Proposed Action and the No Action Alternative and assessed in relation to temperature tolerances of anadromous salmonids. For most of the year, water temperatures are sufficiently cool to provide high-quality habitat for steelhead and Chinook salmon.

Warmer water temperatures may limit habitat quality during the summer months of June–September (Kier Associates 1999). Several factors cause warming in Battle Creek. Dry and warm meteorological conditions tend to increase water temperature, whereas wet and cold conditions lead to lower water temperatures. Water diversions from North Fork to South Fork Battle Creek tend to warm the North Fork Battle Creek by removing its cool water and to cool the South Fork Battle Creek by introducing relatively cold water at South and Inskip Powerhouses. The flow released below diversion dams also affects water temperature. In general, larger streamflows warm more slowly than smaller streamflows. Finally, diversions of relatively cold spring water out of the stream channel increase instream water temperatures.

Approach to Assessment of Temperature Effects

As water temperature increases toward the extremes of the tolerance range of a fish, biological effects, such as impaired growth and increased susceptibility to disease and predation, are more likely to occur (Myrick and Cech 2001; Sullivan et al. 2000). Once temperatures exceed the tolerance range for a species at a certain life stage, survival rate decreases, depending on the magnitude and duration of elevated temperatures. Different life stages and species have different temperature responses, and the tolerance ranges that are identified in available literature are relatively broad (Jones & Stokes 2003, Section 4.1, "Fish"). Conclusive studies of the thermal requirements for Chinook salmon and steelhead in Central Valley streams are limited (Myrick and Cech 2001). For the purposes of this assessment of effects, survival estimates focus on the most temperature-sensitive life stages and the month in which the temperature extreme exists. Temperature response survival estimates are based on studies reported in the literature and impact analysis techniques used for the same assemblage of fish in the Sacramento River. The presence and absence of temperature-sensitive life stages are based on results of life history studies in the nearby Sacramento River and results of trapping and survey estimates on Battle Creek that have produced juvenile and adult abundance indices (U.S. Fish and Wildlife Service [USFWS] 2001).

Water temperatures in Battle Creek were modeled using SNTEMP, a cross-sectional, averaged, one-dimensional model, which was applied to the Battle Creek system, including the natural stream channels and Hydroelectric Project canals (Pacific Gas and Electric Company, Land and Water Quality Unit 2001).

Development of the SNTEMP model for Battle Creek is described in Appendix R, "Water Temperatures in the Battle Creek Restoration Area," of the Final EIS/EIR (*during public review of the Draft SEIS/REIR, see Appendix M, "Instream Flow Effects on Water Temperature in the Battle Creek Restoration Project Area," in the Draft EIS/EIR [Jones & Stokes 2003]*). The SNTEMP model simulated the Battle Creek temperature distribution using specified hydrology (dry, normal, and wet water years) and meteorology (hot, normal, and cold climate conditions). The SNTEMP model output subsequently used for this analysis consisted of monthly mean temperature predictions for three modeling simulation conditions (dry-warm, normal-normal, and wet-cold) along the 9.6 miles of North Fork Battle Creek downstream of North Battle Creek Feeder Diversion Dam and along the 14.4 miles of South Fork Battle Creek downstream of South Diversion Dam. The 9.2 miles of mainstem Battle Creek between the confluence and the Coleman Powerhouse were also simulated.

The results of the SNTEMP model are summarized in Figures 1–8. It should be noted that the daily temperatures will vary throughout the month, causing the actual mortality relationships to vary throughout the month as the fish respond to daily average temperatures; however, presenting the performance of the two alternatives on average over a month provides a suitable comparative analysis.

The temperature thresholds presented in the ASIP for survival and suitability for the different life stages of the priority species for the Restoration Project are described below.

- **Winter-Run Chinook Salmon Embryos—**Chinook salmon embryos are particularly sensitive to warmer temperatures. For winter-run Chinook, the embryonic life stage occurs in April through August. The warmest water temperature conditions occur during July (Figures 9–11) Temperature-survival relationships indicated on the figures are those developed for the same assemblage of Chinook salmon in the nearby upper Sacramento River for use in a similar impact analysis for a temperature control project (USFWS 1990; U.S. Department of the Interior, Bureau of Reclamation 1991). These temperature-survival relationships were applied to Battle Creek in the Restoration Plan (Kier Associates 1999) and confirmed for winter-run Chinook salmon in later studies by the USFWS.
- **Winter-Run Chinook Salmon Juveniles—**Winter-run Chinook salmon juveniles are more temperature-sensitive during September (Figure 12) when warm climate conditions occur. The temperature response indicated in the figure includes lethality (Brett 1952; Raleigh et al. 1984; Myrick and Cech 2001) and preferred temperature range (Groot and Margolis 1991). Literature covering the response for exposure to temperatures between lethal and preferred shows considerable variation; factors that increase the difficulty of replicating a response include food availability (Bisson and Davis 1976) and acclimation temperature (Brett 1952).
- **Spring-Run Chinook Salmon Embryos—**Chinook salmon embryos are particularly sensitive to warmer temperatures. For spring-run Chinook, the peak months for the embryonic life stage are September through November. Spring-run Chinook salmon embryos are likely most at risk during the month of September because this month typically has the highest water temperature (Figure 13). Temperature-survival relationships indicated on these figures are those developed for the same assemblage of Chinook salmon in the nearby upper Sacramento River for use in a similar impact analysis for a temperature control project (USFWS 1990; U.S. Department of the Interior, Bureau of Reclamation 1991). These temperature-survival relationships were applied to Battle Creek in the Restoration Plan (Kier Associates 1999) and confirmed for winter-run Chinook salmon in later studies by the USFWS.
- **Spring-Run Chinook Salmon Smolts**—Spring-run Chinook salmon smolts are more temperature-sensitive during June when the last of these smolt populations are present (Brown pers. comm.) and warm water conditions occur (Figure 14). The temperature response indicated in the figure refers to the advanced juvenile life stages of anadromous salmonids when the parr stage transforms to smolt (smoltification) during the spring. Changes in behavior and physiology prepare the smolts for survival in saltwater. Based primarily on controlled experiments, water temperatures high enough to interrupt the smoltification process vary by species (Wedemeyer et al. 1980). From literature reviews, Zedonis and Newcomb (1997) identified three categories of thermal tolerance for salmonid smolts for the Trinity River.

The three categories—optimal, marginal, and unsuitable—were defined by the relative likelihood that smolts would revert to parr or lose their ability to osmoregulate in seawater.

- **Spring-Run Chinook Salmon Adults**—Over-summering spring-run Chinook salmon are more temperature-sensitive during July and August, when energy reserves are low, as the adults are reaching the end of their prespawning holding period (Figures 15 and 16). The temperature response indicated on the figures includes the preferred temperature range (California Department of Water Resources 1988) and a range where the exposure represents stressful conditions. The relationships were presented in the Battle Creek Restoration Plan (Kier Associates 1999).
- **Steelhead Smolts—**Steelhead smolts are more temperature-sensitive during June (Figure 17), when the last of these smolt populations is present (Brown pers. comm.) and warm water conditions occur. The temperature response indicated in the figure refers to the advanced juvenile life stages of anadromous salmonids when the parr stage transforms to smolt (smoltification) during the spring. Changes in behavior and physiology prepare the smolts for survival in saltwater. Based primarily on controlled experiments, water temperatures high enough to interrupt the smoltification process vary by species (Wedemeyer et al. 1980). From literature reviews, Zedonis and Newcomb (1997) identified three categories of thermal tolerance for salmonid smolts for the Trinity River. The three categories—optimal, marginal, and unsuitable—were defined by the relative likelihood that smolts would revert to parr or lose their ability to osmoregulate in seawater. Studies examining relationships between water temperature and smoltification for steelhead have observed a reduction in migratory tendencies in response to elevated temperatures (greater than 55.4ºF) (Zaug 1981) and reduced physiological changes at higher temperatures (59ºF) that were inferred to be associated with a sharp decline in the number of outmigrating wild steelhead smolts captured in traps (Kerstetter and Keeler 1976).

Assessment of Temperature Effects on Anadromous Salmonids

As indicated previously, the minimum instream flow requirements and release of presently diverted spring water are increased over present Federal Energy Regulatory Commission requirements (i.e., minimum flow requirements described in the 1999 Memorandum of Understanding, included as Appendix A in the Final EIS/EIR [*during public review of the Draft SEIS/REIR, see Appendix A in the Draft EIS/EIR*]) in the reaches downstream of the North Battle Creek Feeder Diversion Dam on North Fork Battle Creek and downstream of the South Diversion Dam on South Fork Battle Creek. The higher flows and cold spring waters will substantially cool water temperature at most locations, especially during the warmer months (Figures 9–17), and are likely to have a substantial beneficial effect on steelhead, Chinook salmon, and essential fish habitat for Chinook salmon.

Potential beneficial effects provided by cooler water temperatures in each reach from June through September are estimated using the SNTEMP model (Figures 9–17). A general indication of the magnitude of beneficial water temperature effects over all months is presented using the Warming Model for unspecified runoff and climate conditions described in Appendix R, "Water Temperatures in the Battle Creek Restoration Area," of the Final EIS/EIR (*during public review of the Draft SEIS/REIR, see Appendix M, "Instream Flow Effects on Water Temperature in the Battle Creek Restoration Area" in the Draft EIS/EIR*). Both approaches illustrate that, during summer months, higher flows associated with the Restoration Project substantially increase the extent of usable spawning and rearing habitat.

There are two short segments in South Fork Battle Creek where baseline conditions provide cooler summer temperatures than the Restoration Project. These cooler summer temperatures occur when the Inskip and South Powerhouses inject cooler North Fork Battle Creek water into South Fork Battle Creek. However, the powerhouses do not reliably inject cooler water under baseline conditions—canal and turbine outages occur at unpredictable times, producing substantial temperature fluctuations that reduce habitat value compared to the stabilized conditions under the Restoration Project.

The Restoration Project will result in cooler temperatures throughout most of the reaches during the month of July. An exception to this is immediately below the Inskip and Coleman Diversion Dams (Figures 18–20). Point estimates of temperature changes over the length of the project area for June (Figure 9), August (Figure 11), and September (Figure 13) also reveal warmer temperatures will occur immediately below the Inskip and Coleman Diversion Dams under the Restoration Project.

Under the baseline conditions during the summer, Inskip Powerhouse discharges North Fork Battle Creek water. This discharge can result in an 8°F cooling of the water temperature immediately upstream of the Coleman Diversion Dam and downstream into the Coleman reach. Inversely, when an outage is needed to repair the turbine or canal, the cool water shuts off at the intake, causing the temperature below the powerhouse to suddenly warm 8°F. The warming affects several miles of stream downstream of the discharge points.

Under the Restoration Project during the summer, the cooler Inskip Powerhouse flow will bypass South Fork Battle Creek via connectors, which can result in temperatures as much as 8°F warmer in the 1-mile stream segment below Coleman Dam (cooled under baseline conditions). Although the Restoration Project will not provide the cooler discharges noted as part of the baseline conditions, it will not result in a significant reduction of habitat because it will stabilize the overall temperature regime by eliminating fluctuations associated with outages. The downstream segment of the Coleman reach is cooler under the

Restoration Project because of the higher minimum flows compared to baseline conditions (Figures 9–17).

Under baseline conditions, South Powerhouse discharges cool water from Upper South Fork and North Fork Battle Creek during the summer months, resulting in a 6°F cooling of the water temperature immediately downstream of the powerhouse to Inskip Diversion Dam and into the upstream segment of the Inskip reach. Inversely, when an outage is needed to repair the turbine or canal, the cool water shuts off at the intake, causing the temperature below the powerhouse to suddenly warm 6°F.

Under the Restoration Project, the cooler powerhouse flow will bypass South Fork Battle Creek via connectors, resulting in temperatures as much as 4°F warmer in the 1-mile stream segment below Inskip Diversion Dam. The Restoration Project will not result in a significant reduction of habitat because it will stabilize the overall temperature regime by eliminating fluctuations associated with outages. Water temperatures are cooler in the downstream segment of the Inskip reach under the Restoration Project because of the higher minimum flows. Overall, the Restoration Project creates a temperature regime in which temperature warms as the stream drops in elevation (Figures 21 and 22), providing the salmon with the environmental cue to continue their upstream migration to the reaches that have the most reliable cold water environment in the South Fork Battle Creek (Figures 9–17).

The extension of cooler water temperatures into downstream reaches under the higher instream flow requirements of the Restoration Project occurs during warmer months (Figures 9–17). Cooler temperatures are especially apparent in North Fork and South Fork Battle Creek above Inskip Dam (Figure 18). The cooler water temperature under higher instream flow and the addition of cold water to the North Fork and South Fork Battle Creek from the Eagle Canyon Spring and Bluff Spring Complexes substantially increase suitable habitat for all Chinook salmon and steelhead temperature-sensitive life stages during June–September (Figures 9–17). Water temperatures during October–May are cool and generally have minimal effect on survival.

The comparative analyses of the biological consequences shown in Figures 9–13 compare the estimated survival rates as predicted by SNTEMP model for June–September. These analyses focus on stream reaches that are functional for various life stages of the priority species during vulnerable times. This approach, described in Chapter 3, is similar to that developed by the BCWG Technical Team (Kier Associates 1999). In addition to survival estimates during the warm season, point survival estimates and their corresponding water temperatures are provided at the start and terminus of the reach for the entire year (Tables 1–8).

It should be noted that there are significant differences in the results of the two comparative analysis methods that predict water temperature and characterize survival rates (e.g., there is a 50% difference in survival rates in one case). The adaptive management plan for the Restoration Project (refer to Appendix C of the Final EIS/EIR [*during public review of the Draft SEIS/REIR, see Appendix D,* *"Battle Creek Salmon and Steelhead Restoration Project Adaptive Management Plan" in the Draft EIS/EIR*]), recognizes the uncertainty associated with prediction of water temperature regimes and survival rates for different life stages under various environmental conditions. The adaptive management plan includes measures to:

- improve modeling efforts during the postproject period,
- apply those improvements to real-time temperature management in the project area, and
- provide necessary improvements though the Water Acquisition Fund.

The SNTEMP model was determined to adequately meet the current modeling needs. The model examined the expected survival for critical salmonid life stages, including spring-run and winter-run Chinook salmon embryos, steelhead and spring-run Chinook salmon smolts, juvenile Chinook salmon, and prespawning adult spring-run Chinook salmon (Figures 9–17). The model results are described below.

Winter-run Chinook salmon embryo survival rates (Figure 9) at locations where the estimated survival rates exceed 50% predict that the Restoration Project substantially improves temperature conditions over baseline conditions in the South Diversion reach; however, embryo survival rates are essentially unchanged between baseline and restoration conditions in the Eagle Canyon and North Battle Creek Feeder reaches. Winter-run Chinook salmon embryo survival rates throughout the year (Table 1) generally indicate that the Restoration Project improves conditions in the Eagle Canyon reach and to a lesser extent the Wildcat reach, but not elsewhere, compared to baseline conditions.

The portions of the project area shown in the longitudinal profile for September where survival of spring-run Chinook salmon embryos exceeds 50% (Figure 13) show that the Restoration Project substantially improves temperature conditions. The Restoration Project provides cooler, more stable habitat in the reaches below South Diversion, Eagle Canyon, and Wildcat Diversion Dams compared to baseline conditions. In addition, the Restoration Project provides substantial improvements over baseline conditions in the reaches with estimated survival rates above 90%, including the Eagle Canyon and South Diversion reaches.

Prior to spring-run Chinook salmon spawning activity in the late summer and fall, the adults and unfertilized ova can be vulnerable to adverse effects of elevated temperatures (Kier Associates 1999). The August longitudinal temperature regime in Figure 16 shows that the Restoration Project provides substantially more habitat in the temperature range preferred for adult salmon holding in both the Eagle Canyon and South Diversion reaches. The Restoration Project also improves adult holding areas in the Wildcat and Inskip reaches. For the Restoration Project, the temperature range is categorized as stressful compared to an unsuitable classification under baseline conditions.

For steelhead, spawning begins in December and ends in April, with incubation extending through May (Table 3). Spawning is supported under both baseline conditions and the Restoration Project. Under the Restoration Project, however, cool temperatures extend farther downstream and through May. The cooler water temperatures in April and May generally indicate higher embryo survival in the forks and in the mainstem of Battle Creek.

Juvenile spring-run Chinook salmon benefit from cooler water temperatures that would support rearing through May (Table 5). Spring-run smolts outmigrate through June (Brown pers. comm.), and the Restoration Project results in substantial cooling to optimum temperatures in the reaches below South Diversion and Wildcat Diversion Dams. The Restoration Project also cools the temperatures considered unsuitable for the Inskip, Coleman, and mainstem reaches under baseline conditions (Figure 14).

