Bonaparte Watershed Water Management Project: Opportunities for Improved Water Management in the Bonaparte River Watershed , 2010.

1.0 Project Focus

The objective of this project was to review Bonaparte watershed low flow issues and develop a water conservation and beneficial use strategy that supports the BWSS long term watershed sustainability plan using salmonid habitat values as an indicator of sustainable water management. The project builds upon relationships established within the BWSS watershed planning and restoration program over the past decade. The 2010 water management project reviewed and assessed water management issues at a watershed scale, developed new partnerships in headwater areas of the Upper Bonaparte and provided opportunities for education and engagement supporting salmonid habitat values.

The findings of the water use review were that although there are licensing, low flow, supply and demand issues evident within the watershed, which represent a constraint to sustainability, there are also many opportunities to utilize existing resources much more effectively and help mitigate supply issues at a watershed scale. Opportunities for further water management improvements were identified including improved governance and licensing, storage and conservation that support sustainability, with benefits for fish and human use.

The Bonaparte Watershed supports salmonid populations that are ecologically, culturally and economically very important, including rainbow and brook trout, kokanee, steelhead, as well as chinook, coho and pink salmon. Potential conflicts between irrigation demand and aquatic needs (including instream fish needs) have been previously identified in the Bonaparte River Watershed. (MOEP, Sept 1986). These have been discussed at length during community based (WFSP) watershed planning sessions. Water demand (human use) and other factors such as climate change continue to affect surface water availability for fish and other aquatic values and are a constraint to fish habitat quality especially in low flow events.

Over-licensing of streams at some locations within the Bonaparte watershed as well as an important gap in effective groundwater legislation have been historical issues impacting fish populations that are currently being addressed through the ongoing Provincial Governments Water Act Modernization (WAM) planning processes. One of the main functions of the project was to incorporate instream flow needs of fish as an indicator of sustainable water management, within the context of overall water storage, water use and watershed sustainability planning. The project assesses water demand and incorporates the achievement of salmonid instream flow needs as an indicator of effective water management for future watershed sustainability as part of the ongoing Bonaparte Watershed Sustainability Plan. The water management plan builds instream flow and habitat needs into a plan to guide future water management planning action that respects all concerns and interests within the watershed. This is also one of the key ingredients currently taking shape within WAM. The provincial government is leading toward improved water management practices through its Water Act Modernization initiative which is flexible and includes consideration to the needs of key aquatic species such as salmonids. In the context of WAM this Water Management Project undertaken by the BWSS (funded primarily by FSWP) is timely.

The following report summarizes water supply (watershed hydrology), human use water demand (primarily agricultural use), salmonid utilization requirements (instream requirements for viability) as well as and some conservation, storage, governance and pilot project ideas assembled for local use to help increase awareness and engage participation in improved and beneficial use of water resources.

2.0   Bonaparte River Watershed Background

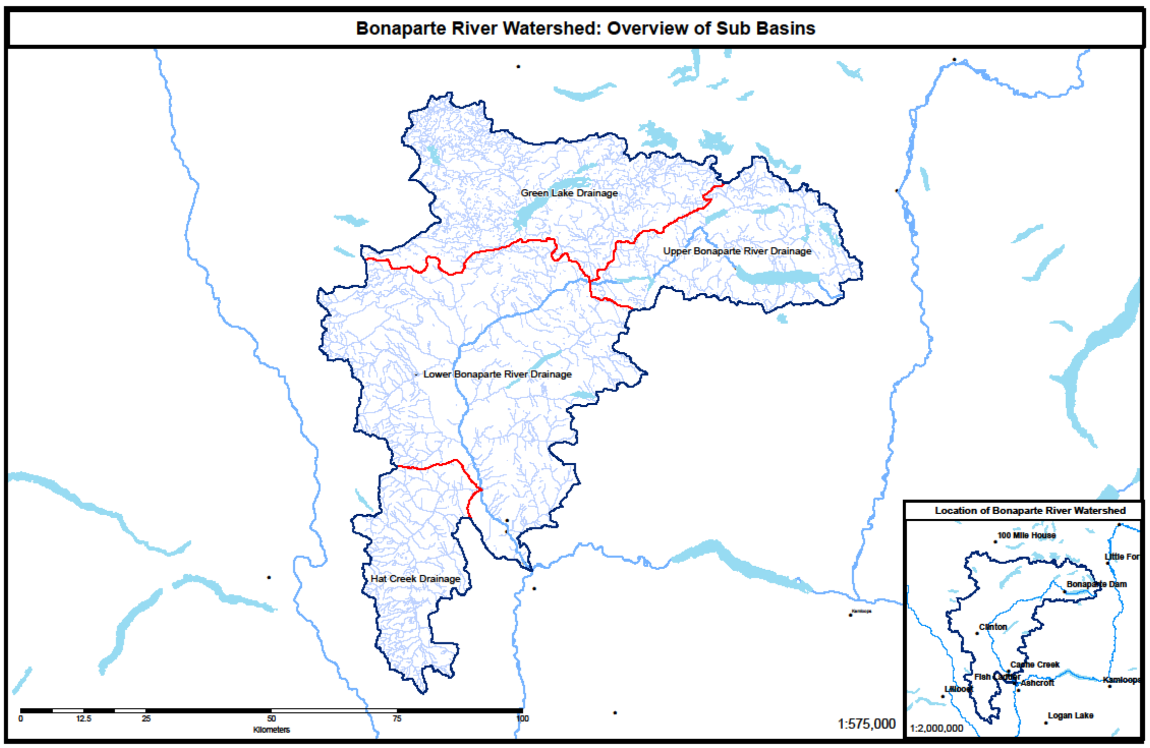
The Bonaparte River is a major tributary of the Thompson River in south central British Columbia. It lies entirely within the Interior Plateau physiographic region, which is a relatively high, dry plateau large portions of which are sparsely populated and relatively undeveloped. The headwaters of the Bonaparte River originate on the Fraser Plateau east of Bonaparte Lake draining 140 km in mainstem length from its headwaters above Bonaparte and Bridge lakes through an ecologically, hydrologically and anthropologically complex and diverse watershed into the Thompson River south of Cache Creek. From its headwaters in the upper Bonaparte Watershed the Bonaparte River flows southwest to Young Lake and from its confluence with Clinton Creek south and south east to the Thompson River. Loon Creek originates as an outflow from Upper Loon Lake flowing southwest to Loon Lake joining the Bonaparte River downstream from Clinton Creek The mainstem river as well as several of its major tributaries such as Cache Creek, Hat Creek, Clinton Creek, Loon Creek, and Rayfield River are important fish bearing streams. Cache Creek and Clinton are the largest communities within the watershed with an estimated combined population of 3200. Smaller Communities include Upper Hat Creek, Carquile, Chasm, 70 Mile House, 83 Mile House, North Bonaparte and others. There is a large agricultural component to human activity within the watershed especially between Clinton and Cache Creek as well as Hat Creek, and many other less densely developed areas of this large watershed. Green Lake and its relatively large catchment area are also linked to the Bonaparte system by an ephemeral stream that flows only during freshet. The stream is dry most of the season during which period Green Lake drains through and underground aquifer into the Rayfield River system. Much of the watershed area is semi-arid.

For the purpose of this water use assessment the Bonaparte watershed is divided into 4 sub-basin areas (Upper Bonaparte, Lower Bonaparte, Hat Creek and Green Lake Sub-basins) as shown in Figure 1 and Appendices1-4. The Bonaparte River watershed including these four sub-basins is approximately 5308 km2 in size. The area breakdown in terms of HA and % of total watershed area for each of the 4 sub-basin units is as follows: Upper Bonaparte: 95061 HA (18%), Lower Bonaparte 133,689 HA (25%), Green Lake 233,351 HA (44%) and Hat Creek 68,739 HA (13%).

Watershed hydrology is snowmelt driven with 35-40% of the watershed precipitation arriving in the form of snow and a normal spring runoff peaking at the end of May. As a result, flooding can often occur in the spring and low flow in the summer and fall, especially in tributary streams that generate little runoff.

Main development pressures on the watershed are agriculture, forest harvest, recreational use, corridor transportation infrastructure, mining and urbanization. The main farm operations are livestock, forage and vegetable crops with a watershed wide emphasis on cattle operations amongst many large and small, commercial and hobby farming and ranching operations. Most of the upper watershed crown land base is involved in cattle grazing tenures.

Figure 1: Bonaparte Watershed



3.0 Water Supply: Watershed Hydrology and Streamflow

The hydrology of the Bonaparte watershed is snowmelt driven, with maximum stream flow in April to June. Snowpack is not generally high, annual precipitation is relatively low (less than 500mm), summer temperatures relatively high (greater than 20 C), winter temperatures are moderate (greater than -7.5 C). Summer low flow occurs in July-August and is dependant upon residual stream flow and lake Drawdown, groundwater input and summer rain events coupled with the effects of irrigation withdrawal and geology. The hydrograph in Figure 2 is based on data from Water Survey Canada gauging station 08LF002, located upstream from the confluence of the Bonaparte and Thompson River, but downstream of all major contributing tributaries such as Hat Creek. The data from this station includes 24 years of reliable year-round data and 13 years of partial data (mainly April-October (MELP, 2000). As such it is a reliable measure of stream flow from the Bonaparte System net of irrigation demand.

WSC data show that flows in the Bonaparte River increase from an annual mean of about 3 m3/s at Site 08LF062 near the source to 5.9 m^3/s near its mouth at site 08LF002. Other mean annual flows were as follows: 0.344 m^3/s in Clinton Creek near its mouth at Site 08LF064, 0l535 m^3/s in Loon Creek at Site 08LF071 and 0.816 m^3/s in Hat Creek at Site 08LF015. The 7-day average low flow with a 10-year return period was calculated to be 1.64 m^3/s for Site 08LF002 on the Bonaparte River near Cache Creek, and 0.27 m^3/s for Site 08LF015 on Hat Creek. The data base was not sufficient for Clinton or Loon Creeks to determine comparable low flows

Similarly, a station at the mouth of Loon Lake on Loon Creek (08LF071) has been operated for varying periods during five years. Mean monthly flows ranged from 0.141 m^3/s to 1.27 m^3/s [(3)]. Freshet occurs from April through July. Outflows from Loon Lake ranged from 0.12 m^3/s to 0.18 m^3/s in the period 1970 to 1974. Loon Lake has a 960 ha surface area, shoreline perimeter of 28,970 m, a length of 13 km, a width from 0.4 to 0.8 km, mean and maximum depths of 27 m and 65 m, respectively, and a 262, 550 dam^3 volume. It has a flushing rate of 0.64 times/year (15.6-year retention).

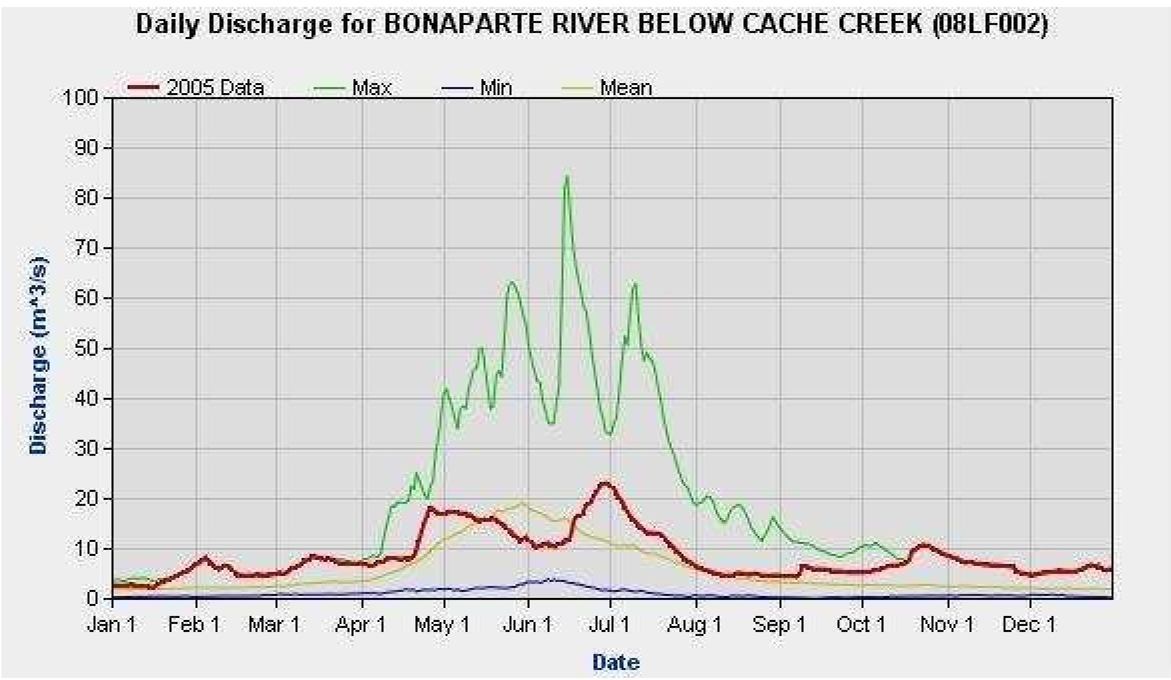
The groundwater component of the Bonaparte Watershed hydrologic cycle is poorly understood, except that significant groundwater reserves exist within unconsolidated and porous bedrock deposits. Groundwater management is critical to a sustainable watershed plan. Groundwater is currently being utilized for domestic, agricultural and municipal purposes. Groundwater upwellings are also critically important habitat features to many salmonids for spawning and rearing life stages (M Walsh, SNFC). Extensive groundwater withdrawals may affect surface water flows, as well as depletion of an aquifer water supply. Creek flows may be indirectly affected when the artesian head in an aquifer is lowered and induces recharge from the creek into the aquifer. In areas near Cache Creek, it is estimated that groundwater mining (where groundwater withdrawals exceed the average amount of annual recharge to the aquifer) may be occurring. As a result of extensive groundwater use, conflicts between groundwater and surface water users, as well as between groundwater users themselves, may be created (MOEP, 1986).

