RECLAMATION
Managing Water in the West

Potholes Reservoir Supplemental Feed Route

Draft Environmental Assessment

Columbia Basin Project
Grant County, Washington

U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region

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TABLE OF CONTENTS

1.0 PURPOSE OF AND NEED FOR ACTION

1.1 Background

Potholes Reservoir is a feature of the Columbia Basin Project (CBP), located in central Washington State. The CBP was authorized for the irrigation of 1,029,000 acres; currently, approximately 671,000 acres (557,530 acres of platted farm units, 73,227 acres of water service contracts, 40,323 acres of Quincy sub-groundwater license) are served by the CBP; most development occurred in the 1950s and 1960s with acreage added sporadically through the mid-1980s.

In the late 1970s, The Bureau of Reclamation (Reclamation) determined that a feed route to Potholes Reservoir was necessary to ensure a reliable supply of water for the South Columbia Basin Irrigation District (SCBID) (Reclamation 1980). The CBP was designed so that overall return flows from irrigation on the northern half of the project would be captured in Potholes Reservoir and subsequently used to supply land in the south half of the CBP. As outlined in House Document 172 (H. Doc. 172, 79th Cong., 1st Session, Joint Report on Allocation & Repayment of the Costs of the Columbia Basin Project, Reclamation Report of Oct. 30, 1944, approved by the Secretary on Jan. 31, 1945), the project was estimated to take 71 years to complete and was to be developed in phases. Irrigation development in the north half is not yet capable of providing the return flows needed to provide a full supply of water for the south end of the CBP.

To correct this problem, a feed route was developed to move water from Banks Lake to Potholes Reservoir. The feed route transports water through the Main Canal to the bifurcation, then south through the East Low Canal (ELC) to Rocky Coulee Wasteway where the feed is discharged into Upper Crab Creek near the north end of Moses Lake. From this point, the water moves through Moses Lake and into Potholes Reservoir at the Moses Lake outlet structure. Feeding can be done early and late in the irrigation season when demand for irrigation water is low and the ELC is operating at less than full capacity. At these times, the "unused" capacity is used to carry feed water to Potholes Reservoir.

The ELC feed route solved the immediate problem in 1980 and is still used today as the primary route. However, the ability of this route to meet the required need has diminished over time. Improvements in irrigation efficiency in the northern half of the project have led to lower returns and an increased need for feed. In addition, demand has changed. Block 26 was added to the Potholes system in 1984 and the East Columbia Basin Irrigation District (ECBID) Supplement No. 1 to the Master Water Service Contract allowed for additional use out of the ELC. As a result, the demand on Potholes is greater, and the amount of "unused" capacity in the ELC has declined. These factors and a need for system reliability have led to the need for a supplemental feed route.

1.2 Purpose and Need for the Action

Reclamation is proposing to establish a supplemental feed route to supply water to Potholes Reservoir. A lack of full development of north half irrigation facilities, irrigation facility efficiency improvements, and an increase in demand have diminished the reliability of the existing primary feed route. Insufficient feed water into Potholes Reservoir could negatively impact water deliveries to the SCBID. The purpose of this project is to increase the reliability of transporting water from Banks Lake to Potholes Reservoir in order to offset current limitations of the CBP.

<u>Project Objectives</u>

Identify an alternative that:

- Provides supplemental feed water to Potholes Reservoir
- Is economically justified
- Is financially feasible
- Utilizes existing infrastructure

Reclamation has a responsibility to deliver water to the South Columbia Basin Irrigation District (SCBID) under Article 13(a) of the "Amendatory, Supplemental, and Replacement Repayment Contract between the United States of America and the South Columbia Basin Irrigation District" which states:

> "The water supply available for irrigation of the lands entitled to receive water from each of the canals systems shall be delivered by the United States at the Bifurcation Works of the Main Canal in the case of the West and East Low Canals, and at the outlet works of O'Sullivan Dam in the case of the Potholes Canal."

In determining a preferred alternative, emphases is on options that are economically justified, financially feasible, and utilize existing infrastructure and/or natural topography to convey the feed with the understanding that some additional facilities may need to be constructed. The scope of the study is limited to the physical area of the CBP from Billy Clapp Reservoir to Potholes Reservoir.

1.3 Cooperating Agencies and Related Actions

A Memorandum of Understanding concerning the State of Washington's Columbia River Initiative was entered into between the State of Washington, the Pacific Northwest Region of the U.S. Bureau of Reclamation, the SCBID, the ECBID, and the Quincy-Columbia Basin Irrigation (Q-CBID) District on December 17, 2004. The parties agreed to cooperate in numerous studies, one of those being the Potholes Assessment, a part of which is the alternative feed route study. The State of Washington, through the Washington Department of Ecology (WDOE), has been a full partner with Reclamation on the alternative feed route study. WDOE took part in the scoping for the project, discussed below, has funded Reclamation's work on the study, and has been an active participant in the development of this draft EA. Should one of the action alternatives be selected for implementation, the WDOE would continue in their role as a partner, assisting with implementation when all necessary compliance activities are completed.

Other cooperating agencies on the project include the Washington Department of Fish and Wildlife (WDFW) and the Columbia Basin Project Irrigation Districts.

1.3.1 Related Actions

Reclamation will work with the U.S. Fish and Wildlife Service and the WDFW to develop a management plan for lands along the selected feed route. The plan will include adaptive management elements to ensure that the plan is flexible and able to change in the future if needed.