Juvenile winter-run Chinook salmon benefit from the cooler temperatures that extend to the lower elevation reaches during juvenile emigration periods under the Restoration Project. The emigration of winter-run Chinook salmon juveniles from the spawning areas is highly dependent on streamflow conditions and water year type. Emigration past Red Bluff Diversion Dam generally peaks in September (National Oceanic and Atmospheric Administration, National Marine Fisheries Service 1997). During September of normal years, the Restoration Project temperature is 65°F or less, which is more than 10°F less than the temperature resulting in lethal response during a short exposure (Figure 12). Substantial improvements in the temperature regime in September are provided under the Restoration Project in the Inskip, Coleman, Wildcat, and mainstem reaches (Figure 8 and Table 5).

For steelhead, juvenile rearing occurs year-round (Table 7). The last smolts of the emigration period are present in June (Brown pers. comm.), when the lower elevation reaches of the project area become unsuitable for smolts (Figure 17). The Restoration Project temperatures in June are marginally suitable for maintaining smolts in good condition in the North Battle Creek Feeder and South Diversion reaches, representing a substantial improvement over baseline conditions in the South Diversion reach (Figure 17). There is a general indication that steelhead juveniles residing in the summer benefit from the Restoration Project's cooler temperatures in the lowest elevation reaches, except for the terminus of the South Fork- and terminus of the mainstem (Table 7).

Additional water temperature benefits related to coldwater refugia are not fully captured by the SNTEMP water temperature analysis. The importance of coldwater refugia for the overall performance of the project is recognized in the adaptive management plan located in Appendix C, "Revised Draft Battle Creek Salmon and Steelhead Restoration Project Adaptive Management Plan, Executive Summary," of the Final EIS/EIR (*during public review of the Draft SEIS/REIR, see Appendix D, "Battle Creek Salmon and Steelhead Restoration Project Adaptive Management Plan" in the Draft EIS/EIR*). Under baseline conditions, cool springs are diverted into canals that convey flow from Eagle Canyon Diversion Dam and Soap Creek Feeder Diversion Dam. At Eagle

Canyon Diversion Dam, the spring flow is approximately 12 cubic feet per second (cfs), and the temperature of the spring flow is near 52°F year-round. Under the Restoration Project, the spring flow would discharge to North Fork Battle Creek and would cool streamflow during the warmer months (Figure 23). The cooling would provide temperatures more conducive to supporting spawning and rearing and would especially benefit winter- and spring-run Chinook salmon and steelhead.

Soap Creek inflow to South Fork Battle Creek would also increase under the Restoration Project. Flow in Soap Creek originates from Bluff Springs and would contribute cool water to South Fork Battle Creek. Under baseline conditions, flow in Soap Creek is diverted and does not contribute to cooling of South Fork Battle Creek. The approximate effect of Soap Creek flow, based on 15 cfs at a minimum water temperature of 52–54°F, is shown in Figure 24. Coldwater refugia can develop in the bottom of pools, provided that stratification is allowed to occur through flow management. Development of coldwater refugia will be substantially beneficial, providing temperatures more conducive to support of adult holding, spawning, smolting, and rearing and especially benefiting early spawning winter- and spring-run Chinook salmon and steelhead.

Stream reaches receiving cool spring flow are expected to provide cool water refugia that will better support spawning and rearing of Chinook salmon and steelhead, benefits not fully reflected by the simulated water temperature. The longitudinal temperature profiles for the driest months show regions with potential to develop coldwater refugia (outside the powerhouse cooling zones). Specifically, inputs are visible in the profiles at the locations upstream of Coleman Powerhouse:

1. mainstem at 8.5 miles,
2. Inskip at 13 miles,
3. South Diversion at 21 miles, and
4. Eagle Canyon at 14.5 miles.

The minimum flow requirements under the Restoration Project support future adaptive management of water temperature to realize benefits from spring-flow refugia to meet the adult holding, rearing, and spawning life stage needs of Chinook salmon and steelhead (Figures 5–8).

Fall/late fall–run Chinook salmon survival is less affected by water temperature than the other Chinook salmon runs because spawning occurs in late fall and winter. Winter- and spring-run Chinook salmon and steelhead juveniles and smolts would receive the most temperature benefits from increased flows and cool water accretions because embryos and smolts generally occur during warmer months. Fall/late fall–run juveniles would benefit from cooler water temperatures through the summer (Table 5).

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Table 1. Estimated Survival of Chinook Salmon Eggs in Response to Water Temperature during Incubation at Various Locations in Battle Creek under Baseline Conditions and the Restoration Project

	Potential Occurrence of Spawning and Incubation for Spring-, Winter-, Fall-, and Late Fall–Run Chinook Salmon											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Spring-Run								■	■	■	■	■
Winter-Run				■	■	■	■	■	■	■		
Fall-Run	■	■								■	■	■
Late Fall–Run	■	■	■	■	■	■						
Location	Estimated Incubation Survival by Month (%)*											
North Battle Creek Feeder Diversion Dam												
Baseline	100%	100%	100%	100%	99%	96%	87%	96%	99%	100%	100%	100%
Restoration Project	100%	100%	100%	100%	99%	96%	87%	96%	99%	100%	100%	100%
Eagle Canyon Diversion Dam												
Baseline	100%	100%	100%	100%	81%	49%	0%	24%	67%	98%	100%	100%
Restoration Project	100%	100%	100%	100%	97%	90%	72%	88%	96%	100%	100%	100%
Wildcat Diversion Dam												
Baseline	100%	100%	100%	79%	0%	0%	0%	0%	0%	25%	97%	100%
Restoration Project	100%	100%	100%	100%	87%	66%	15%	52%	79%	99%	100%	100%
Mouth of North Fork Battle Creek												
Baseline	100%	100%	100%	0%	0%	0%	0%	0%	0%	0%	54%	100%
Restoration Project	100%	100%	100%	99%	63%	5%	0%	0%	33%	91%	100%	100%
South Diversion Dam												
Baseline	100%	100%	100%	100%	99%	52%	0%	0%	52%	99%	100%	100%
Restoration Project	100%	100%	100%	100%	99%	52%	0%	0%	52%	99%	100%	100%
South Powerhouse												
Baseline	100%	100%	100%	100%	79%	0%	0%	0%	0%	79%	100%	100%
Restoration Project	100%	100%	100%	100%	96%	21%	0%	0%	21%	96%	100%	100%

	Potential Occurrence of Spawning and Incubation for Spring-, Winter-, Fall-, and Late Fall–Run Chinook Salmon											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Inskip Diversion Dam												
Baseline	100%	100%	100%	100%	96%	78%	27%	53%	81%	100%	100%	100%
Restoration Project	100%	100%	100%	100%	96%	21%	0%	0%	21%	96%	100%	100%
Above Inskip Powerhouse												
Baseline	100%	100%	100%	59%	0%	0%	0%	0%	0%	0%	81%	100%
Restoration Project	100%	100%	100%	100%	57%	0%	0%	0%	0%	57%	100%	100%
Coleman Diversion Dam												
Baseline	100%	100%	100%	100%	75%	0%	0%	0%	60%	97%	100%	100%
Restoration Project	100%	100%	100%	100%	57%	0%	0%	0%	0%	57%	100%	100%
Mouth of South Fork Battle Creek												
Baseline	100%	100%	100%	77%	0%	0%	0%	0%	0%	0%	96%	100%
Restoration Project	100%	100%	100%	100%	18%	0%	0%	0%	0%	0%	100%	100%
Below the Confluence of North and South Fork Battle Creek												
Baseline	100%	100%	100%	53%	0%	0%	0%	0%	0%	0%	87%	100%
Restoration Project	100%	100%	100%	100%	33%	0%	0%	0%	0%	56%	100%	100%
Battle Creek at Coleman Powerhouse												
Baseline	100%	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%
Restoration Project	100%	100%	100%	98%	0%	0%	0%	0%	0%	0%	96%	100%

Note:

* Values in this table are based on water temperatures in Table 2.

Table 2. Monthly Water Temperatures Corresponding to Chinook Salmon Egg Survival at Various Locations in Battle Creek under Baseline Conditions and the Restoration Project.

	Potential Occurrence of Spawning and Incubation for Spring-, Winter-, Fall-, and Late Fall–Run Chinook Salmon											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Spring-Run												
Winter-Run												
Fall-Run												
Late Fall–Run												
Location	Water Temperatures by Month (^{o}F)*											
North Battle Creek Feeder Diversion Dam												
Baseline	<54.9	<54.9	<54.9	<54.9	55	56	57.4	56	55	<54.9	<54.9	<54.9
Restoration Project	<54.9	<54.9	<54.9	<54.9	55	56	57.4	56	55	<54.9	<54.9	<54.9
Eagle Canyon Diversion Dam												
Baseline	<54.9	<54.9	<54.9	<54.9	58.1	60.2	>61.9	61.2	59.1	55.3	<54.9	<54.9
Restoration Project	<54.9	<54.9	<54.9	<54.9	55.7	57	58.8	57.3	56	<54.9	<54.9	<54.9
Wildcat Diversion Dam												
Baseline	<54.9	<54.9	<54.9	58.3	>61.9	>61.9	>61.9	>61.9	>61.9	61.2	55.7	<54.9
Restoration Project	<54.9	<54.9	<54.9	<54.9	57.4	59.2	61.5	60	58.3	55	<54.9	<54.9
Mouth of North Fork Battle Creek												
Baseline	<54.9	<54.9	<54.9	>61.9	>61.9	>61.9	>61.9	>61.9	>61.9	>61.9	59.9	<54.9
Restoration Project	<54.9	<54.9	<54.9	55	59.4	61.9	>61.9	>61.9	60.9	56.9	<54.9	<54.9
South Diversion Dam												
Baseline	<54.9	<54.9	<54.9	<54.9	55	60	>61.9	>61.9	60	55	<54.9	<54.9
Restoration Project	<54.9	<54.9	<54.9	<54.9	55	60	>61.9	>61.9	60	55	<54.9	<54.9
South Powerhouse												
Baseline	<54.9	<54.9	<54.9	<54.9	58.3	>61.9	>61.9	>61.9	>61.9	58.3	<54.9	<54.9
Restoration Project	<54.9	<54.9	<54.9	<54.9	56	61.3	>61.9	>61.9	61.3	56	<54.9	<54.9

	Potential Occurrence of Spawning and Incubation for Spring-, Winter-, Fall-, and Late Fall–Run Chinook Salmon											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Spring-Run												
Winter-Run												
Fall-Run												
Late Fall–Run												
Location	Water Temperatures by Month (^{o}F)*											
Inskip Diversion Dam												
Baseline	<54.9	<54.9	<54.9	<54.9	56	58.3	61.1	59.9	58.1	<54.9	<54.9	<54.9
Restoration Project	<54.9	<54.9	<54.9	<54.9	56	61.3	>61.9	>61.9	61.3	56	<54.9	<54.9
Above Inskip Powerhouse												
Baseline	<54.9	<54.9	<54.9	59.6	>61.9	>61.9	>61.9	>61.9	>61.9	>61.9	58.1	<54.9
Restoration Project	<54.9	<54.9	<54.9	<54.9	59.7	>61.9	>61.9	>61.9	>61.9	59.7	<54.9	<54.9
Coleman Diversion Dam												
Baseline	<54.9	<54.9	<54.9	<54.9	58.6	>61.9	>61.9	>61.9	59.6	55.7	<54.9	<54.9
Restoration Project	<54.9	<54.9	<54.9	<54.9	59.7	>61.9	>61.9	>61.9	>61.9	59.7	<54.9	<54.9
Mouth of South Fork Battle Creek												
Baseline	<54.9	<54.9	<54.9	58.4	>61.9	>61.9	>61.9	>61.9	>61.9	>61.9	56	<54.9
Restoration Project	<54.9	<54.9	<54.9	<54.9	61.4	>61.9	>61.9	>61.9	>61.9	>61.9	<54.9	<54.9
Below the Confluence of North and South Fork Battle Creek												
Baseline	<54.9	<54.9	<54.9	59.9	>61.9	>61.9	>61.9	>61.9	>61.9	>61.9	57.4	<54.9
Restoration Project	<54.9	<54.9	<54.9	<54.9	60.9	>61.9	>61.9	>61.9	>61.9	59.8	<54.9	<54.9
Battle Creek at Coleman Powerhouse												
Baseline	<54.9	<54.9	<54.9	>61.9	>61.9	>61.9	>61.9	>61.9	>61.9	>61.9	>61.9	<54.9
Restoration Project	<54.9	<54.9	<54.9	55.3	>61.9	>61.9	>61.9	>61.9	>61.9	>61.9	56	<54.9

Note:

* Values are based on the relationship between Chinook Salmon egg survival and water temperature depicted on Figure 1 in Appendix H of the Final EIS/EIR.

Table 3. Estimated Survival of Steelhead Eggs in Response to Water Temperature during Incubation at Various Locations in Battle Creek under Baseline Conditions and the Restoration Project

	Potential Occurrence of Spawning and Incubation for Steelhead											
	Jan	Feb	Mar	Apr	May	Jun*	Jul*	Aug*	Sep*	Oct	Nov	Dec
Steelhead Occurrence												
Location	Estimated Incubation Survival by Month (%)†											
North Battle Creek Feeder Diversion Dam												
Baseline	100%	100%	100%	100%	91%	80%	51%	80%	91%	100%	100%	100%
Restoration Project	100%	100%	100%	100%	91%	80%	51%	80%	91%	100%	100%	100%
Eagle Canyon Diversion Dam												
Baseline	100%	100%	100%	95%	33%	0%	0%	0%	0%	85%	100%	100%
Restoration Project	100%	100%	100%	100%	83%	62%	8%	55%	80%	100%	100%	100%
Wildcat Diversion Dam												
Baseline	100%	100%	100%	28%	0%	0%	0%	0%	0%	0%	83%	100%
Restoration Project	100%	100%	100%	98%	53%	0%	0%	0%	30%	92%	100%	100%
Mouth of North Fork Battle Creek												
Baseline	100%	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%
Restoration Project	100%	100%	100%	91%	0%	0%	0%	0%	0%	65%	100%	100%
South Diversion Dam												
Baseline	100%	100%	100%	100%	91%	0%	0%	0%	0%	91%	100%	100%
Restoration Project	100%	100%	100%	100%	91%	0%	0%	0%	0%	91%	100%	100%
South Powerhouse												
Baseline	100%	100%	100%	100%	30%	0%	0%	0%	0%	30%	100%	100%
Restoration Project	100%	100%	100%	100%	81%	0%	0%	0%	0%	81%	100%	100%
Inskip Diversion Dam												
Baseline	100%	100%	100%	100%	81%	25%	0%	0%	33%	94%	100%	100%
Restoration Project	100%	100%	100%	100%	81%	0%	0%	0%	0%	81%	100%	100%

Table 3. Continued

	Potential Occurrence of Spawning and Incubation for Steelhead											
	Jan	Feb	Mar	Apr	May	Jun*	Jul*	Aug*	Sep*	Oct	Nov	Dec
Steelhead Occurrence												
Location	Estimated Incubation Survival by Month (%)†											
Above Inskip Powerhouse												
Baseline	100%	100%	100%	0%	0%	0%	0%	0%	0%	0%	34%	100%
Restoration Project	100%	100%	100%	100%	0%	0%	0%	0%	0%	0%	100%	100%
Coleman Diversion Dam												
Baseline	100%	100%	100%	97%	15%	0%	0%	0%	0%	84%	100%	100%
Restoration Project	100%	100%	100%	100%	0%	0%	0%	0%	0%	0%	100%	100%
Mouth of South Fork Battle Creek												
Baseline	100%	100%	100%	21%	0%	0%	0%	0%	0%	0%	81%	100%
Restoration Project	100%	100%	100%	99%	0%	0%	0%	0%	0%	0%	93%	100%
Below the Confluence of North and South Fork Battle Creek												
Baseline	100%	100%	100%	0%	0%	0%	0%	0%	0%	0%	52%	100%
Restoration Project	100%	100%	100%	97%	0%	0%	0%	0%	0%	0%	98%	100%
Battle Creek at Coleman Powerhouse												
Baseline	100%	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%
Restoration Project	100%	100%	100%	86%	0%	0%	0%	0%	0%	0%	81%	100%

Note:

*Spawning does not occur during this month.
†Values in this table are based on water temperatures in Table 4.

Table 4. Monthly Water Temperatures Corresponding to Steelhead Egg Survival at Various Locations in Battle Creek under Baseline Conditions and the Restoration Project.