Table 1: Bonaparte River Mainstem Mean Annual Discharge (MAD) Values m3/sec

Upper Bonaparte (Bridge Lake)	3.0 m3/sec
Lower Bonaparte (Cache Creek)	5.9 m3/sec

The following chart shows historical max, min, average and 2002 WSC hydrometric data for the Bonaparte River at Station 08LF002 (near Cache Creek) .

Figure 2: Bonaparte River Mean Monthly Discharge



4.0 Water Demand

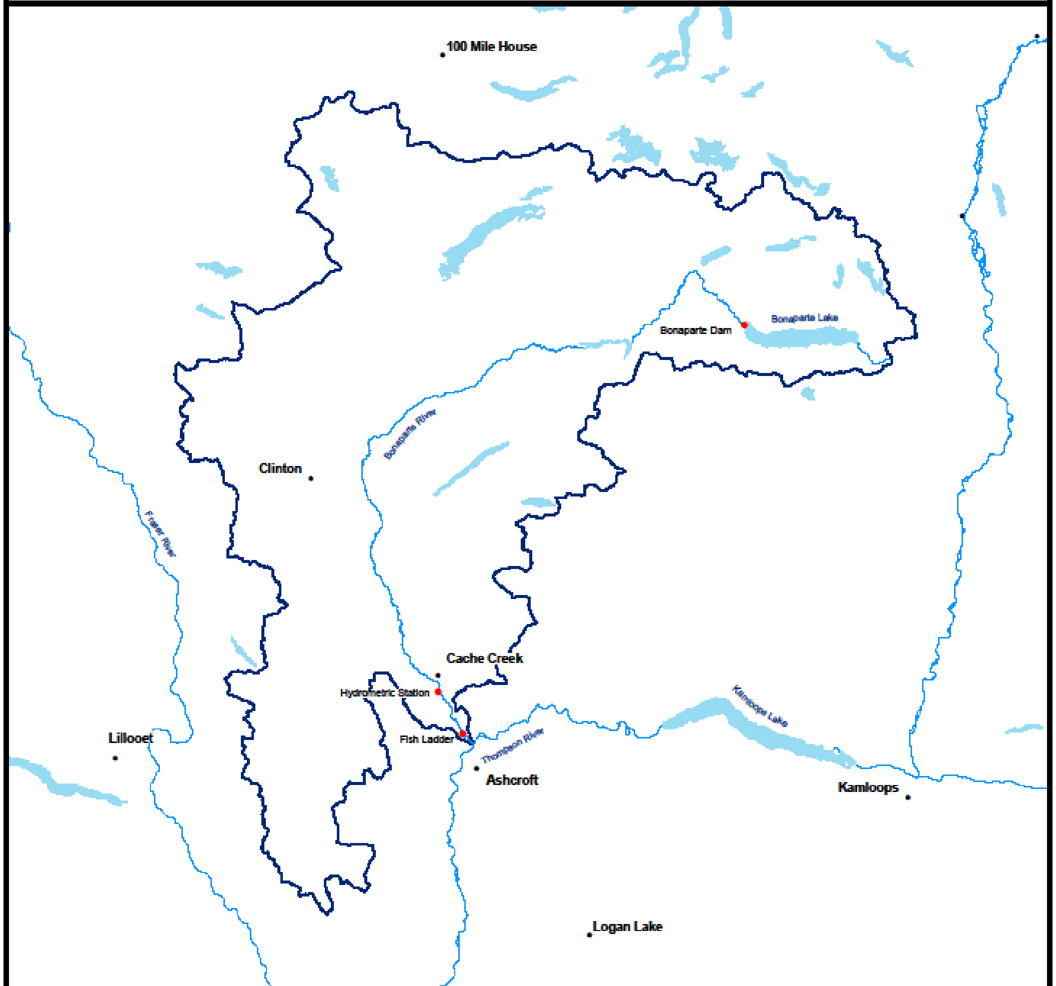
Agriculture, including the most intense of the cattle ranching operations take place mainly in the lower Bonaparte valley between Clinton and Cache Creek, and Hat Creek. Approximately 40% of the watershed has been logged, and about half of that has occurred relatively recently (since 1972). Forest cover, especially in the upper watershed is heavily dominated by lodgepole pine which has recently become very susceptible to mountain pine beetle attack with associated fire hazard, hydrologic and even cattle herd management implications resulting from rapid forest loss. Tourism and recreational use are significant economic drivers affecting water use. Communities such as Green Lake have been organizing to manage this impact through the development of OCPs and other management tools. Collectively these uses represent a total demand on the watershed ecosystem that is in some areas unsustainable.

The total licensed demand on the Bonaparte River is approximately 33,660 acre-feet. In total 90.6% (30,528 acre-feet) of this demand is dedicated to meet irrigation licences and another 8.6 percent (2904 acre-feet) is waterworks licences. Domestic licensing accounts for only 0.4% (126 acre-feet) of licensed demand, while industrial demand represents 0.2% (61.9 acre-feet) and stock watering accounts for the remaining 0.1% (40 acre feet) (MOE, 2000). The proportional use of water licensed from the Bonaparte River is illustrated in Figure 3. Total licensed demand is approximately 20% of total average annual naturalized stream discharge (supply) but is extracted in a short period during summer, coinciding with low flow and fish flow issues making water management for multiple values a challenge for users and managers.

In addition, there are 16,503 acre-feet of conservation storage in the watershed (mostly for fisheries). A further 20,904 acre-feet of conservation storage is included in outstanding applications by the Fisheries Program – mainly on Bonaparte, Machete, Eagan, and Young Lakes. (MELP, 2000).

Recently the Bonaparte River watershed has experienced unusual water shortages. This is due in part to climate change and geomorphology where large areas of the watershed contribute relatively little surface flow as well as an over commitment of water licenses on easily accessible surface water resources. Water resources appear to have been over-licensed with insufficient storage to back up licensed demand. As such water flow and irrigation demand are critical local issues, which rival riparian vegetation loss and streambank erosion in local agri-environmental importance. With continuing development pressure it is expected that water management issues left unaddressed on the Bonaparte will intensify (MOE, 1986). Estimated irrigation use by the Ministry of Agriculture and Food indicate that duties used in estimating irrigation allocation amounts for licensing purposes are high and total demand is expected to increase in the future with climate change increasing the growing season and irrigation need and increases to cultivated farmland.

Bonaparte River Watershed Water Management Project



Bonaparte River Watershed
Rivers
Water Management Feature
Cities
Large Waterbodies

Water Management Map

Bonaparte River Watershed

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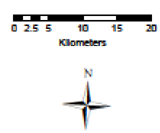
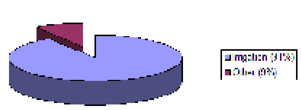
Original Scale: 1:600,000



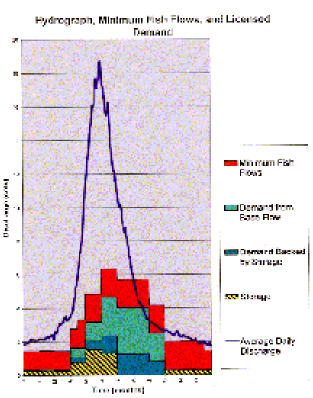
Bonaparte Watershed Licensed Water Volumes

Type of Use	% Lic Vol	Acre Feet
Irrigation	90.6	30528
Waterworks	8.6	2904
Domestic	0.4	126
Industrial	0.2	61.9
Stockwatering	0.1	40

Bonaparte Watershed Licensed Water Use Demand



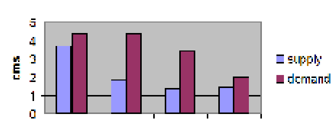
Hydrograph, Minimum Fish Flows, and Licensed Demand



Bonaparte Supply / Demand Overview

Month	1 in 5 drought Supply (cms)	fish and irrig demand Demand (cms)
July	3.7	4.35
August	1.85	4.35
September	1.35	3.45
October	1.5	2

Bonaparte River: on average summer flow (supply) does not meet irrigation demand combined with fish needs (demand) one of every five years



MOEP reported that based on frequency analysis using June to September 7-day average low flow data (WSC hydrometric station 08LF002) for Bonaparte River, it is calculated that licensed irrigation use approaches the mean annual drought condition, if storage is properly regulated. Licensed storage in the watershed (other than that for conservation) amounts to 10,292 acre-feet, mainly for irrigation. Only about 30.6% of irrigation demand is backed up by storage.

Appendices 1-4 show licensed demand by sub-basin. When total demand on the Bonaparte is apportioned over the irrigation cycle to generate the probable irrigation demand profile it is apparent that flow will not always meet fish and irrigation licensing needs due to the variability in snowpack and runoff patterns between different years that is expected. Historical data bases indicate that summer flows are often critically low and conflict with aquatic values and that licensed agricultural demand and instream fish needs cannot even be met for the 1 in 5 drought frequency.

These concerns motivated the BWSS to seek another series of options for improving water management on a watershed scale, to meet all needs as part of a long term ecosystem-based sustainability plan.

The Bonaparte Dam plan was developed by DFO and MOE to help alleviate low flow conditions in the Bonaparte River, however there is still concern that this storage is not sufficient for extreme drought years. The other major concern is that the water shortages that occur in the major tributaries to the Bonaparte River will not be addressed by the Conservation storage at Bonaparte Lake. (MOE, 2000)

A review of Bonaparte Dam conceptualization, construction and operation is summarized as follows. A conditional water license (License # 103069 – File #3000591) was granted to the Ministry of Environment, Lands, and Parks (MELP), on January 27, 1992 to store 13,300 acre feet of water for conservation purposes (MELP, 1996). A second water license was granted to the Bonaparte Dam Water users' Community (License # 103065- File# 3000591) to store 3,000 acre feet of water (MELP, 1996). A condition of both licenses is that the stored water must be released in accordance with the rule curve and release schedule that is attached to the license.

In 1993, the Bonaparte River was placed under a Water Reserve, Section 44 of the Water Act, for "conservation purposes to protect the fishery resource, and in order to make provision for water supply for irrigation projects" (MELP, 2000).This water reserve status prohibits further water licensing, except for small domestic users and for projects within the Bonaparte Dam Water Users Community (MELP, 2000).

In February, 1994, a storage dam was constructed by the Department of Fisheries and Oceans (DFO) at the outlet of Bonaparte Lake to store water for the purpose of augmenting streamflow during low flow periods to maintain and preserve salmon and trout habitat. The dam has a 14,300 acre-foot conservation storage for fisheries and 3,000 acre-foot storage for irrigation. Currently, the Fish and Wildlife Branch of Ministry of Environment, Lands and Parks (MELP) operates the dam and coordinates the collection of Bonaparte Lake level and outflow data.

As expected, although this storage reduces the severity of water shortages on the Bonaparte mainstream, it does not help to address shortages experienced on some of the tributaries such as Hat Creek, which have significant fish production potential, but which have no water storage facilities, and does not fully address flow issues on the Bonaparte mainstem in unusually dry years.