These projects could include a number of activities proposed by the wildlife agencies, including modifications to existing control structures, and development of isolation structures for side streams. Additional environmental compliance will be done on any additional actions associated with this project.

1.4 Authority

This project is being undertaken under the authority of the Columbia Basin Project Act of 1943 and the Reclamation Act of 1939. House Document 172 (H. Doc. No. 172), submitted by the Secretary to the President and Congress in1945.

1.5 Public Scoping

A community meeting was held on May 16, 2006, in Ephrata, Washington. The purpose of this meeting was to present project concepts, goals, and objectives to the public. Additionally, a major goal of the meeting was to promote discussion and elicit input from the public detailing additional alternatives and overall concerns.

1.6 Environmental Concerns and Issues

Environmental concerns and issues related to the project were determined by the study team and from the public meeting. Concerns raised during the public meeting generally covered the following areas:

- Sedimentation in Moses Lake
- Impacts to recreation
- Aquatic weed infiltration due to changes in water quality in Moses Lake
- Impacts to Soap Lake, Moses Lake, Billy Clapp Lake, and Banks Lake
- Effects on endangered species below Potholes Reservoir
- Beaver dams
- Potential flooding along the proposed routes
- Effects on private property
- Cumulative effects of water usage, diversions, etc.

In addition to these concerns, Reclamation determined which resources may or may not be affected by the project. These resources included:

- Fish and wildlife
- Threatened and endangered species
- Historic Properties
- Hydrology
- Vegetation
- Geology/soils
- Stream morphology
- Water quality
- Land use
- Recreation
- Hazardous and toxic materials
- Other issues

These issues are either discussed or addressed in Chapter 3 and impacts to relevant resources are discussed in Chapter 4.

1.7 Permits and Related Laws

The following are Federal, State, and local permits and related laws necessary to comply with in order to implement the proposed project.

1.7.1 National Environmental Policy Act

Reclamation is responsible for determining if the proposed project might have significant effects to the human environment under the National Environmental Policy Act (NEPA). If Reclamation determines that effects are not significant, a Finding of No Significant Impact (FONSI) will be prepared. A FONSI would allow Reclamation to proceed with the proposed action without preparation of an Environmental Impact Statement.

1.7.2 Endangered Species Act

The Endangered Species Act (ESA) requires Federal agencies to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. Section 7 of the ESA (16 U.S.C. Section 1536[a][2]), requires all Federal agencies to consult with the National Oceanic and Atmospheric Administration – National Marine Fisheries (NMFS) for marine and anadromous species, or the United States Fish and Wildlife Services (USFWS) for fresh-water and wildlife species, if an agency is proposing an "action" that may affect listed species or their designated habitat. If such species may be present, the Federal agency must conduct a biological assessment (BA) to analyze the potential effects of the project on listed species and critical habitat in order to establish and justify an effect determination.

1.7.3 Native American Graves Protection and Repatriation Act

The Native American Graves Protection and Repatriation Act (NAGPRA) establishes the rights of Native American groups to human remains of Native American ancestry and certain associated cultural or funerary objects recovered from Federal or Indian lands. The Act also establishes procedures and consultation requirements for intentional excavation or accidental discovery of Native American remains on Federal or Tribal lands. If these resources were discovered, Reclamation would consult with the Office of Archeology and Historic Preservation (OAHP) and appropriate Tribe or Tribes. These consultations would aid in determining measures to mitigate the adverse effects.

1.7.4 National Historic Preservation Act

The National Historic Preservation Act of 1966 (NHPA) requires that Federal agencies complete inventories and site evaluation actions to identify cultural resources that may be eligible for listing on the National Register of Historic Places (National Register) and then ensure those resources "are not inadvertently transferred, sold, demolished, substantially altered, or allowed to deteriorate significantly." Regulations entitled "Protection of Historic Properties" (36 CFR 800) defines the process for implementing requirements of the NHPA, including consultation with the appropriate State Historic Preservation Office (SHPO) and Advisory Council on Historic Preservation.

1.7.5 Permitting

Implementation of the preferred alternative may require acquisition of permits. As each alternative will require different actions, different permits may need to be acquired. This may involve permitting with the WDFW, Ecology, the Corps of Engineers, the Washington State Department of Natural Resources, and other federal, State, or local governments. Reclamation or managing partners will apply for all applicable permits.

2.0 ALTERNATIVES

This chapter describes the alternatives or potential actions, and includes the general environmental consequences of the proposed alternatives.

2.1 Alternative 1 – Continue Current Feed Route via East Low Canal (No Action)

The no action alternative would provide water to Potholes Reservoir via existing feed routes. The reservoir receives and stores runoff water from the Upper Crab Creek Basin and return flows from irrigated land served by the West and East Low Canals. This water then becomes the water supply for the area served by the Potholes Canal System. Current amounts of runoff and return flows are not sufficient to supply the required irrigation water to the Potholes Canal System. "Feed" water is therefore diverted from Banks Lake to Potholes to meet the Potholes Canal System water supply shortfall.