	Potential Occurrence of Spawning and Incubation for Steelhead											
	Jan	Feb	Mar	Apr	May	Jun*	Jul*	Aug*	Sep*	Oct	Nov	Dec
Steelhead Occurrence												
Location	Water Temperatures by Month (°F)†											
North Battle Creek Feeder Diversion Dam												
Baseline	<53.5	<53.5	<53.5	<53.5	55	56	57.5	56	55	<53.5	<53.5	<53.5
Restoration Project	<53.5	<53.5	<53.5	<53.5	55	56	57.5	56	55	<53.5	<53.5	<53.5
Eagle Canyon Diversion Dam												
Baseline	<53.5	<53.5	<53.5	54.5	58.1	>58.9	>58.9	>58.9	>58.9	55.6	<53.5	<53.5
Restoration Project	<53.5	<53.5	<53.5	<53.5	55.8	57	58.8	57.3	56	<53.5	<53.5	<53.5
Wildcat Diversion Dam												
Baseline	<53.5	<53.5	<53.5	58.3	>58.9	>58.9	>58.9	>58.9	>58.9	>58.9	55.8	<53.5
Restoration Project	<53.5	<53.5	<53.5	54	57.4	>58.9	>58.9	>58.9	58.2	54.9	<53.5	<53.5
Mouth of North Fork Battle Creek												
Baseline	<53.5	<53.5	<53.5	>58.9	>58.9	>58.9	>58.9	>58.9	>58.9	>58.9	>58.9	<53.5
Restoration Project	<53.5	<53.5	<53.5	55	>58.9	>58.9	>58.9	>58.9	>58.9	56.9	<53.5	<53.5
South Diversion Dam												
Baseline	<53.5	<53.5	<53.5	<53.5	55	>58.9	>58.9	>58.9	>58.9	55	<53.5	<53.5
Restoration Project	<53.5	<53.5	<53.5	<53.5	55	>58.9	>58.9	>58.9	>58.9	55	<53.5	<53.5
South Powerhouse												
Baseline	<53.5	<53.5	<53.5	<53.5	58.2	>58.9	>58.9	>58.9	>58.9	58.2	<53.5	<53.5
Restoration Project	<53.5	<53.5	<53.5	<53.5	60	>58.9	>58.9	>58.9	>58.9	60	<53.5	<53.5
Inskip Diversion Dam												
Baseline	<53.5	<53.5	<53.5	<53.5	60	58.3	>58.9	>58.9	58.1	54.6	<53.5	<53.5
Restoration Project	<53.5	<53.5	<53.5	<53.5	60	>58.9	>58.9	>58.9	>58.9	60	<53.5	<53.5

Table 4. Continued

	Potential Occurrence of Spawning and Incubation for Steelhead											
	Jan	Feb	Mar	Apr	May	Jun*	Jul*	Aug*	Sep*	Oct	Nov	Dec
Steelhead Occurrence												
Location	Water Temperatures by Month (°F)†											
Above Inskip Powerhouse												
Baseline	<53.5	<53.5	<53.5	>58.9	>58.9	>58.9	>58.9	>58.9	>58.9	>58.9	58.1	<53.5
Restoration Project	<53.5	<53.5	<53.5	<53.5	>58.9	>58.9	>58.9	>58.9	>58.9	>58.9	<53.5	<53.5
Coleman Diversion Dam												
Baseline	<53.5	<53.5	<53.5	54.2	58.6	>58.9	>58.9	>58.9	>58.9	55.7	<53.5	<53.5
Restoration Project	<53.5	<53.5	<53.5	<53.5	>58.9	>58.9	>58.9	>58.9	>58.9	>58.9	<53.5	<53.5
Mouth of South Fork Battle Creek												
Baseline	<53.5	<53.5	<53.5	58.5	>58.9	>58.9	>58.9	>58.9	>58.9	>58.9	60	<53.5
Restoration Project	<53.5	<53.5	<53.5	53.6	>58.9	>58.9	>58.9	>58.9	>58.9	>58.9	54.8	<53.5
Below the Confluence of North and South Fork Battle Creek												
Baseline	<53.5	<53.5	<53.5	>58.9	>58.9	>58.9	>58.9	>58.9	>58.9	>58.9	57.4	<53.5
Restoration Project	<53.5	<53.5	<53.5	54.2	>58.9	>58.9	>58.9	>58.9	>58.9	>58.9	54	<53.5
Battle Creek at Coleman Powerhouse												
Baseline	<53.5	<53.5	<53.5	>58.9	>58.9	>58.9	>58.9	>58.9	>58.9	>58.9	>58.9	<53.5
Restoration Project	<53.5	<53.5	<53.5	55.5	>58.9	>58.9	>58.9	>58.9	>58.9	>58.9	60	<53.5

Note:

*Spawning does not occur during this month.
†Values are based on the relationship between Steelhead egg survival and water temperature depicted on Figure 1 in Appendix H of the Final EIS/EIR.

Table 5. Estimated Survival of Juvenile Chinook Salmon in Response to Water Temperature during Rearing at Various Locations in Battle Creek under Baseline Conditions and the Restoration Project

	Potential Occurrence of Juvenile Spring-, Winter-, Fall-, and Late Fall–Run Chinook salmon											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Spring-Run												
Winter-Run												
Fall-Run												
Late Fall–Run												
Location	Estimated Juvenile Survival by Month (%)*											
North Battle Creek Feeder Diversion Dam												
Baseline	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Restoration Project	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Eagle Canyon Diversion Dam												
Baseline	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Restoration Project	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Wildcat Diversion Dam												
Baseline	100%	100%	100%	100%	100%	90%	28%	58%	95%	100%	100%	100%
Restoration Project	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Mouth of North Fork Battle Creek												
Baseline	100%	100%	100%	100%	66%	0%	0%	0%	0%	91%	100%	100%
Restoration Project	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
South Diversion Dam												
Baseline	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Restoration Project	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
South Powerhouse												
Baseline	100%	100%	100%	100%	100%	100%	88%	88%	100%	100%	100%	100%
Restoration Project	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table 5. Continued

	Potential Occurrence of Juvenile Spring-, Winter-, Fall-, and Late Fall–Run Chinook salmon											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Spring-Run	■	■	■	■	■						■	■
Winter-Run	■	■	■				■	■	■	■	■	■
Fall-Run	■	■	■	■	■	■						■
Late Fall–Run				■	■	■	■	■	■	■	■	■
Location	Estimated Juvenile Survival by Month (%)*											
Inskip Diversion Dam												
Baseline	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Restoration Project	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Above Inskip Powerhouse												
Baseline	100%	100%	100%	100%	95%	9%	0%	0%	16%	99%	100%	100%
Restoration Project	100%	100%	100%	100%	100%	96%	58%	58%	96%	100%	100%	100%
Coleman Diversion Dam												
Baseline	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Restoration Project	100%	100%	100%	100%	100%	96%	58%	58%	96%	100%	100%	100%
Mouth of South Fork Battle Creek												
Baseline	100%	100%	100%	100%	99%	55%	0%	5%	85%	100%	100%	100%
Restoration Project	100%	100%	100%	100%	100%	74%	0%	0%	72%	100%	100%	100%
Below the Confluence of North and South Fork Battle Creek												
Baseline	100%	100%	100%	100%	94%	12%	0%	0%	54%	100%	100%	100%
Restoration Project	100%	100%	100%	100%	100%	97%	68%	77%	98%	100%	100%	100%
Battle Creek at Coleman Powerhouse												
Baseline	100%	100%	100%	98%	0%	0%	0%	0%	0%	0%	100%	100%
Restoration Project	100%	100%	100%	100%	100%	62%	0%	0%	68%	100%	100%	100%

Note:
* Values in this table are based on water temperatures in Table 6.

Table 6. Monthly Water Temperatures Corresponding to Juvenile Chinook Salmon Survival at Various Locations in Battle Creek under Baseline Conditions and the Restoration Project.

	Potential Occurrence of Juvenile Spring-, Winter-, Fall-, and Late Fall–Run Chinook salmon											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Spring-Run												
Winter-Run												
Fall-Run												
Late Fall–Run												
Location	Water Temperatures by Month (°F)*											
North Battle Creek Feeder Diversion Dam												
Baseline	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1
Restoration Project	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1
Eagle Canyon Diversion Dam												
Baseline	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1
Restoration Project	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1
Wildcat Diversion Dam												
Baseline	<65.1	<65.1	<65.1	<65.1	<65.1	67.5	72	70.4	66.5	<65.1	<65.1	<65.1
Restoration Project	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1
Mouth of North Fork Battle Creek												
Baseline	<65.1	<65.1	<65.1	<65.1	69.9	>72.9	>72.9	>72.9	>72.9	67.3	<65.1	<65.1
Restoration Project	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1
South Diversion Dam												
Baseline	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1
Restoration Project	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1
South Powerhouse												
Baseline	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	67.8	67.8	<65.1	<65.1	<65.1	<65.1
Restoration Project	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1

Table 6. Continued

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Potential Occurrence of Juvenile Spring-, Winter-, Fall-, and Late Fall–Run Chinook salmon											
Spring-Run	■	■	■	■	■						■	■
Winter-Run	■	■	■				■	■	■	■	■	■
Fall-Run	■	■	■	■	■	■						■
Late Fall–Run				■	■	■	■	■	■	■	■	■
Location	Water Temperatures by Month (^{o}F)*											
Inskip Diversion Dam												
Baseline	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1
Restoration Project	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1
Above Inskip Powerhouse												
Baseline	<65.1	<65.1	<65.1	<65.1	66.5	72.7	>72.9	>72.9	72.4	65.1	<65.1	<65.1
Restoration Project	<65.1	<65.1	<65.1	<65.1	<65.1	66.3	70.4	70.4	66.3	<65.1	<65.1	<65.1
Coleman Diversion Dam												
Baseline	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1	<65.1
Restoration Project	<65.1	<65.1	<65.1	<65.1	<65.1	66.3	70.4	70.4	66.3	<65.1	<65.1	<65.1
Mouth of South Fork Battle Creek												
Baseline	<65.1	<65.1	<65.1	<65.1	65.1	70.6	>72.9	72.8	68.2	<65.1	<65.1	<65.1
Restoration Project	<65.1	<65.1	<65.1	<65.1	<65.1	69.3	>72.9	>72.9	69.5	<65.1	<65.1	<65.1
Below the Confluence of North and South Fork Battle Creek												
Baseline	<65.1	<65.1	<65.1	<65.1	66.8	72.6	>72.9	>72.9	70.7	<65.1	<65.1	<65.1
Restoration Project	<65.1	<65.1	<65.1	<65.1	<65.1	66	69.8	69	65.8	<65.1	<65.1	<65.1
Battle Creek at Coleman Powerhouse												
Baseline	<65.1	<65.1	<65.1	65.8	>72.9	>72.9	>72.9	>72.9	>72.9	>72.9	<65.1	<65.1
Restoration Project	<65.1	<65.1	<65.1	<65.1	<65.1	70.2	>72.9	>72.9	69.8	<65.1	<65.1	<65.1

Note:
*Values are based on the relationship between Juvenile Chinook Salmon survival and water temperature depicted on Figure 2 in Appendix H of the Final EIS/EIR.

Table 7. Estimated Survival of Juvenile Steelhead in Response to Water Temperature during Rearing at Various Locations in Battle Creek under the Baseline Conditions and the Restoration Project

	Potential Occurrence of Juvenile Steelhead											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Steelhead												
Location	Estimated Juvenile Survival by Month (%)*											
North Battle Creek Feeder Diversion Dam												
Baseline	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Restoration Project	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Eagle Canyon Diversion Dam												
Baseline	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Restoration Project	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Wildcat Diversion Dam												
Baseline	100%	100%	100%	100%	100%	96%	62%	79%	99%	100%	100%	100%
Restoration Project	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Mouth of North Fork Battle Creek												
Baseline	100%	100%	100%	100%	84%	0%	0%	0%	4%	97%	100%	100%
Restoration Project	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
South Diversion Dam												
Baseline	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Restoration Project	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
South Powerhouse												
Baseline	100%	100%	100%	100%	100%	100%	95%	95%	100%	100%	100%	100%
Restoration Project	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Inskip Diversion Dam												
Baseline	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Restoration Project	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table 7. Continued

	Potential Occurrence of Juvenile Steelhead											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Steelhead												
Location	Estimated Juvenile Survival by Month (%)*											
Above Inskip Powerhouse												
Baseline	100%	100%	100%	100%	99%	50%	0%	0%	54%	100%	100%	100%
Restoration Project	100%	100%	100%	100%	100%	99%	79%	79%	99%	100%	100%	100%
Coleman Diversion Dam												
Baseline	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Restoration Project	100%	100%	100%	100%	100%	99%	79%	79%	99%	100%	100%	100%
Mouth of South Fork Battle Creek												
Baseline	100%	100%	100%	100%	100%	77%	16%	48%	94%	100%	100%	100%
Restoration Project	100%	100%	100%	100%	100%	88%	2%	2%	87%	100%	100%	100%
Below the Confluence of North and South Fork Battle Creek												
Baseline	100%	100%	100%	100%	98%	52%	0%	0%	77%	100%	100%	100%
Restoration Project	100%	100%	100%	100%	100%	100%	85%	90%	100%	100%	100%	100%
Battle Creek at Coleman Powerhouse												
Baseline	100%	100%	100%	100%	0%	0%	0%	0%	0%	44%	100%	100%
Restoration Project	100%	100%	100%	100%	100%	81%	0%	14%	85%	100%	100%	100%

Note:

* Values in this table are based on water temperatures in Table 8.

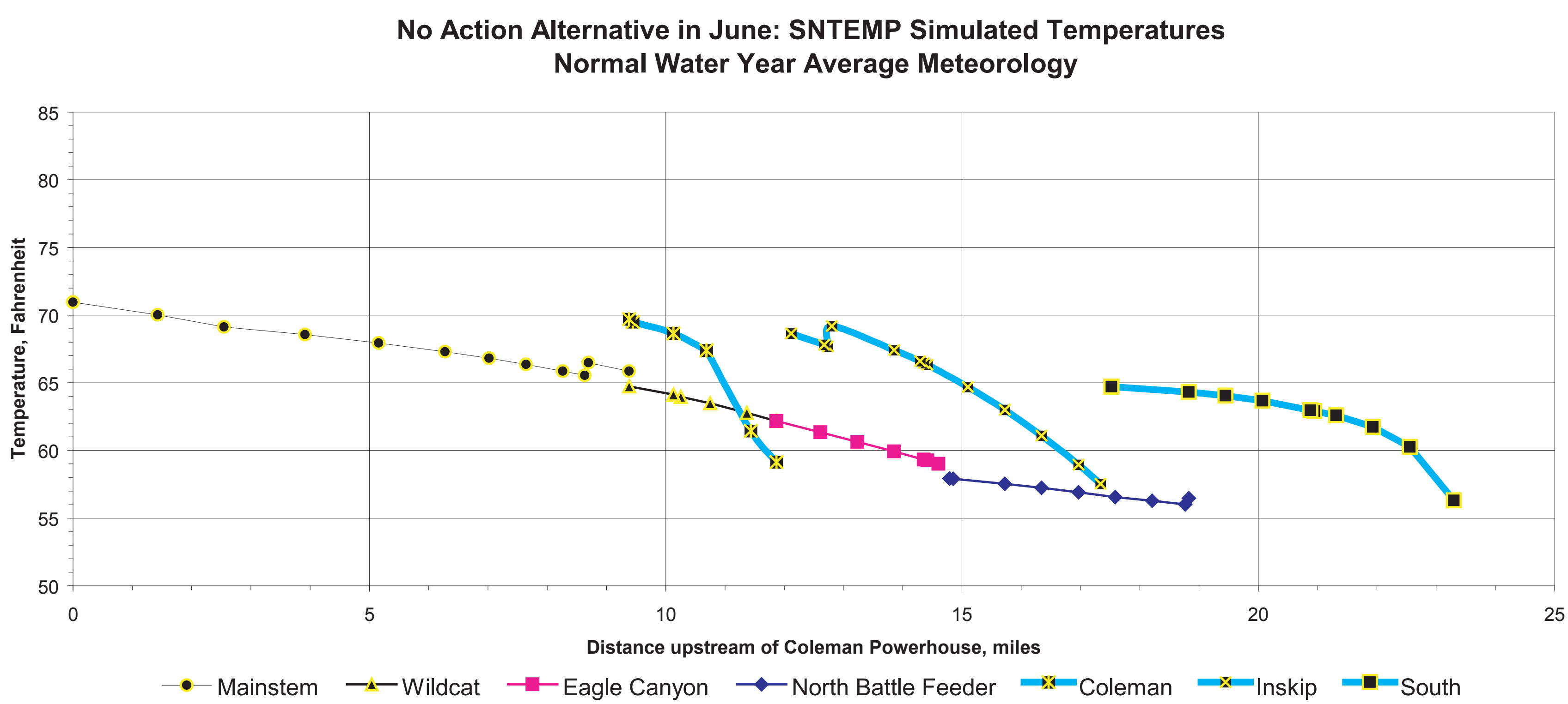
Table 8. Monthly Water Temperatures Corresponding to Juvenile Steelhead Survival at Various Locations in Battle Creek under Baseline Conditions and the Restoration Project.