There has been some debate over the best operating regime for the dam and as a result two rule curves have been developed. One rule curve was developed by Dave Lovedahl, P. Eng. of the Water Management Branch, Ministry of Environment, Lands and Parks and the second by KPA Engineering Ltd (BC Rivers Consulting 2001).

The catchment area of Bonaparte Lake is approximately 288 km2 or approximately 5% of the entire Bonaparte watershed. In the past there has been some persistent confusion, difference of opinion and desire to see the Bonaparte Dam as a solution to all issues, including flood management, increased storage, fish flows and downstream irrigation demands. Any expectation by the public that one structure on one lake that drains 5% of a watershed designed and funded primarily for fish habitat protection would have the capability to solve water shortfall issues in such a large watershed proves to be unrealistic.

In 2010 the manager of the dam came to a BWSS community meeting, explained the operation of the dam and answered long standing questions from community members about the design, construction, operational capacity and limitations of the dam. Since the community meeting in 2010 to explain the capacity and limitations of the Bonaparte dam there been renewed interest in solving water supply issues by looking past the Bonaparte dam as the “silver bullet” to solve all water supply issues. The process of reviewing the function and operation of the Bonaparte dam has clarified what can and cannot be reasonably expected from the dam. The positive side of this FSWP sponsored education and engagement process has been that it has generated interest in alternative solutions including water conservation, alternative storage, efficient use and participation in the ongoing WAM process by using fish needs as a key to trigger cooperative interest.

5.0 Instream Flow Requirements of Salmonids

5.1 Salmonid Access and Habitat Utilization

Fisheries values in the Lower Bonaparte River include migration, spawning and/or rearing habitat for anadromous and non-anadromous salmonid species, among others. Anadromous salmonid species include coho (*Oncorhynchus kisutch*), chinook (*O. tshawytscha*) and pink salmon (*O. gorbuscha*) and steelhead (*O. mykiss*). Resident or adfluvial salmonid species include rainbow trout (*O. mykiss*), kokanee (*O. nerka*), mountain whitefish (*Prosopium williamsoni*) and brook trout (*Salvelinus fontinalis*).

In addition to their intrinsic value as key ecosystem components the salmonid species populations in the Bonaparte watershed also comprise part of an important inland fishery with valuable recreational, social and economic human benefits.

Prior to 1989 fish passage barrier comprised of a natural falls and man-made dam complex located 3 km from the mouth of the Bonaparte River rendered approximately 140 km of mainstream and tributary habitat, up to Young Lake, inaccessible to anadramous salmonids. Access during recent historical periods was limited to the lowermost 2.6 km of the Bonaparte River just above its confluence with the Thompson (see Figure 1). There is historical evidence that before the dam was built, at some previous historical period salmon populations existed in the upper reaches of the Bonaparte (Brown et al, 1980).

Tredger in 1980 reviewed actual and potential fish utilization in the Bonaparte and found that due to the obstruction, significant numbers of steelhead and chinook could only utilize 3 km of a potential 108 or more km of good spawning and rearing habitat located above the fish barrier. Tredger assessed the potential for habitat utilization based on preferred habitat features for species as shown in the following figures. The tributaries Cache, Hat, Clinton, Fiftyseven and Chasm Creeks and the Rayfield River, were also found to show good to medium potential capability for steelhead reproduction.

The anadramous salmonid species primarily use the lower mainstem of the Bonaparte; whereas kokanee are found primarily in the lakes and their inlet streams (MELP. 2000). Trout and salmon spawning activity in the Bonaparte begins in the late summer to early fall (August to September) and can continue up to December depending on the species and stream elevation (MELP, 2000). This timing coincides with low flow periods and as a result extreme low flows could be detrimental to the success of spawning and incubation during this time period. Tredger showed that there is potential to increase fish production (coho, steelhead and chinook) on the Bonaparte River.

Figure 4: Generalized Utilization of Potential Chinook Spawning Areas in the Bonaparte River Watershed below Young Lake (From Tredger, Sept 1980)

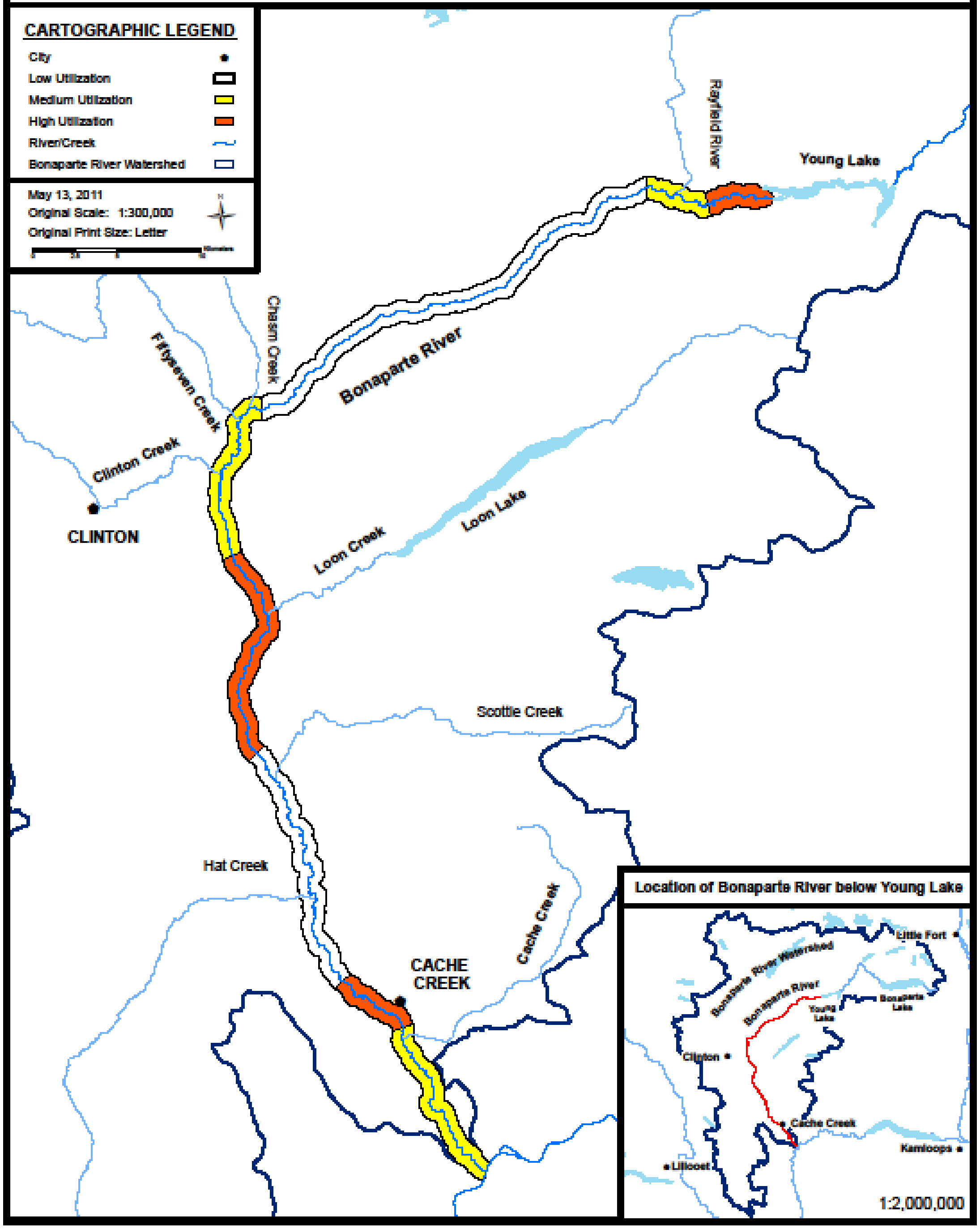


Figure 5: Generalized Utilization of Potential Chinook Rearing Areas in the Bonaparte River Watershed below Young Lake (From Tredger, Sept 1980)

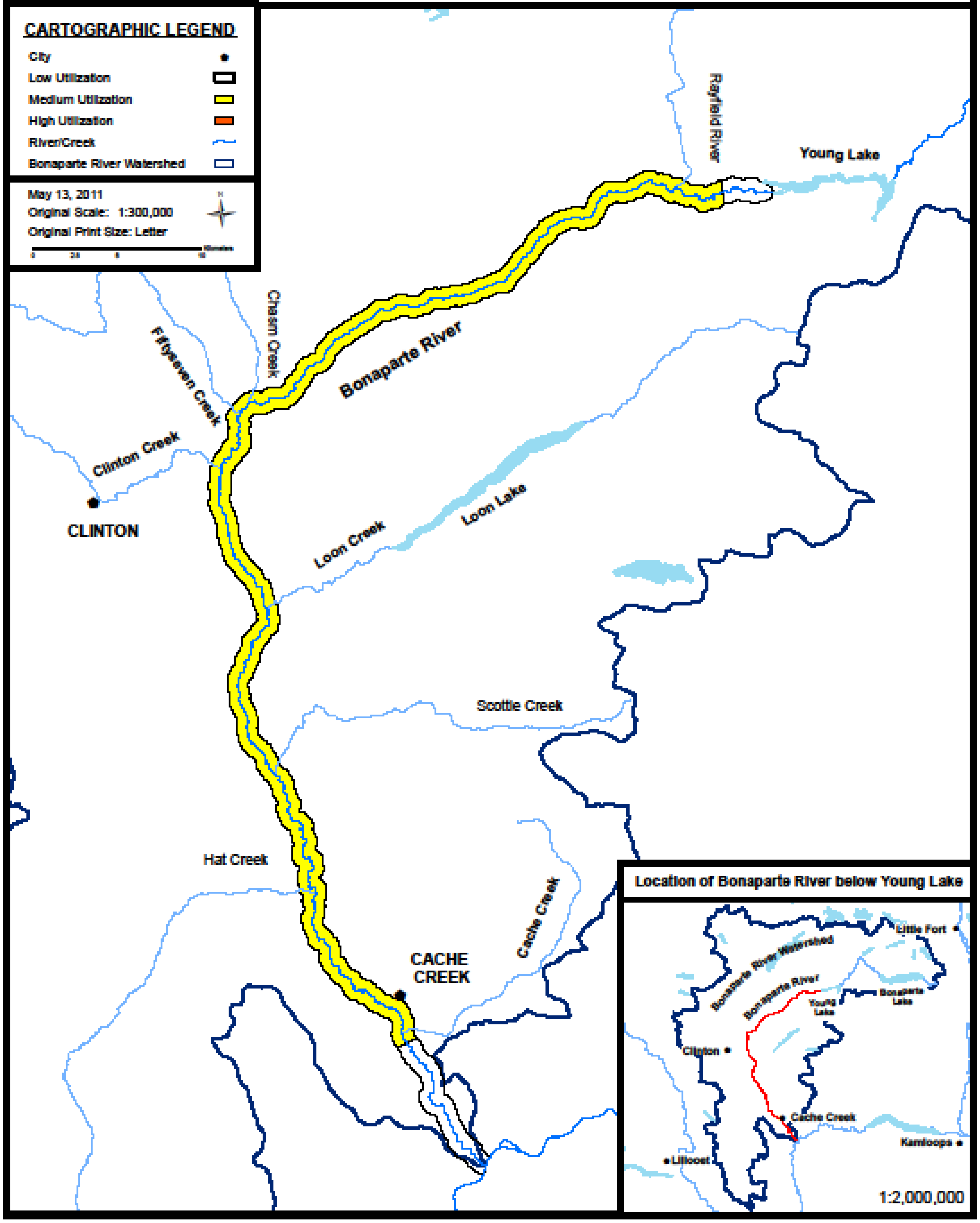


Figure 6: Generalized Utilization of Potential Steelhead Spawning Areas in the Bonaparte River Watershed below Young Lake (From Tredger, Sept 1980)