Project Alternatives

1 – No Action
2A – Crab Creek Perennial
2B – Crab Creek Ephemeral
3 – Frenchman Hills Wasteway

At present, the Potholes Canal System serves approximately 204,000 acres, requiring up to 990,000 acre-feet annually from Potholes Reservoir. To meet this supply Potholes Reservoir requires up to 350,000 acre-feet of feed annually. There are three feed routes currently being utilized: The primary route is through the ELC to Rocky Coulee Wasteway, then into Upper Crab Creek, through Moses Lake, and finally into Potholes Reservoir. The two secondary routes are through Lind Coulee Wasteway and through Frenchman Hills Wasteway. The first of these is through the ELC to Lind Coulee Wasteway, which runs directly into Potholes Reservoir. The other is through the West Canal to Frenchman Hills Wasteway, which also runs directly into Potholes Reservoir. More detail on the current operations is supplied in Chapter 3.

Environmental effects associated with this alternative are mainly related to the potential shortage of water delivered to Potholes Reservoir. No new construction or management practices would occur under this alternative, and would therefore have no environmental impacts.

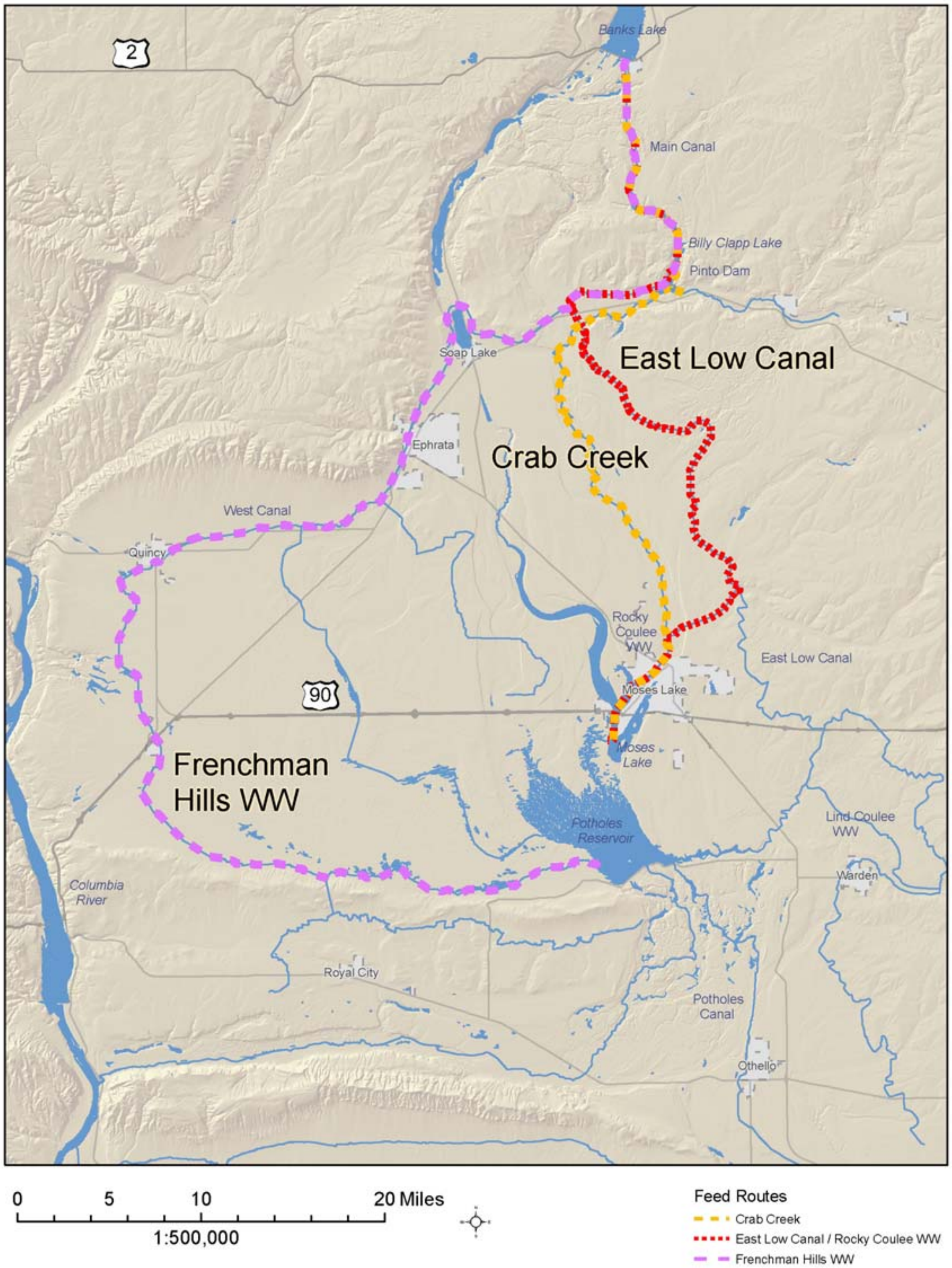
2.2 Alternative 2A – Upper Crab Creek from Pinto Dam to Moses Lake (Perennial)

This alternative would release feed water from Billy Clapp Reservoir through the 4x4 foot outlet into Brook Lake, a natural water body within the Crab Creek channel. The water would then be conveyed down Crab Creek to and through Moses Lake to Potholes Reservoir. Detailed construction models were developed by CH2MHill for this alternative and are available in Reclamation's office in Ephrata, WA.

Alternative 2A

Release water from Billy Clapp Reservoir into Upper Crab Creek year-round.