	Potential Occurrence of Juvenile Steelhead											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Steelhead												
Location	Water Temperatures by Month (°F)*											
North Battle Creek Feeder Diversion Dam												
Baseline	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3
Restoration Project	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3
Eagle Canyon Diversion Dam												
Baseline	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3
Restoration Project	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3
Wildcat Diversion Dam												
Baseline	<66.3	<66.3	<66.3	<66.3	<66.3	67.7	71.9	70.4	66.5	<66.3	<66.3	<66.3
Restoration Project	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3
Mouth of North Fork Battle Creek												
Baseline	<66.3	<66.3	<66.3	<66.3	69.8	>74.9	>74.9	>74.9	74.8	67.3	<66.3	<66.3
Restoration Project	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3
South Diversion Dam												
Baseline	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3
Restoration Project	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3
South Powerhouse												
Baseline	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	68	68	<66.3	<66.3	<66.3	<66.3
Restoration Project	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3
Inskip Diversion Dam												
Baseline	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3
Restoration Project	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3

	Potential Occurrence of Juvenile Steelhead											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Steelhead												
Location	Water Temperatures by Month (^oF)*											
Above Inskip Powerhouse												
Baseline	<66.3	<66.3	<66.3	<66.3	66.5	72.7	>74.9	>74.9	72.5	<66.3	<66.3	<66.3
Restoration Project	<66.3	<66.3	<66.3	<66.3	<66.3	66.5	70.4	70.4	66.5	<66.3	<66.3	<66.3
Coleman Diversion Dam												
Baseline	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3
Restoration Project	<66.3	<66.3	<66.3	<66.3	<66.3	66.5	70.4	70.4	66.5	<66.3	<66.3	<66.3
Mouth of South Fork Battle Creek												
Baseline	<66.3	<66.3	<66.3	<66.3	<66.3	70.6	74.4	72.8	68.2	<66.3	<66.3	<66.3
Restoration Project	<66.3	<66.3	<66.3	<66.3	<66.3	69.3	74.9	74.9	69.4	<66.3	<66.3	<66.3
Below the Confluence of North and South Fork Battle Creek												
Baseline	<66.3	<66.3	<66.3	<66.3	67	72.6	>74.9	>74.9	70.6	<66.3	<66.3	<66.3
Restoration Project	<66.3	<66.3	<66.3	<66.3	<66.3	<66.3	69.7	69	<66.3	<66.3	<66.3	<66.3
Battle Creek at Coleman Powerhouse												
Baseline	<66.3	<66.3	<66.3	<66.3	>74.9	>74.9	>74.9	>74.9	>74.9	73	<66.3	<66.3
Restoration Project	<66.3	<66.3	<66.3	<66.3	<66.3	70.2	>74.9	74.4	69.7	<66.3	<66.3	<66.3

Note:

*Values are based on the relationship between Juvenile Steelhead survival and water temperature depicted in Figure 2 in Appendix H in the Final EIS/EIR.



03035.03 EIR (10-04)

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Figure 1
SNTEMP Simulated Temperatures in Battle Creek for the No Action Alternative in June

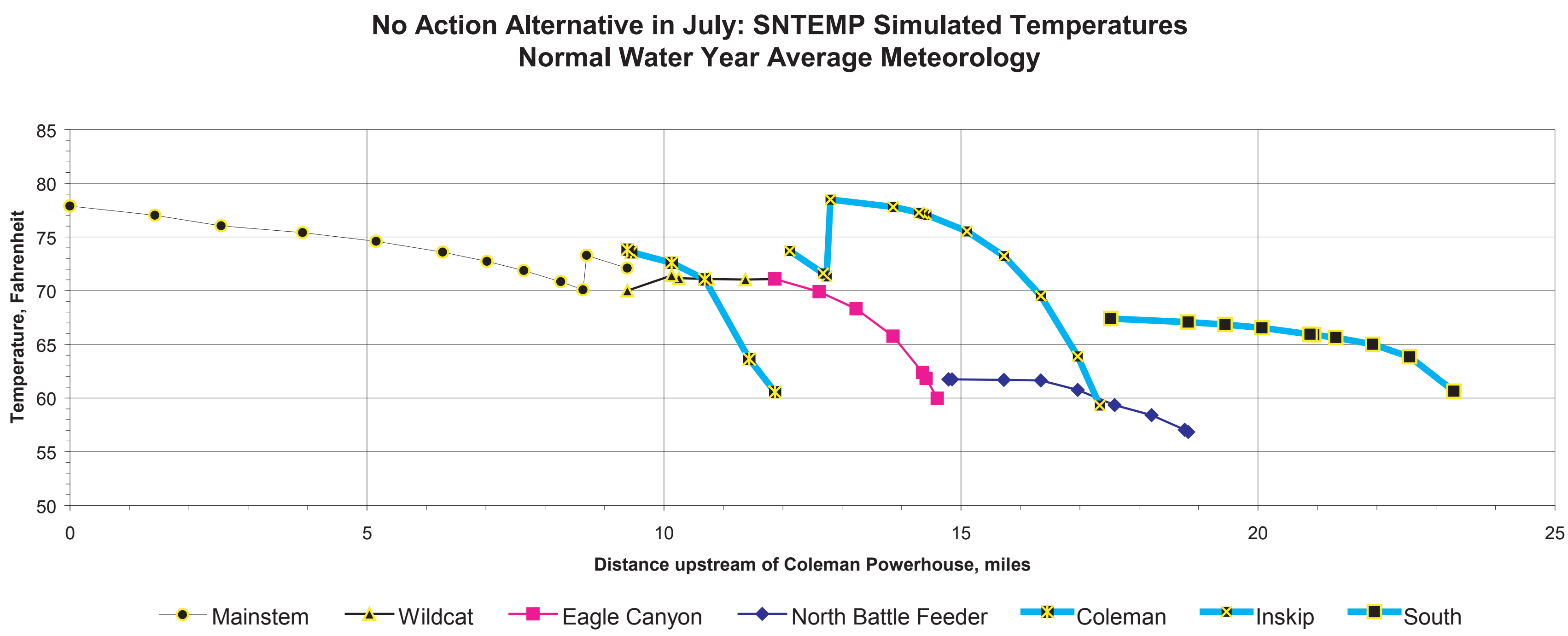

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Figure 2
SNTEMP Simulated Temperatures in Battle Creek for the No Action Alternative in July

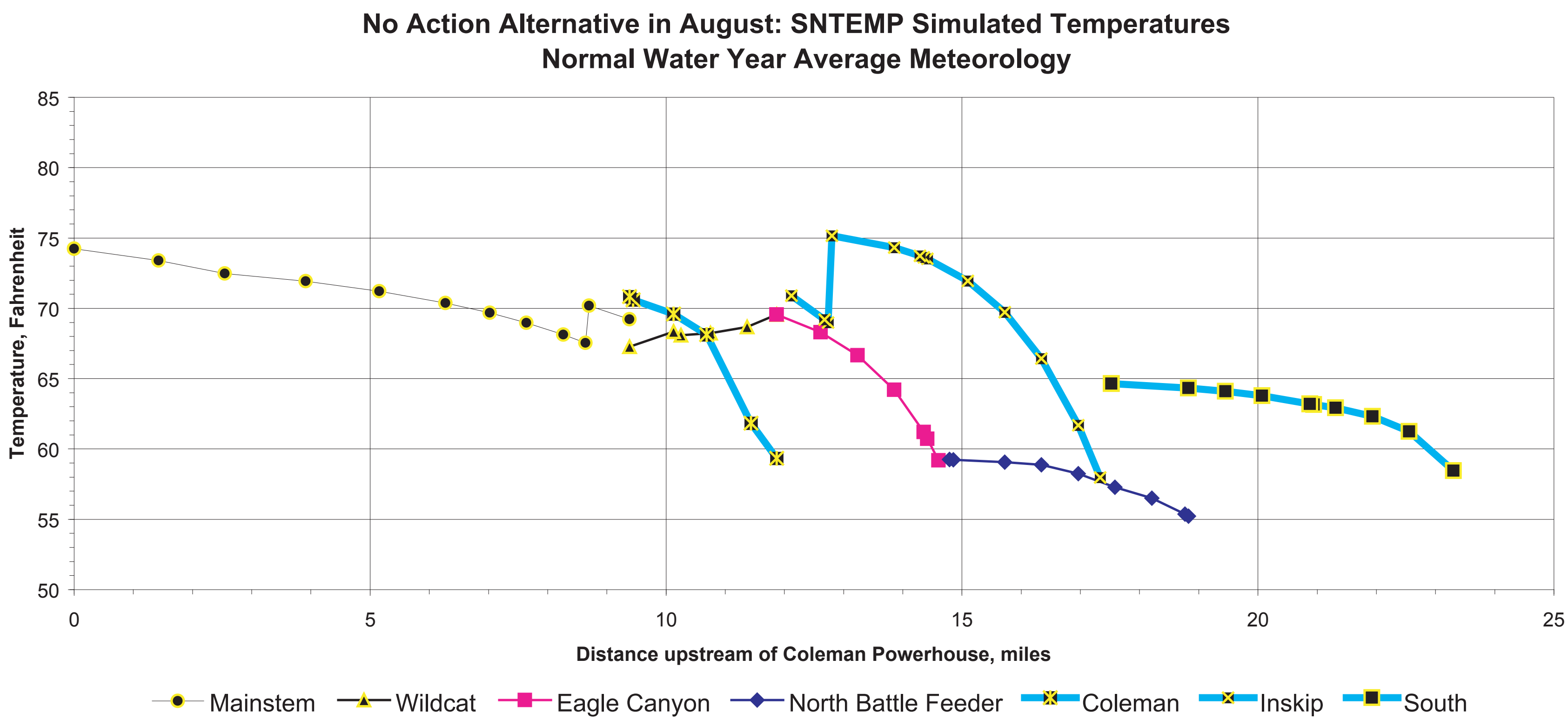

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Figure 3
SNTEMP Simulated Temperatures in Battle Creek for the No Action Alternative in August

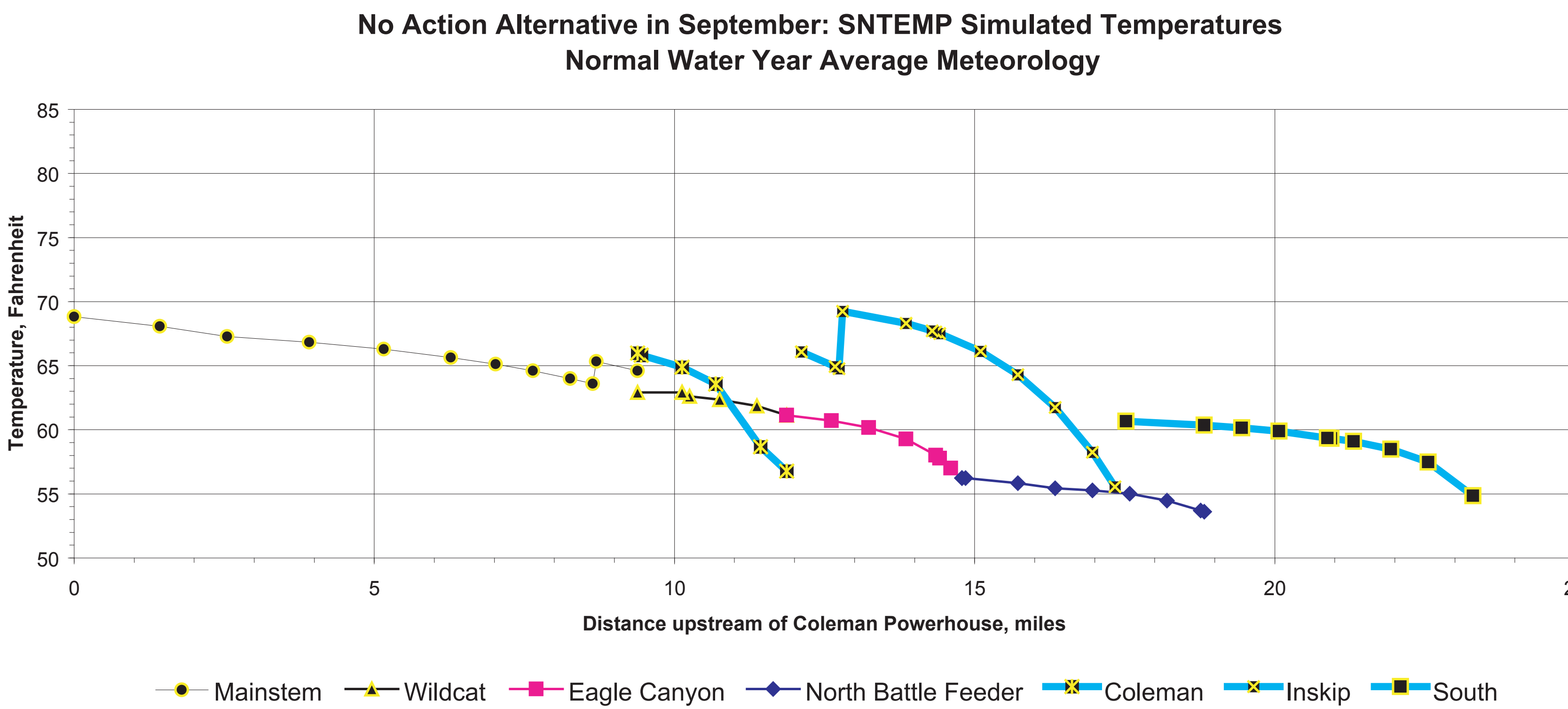

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Figure 4
SNTEMP Simulated Temperatures in Battle Creek for the No Action Alternative in September

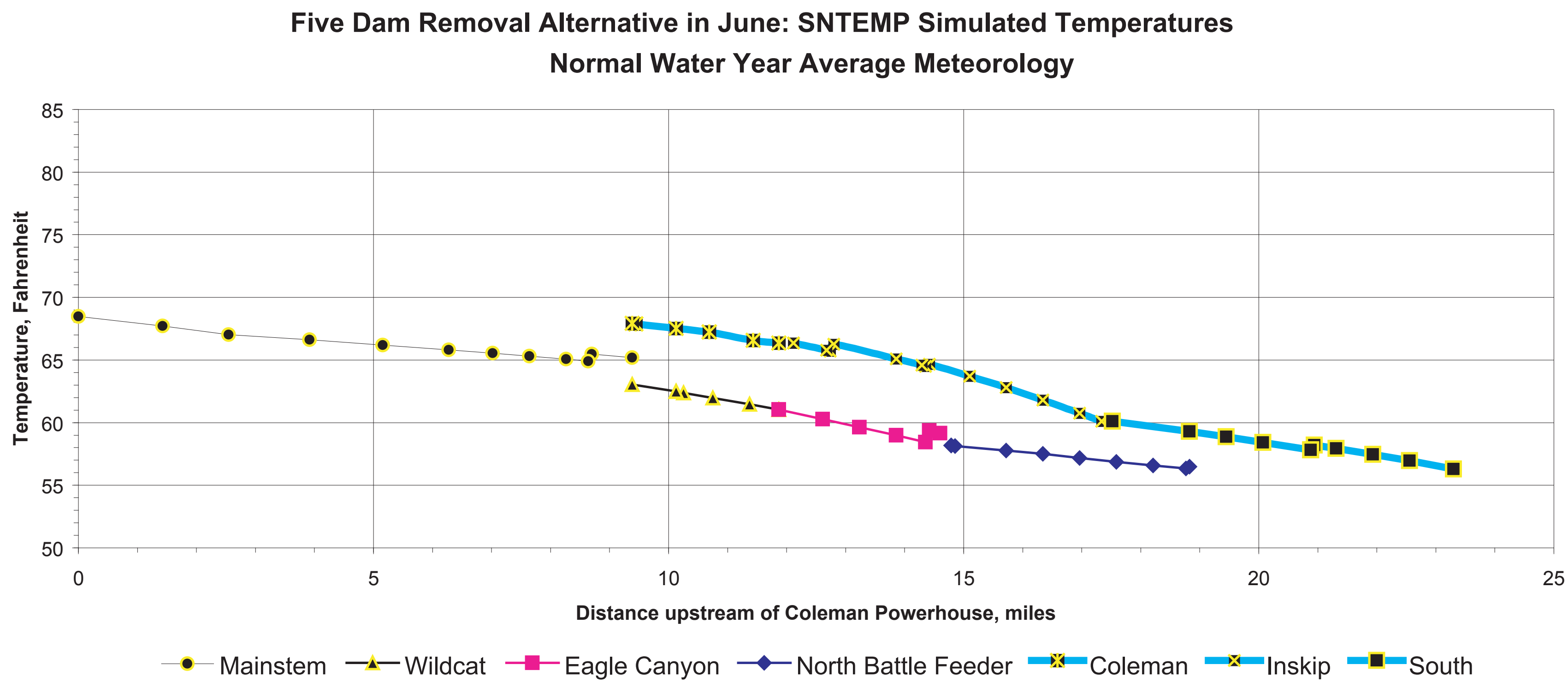

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Figure 5
SNTEMP Simulated Temperatures in Battle Creek for the Five Dam Removal Alternative in June