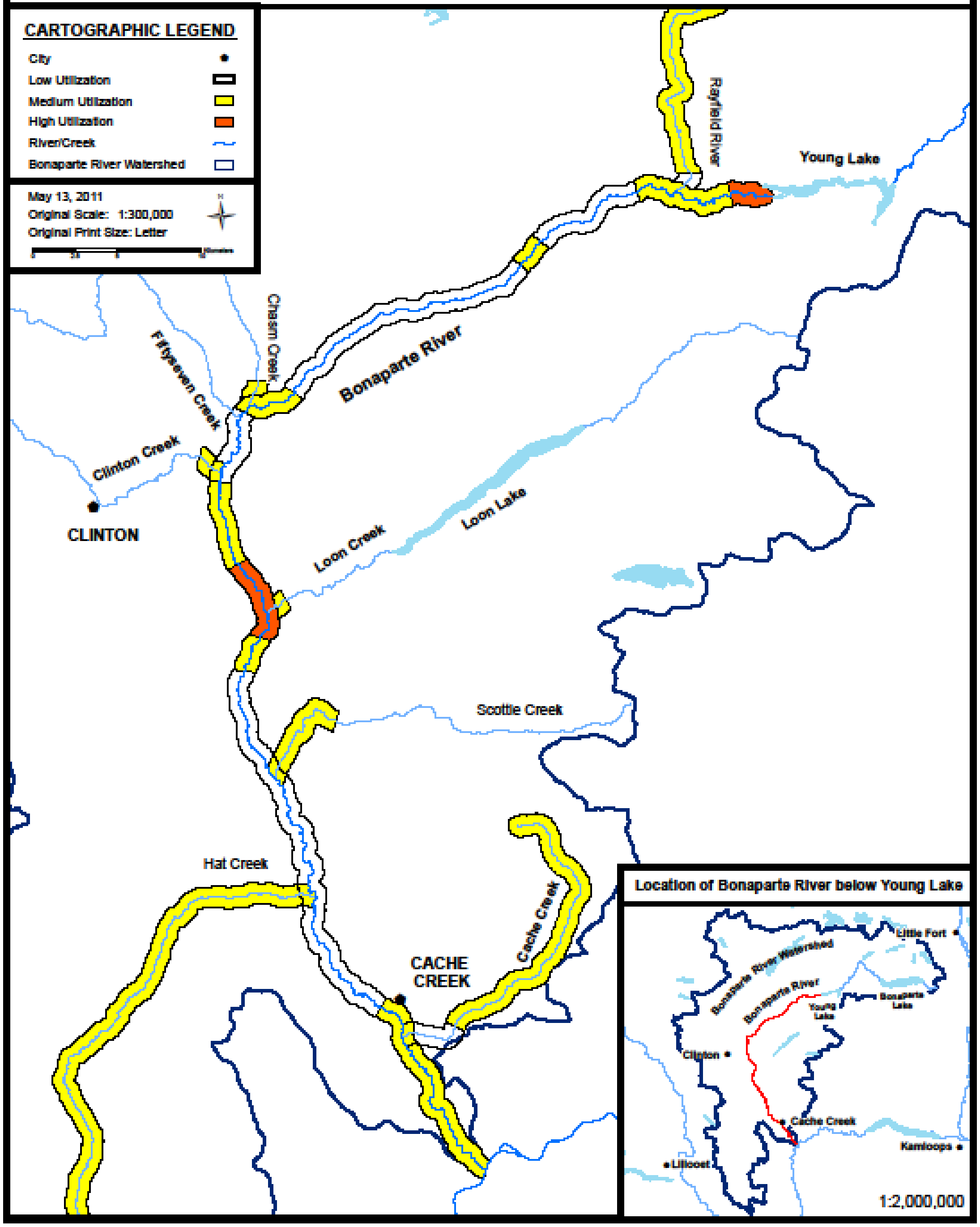
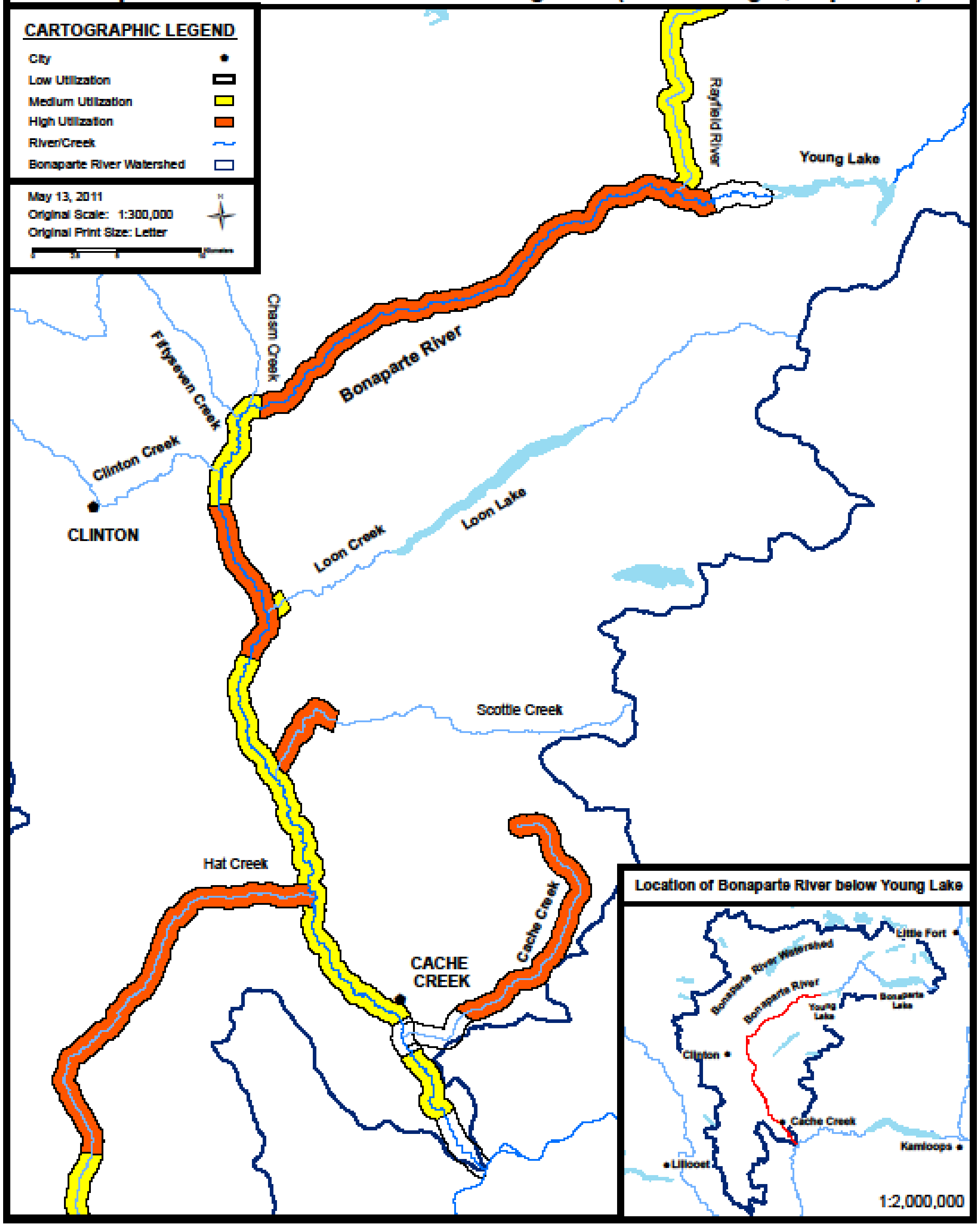


Figure 7: Generalized Utilization of Potential Steelhead Rearing Areas in the Bonaparte River Watershed below Young Lake (From Tredger, Sept 1980)



Due to the vast amount of good quality habitat above the falls a plan to improve access was undertaken. This fish ladder construction was one of three salmonid enhancement projects coordinated under the Salmonid Enhancement Program (a joint effort between the federal Department of Fisheries and Oceans (DFO) and the Provincial Fish and Wildlife Branch (MOELP)). These three projects included: construction of a steelhead and chinook smolt production hatchery located at Loon Creek, release of Loon Creek hatchery-reared Deadman River steelhead fry into the Bonaparte River mainstem and the 1989 construction of a fishway to allow access above the 7 m high falls near Ashcroft to allow spawning steelhead trout and chinook and coho salmon to access an additional 108 km of the Bonaparte River mainstem river plus tributary habitats. Since then chinook and steelhead have been found as far upstream as Young Lake (140 km upstream).

Chinook escapement was 275 during 1951-1953, but it declined to less than 100 fish on average through 1962-1981. Depressed ocean survival, excessive fishing pressure, and loss of stream habitat quality are thought to have been key factors. After this period of decline a 2 phase rebound in Chinook numbers occurred. The first in the 1980s and the second in the 1990's. The 1980s increase was part of a region wide increase so the specific causes do not appear to be lodged within the Bonaparte watershed; however the second rebound of the 1990s is attributable to the installation of a fishway near Ashcroft that enabled better access to the Bonaparte River from the Thompson. Chinook numbers increased to approximately 4,000 for 4 years in a row from 1994-1997 (with an exceptional 10,084 returning in 1997). Even with the fish ladder in place, fisheries managers believe that chinook production in the watershed is still much less than the historical norm (Figures 4 and 5). Meanwhile much of the potential upstream habitat in some Bonaparte River tributaries (e.g. Hat Creek) remains alienated by low flows.

Coho population in the Bonaparte is relatively small. generally thought to be less than 100 fish. Historically reported highs of 3,500 fish in 1953 and 1500 in 1954 are suspected to be incorrect since no such peaks have occurred in recent decades. Coho salmon numbers did not follow the trend that Chinook numbers did. Coho habitat availability has nevertheless increased substantially as a result of the fishway installation. It is expected that, with fish protection measures and the passage of time, there should be a major, sustained, increase in coho numbers.

Pink Salmon spawn in the Bonaparte River during odd-numbered years. Estimates of Pink returns have not been undertaken recently so recent trends are not available

Kokanee are present in the Bonaparte Lake and spawn in its inlet streams in relatively large numbers. They are also present in Eagan, Machete Lakes and spawn in Machete Creek above each lake. Kokanee are also present in green and Young Lakes and are known to span in the inlet streams of those lakes. Kokanee populations appear to be near norm on Bonaparte Lake but declining in Machete and Eagan lakes. Green Lake has significant fishery resources (including a kokanee population) even though it is not accessible to anadromous salmon. It also supplies a significant volume of water for licensed diversion. (Profile of a sensitive stream, MELP, Nov 2000).

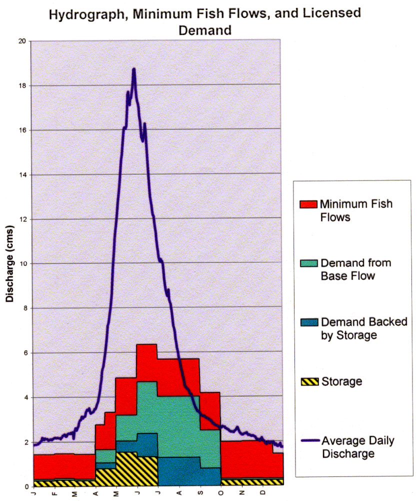
Steelhead trout escapements have been monitored from 1981 except for 1989. Steelhead numbers are thought to be below potential (Figures 6 and 7) , however steelhead have been reported as far upstream as Young Lake, Escapement numbers varied from a low of 135 in 1996 to a high of 720 in 1994, averaging 338/year.

5.2 Minimum Flow Criteria for Salmonids

Trout and salmon spawning activity in the Bonaparte system begins in August or September and can continue into December. Extremely low flows during these months could be detrimental to the success of one or more life stages (in particular, spawning and incubation). Failure of spawning or incubation leads to reduced fry production and could put a year-class at risk. Minimal flows to support Bonaparte River aquatic values at including various salmonid life stages have been set as tentative flow management goals (MOEP, 2004). These values represent the water managers instream flow goals after the total net effect of streamflow inputs, withdrawals and losses which vary over the length of the river and from year to year.

Previous estimates of Bonaparte River flow below Cache Creek are that MAD is 5.9 m3/s, and that during June to Sept flow averages 30% of MAD (1.76m3/s), while during Oct-May flows average 20% of MAD (1.17 m3/s) (MOEP, 86). By contrast Hat Creek averages 40% MAD during April-Sept (.214 m3/s) and 30% MAD during Oct-Mar (.286m3/s). This data was utilized to help determine the general scope of the instream flow issues at a watershed scale and to formulate a conceptual plan for mitigating the shortfall that exists between supply (naturalized discharge) and demand (approximated by combining licensed agricultural demand and fish flow needs).

Figure 8: Bonaparte River Hydrograph showing minimum fish flow requirements, base flow demand, demand backed by storage and average daily discharge (MOEP).