Proposed Potholes Reservoir Supplemental Feed Routes
Columbia Basin Project, Grant County, Washington



Modifications to Crab Creek will include an outlet structure and energy dissipater from the Pinto Dam 4'x4' slide gate to Brook Lake, removal of a rock weir at the outlet of Brook Lake and installation of an overflow weir section constructed of concrete approximately 100 feet wide at the same locations as described in CH2M Hill's report. In addition, several obstructions within the first 5 miles of Crab Creek below Brook Lake will be removed including a rock structure near the inlet to Round Lake and two other raised areas described as beaver dams downstream of the second railroad bridge. A dike approximately 100 feet long across the left or Lone Springs channel of the creek will be constructed to protect the Lone Springs stream from becoming infested by carp.

The road crossing at Rd. 16 NE will be improved and a rock barrier approximately 400 feet long to isolate the side channel near Loan Springs will be carried out, as described in CH2M Hill's report. The Stratford Rd crossing in the town of Stratford will not be improved as there is an alternate route around the creek and Grant County has indicated they have plans to improve Stratford Road, which include replacement of the crossing.

Sediment transportation studies indicate that only minor amounts of sediment will be transported through the system and no modifications to the creek are anticipated for erosion protection.

Under this alternative approximately 100 cfs of base flow would be released from Billy Clapp Reservoir year-round with larger spring feed of up to 500 cfs occurring between April 1 and June 30. The 100 cfs base inflow would move approximately 72,000 acre-feet annually from the existing feed to Potholes Reservoir to the supplemental route. The base feed would add 30,000 acre-feet to the winter inflows to Potholes Reservoir, while still providing sufficient capacity to capture a 25-year runoff volume in the reservoir. To meet the winter releases, Billy Clapp Reservoir would be drawn down to an elevation of 1300 feet by March 1 and refilled to 1326 feet by the third week of March at a rate of two feet per day. In addition to the base feed, this route could be used during the spring, summer months to increase the feed during dry years when existing feed routes are at capacity and water is still needed to fill Potholes. The exact amount would vary due to runoff and irrigation demands. The ability to feed 500 cfs from April through the end of June, if needed, would provide 54,000 acre-feet. The annual total feed with this route could be 126,000 acre-feet. This would replace existing feed, primarily down the Rocky Coulees wasteway, and would not be an addition to the total annual feed.

Environmental effects associated with this alternative are mainly related to alterations at Pinto Dam, modifications to the Crab Creek channel, and increased flows in Crab Creek and Rocky Ford Creek.

2.3 Alternative 2B – Upper Crab Creek from Pinto Dam to Moses Lake (Ephemeral)

Alternative 2B

Release water from Billy Clapp Reservoir into Upper Crab Creek part of the year.

This alternative is identical to 2A with the exception of the timing and volume of water released from Billy Clapp. In order to achieve the necessary amount of feed this alternative would require the annual release of approximately 650 cfs from Billy Clapp Reservoir between approximately April 1 and June 30. The 650 cfs flow for this period would supply approximately 87,000 acre-feet through this supplemental route. The exact amount would vary due to runoff and irrigation demands. As with alternative 2A, the feed would replace feed down Rocky Coulee wasteway. This alternative would not affect winter water levels in Billy Clapp Reservoir.

Environmental effects associated with this alternative are mainly related to alterations at Pinto Dam, modifications to the Crab Creek channel, and increased flows in Crab Creek and Rocky Ford Creek as described in Alternative 2A.

2.4 Alternative 3 – West Canal to Potholes Utilizing the Frenchman Hills Wasteway

Under this alternative, feed water would be conveyed from Billy Clapp Reservoir via the Main Canal and West Canal to the Frenchman Hills Wasteway, which is currently being used for a portion of the feed route. The water would then be discharged through the Frenchman Hills Wasteway into Potholes Reservoir. Detailed construction models were developed by CH2MHill for this alternative and are available in Reclamation's office in Ephrata, WA.

Frenchman Hills Wasteway crosses under two county roads, Dodson Road and Road C SE. Implementation of this alternative would require the alteration of the Road C SE crossing. The Road C SE crossing has a capacity of 500 cfs. The current annual peak flow in Frenchman Hills Wasteway is 500 cfs, with the April to May flow ranging from 350 to 400 cfs, as measured at Road C SE.

Alternative 3

Supplemental feed water is delivered through the Frenchman Hills Wasteway into Potholes Reservoir.

Frenchman Hills Wasteway is currently used during the spring feed operation. Currently, feed is limited to between 100 to 150 cfs of feed because of Road C SE culvert flow capacity above current return flows. Under this alternative additional feed would be shifted from the Rocky Coulee wasteway route and fed down Frenchman Hills Wasteway.

The West Canal is charged with water from the Main Canal at the bifurcation around the third week of March. The first week of the irrigation season is used to charge the canal systems indicating a start date for feed through the Frenchman Hills Wasteway of approximately the fourth week of March. The Q-CBID treats the canal system for aquatic weeds. Due to the nature of material used for weed treatment, no water can be released to a feed route while a treatment is taking place. Additionally, due to the difficulty of starting and stopping large flow rates in the canal system, it is assumed that large feed flows will not be restarted after the first treatment. The West Canal treatment starts during the second week of May and results in the final feed for the Frenchman Hills Wasteway during the third week of May.