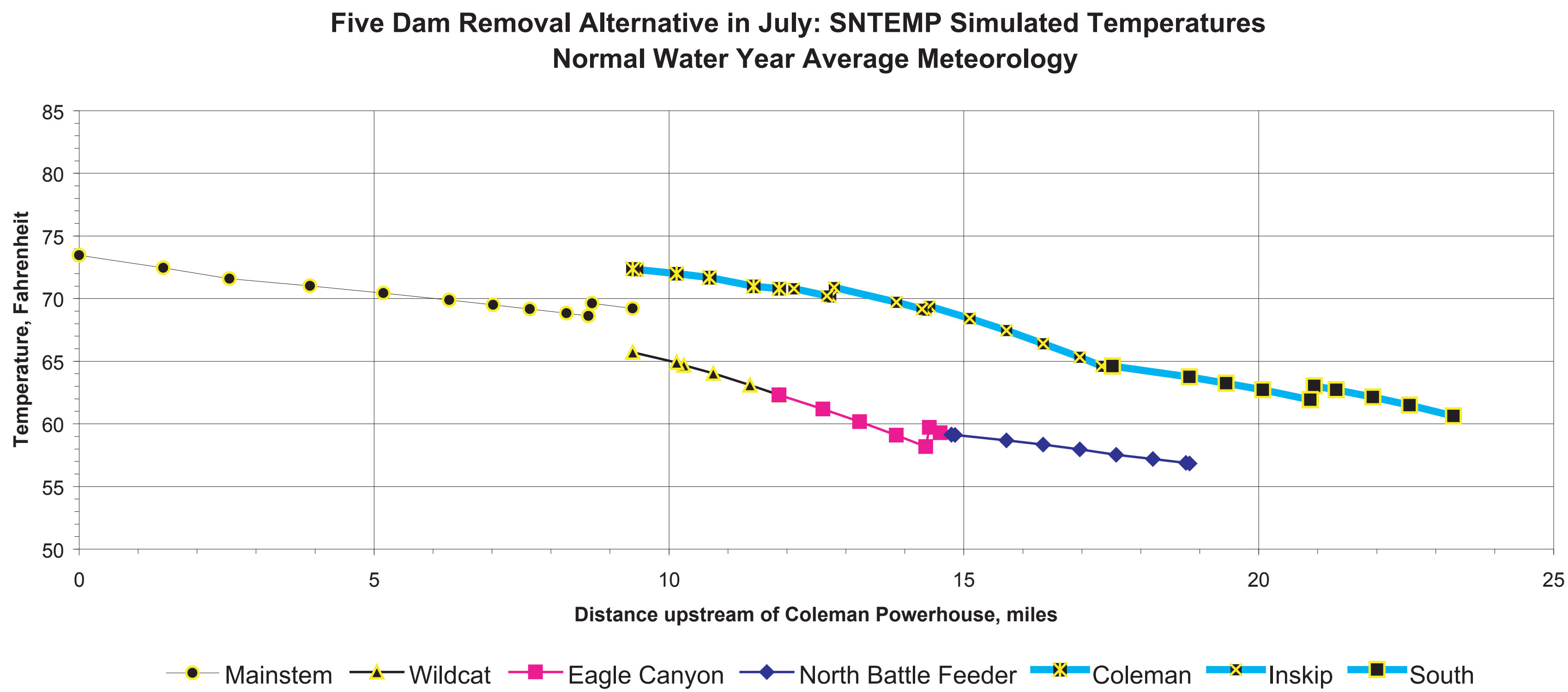

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Figure 6
SNTEMP Simulated Temperatures in Battle Creek for the Five Dam Removal Alternative in July

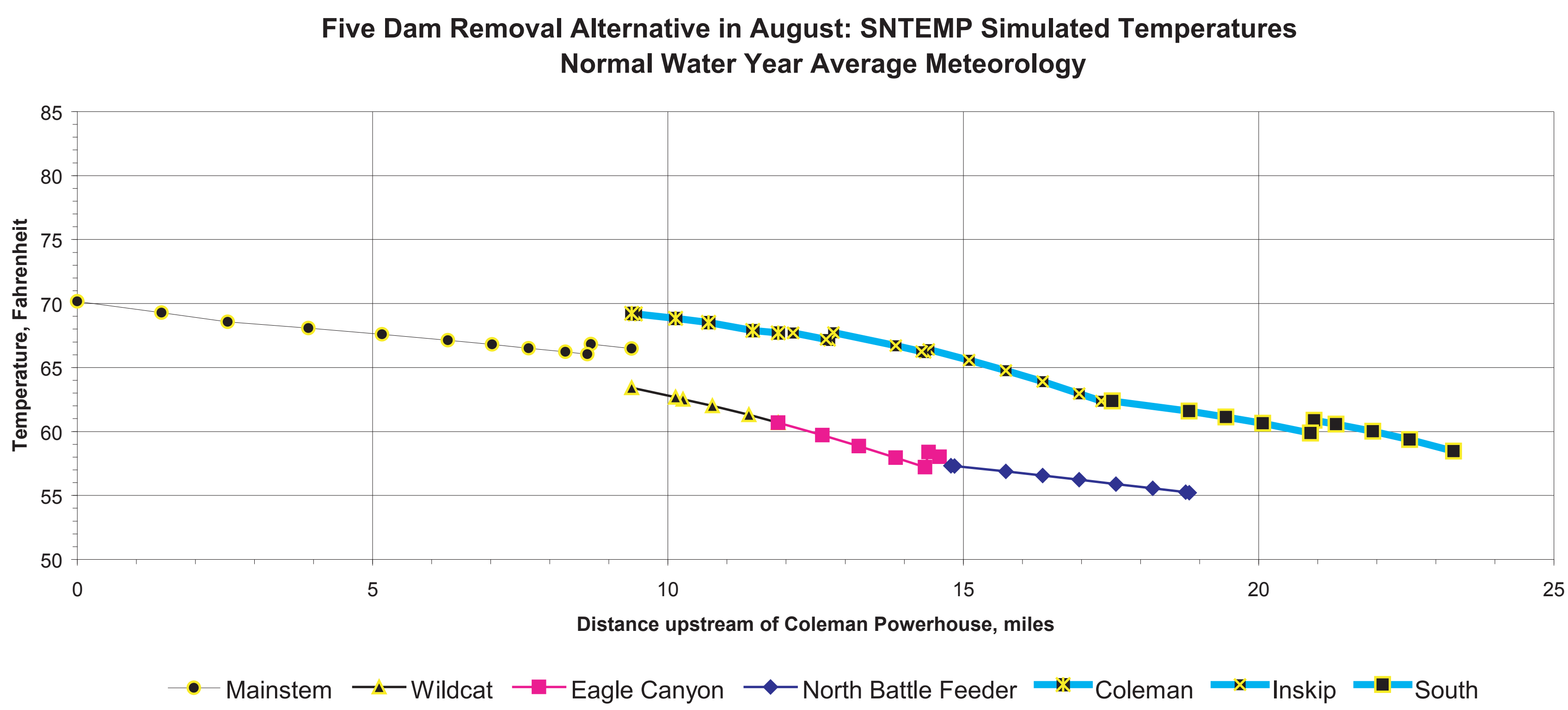

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Figure 7
SNTEMP Simulated Temperatures in Battle Creek for the Five Dam Removal Alternative in August

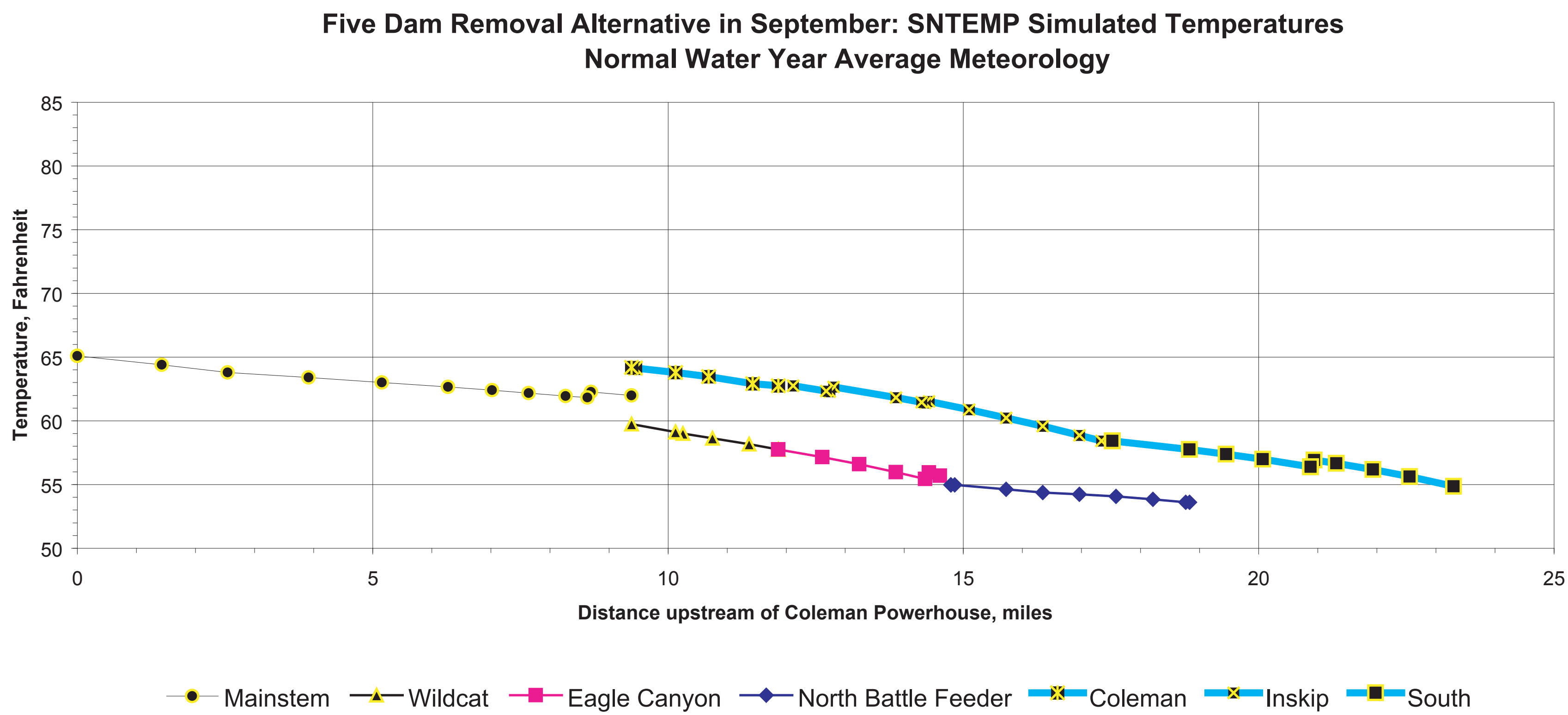

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Figure 8
SNTEMP Simulated Temperatures in Battle Creek for the Five Dam Removal Alternative in September

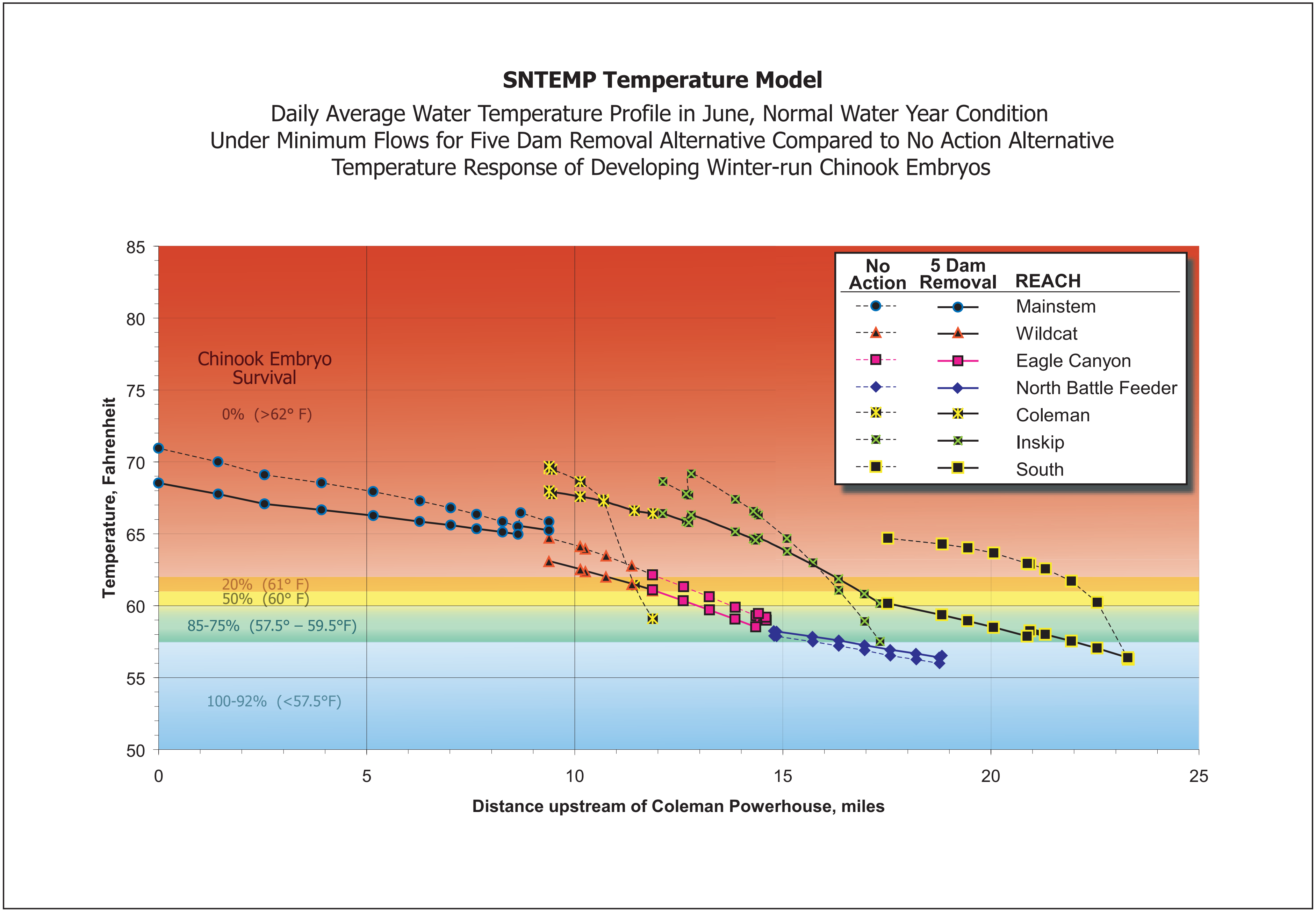

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Figure 9
Temperature Response of Developing Winter-run Chinook Embryos
Daily Average Water Temperature Profile in June