(Source, MOE/DFO)

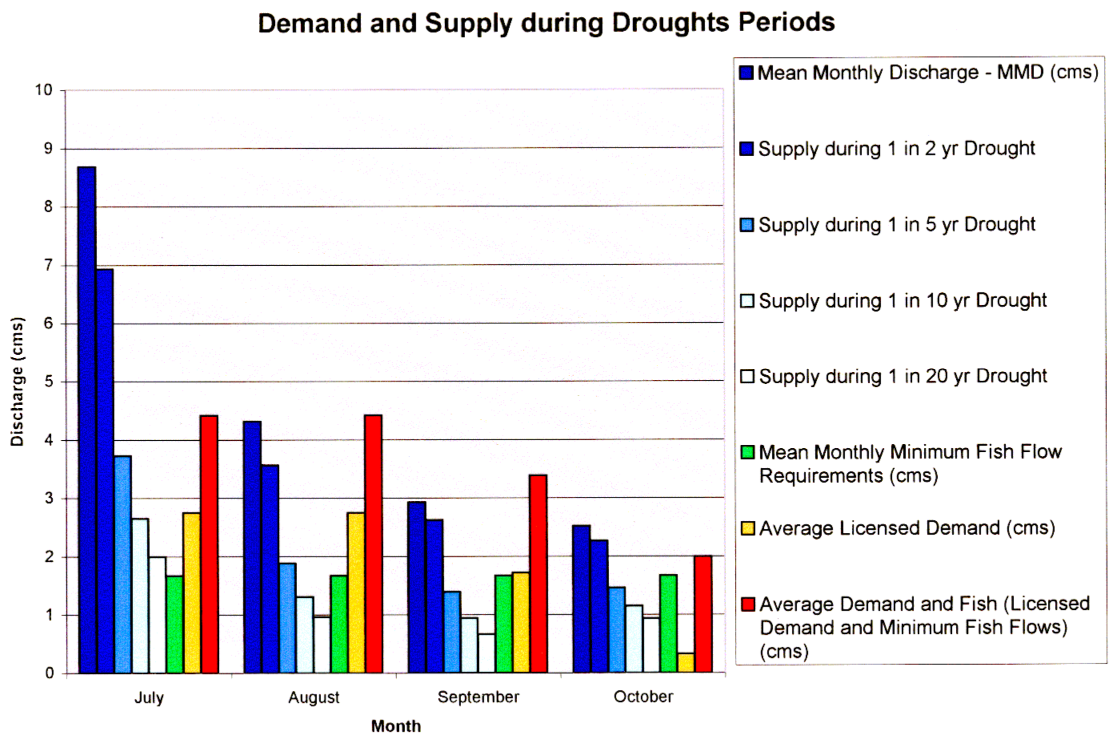
5.3 Conceptual Storage/Release Profile for Salmonids.

Low natural flows combined with irrigation water needs on the Bonaparte River result in high summer temperatures and reduced habitat for salmonids. As a result the productive potential of the Bonaparte River appears restricted for rainbow trout, steelhead, and chinook and coho salmon.

Based on recent hydrograph data there is not enough water in the Bonaparte River to reliably support major fisheries enhancement unless supported by storage. Although the conservation storage license on Bonaparte Lake helps to relieve the extreme low flow conditions, the available capacity from this infrastructure, even when managed to optimal benefit to be insufficient for the worst droughts. It will also not help in alleviating water shortages on some of the major Bonaparte River tributaries like Hat Creek and Cache Creek, which have high fisheries potential but suffer worse water shortages than the Bonaparte mainstem.

In this conceptual plan the BWSS proposes that a practical goal that is achievable to support salmonids is required. If interim fisheries maintenance flows determined for the Bonaparte River could be reliably achieved through improved water management practices fish population sustainability would be improved, even though these flows may not provide for optimum enhancement. To support watershed sustainability (including salmonid requirements) effective and achievable flow criteria must be converted to a conceptual plan for improving storage and release, not only for the mainstem of Bonaparte River but also for its tributaries. This is a large task but critical to advancing the watershed sustainability plan that supports all uses. There is a watershed wide need for increased conservation storage on the mainstem Bonaparte and some of its tributaries. There is also a need for other water conservation measures aimed at reducing the water shortage (such as irrigation efficiency) during key months (especially August to October).

Watershed wide targets for water storage to accomplish salmonid and irrigation withdrawal needs were estimated using irrigation demand which coincides with low flow and key fishery migration spawning and rearing activities. Shortfalls have been calculated using normal runoff as well as drought frequencies. Meeting needs for irrigation and fish in runoff events including up to a one in five year frequency drought event is a minimum flow management criteria that makes sense given climate change conditions and the uncertainty it places on water supply, provides a reasonable measure of assurance and remains somewhat practical to contemplate, at least as a significant first step towards long term water management improvement. These shortfalls can be mitigated if streamflows are increased at critical seasons using a combination of storage releases and efficient use and other conservation approaches. The plan is based on the estimate that storage and delivery (strategically timed and located release) of approximately 19-25 M m3 of water would probably be sufficient to provide for current licenced demand and instream salmonid needs in run-off years ranging from normal to a 1:5 year frequency drought events (Figure 9).



The plan is based on storing (and delivering) 15-20% of peak flow for seasonal augmentation of summer low flows to offset shortfalls. A review of the 1 in 5 frequency drought flows as compared with combined irrigation and instream salmonid needs reveals that 16 M m3 of delivered water would mitigate a 1:5 year drought. Approximately 30% of the current licensed irrigation demand of 41.4M m3/year is backed up with storage, leaving 27.6 M m3 that is not. Theoretically the offset of irrigation demand that can be achieved with storage (and delivery) of 10% of peak flows is approximately 45% (12.4 M m3/year) of the 27.6 M m3 of unbacked licensed demand The offset of irrigation demand that can be achieved with storage of 15% of peak flows is approximately 68% (18.7 M m3/year) of the unbacked portion (27.6 M m3) of licensed demand. The offset that can be achieved with storage of 20% of peak flow is approximately 91% of the unbacked licences irrigation demand (Figure 10).

Considering that serious issues exist that have not been addressed in this conceptual plan such as efficient delivery of stored water due to evaporative and infiltration losses, and the need for tributary flow management to be built into the watershed scale plan, the 20% (25 M m3/year) peak flow storage target is the preferred goal (as illustrated in the attached Figure 9: Bonaparte River Conceptual Detention and Release Profile. The Bonaparte River discharges approximately 186 M m3/year to the Thompson River. Naturalized flow (discharge plus assumed irrigation demand) totals approximately 225 M m3/year. It is interesting and perhaps not coincidental that at an overview level a plan to store 20% of peak flow to mitigate a 1:5 year (moderate) drought frequency impacts to fish essentially matches the main human demand on instream flows (irrigation demand that is not currently backed by storage).

The above storage concept is an achievable long term goal that would significantly support fish and irrigation needs. There is already irrigation storage infrastructure in place and operating to store 10,292 ac ft (12.7 M m3) within the watershed. To provide a relative view of scale and practicability the Bonaparte dam alone stores 14,300 ac ft (17.6 M m3) for storage and 3,000 ac ft (3.7 M m3) for irrigation, which collectively is equivalent to about 50% of what is needed under this conceptual plan to rectify current conditions. Examples of opportunites to undertake cooperative assessments of storage potential also exisit. The province already holds conservation licences for fish habitat of 20,904 ac ft (25.7 M m3) not yet utilized (only part of which would be practical) and in addition hundreds of other smaller potential storage sites exist that could be inventoried and screened to determine feasibility using cost benefit scoring. MOE through cooperative partnerships might support a share-benefit storage plan that benefits lakeshore owner, ranchers, irrigators First Nations wetland managers and others along with protection of fishery resources in mutually beneficial partnership agreements.

To provide a bit more perspective on practicality, if larger sized structures like the Bonaparte dam could be replicated elsewhere in the Bonaparte system, two such caliber structures would be sufficient to complete the current water storage and conservation goal. If medium sized (0.5 M m3) storage sites could be developed 50 sites would be required. If small sites (0.16 M m3) were developed approximately 200 sites of this caliber would be required and it very small sites (.001M m3) were utilized exclusively then approximately 2,500 would be required to reasonably address the goal. Any combination of these types of sites could be used at various elevations, aspects and locations within the drainage so as to mimic natural runoff and improve deliverability of stored or detained water for irrigation or fish use.

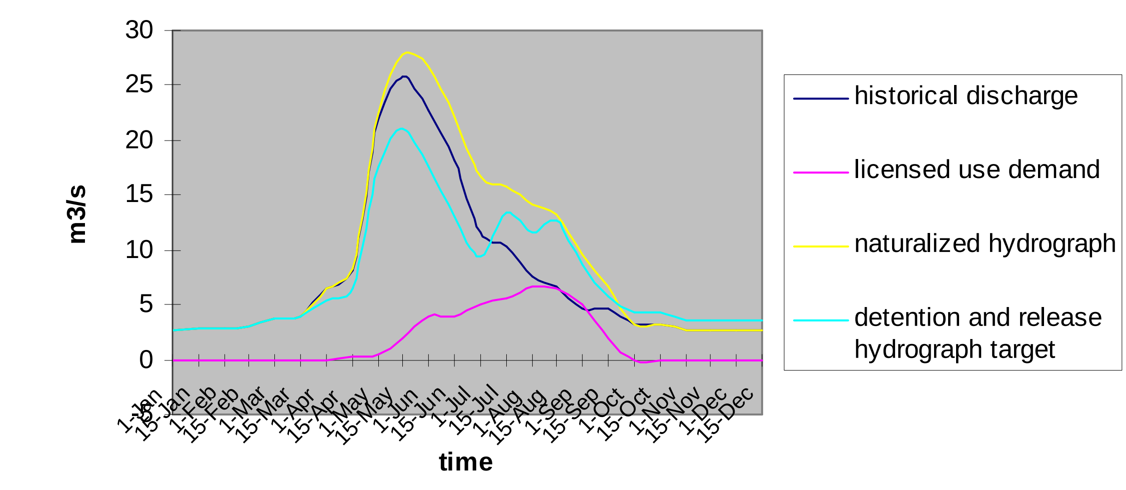
These plans are conceptual in that they do not provide assurance of efficient or timely delivery of the stored/detained water to important salmonid and/or irrigation utilization locations. These considerations remain to be made.

6.0 Opportunities for improved water management for agricultural and instream fish needs

These conceptual estimates provide some perspective to the problem and identify that to propose that storage could be developed to mitigate current issues using existing designs is on scale with currently existing local examples of water storage and water storage planning. Although there are licensing, low flow, supply and demand issues evident within the watershed, which represent a constraint to sustainability, there are also many opportunities to utilize existing resources much more effectively and help mitigate supply issues at a watershed scale. A cooperative approach driven by fish and irrigation resource interests would probably generate the best success in addressing these storage opportunities.

The proposed plan is predicated on the assumption that a combination of conservation, efficient use, and storage practices can be combined to help achieve water supply and delivery shortfalls within the watershed that respects and supports all uses, using instream minimum fish flow requirements as a main driver. Many opportunities for storage, efficient use, education and engagement exist, and successful long term watershed sustainability depends upon practically utilizing these opportunities. These include continuing to educate and demonstrate support on farm BMP's such as irrigation efficiency activity to achieve approximately 15% of the salmonid sustainability water goal, storage of approximately 75% of salmonid sustainability goal to meet the deficit between average year runoff and meeting instream minimum salmonid flows 4 of 5 years, and other conservation activities under WAM to provide the remaining 10% of the salmonid sustainability reduction in demand at critical low flow seasons. Developing a unified approach to achieving these goals would greatly benefit salmonids and other users. A 20 year plan for achieving these goals can be developed including partnerships between agriculture, fishery manager, and other partners such as Ducks Unlimited.

Figure 10: Conceptual Bonaparte River Detention and Release Profile



6.1 Water Conservation Opportunities

The concept that water conservation should be undertaken where feasible is already part of the FSWP sponsored BWSS watershed plan developed in 2008. Recent work sponsored by the Ministry of Agriculture, FBC and AAFC undertook important agricultural land use assessment and irrigation efficiency projects in the Bonaparte River watershed. DFO, FSWP and many others have sponsored considerable streambank restoration in the Bonaparte River watershed that has benefited both fish and agricultural values, along with many contributing partners such as First Nations, agricultural producers and other agencies. All of this effort has helped build rapport with producers and other residents and has provided the basis for better acceptance of this salmonid based water management plan.

Conservation methods include irrigation efficiency projects. Most of the lands currently irrigated throughout the Bonaparte are irrigated by sprinkler system. The remaining areas are irrigated by open ditches. Increased water use efficiency could be achieved throughout by implementing standardized beneficial farm practices (through the Provincial Ministry of Agriculture and Agriculture Canada). Irrigation withdrawals are not monitored directly . Estimates of use are still based on licensing and land use so there is a high degree of uncertainty associated with irrigation demand. At present, there is little capability to monitor actual water diversions or to enforce water license conditions. Water supplies are fully allocated in the Bonaparte and Hat Creek. Using fish flows as a guideline for future water management and conservation will help clarify why further surface water licensing is unlikely unless paired with storage. Monitoring actual use by irrigation water license holders would be helpful as a conservation management (and licensing) tool.