In addition to the aquatic weed treatment constraint, space must be maintained in the West Canal for emergency shutdown of five main pumping plants: Quincy, Babcock, Evergreen, Frenchman Springs, and Frenchman Hills. This limits the capacity of the West Canal to carry feed water to a maximum total, including existing feed, of 700 cfs. This maximum feed can only occur at the very beginning of the irrigation season and rapidly declines. Additionally, Frenchman Hills Wasteway needs to be able to pass flows resulting from a potential canal failure in the fifth section of the West Canal or the Royal Branch Canal. In order to take into account the maximum feed of 700 cfs, the Frenchman Hills Wasteway would need to be able to pass 1500 cfs. To do this the culvert crossing at Road C SE would need to be enlarged as detailed in CH2MHill's report.

Frenchman Hills Wasteway feeds approximately 21,000 acre-feet in the spring. Assuming enlarged culvert crossings, the West Canal would have a capacity to feed an additional 25,000 acre-feet in the spring via Frenchman Hills Wasteway, replacing feed down Rocky Coulee Wasteway. The Frenchman Hills Wasteway route does not have additional capacity to add to summer feed. In addition, the wasteway would not be used for fall feed.

Environmental effects associated with this alternative are mainly related to the crossing alteration, and the increased flow in Frenchman Hills Wasteway.

2.5 Alternatives Eliminated

In preparation of this document, one alternative was developed, but eliminated from further study. This alternative required the construction of a new canal and siphon to divert water from the W20 lateral to Rocky Ford Creek. This alternative was eliminated because construction costs were too high, preliminarily estimated at $16,000,000, and because the alternative only provided about 50,000 acre-feet of additional feed water (i.e., the cost-to-flow ratio was too high).

No other alternatives were identified.

2.6 Preferred Alternative

Reclamation has determined that the preferred alternative for this project is alternative 2A Upper Crab Creek from Pinto Dam to Moses Lake (Perennial).

3.0 AFFECTED ENVIRONMENT

This chapter presents relevant resource components of the existing environment to be affected or created by the alternatives under consideration.

3.1 Resources Not Affected by the Proposed Alternatives

The following table 3-1 details all resources eliminated from further consideration in this document. These resources include concerns raised during the public meeting, or normally covered in environmental documents, that are definitively irrelevant to this discussion of environmental impacts.

Table 3-1: Resources Not Affected by the Proposed Alternatives

Resource/Concern	Justification
Soap Lake	None of the alternatives would have direct or indirect effects on Soap Lake, as any additional seepage from the West Canal will be intercepted by the Soap Lake Protective Works. All other impacts would occur below Billy Clapp Lake.
Below Potholes Reservoir	None of the alternatives would cause impacts below Potholes Reservoir. All of the alternatives deliver water to Potholes Reservoir; releases from the reservoir would remain unchanged.
Climate/Air Quality	Minor impacts to climate or air quality may occur during construction activities.
Economics	The amount of water fed into Potholes Reservoir remains unchanged. This will not affect existing or potential economic development.
Noise/Visual Impacts	Some noise or visual impacts may occur during construction associated with the alternatives; however, these impacts were determined to be minimal and did not warrant further consideration.
Wild and Scenic Rivers	No Wild and Scenic Rivers are located within the project area.
Wetlands	No direct impacts to wetlands were identified. Some of the alternatives may lead to potential wetland projects; however, those projects would be considered by the appropriate party on a case-by-case basis.

3.2 Fish and Wildlife

This section is taken from US Fish and Wildlife's Planning Aid Memo (PAM) written in 2006. This document is available from Reclamation's offices in Ephrata, WA.

3.2.1 Affected Environment

The following discussion describes existing conditions in the project area. The specific areas of interest within the project area include Billy Clapp Reservoir, middle Crab Creek, Moses Lake, Frenchman Hills Wasteway, and Potholes Reservoir.

Billy Clapp Reservoir

Billy Clapp Reservoir is an artificial reservoir formed by Pinto Dam, which is part of the CBP. The reservoir is a 1010-acre equalizing reservoir 10.5 miles downstream from Banks Lake. The lake is approximately 6 miles long and forms a wide spot in the Main Canal with an average inflow/outflow rate of 6500 cfs of water during normal irrigation demand periods. This results in a rather rapid turnover rate for the reservoir, and low retention of nutrients. These characteristics complicate fish management for this water body. Using a supplemental feed route will not increase the amount of water flowing through Billy Clapp.

Synonymous with irrigation waters is a continuous recruitment, or replenishment, of the twenty plus fish species present. Gamefish as well as less desirable fish such as carp (*Cyprinus carpio*), northern pikeminnow (*Ptychocheilus oregonensis*), pumpkinseed (*Lepomis gibbosis*), and suckers (*Catostomus sp.*) are common (WDG 1982).

Historically, Billy Clapp was a very popular kokanee (*Oncorhynchus nerka*) and walleye (*Stizostedion vitreum*) fishery. These two fish species accounted for around 95 percent of the fishing activities (Stober 1979). Stober's study gave evidence that Billy Clapp's kokanee fishery was somewhat dependent upon adult kokanee that emigrated from Banks Lake via the Main Canal. The installation of an outlet barrier net at Banks Lake from 1978-1981 appeared to have a negative impact on the Billy Clapp fisheries, including walleye (WDG 1982).