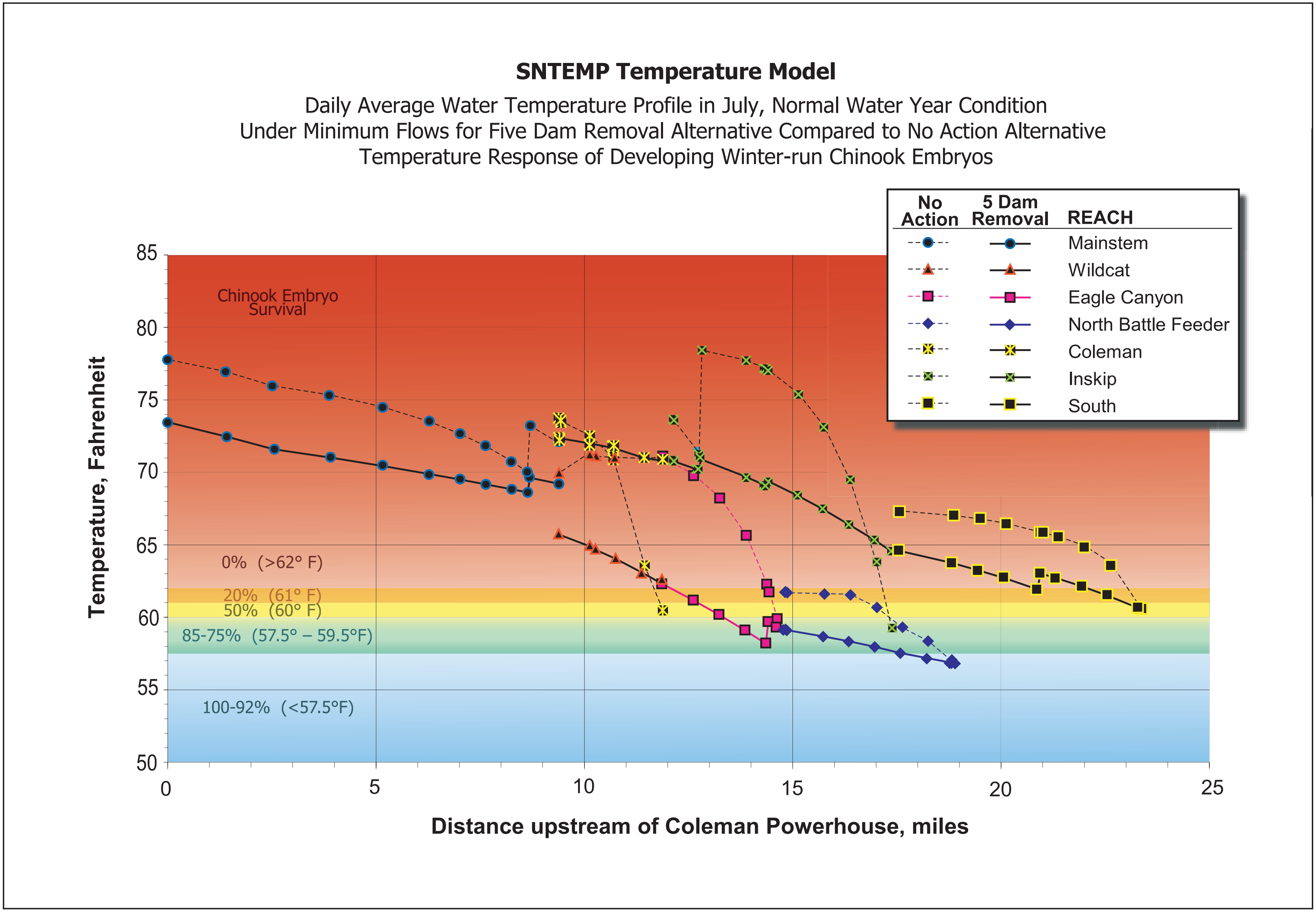

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Figure 10
Temperature Response of Developing Winter-Run Chinook Embryos
Daily Average Water Temperature Profile in July

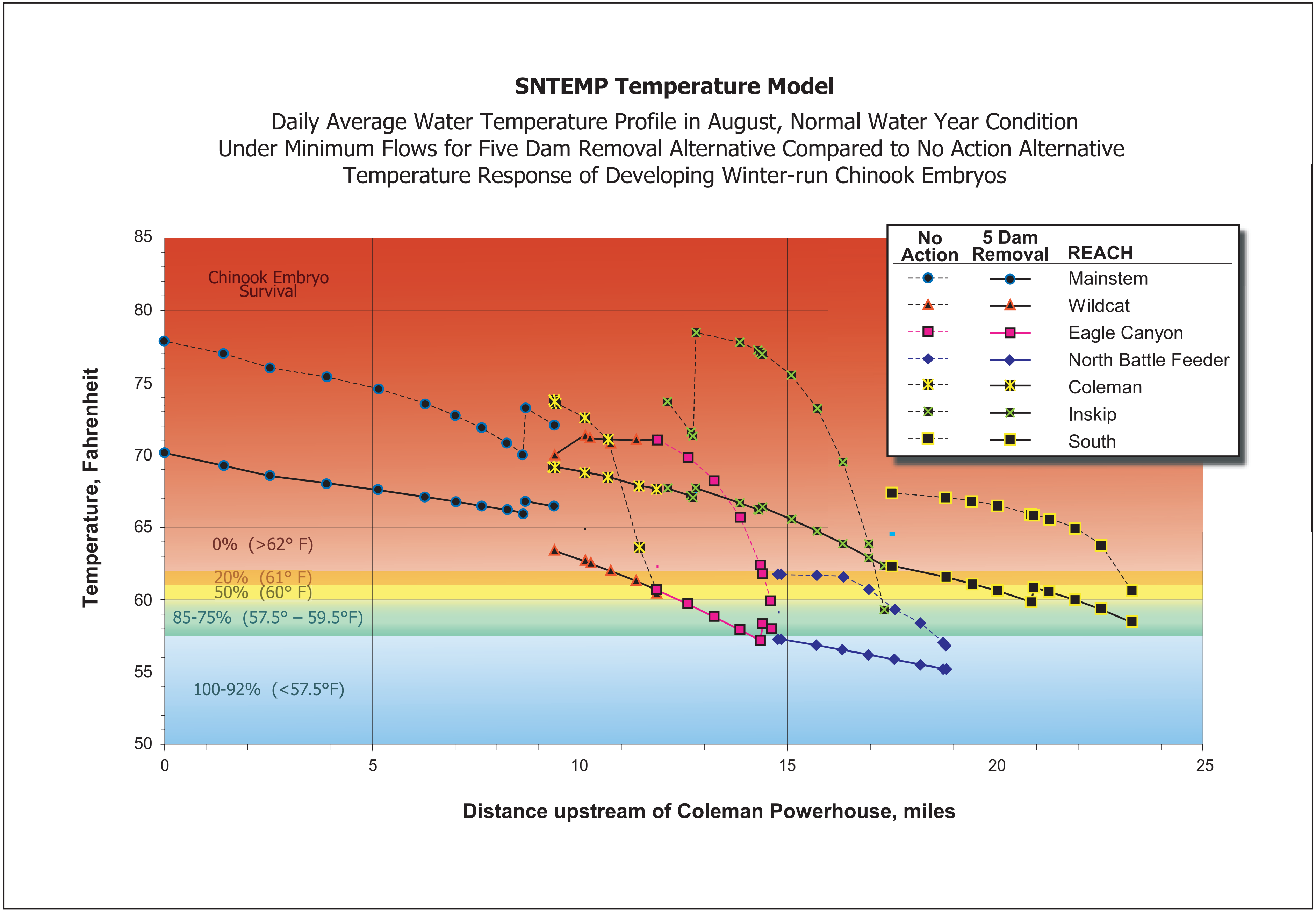

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Figure 11
Temperature Response of Developing Winter-Run Chinook Embryos
Daily Average Water Temperature Profile in August

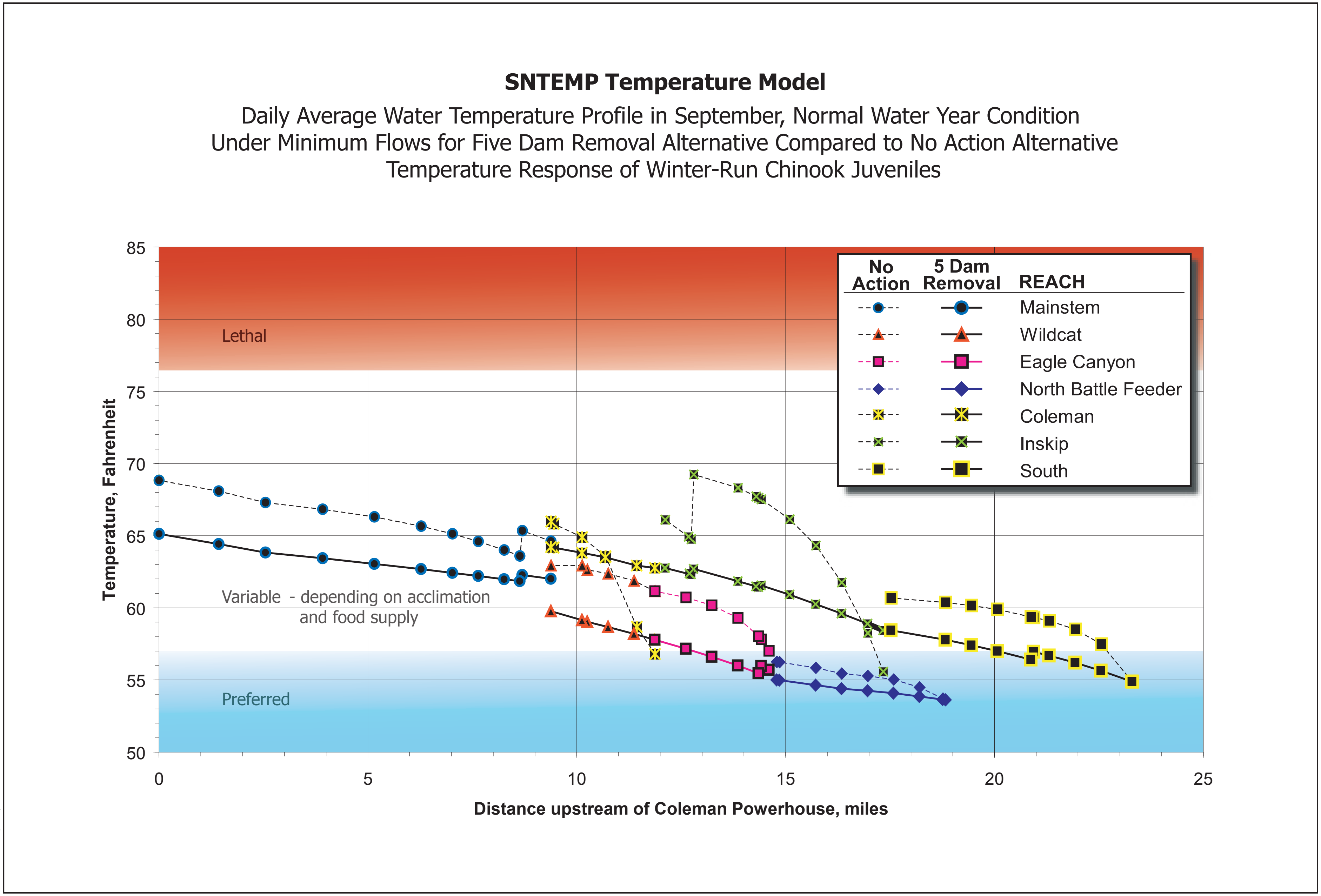

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Figure 12
Temperature Response to Developing Winter-Run Chinook Juveniles Daily Average Water Temperature Profile in September

SNTEMP Temperature Model

Daily Average Water Temperature Profile in September, Normal Water Year Condition
Under Minimum Flows for Five Dam Removal Alternative Compared to No Action Alternative
Temperature Response of Developing Spring-run Chinook Embryos

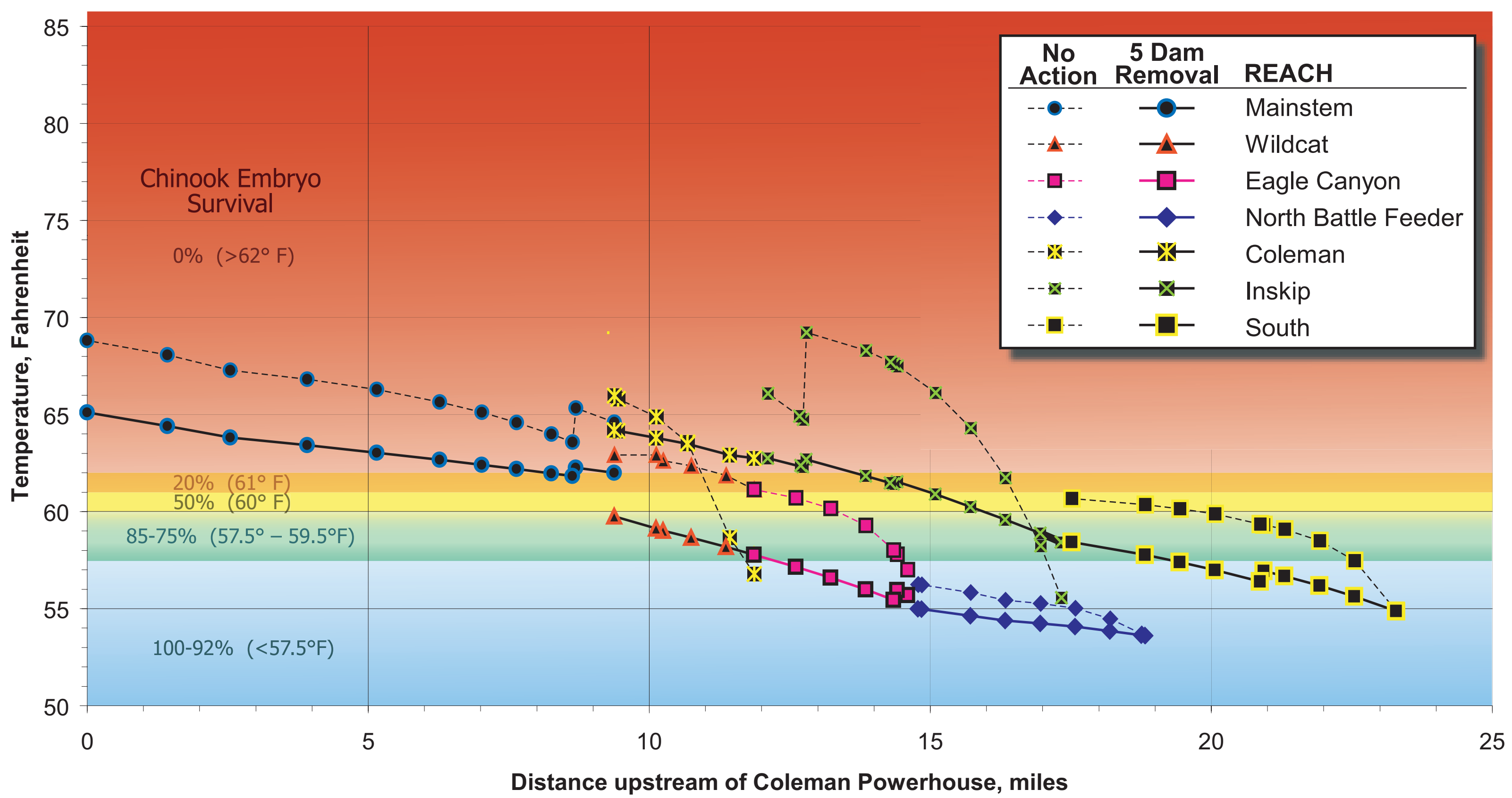

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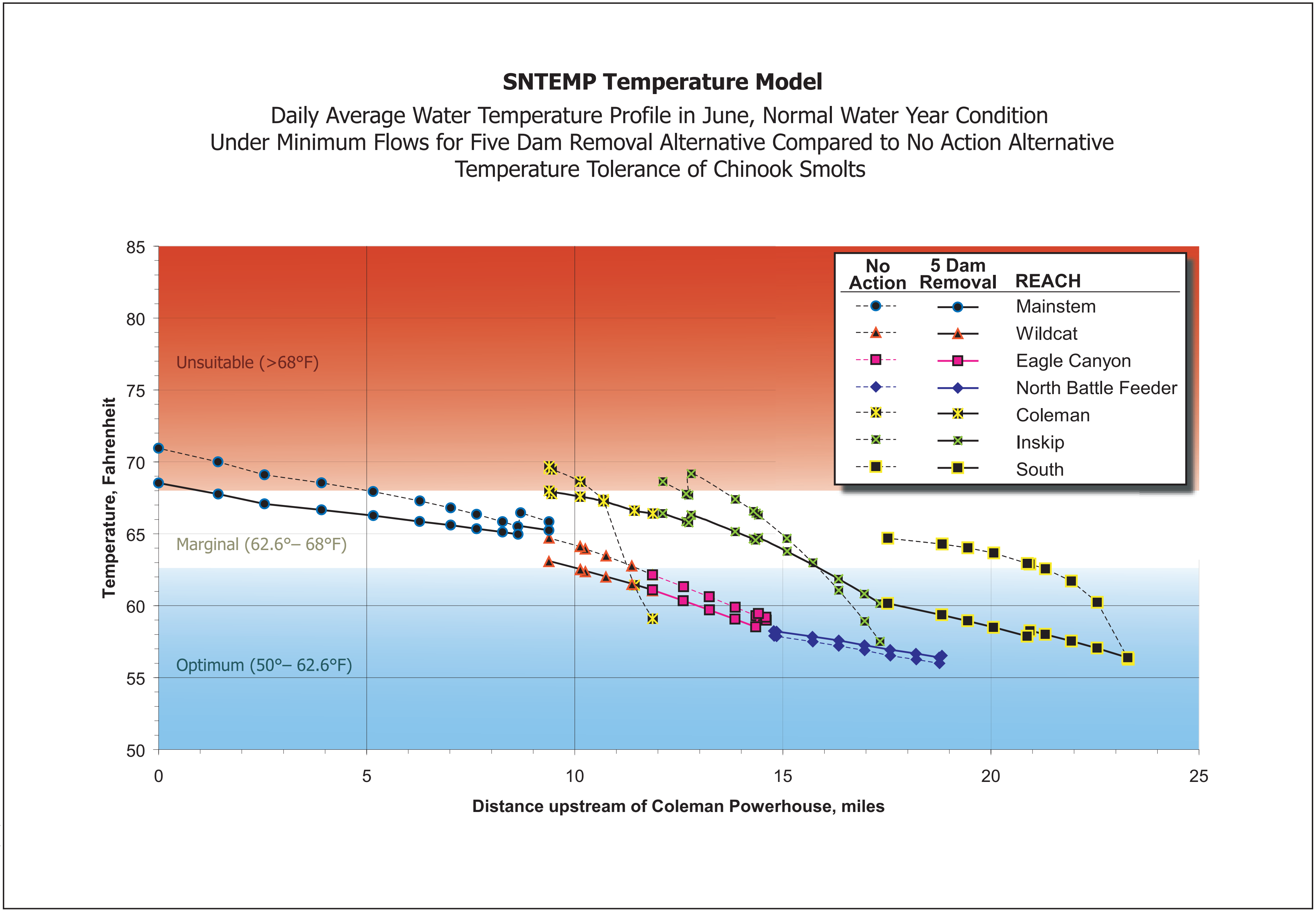
Figure 13
Temperature Response of Developing Spring-run Chinook Embryos
Daily Average Water Temperature Profile in September