6.2 Water Storage/Detention Opportunities

The concept that water storage should be developed for the Bonaparte watershed where feasible (environmental, economic or social constraints considered) has been previously proposed (MOE, 1986) and is already part of the FSWP sponsored BWSS watershed plan developed in 2008. Water is available in the freshet period for storage. (MOEP, 1986).

The idea behind this Bonaparte water storage plan was to determine if sufficient water could be stored through a large number of relatively small or medium sized detention and retention structures within the watershed to significantly offset late summer –early fall low flow irrigation needs and protect critical salmonid habitat values. Other potential benefits from implementing the storage/detention salmonid water supply concept include securing existing licenses, creating opportunity for additional licensing, the retention or improvement of wetland values, and providing the capacity to buffer peak discharge events such as those expected to result from mountain pine beetle impacts to forest hydrology in coming decades.

There are many opportunities for large and small storage sites to provide a combination of live storage or detention/retention sites similar to those existing at Bonaparte Lake and Taweel Lake that could be used to meet these needs without compromising other key values or functions such as wetland values and hyrdrological freshet functions of natural flooding for stream health.

The Bonaparte River Watershed is rich in species and habitat diversity including wetland values. A wide range of plant, mammal, reptile, amphibian and avian species utilize the Bonaparte River watershed at various life stages and seasons. Many important wetland and riparian areas exist, offering great diversity in available habitats, microhabitats and interconnections between special use areas. Habitat connectivity including a healthy riparian corridor is critical to maintaining the biodiversity of the watershed, which is an indicator of overall ecosystem and human health. Many of these species rely on riparian habitats for part or all of their life cycles. The BWSS has supported the concept since 1999 that environmentally sound agriculture is sustainable agriculture. A key to maintaining biodiversity is to retain habitat complexity and connectivity. In this regard the wetland and riparian habitat values need to be considered in developing improved agricultural water supply. Only a proportion of the hundreds of potential storage sites that might be considered are feasible opportunities for improved agricultural water supply when the intrinsic values of wetlands and other considerations are incorporated into the scoring process. Any such development is probably best undertaken in partnership with an experienced organization in similar project design, construction and management such as Ducks Unlimited using design types such as those included in Appendix 2, that have been customized and engineered to suite site conditions.

The location, design, cost and partnerships to manage these structures needs to be assessed by qualified technical staff so that sites are effectively located and managed within a reach by reach and tributary by tributary watershed plan for maximum benefit. Many engineering and construction details would need to be considered on a site by site basis to establish a network of effective impoundments, such as catchment areas and recharge capacity. However, it remains that there is considerable opportunity to capture and release surface runoff to help mitigate low flow impact to salmonids as well as help meet irrigation demand, mitigate flooding and protect wetland and other values.

This is not an engineering report. There are many practical considerations will determine if a storage site is feasible (cost effective in a total cost accounting).
Many sites that appear at first to be good candidates can be eliminated as impractical if they will not constribute to a measurable positive impact on low flows in the river. For example, some considerations as below were pointed out by C Pentilchuck on a similar project undertaken on the Salmon River. "…Often marshy areas that appear sizeable proved to be sedge fens having a considerable gradient hence requiring a sizeable dam to develop any storage volume. Although upper watershed basins are larger these typically have limited freshet inflow – relatively small catchments in the dry grassland area…. " Some wetland values are already high and might be unreasonably diminished if the site were utilized for fish or agricultural water storage, unless wetland values are also properly valuated Also, downstream connectivity and deliverability (losses, proximity, delivery timing) of stored water are important practical considerations. Sites can be scored based on criteria and candidates selected for demonstration projects accordingly, if the political, funding and licensing support are found.

The function of water storage for fish value can be to provide live storage and controlled releases at important times and locations to provide beneficial use by fish. Alternatively, some of the storage may be structured to provide passive storage for slow releases to surface flow or simply to infiltrates over time contributing to groundwater and ultimately to stream flow.

A tendency toward using low cost, low risk designs is proposed to meet the storage goal of storing and releasing peak flows at many smaller detention or retention structures to achieve the watershed wide water storage goal. Ducks Unlimited is very experienced in licensing, installing and managing these types of structures. Some existing designs for small scale passive and live storage structures is provided in Appendices 5-8.

To bridge the gap between this longer term conceptual water storage/detention plan and a more achievable, short term goal set, two specific sites were selected as potential demonstration sites that could be undertaken to engage local support and demonstrate the practicality of how a larger scale series of similar structures might help better manage available water resources. One is an example of a small volume (0.2 M m3) and the second is an example of a very small volume (.002 M3/m) site. Planning and constructing one or two demonstration pilot project storage sites to establish the process and engage cooperative support at locations such as Sharpe Lake are recommended as important first steps. Under the plan additional storage can also be planned and undertaken as required in conjunction or in partnership with these salmonid sustainability activities to secure and increase current irrigation demands. In the long term this is critical to ensure that agricultural needs and fishery values are protected so all other needs can be equitably managed.

6.3 Water Supply Governance Considerations

Planning to alter licensing in order to undertake water storage/retention projects to support salmonids may be problematic due to complicated jurisdictional issues. WAM is addressing these issues, and has an objective to be flexible in application presumably to support positive change in how water is licensed and managed. In the meantime, DFO and MOE have completed good examples of the type of projects proposed at Taweel Lake and Bonaparte Lake. WAM may provide a reorganized framework for undertaking such projects in the future. However, at the present any proposal to alter or apply for change of use regarding water storage licensing should be well organized with funding for design construction and maintenance works , as well as assumption of liability partnerships in place and be pre-approved by other potentially affected licencees prior to approaching MOE for approval. It would be advisable to contract experienced assistance to organize such a project to make success more likely than simply planning it at an informal community watershed level and expecting Ministry approval to be provided.

Community watershed groups such as the BWSS cannot hold licenses, and normally the landowner or a water utility/ water user group would need to undertake a water storage application. Organizations such as irrigation improvement districts can be structure to administer and manage water management operations objectives as outlined in the Letters Patent to properly address operational, administrative, maintenance and liability aspects of water storage and management. If an irrigation district or similar body were formed it would require coordination between regional districts, municipalities and provincial/federal agencies is essential as jurisdictions often overlap. A benefit to structuring and maintaining such an organization is that regional districts can apply on behalf of an improvement district for infrastructure planning and capital grants from the local government.

To operate the finances of an irrigation improvement district operating costs must be levied from the tax base and tolls that are collected from the landowners by the board of trustees. The taxes are usually collected on a parcel tax basis and tolls are a set rate, a metered price or a combination of both and are generally based on the total operating cost of the service provided. If the irrigation district requires they are able to access their right to borrow by enabling certain bylaws within their Letters Patent through the Local Government Act. Short-term borrowing is used for terms of up to five years. For long-term borrowing, a board of trustees can enact bylaws to borrow money by the issue and sale of notes, bonds, debentures and other securities in principal amounts the board believes are necessary. Loans are usually borrowed from a financial institute and require approval from the ministry and most often the landowners as well. These may or may not provide a practical option within the Bonaparte watershed water management plan.

6.4 Water Act Modernization Opportunities

Watershed scale demand and supply assessments are identified in WAM as being an important tool for improved water management planning. Standards and guidelines may soon be adopted through WAM to provide direction fro future water management planning. The WAM process puts high value on stream health, governance, water allocation and groundwater management as key drivers behind the improving water management in BC. By following further developments in WAM and adopting the guidelines, procedures and recommendations of WAM into a conceptual plan such as this, Regional Water Manager support for any such changes to water management is more likely

7.0 Summary and Recommendations

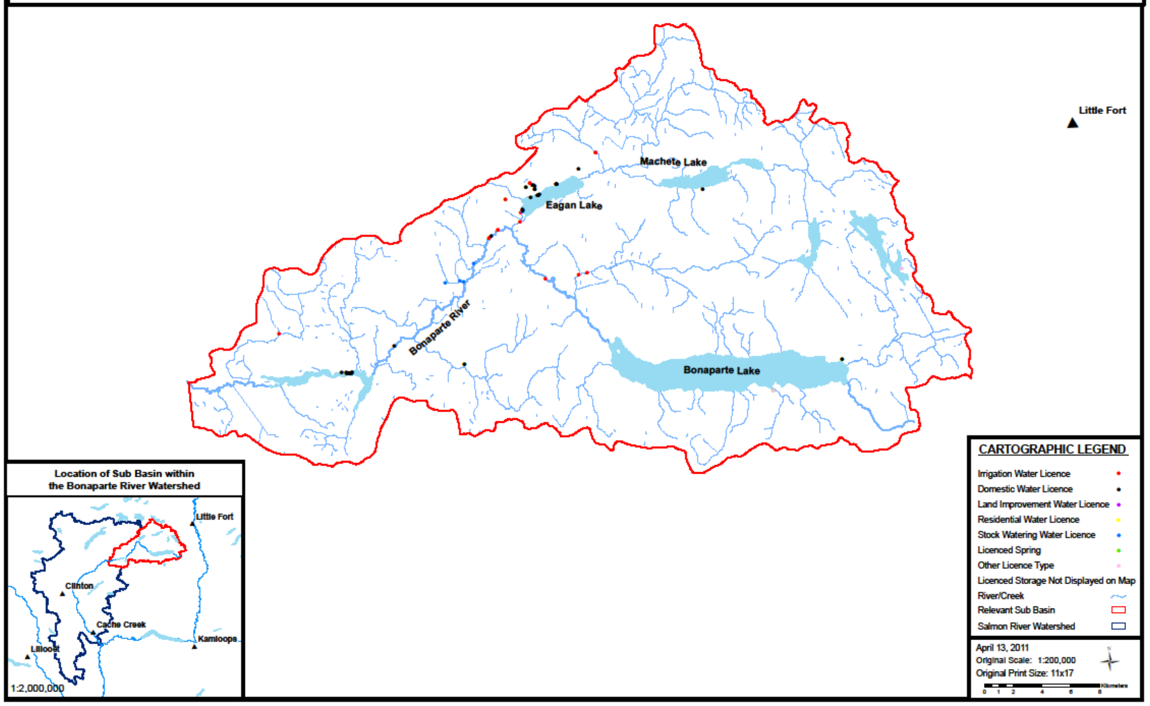
This water management planning project sponsored by FSWP and BWSS has provided an improved perspective for engaging support for improved water management practices by using salmonid instream flow needs as a base line indicator of success. In essence the plan gives salmonids a voice at the water planning table, and uses salmonid needs as a key to address irrigation and storage needs that support watershed sustainability. The plan meshes well with the current direction of the Water Act Modernization initiative and respects the need to support licensed irrigation demand.