Billy Clapp Reservoir is one of several wildlife areas in the Columbia Basin, which is one of the most important waterfowl breeding grounds in Washington. It provides a resting area for migrating lesser Canada geese (*Branta Canadensis*) each fall. Many other birds also use this area for resting and feeding on their annual migrations along the Pacific Flyway, including:

- Mallards (*Anas platyrhynchos*)
- Redheads (*Aythya Americana*)
- Canvasbacks (*Aythya valisineria*)
- Ringnecks (*Aythya collaris*)
- Ruddy ducks (*Oxyura jamaicensis*)
- Gadwalls (*Anas strepera*)
- Bluewing teal (*Anas discors*)
- Greenwing teal (*Anas crecca*)
- Northern shoveler (*Anas clypeata*)
- Pintails (*Anas acuta*)
- Goldeneyes (*Bucephala clangula*)
- Wood ducks (*Aix sponsa*)

Shorebirds are also common in the CBP and include:

- Caspian terns (*Sterna caspia*)
- American white pelicans (*Pelecanus erythrorhynchos*)
- Sandhill crane (*Grus canadensis*)

- Swans (*Cygnus sp.*)

Game birds are also present in the area and include:

- Ring-necked pheasant (*Phasianus colchicus*)
- Chukar (*Alectoris chukar*)
- Gray partridge (*Perdix perdix*)
- California quail (*Lophortyx californicus*)

Coyote (*Canis latrans*) are the most abundant predatory mammal. Jackrabbit (*Lepus sp.*), marmot (*Marmota sp.*), ground squirrel (*Citellus sp.*), muskrat (*Ondotra zibethica*), and a wide variety of shrews (*Sorex sp.*) occur.

Mule deer (*Odoccoileus hemionus*) occur in fringe areas where suitable habitat exists. Resident prairie falcon (*Falco mexicanus*), red-tailed hawk (*Buteo jamaicensis*), Swainson's hawk (*Buteo swainsoni*), golden eagle (*Aquila chrysaetos*), wintering bald eagle (*Haleaeetus leucocephalus*), and the occasional snowy owl (*Nyceta scandiaca*) or gyrfalcon (*Falco rusticolus*) are present.

Middle Crab Creek

Middle Crab Creek is the most heavily populated reach within the Crab Creek Subbasin, with the City of Moses Lake as the main human population center. It is this reach that endures the most winter and spring runoff that carries agricultural chemicals and eroded soil from Upper Crab Creek. However, Brook Lake intercepts flows and acts as a sump for much of the silt and chemicals.

Historical information indicates that long before irrigation development, perennial connection between Crab Creek at Brook and/or Round Lakes and Moses Lake did not occur (Evermann 1909). Groves (1951) states that only two tributaries historically fed Moses Lake: Rocky Ford Creek, and a small tributary emanating from two points above Parker Horn, probably in the Willow Lakes area and at Homestead Creek. Only during high water conditions did Upper Crab Creek flow through the present Willow Lakes area and on to Moses Lake at Parker Horn. Today, several springs join the Crab Creek channel in this reach because of elevated groundwater from irrigation development. The springs creating the 7 miles of nearby Rocky Ford Creek are connected by underground flows to Crab Creek near Round and Willow Lakes.

This portion of Crab Creek also contains the Gloyd Seeps Wildlife Area. The wildlife area is about 10,000 acres of public land owned by the WDFW and Reclamation. It is managed by WDFW for wildlife habitat and wildlife related recreation. Numerous wetlands, ponds, and seeps are surrounded by older shrub-steppe uplands and basalt scablands. Fires have created grasslands on most of the area along the west side of Crab Creek. When last inventoried, the Gloyd Seeps Wildlife Area was approximately 73 percent shrub-steppe (including grasslands created by fire), 7 percent wetland, 6 percent steppe, 6 percent riparian, and 4 percent open water habitat. Habitat enhancements include 18 acres of planted shrubs in 3 locations, 40-200 acres of grain fields in 6 locations, 5 winter feeders dispensing about 500 lbs. of wheat each year, 4 impounded ponds (Homestead, Magpie, Mansfield & Gloyd), and 2 flooded fields (the Flood Flat and Spud Field).

WDFW releases 1500 cock pheasants on Gloyd Seeps during the hunting season. Trout are planted at Homestead Creek, Mansfield Pond, Gloyd Seeps, and a few places in the main stem of Crab Creek. Public access to the wildlife area is somewhat limited by lack of roads. WDFW maintains about 5 miles of gravel and dirt roads for public access into the wildlife area from nearby county roads.

A lack of perennial flows limits the establishment of an effective fishery in most of middle Crab Creek. Trout fisheries are currently managed where perennial flows do exist. Rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), eastern brook trout (*Salvelinus fontinalis*), and tiger trout (*Salmo trutta x Salvelinus fontinalis*) are stocked annually. The system is managed as a low-key trout fishery with statewide rules and walk-in access. Angling success is sporadic, and stocking occurs on an "as available" basis. Willow and South Willow Lakes are stocked with rainbow trout when water levels permit. When adequate water is present, fingerling trout survival is sufficient to produce a good trout fishery. However, adequate water has been available less than 25 percent of the last 20 years. During lower water periods, these waters have been good warmwater fisheries, most notably for black crappie (*Pomaxis nigromaculatus*).

The Homestead tributary flows westerly to Crab Creek at Road 12. The plentiful springs that feed this system have exceptional water quality. The habitat is diverse, consisting of about 3 miles of creeks with beaver (*Castor canadensis*) dams, impoundments, and the artificially created Homestead Lake of 30 acres and a maximum depth of 10 feet. Flows throughout the system are perennial and vary with irrigation season and the resultant re-charging of local groundwater. Base flow is approximately 10 cfs.