0303S.03 EIR (7-04)

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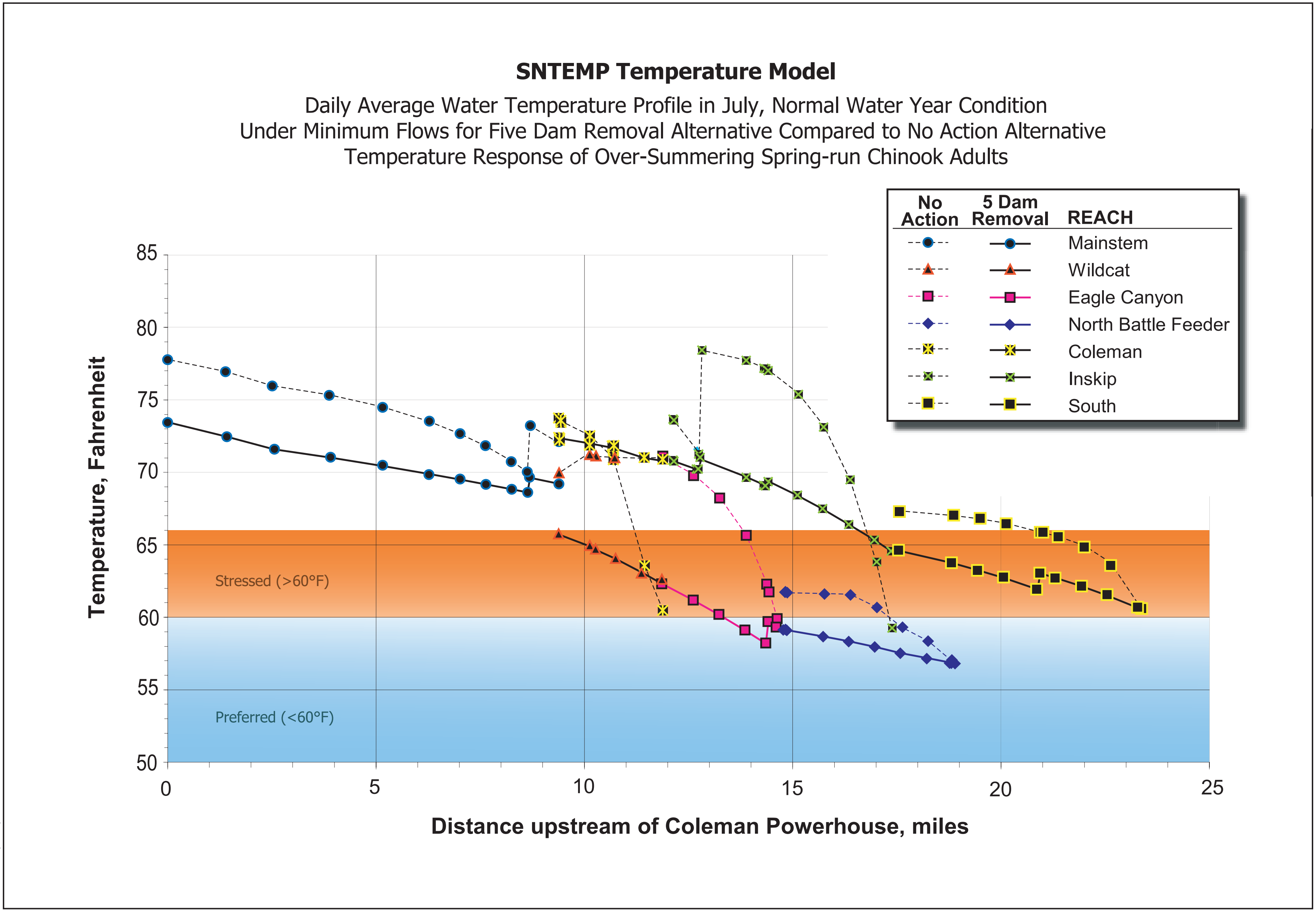
Figure 14
Temperature Tolerance of Chinook Smolts



03035.03 EIR (10-04)

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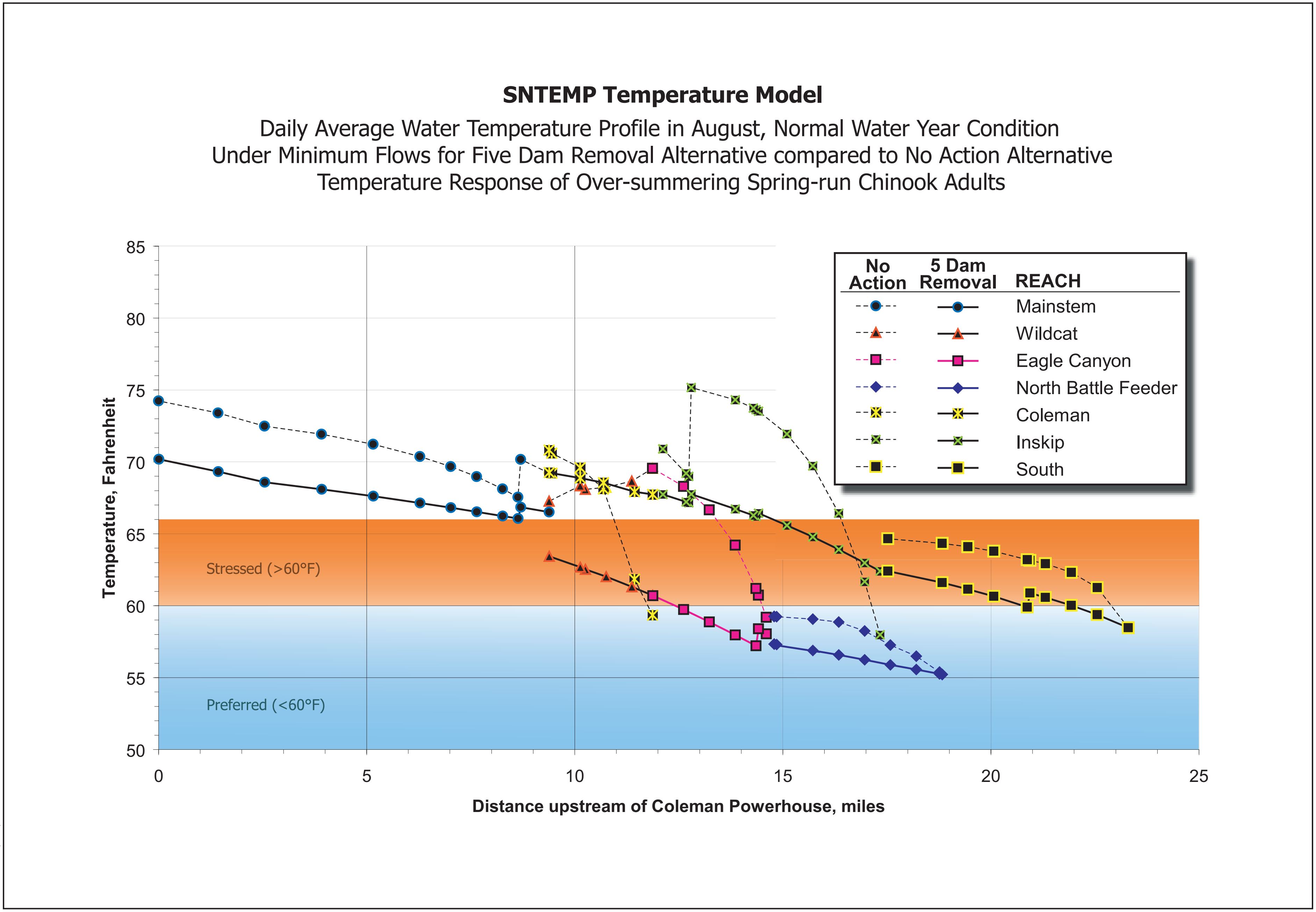
Figure 15
Temperature Response of Over-Summering Spring-run Chinook Adults
Daily Average Water Temperature Profile in July



03035.03 EIR (7-04)

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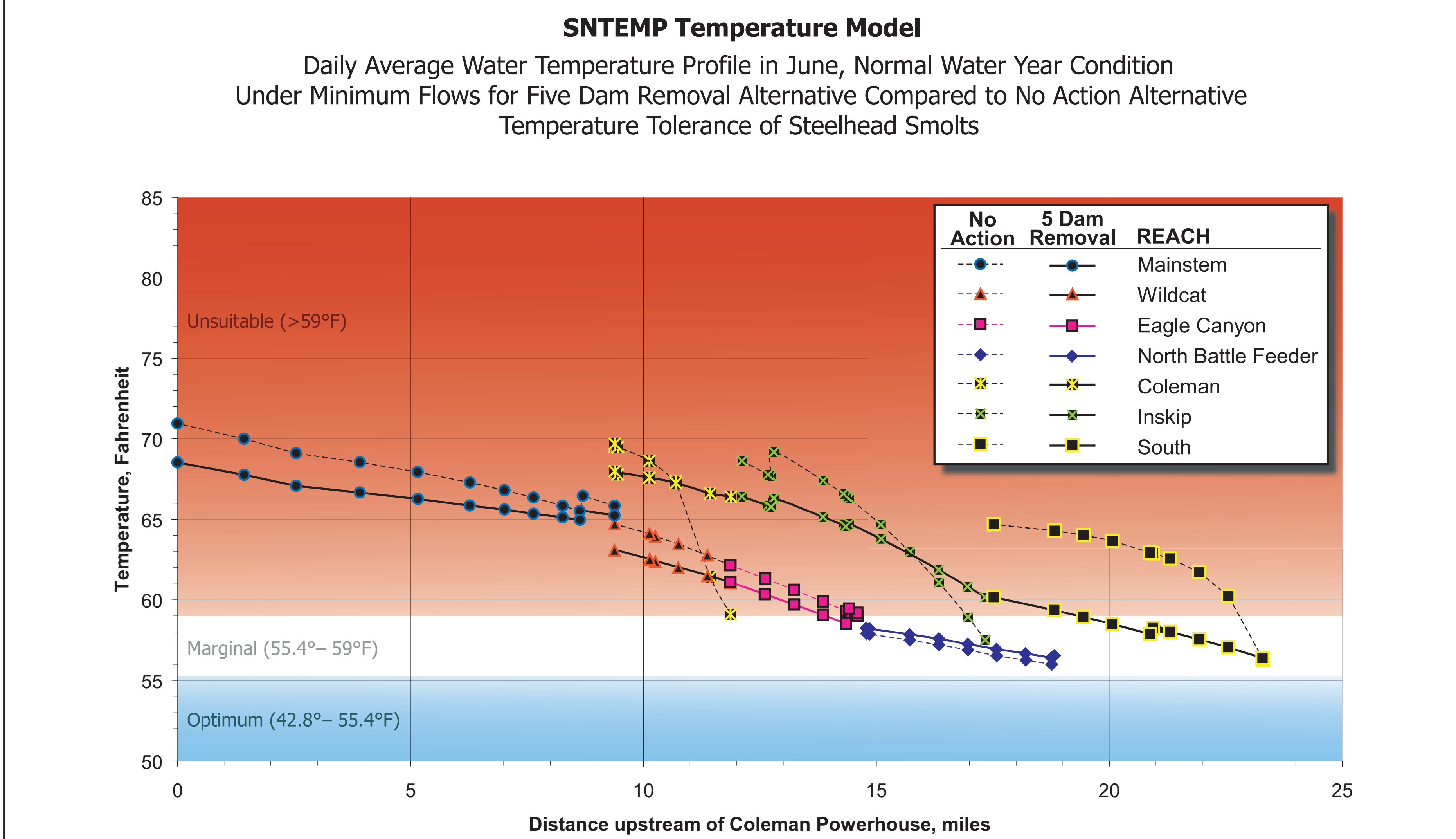
Figure 16
Temperature Response of Over-summering Spring-run Chinook Adults
Daily Average Water Temperature Profile in August



03035.03 EIR (7-04)

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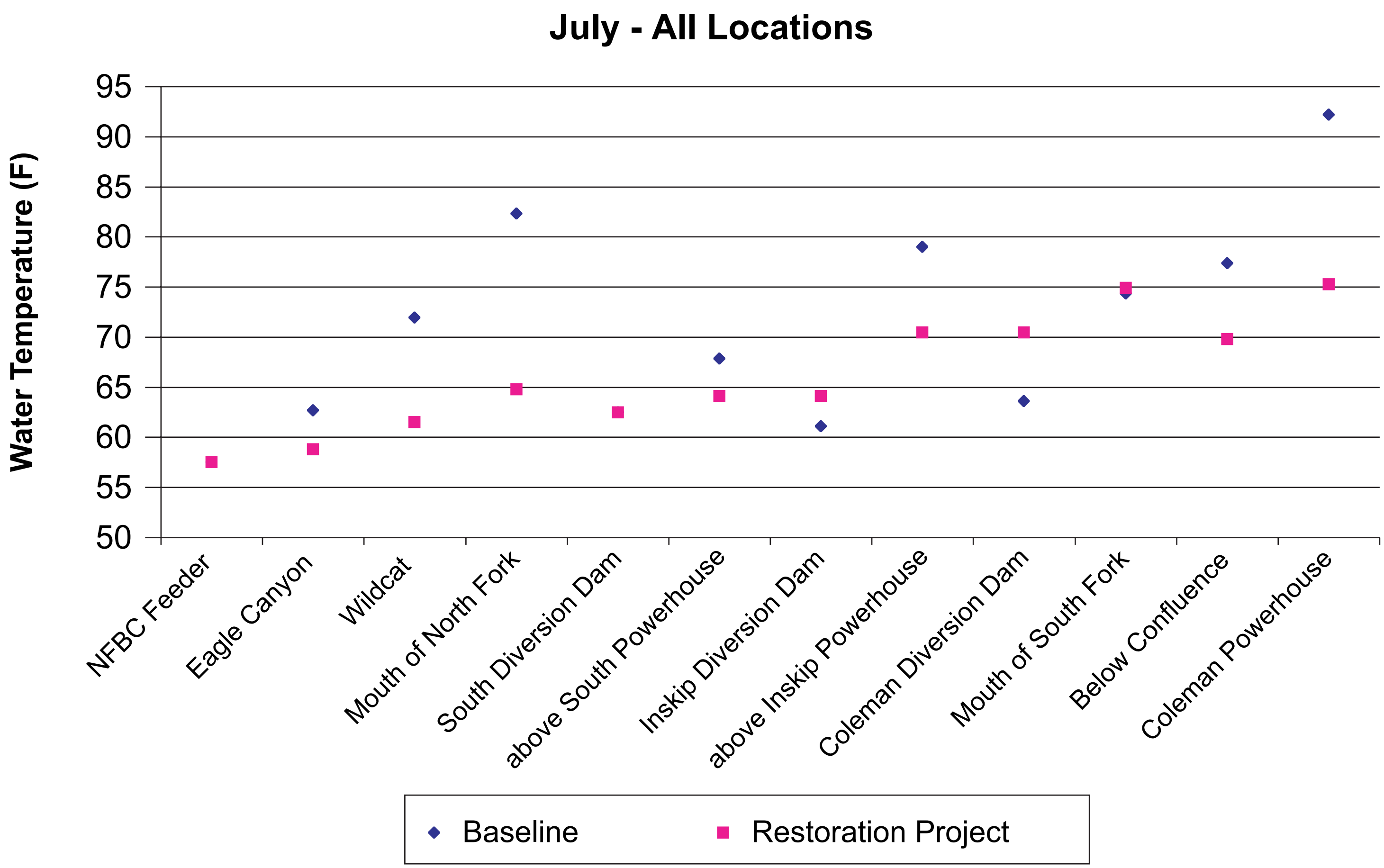
Figure 17
Temperature Tolerance of Steelhead Smolts