There are many relevant recommendations that have previously been made by MOE some of which have been implemented and others which have only been partially implemented to date. In the meantime, the BWSS watershed plan of 2008 should continue to support development of additional water storage capacity where feasible and necessary, promote more efficient water use, continue to restore riparian vegetation and stabilize streambanks along the Bonaparte River. The value of improved water management for fish is significantly diminished without effective streambank protection and restoration. Regular.monitoring of habitat restoration sites should be conducted. This also includes a need to support the refinement and testing of instream flow requirements not only for fish and other values such as agriculture, recreation, ambient water quality and waste management water quality objectives and recreational use. Groundwater should be monitored including an inventory of wells, present groundwater utilization, recharge capacity, sustainable yield, and aquifer delineations and extents to help avoid groundwater mining complications. Opportunities to improve water management practices through participation and support for the water Act Modernization initiative being undertaken by MOE should be pursued as feasible

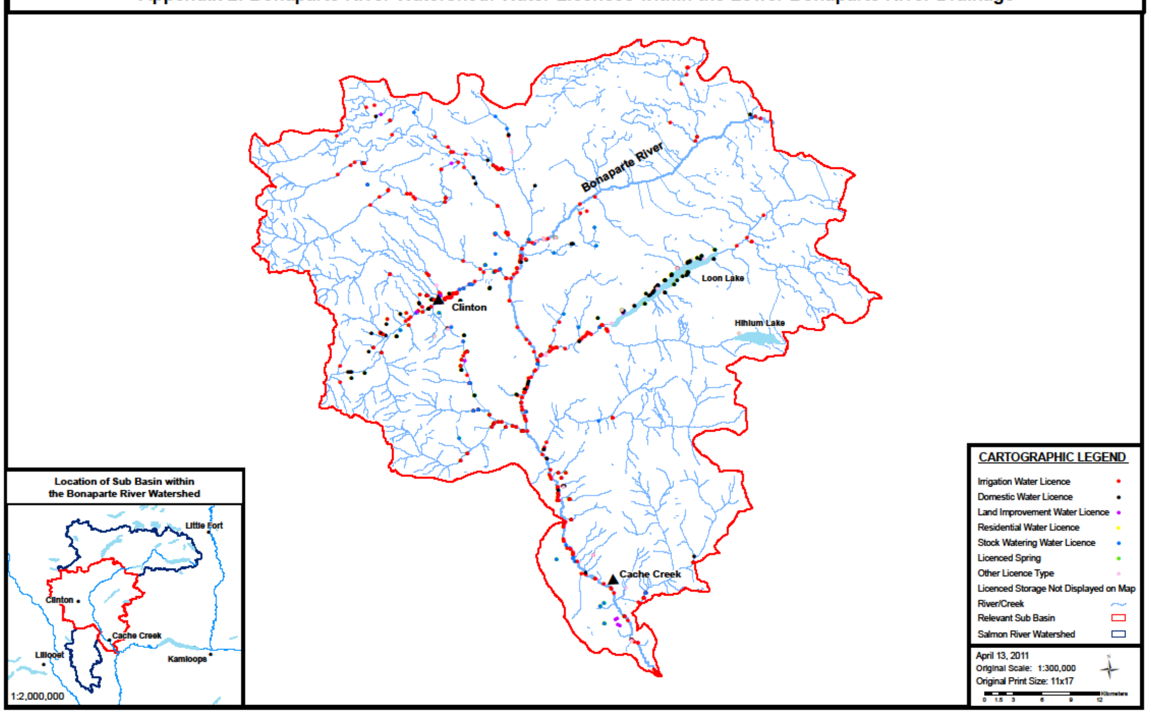
With existing water management issues linked to antiquated water allocation, licensing and management processes WAM offers an opportunity to improve the plan described herein and prepare for implementation. WAM includes fish and instream values, so fish values are implied as part of the general water management paradigm for future. The development of a pilot project storage site, with technical design, funding and licensing partnerships organized is the next step in implementing the concept. The potential demonstration projects for storing water at Sharpe Lake and in a meadow above Sharpe lake offers potential benefits and significant opportunity for partnership as an example of engaging local partnerships that can be applied incrementally to affect a watershed scale improvement that supports long term sustainability. Meanwhile promotion of conservation activities including irrigation efficiency that engage participation and provide immediate results to benefit juvenile and adult salmonids utilizing the Bonaparte River and its tributaries.

Appendices 1-4: Bonaparte Watershed Irrigation Demand by Subbasin

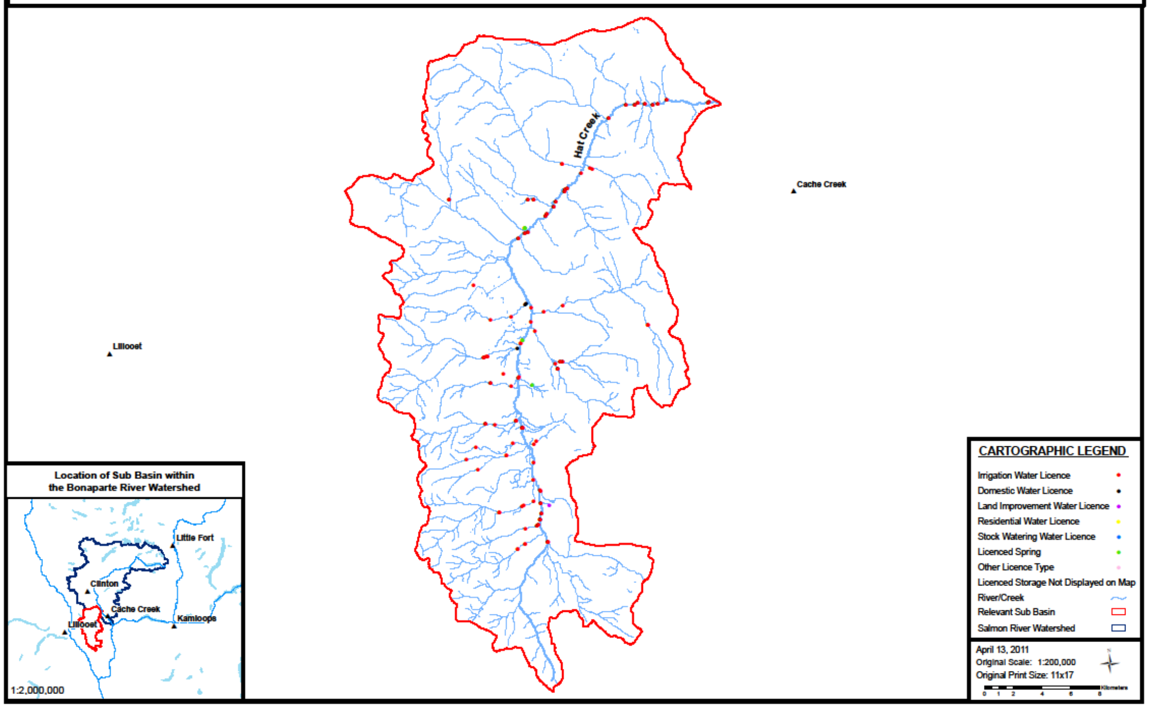
Appendix 1: Bonaparte River Watershed: Water Licences within the Upper Bonaparte River Drainage



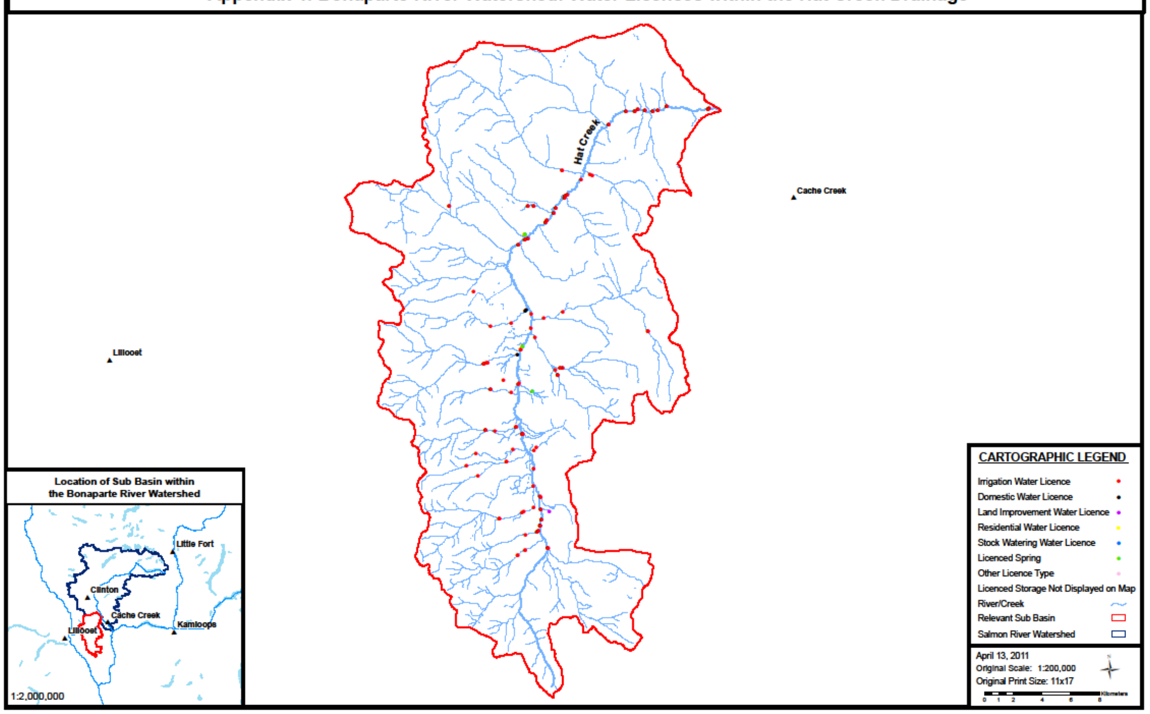
Appendix 2: Bonaparte River Watershed: Water Licences within the Lower Bonaparte River Drainage



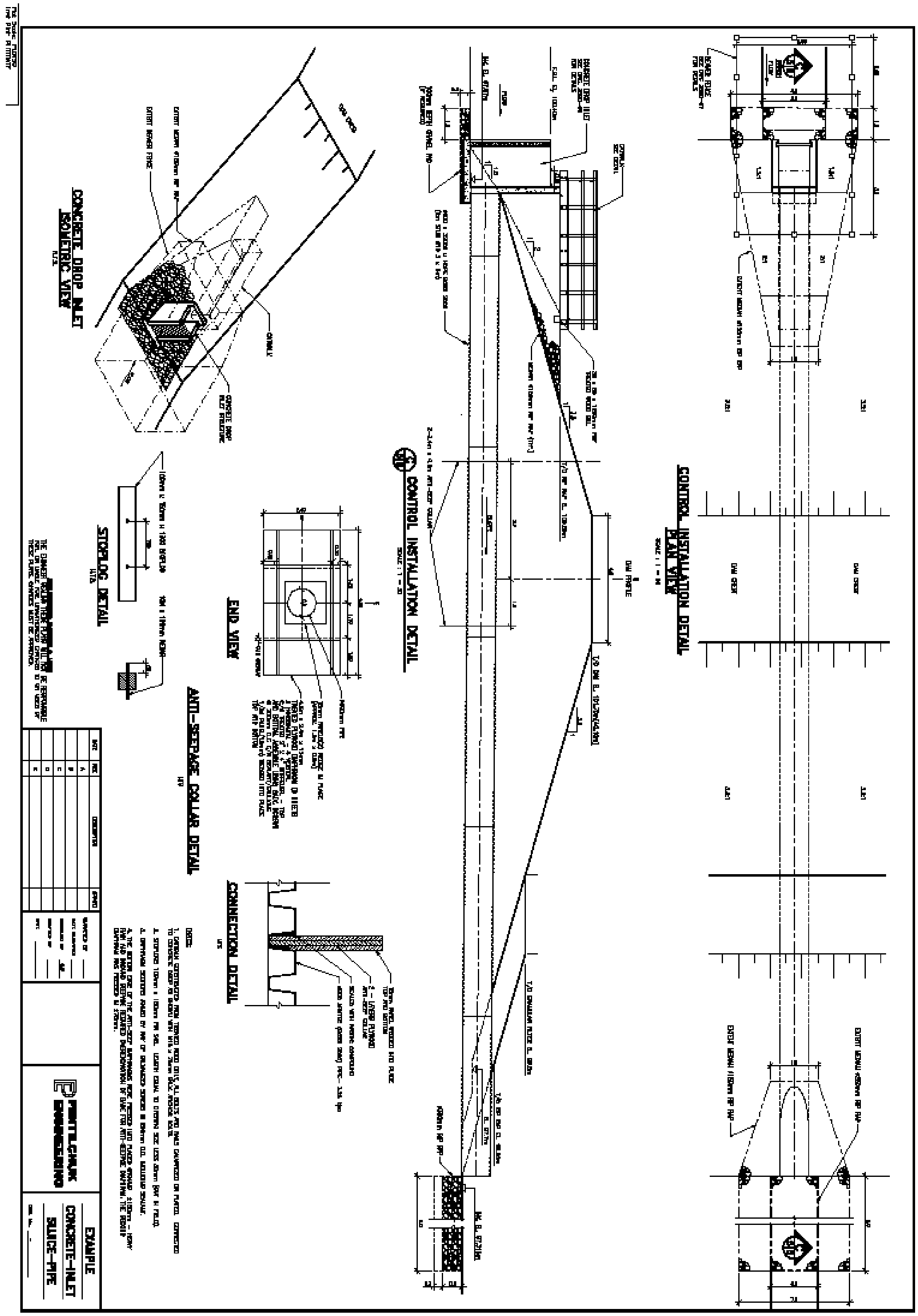
Appendix 4: Bonaparte River Watershed: Water Licences within the Hat Creek Drainage