Several hydraulic projects to enhance fisheries and improve waterfowl production were constructed in this area during the 1970s. The outlet dam and water control structure forming Homestead Lake and the barrier dam separating Homestead Creek and Crab Creek prevent fish migration from Crab Creek. The Homestead system is managed as a quality trout fishery. Rainbow, brown, tiger, and eastern brook trout are stocked annually. Other management actions include selective gear regulations, one fish limit, a year around season, and walk-in access. The entire Homestead system was treated with rotenone, a fish-killing chemical, to remove carp in 1994, and no deleterious fish species have been noted since. Initially, the trout fishery was very good; however, low flows and aquatic weed growth has since diminished fingerling survival.

The Magpie system is another smaller tributary that flows westerly to Crab Creek at Road 12, although it has very rarely actually connected via surface water. Spring-origin flows are perennial and vary with irrigation season and the resultant re-charging of local groundwater. The habitat is diverse, consisting of about one and a half miles of creek with a base flow of 2 cfs, beaver dam impoundments, and an artificially created lake of 11 acres and a maximum depth of 10 feet. Several hydraulic projects to enhance the fisheries and waterfowl production were constructed in the 1970s. The outlet dam and water control structure forming Magpie Lake prevented fish migration from Crab Creek. The Magpie system is managed as a trout fishery with statewide rules (currently a year around season and five fish limit) and walk-in access.

Rainbow, brown, tiger, and eastern brook trout are planted annually. The entire system was treated with rotenone to remove carp and bass in 1994; however, both species and other introductions currently persist.

The Gloyd Seeps are another system of springs that form a small tributary that flows westerly to Crab Creek at Road 10. Spring-origin flows are perennial and vary with irrigation season and the resultant re-charging of local groundwater. Several hydraulic projects to enhance the fisheries and waterfowl production have been constructed to prevent fish migration from Crab Creek. The system is managed as a low-key trout fishery with State-wide rules and walk-in access. Rainbow, brown, tiger, and eastern brook trout are allotted annually. Angling success is sporadic, and stocking occurs on an “as available” basis.

The bird and mammal species that utilize this are essentially identical to that described for Billy Clapp Reservoir. One notable exception is that this area is of significant importance for the northern leopard frog (*Rana pipens*) as it contains the only two confirmed occurrences of this species in the State of Washington since 1992 (McAllister 1999).

Moses Lake

Moses Lake is the third largest natural lake in Washington and represents a valuable asset for wildlife and fisheries propagation and recreational interest. The lake covers a maximum of 6800 acres (10.6 square miles), inundates 51.9 kilometers of shoreline, and is 16.75 kilometers long. Tributaries to Moses Lake encompass approximately 2041 square kilometers, principally within the Crab Creek drainage (Bain 1990). The longest part of the lake is fed by a spring-fed tributary, Rocky Ford Creek. The source of this creek is a series of springs located about 4.2 kilometers east of Ephrata (Brown and Caldwell 1978). Following the development of the Columbia Basin Irrigation Project in the early 1950s, surface and subsurface runoff entering Moses Lake increased substantially and will be enhanced by the Supplemental Feed to Potholes Reservoir.

Native fish present in Moses Lake include largescale sucker (*Catostomus macrocheilus*), longnose sucker (*Catostomus catostomus*), peamouth (*Mylocheilus caurinus*), and northern pikeminnow. Common carp, which have dominated the lake for the past 90 years, were first introduced to the lake when flood waters breached the outlet of the lake connecting it to the Columbia River in 1904 (Groves 1951). Gamefish species present in the lake include black crappie, bluegill (*Lepomis macrochirus*), yellow perch (*Perca flavescens*), pumpkinseed *(Lepomis gibbosis)*, walleye, largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieui*), rainbow trout, and lake whitefish (*Coregonus clupeaformis*). Sixteen species of fish are known to currently occupy Moses Lake.

In the areas surrounding Moses Lake, coyotes are the most abundant predatory mammal. Jackrabbits, marmots, ground squirrels, muskrats, and a wide variety of mice and shrews occur. Mule deer occur in fringe areas where suitable habitat exists.

Frenchman Hills Wasteway

The Frenchman Hills Wasteway is managed as a part of the Desert Wildlife Area (DWA). The DWA is 35,100 acres in size, and was desert prior to the construction of the CBP. Black sands created by ground-up basalt formed sand dunes, which were very actively moving until recent times. The natural basin now serves as a collector for irrigation water from upslope farmlands. Most of this water is collected in the Winchester and Frenchman Hills Wasteways.

County roads provide access to much of the perimeter of this large area. Access to the interior is primarily on foot. Large numbers of waterfowl utilize the remote wetlands. Coyotes are the most abundant predatory mammal. Jackrabbits, marmots, ground squirrels, muskrats, and a wide variety of mice and shrews occur. Mule deer are present and are a primary management focus in this area. Many ponds have been isolated from the wasteways with low sand dikes to exclude carp and improve waterfowl habitat.

This area is important to birds both as a relatively undisturbed breeding area and as an important stopover point during migration to rest and refuel. Winter residents find the areas of thick brush an ideal location to find food and cover. A game reserve on part of the wasteway attracts ducks and geese during the fall migration, improving local waterfowl hunting. There are a series of ponds with water control structures north of the reserve, which are also managed to attract waterfowl for hunting and to provide some brooding habitat for dabbling ducks. Year-round residents include:

- Red-tailed hawk
- American kestrel (*Falco sparverius*)
- Great horned (*Bubo virginianus*)
- Short-eared (*Asio flammeus*) and long-eared (*Asio otus*) owls
- Great blue heron (*Ardea herodias*)
- Black-crowned night-heron (*Nycticorax nycticorax*)

There are also several species of waterfowl present including song sparrow (*Melospiza melodia*) and marsh wren (*Cistothorus palustris*).