03035.03 ASIP

Figure 18
Estimated Average July Water Temperature for Selected Locations on Battle Creek, Minimum Instream Flow Requirements under Baseline Conditions and for the Restoration Project

Figure 19

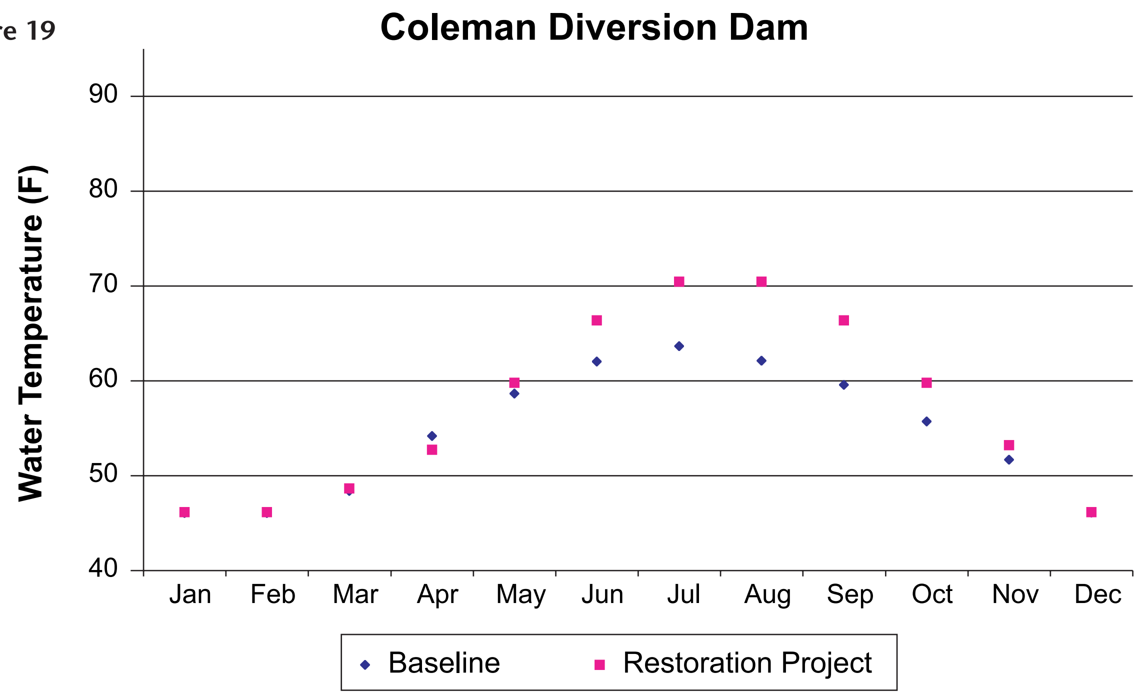
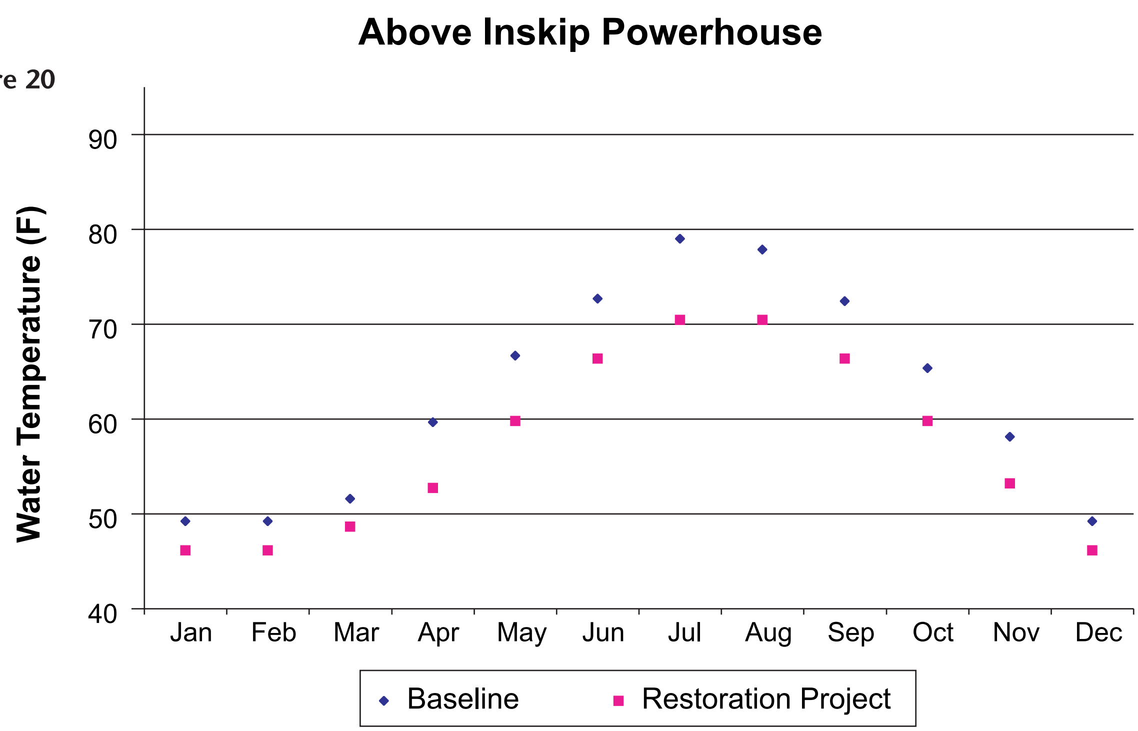


Figure 20



03035.03 EIR (7-04)

Figures 19 and 20
Estimated Average Monthly Water Temperature at Coleman Diversion Dam and above Inskip Powerhouse, Minimum Instream Flow Requirements under Baseline Conditions and for the Restoration Project

Figure 21

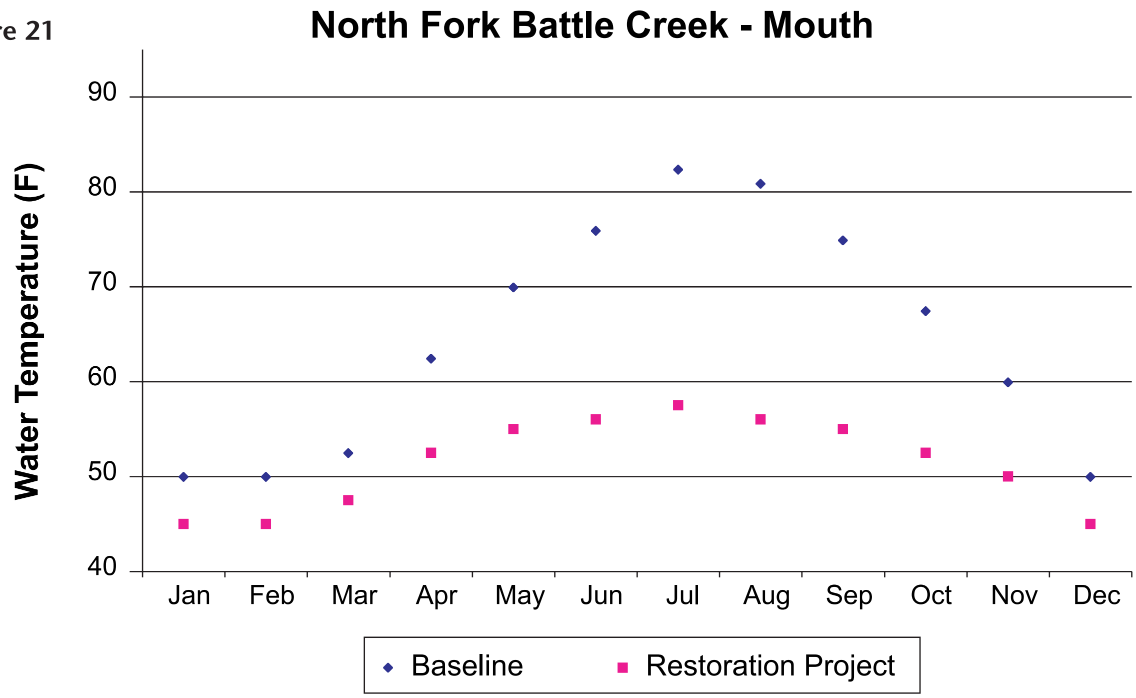
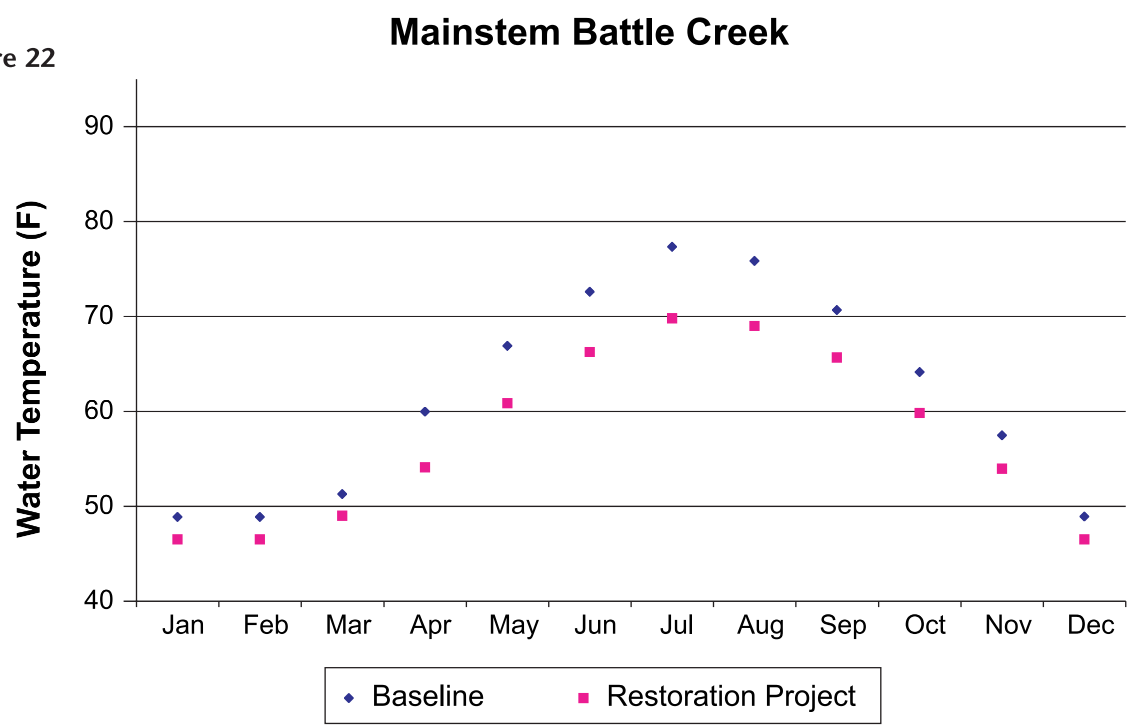


Figure 22



03035.03 EIR (7-04)

Figures 21 and 22
Estimated Average Monthly Water Temperature at the Mouth of North Fork Battle Creek and on the Mainstem of Battle Creek, Minimum Instream Flow Requirements under Baseline Conditions and for the Restoration Project

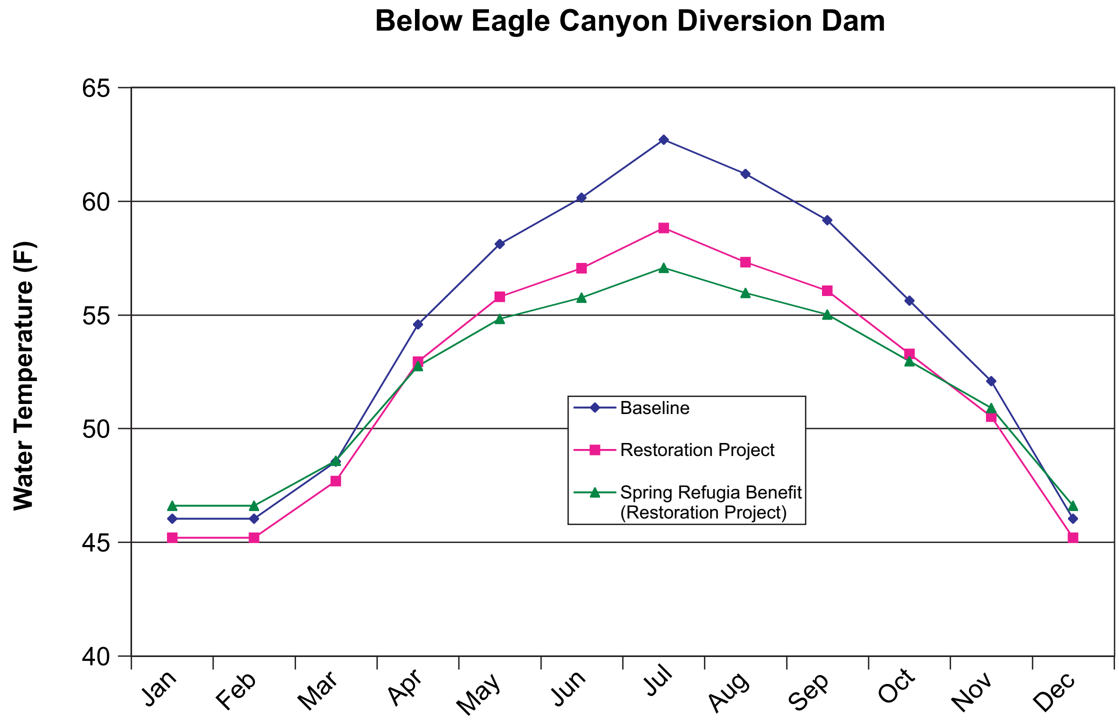


Figure 23. Water Temperature Effects to North Fork Battle Creek below Eagle Canyon Diversion Dam.

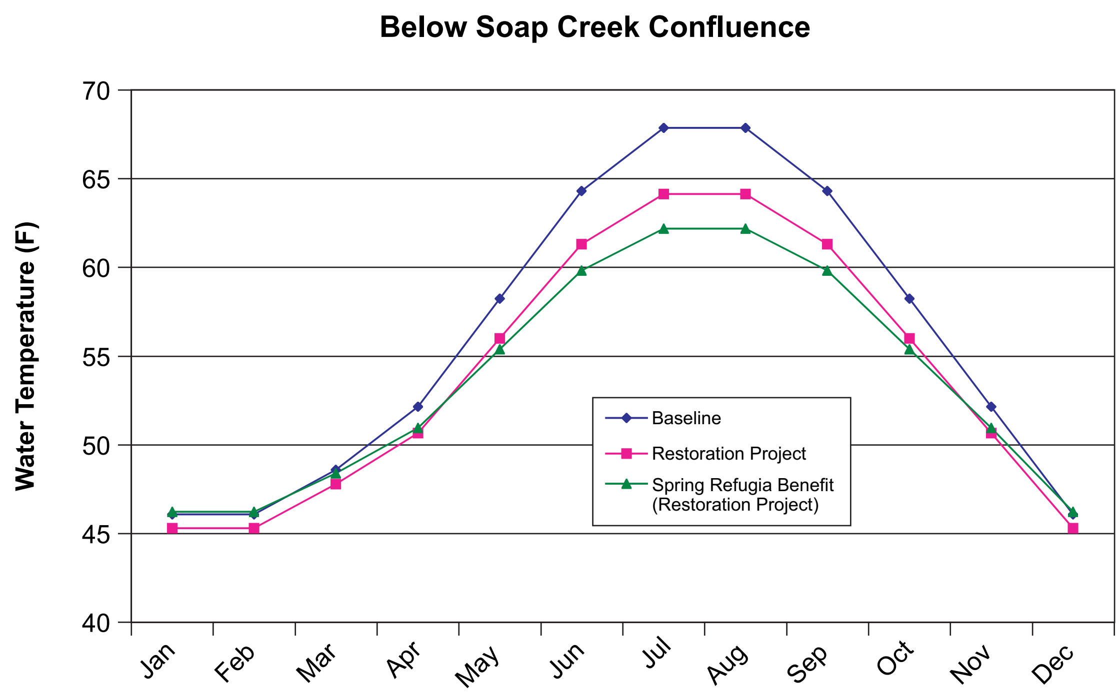


Figure 24. Water Temperature Effects to South Fork Battle Creek below the Soap Creek Confluence.