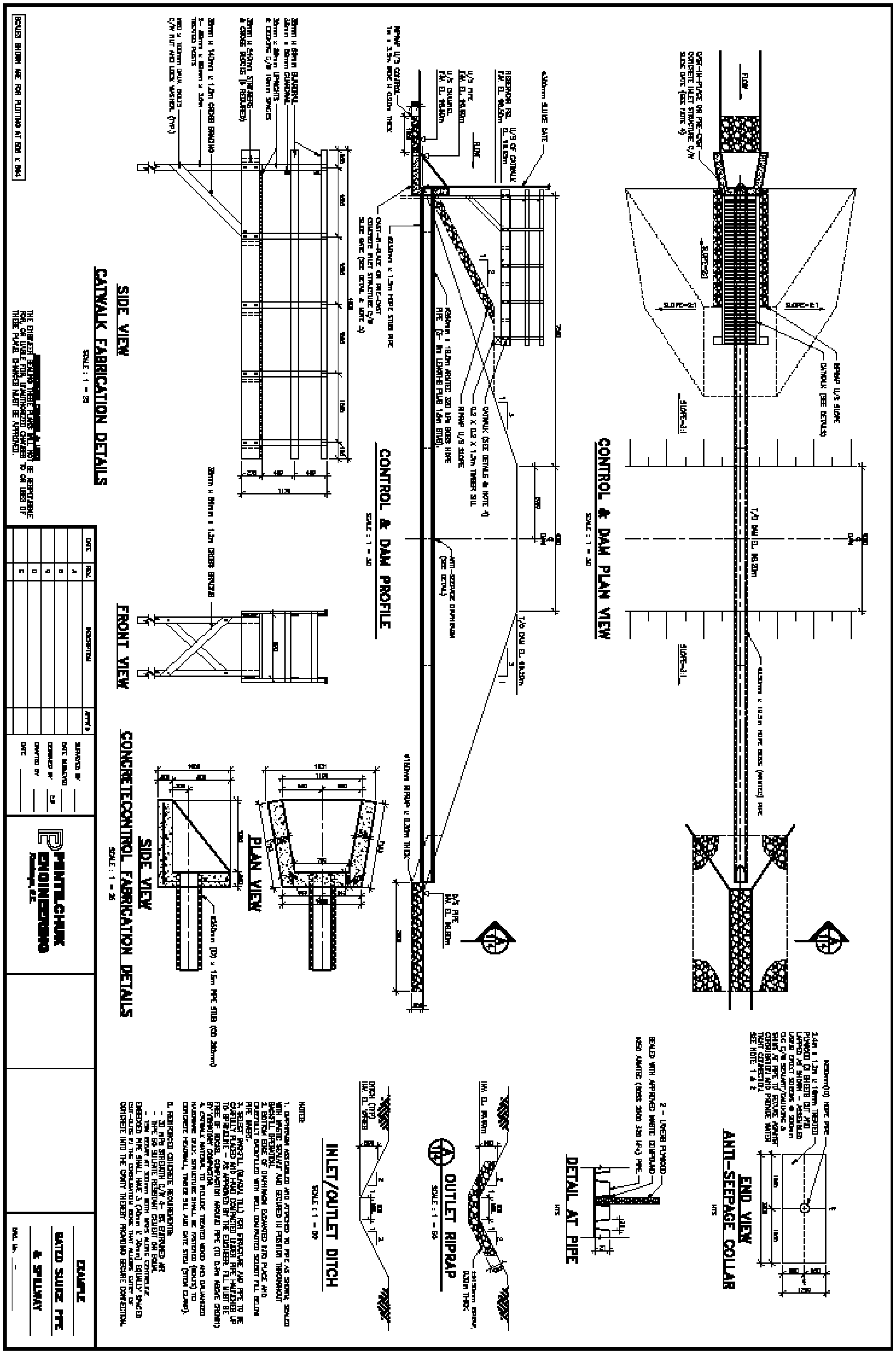


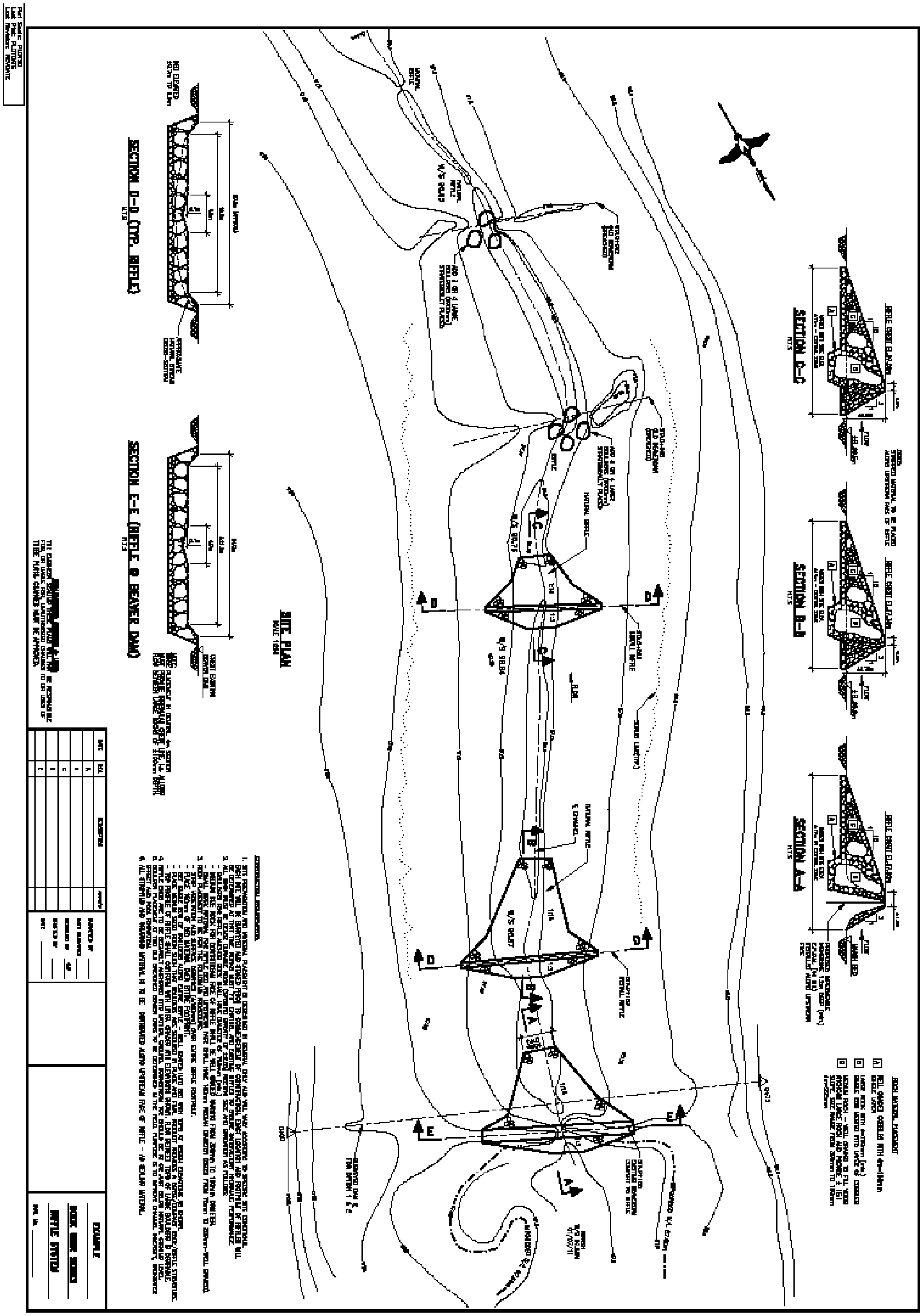
Appendix 4: Bonaparte River Watershed: Water Licences within the Hat Creek Drainage

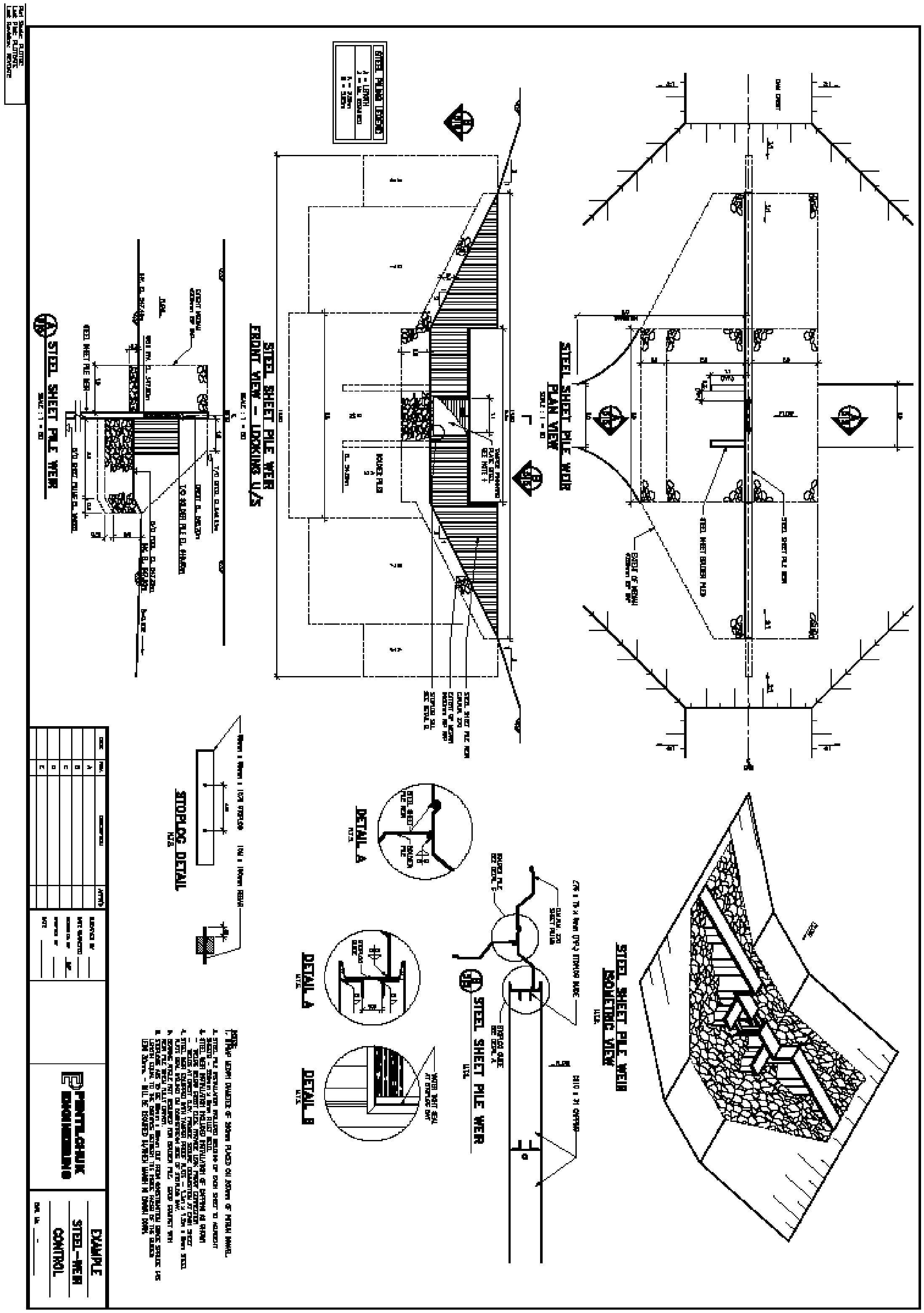


Appendices 5-8: Examples of Typical Storage Designs (source: C Pentilchuk)


CONTROL INSTALLATION PLAN VIEW
CONTROL INSTALLATION DETAIL
END VIEW
ANTI-SEEPAGE COLLAR DETAIL
CONNECTION DETAIL
STOPLOG DETAIL
CONCRETE DROP INLET ISOMETRIC VIEW
EXAMPLE
CONCRETE-INLET
SLUICE-PIPE


CONTROL & DAM PLAN VIEW
CONTROL & DAM PROFILE
SIDE VIEW
CATWALK FABRICATION DETAILS
FRONT VIEW
PLAN VIEW
SIDE VIEW
CONCRETE CONTROL FABRICATION DETAILS
END VIEW
ANTI-SEEPAGE COLLAR
DETAIL AT PIPE
OUTLET RIPRAP
INLET/OUTLET DITCH
PINTELCHUK ENGINEERING
EXAMPLE
GATED SLUICE PIPE
& SPILLWAY





STEEL SHEET PILE WEIR
PLAN VIEW
STEEL SHEET PILE WEIR
FRONT VIEW – LOOKING U/S
STEEL SHEET PILE WEIR
STEEL SHEET PILE WEIR
ISOMETRIC VIEW
STEEL SHEET PILE WEIR
DETAIL A
DETAIL A
DETAIL B
STOPLOG DETAIL
EXAMPLE
STEEL–WEIR
CONTROL