Breeding residents that migrate to and from this area include:

- Black-necked stilt (*Himantopus mexicanus*)
- Swainson's hawk
- Burrowing owl (*Athene cunicularia*)
- American bittern (*Botaurus lentiginosus*)
- Black tern (*Chlidonias niger*)

Many migrants utilize the area and include solitary sandpiper (*Tringa solitaria*), American white pelican, tundra swan, bald eagle, and the usual wading birds and waterfowl. Passerines find the thickets especially attractive, and swamp (*Melospiza Georgiana*), white-throated (*Zonotrichia albicollis*), and Harris's (*Zonotrichia querula*) sparrow have all been observed. Sharp-shinned (*Accipiter striatus*) and Cooper's (*Accipiter cooperii*) hawks are common in late fall and winter.

Merlins (*Falco columbarius*) are also regular around the thickets in fall and winter. Snowy owls (*Bubo scandiacus*) have been observed in the dune areas.

Potholes Reservoir

Potholes Reservoir is a 28,200-acre reservoir formed by the construction of O'Sullivan Dam across the Crab Creek valley in 1949. Water flows into the reservoir from the outlet of Moses Lake via Crab Creek, and irrigation return water from Winchester Wasteway, Frenchman Hills Wasteway, and Lind Coulee. Water discharge occurs through O'Sullivan Dam to the Potholes Canal to irrigate farmlands in Adams and Franklin Counties. Owned by Reclamation, Potholes Reservoir is renowned for its warmwater fishery, wetland habitat for colonial nesting birds, and attracts large numbers of migrant and wintering waterfowl.

Since its inception, Potholes Reservoir has been populated by warmwater gamefish species such as largemouth bass, bluegill, pumpkinseed, black crappie, yellow perch, brown bullhead (*Ictalurus nebulosus*), and non-gamefish such as largescale sucker, bridgelip sucker (*Catostomus columbianus*), longnose sucker, and common carp. These species are believed to have been present in the backwaters of Crab Creek prior to reservoir impoundment and may have drifted down from Moses Lake. Lake whitefish and burbot (*Lota lota*) were also discovered in Potholes Reservoir and likely migrated from Banks Lake via irrigation canals from Billy Clapp and Moses Lakes (Fletcher 1997).

In the early 1970s, walleye and yellow bullhead (*Ictalurus natalis*) entered the reservoir most likely by the same method as whitefish. Smallmouth bass were released into Frenchman Hills Wasteway from 1958 to 1964 by the Washington Department of Game and the Richland Rod and Gun Club (Duff 1974) and are now a species of major importance to the fishery of Potholes Reservoir. Hatchery releases of rainbow trout, brown trout, and channel catfish (*Ictalurus punctatus*) also contribute to the fishery of this reservoir (Fletcher 1997).

Potholes Reservoir has a diverse population of colonial nesting birds that include ring-billed gull (*Larus delawarensis*), California gull (*L. californicus*), caspian tern, Forester's tern (*Sterna forsteri*), black-crowned night heron, double-crested cormorant (*Phalacrocorax auritus*), great blue heron, great egret (*Casmerodius albus*), western grebe (*Aechmophorus occidentalis*), and Clark's grebe (*Aechmophorus clarkia*).

Hundreds of small, sandy islands are found within Potholes Reservoir. These dunes contain such vegetation as willow (*Salix spp.*), sand dock (*Rumex venosus*), wild alfalfa (*Psoralea tenuiflora*), and mustard (*Isymbrium spp.*) which provide ideal breeding, nesting, and rearing sites for these colonial birds (Finger 1997).

Potholes Reservoir also attracts large numbers of migratory waterfowl. The most abundant migratory waterfowl includes mallards, green wing teal, wigeon, gadwall, and Canada goose. Migratory waterfowl that use Potholes Reservoir for breeding include Canada goose, mallard, gadwall, and cinnamon teal (*Anas cyanoptera*). This area contains one of the largest rookeries of great blue herons and great egrets in the State. In late summer and early fall, it is one of the largest staging areas for American white pelicans in the State. Winter brings large numbers of bald eagles, which use the area as a nighttime roost. North Potholes Reservoir also hosts one of the only known communities of bushtit (*Psaltriparus minimus*).

3.3 Threatened and Endangered Species

Upper Columbia steelhead ("threatened"), bull trout ("threatened"), and Chinook salmon ("endangered") are federally listed in Grant County, specifically in the Columbia River. Since none of the alternatives would have a direct or indirect impact on the Columbia River or Lower Crab Creek, a designated critical habitat for steelhead, these species have not been considered further.

3.3.1 Affected Environment

In preparation of this document, the USFWS and NMFS websites were consulted to determine the potential of threatened or endangered species within the project area, Grant County. The listed species are shown in table 3-2:

Table 3-2: Threatened and Endangered Species, Grant County

Species	Status	Managing Agency
Upper Columbia River Spring Chinook Salmon (*Oncorhynchus tshawytscha*)	Endangered	NMFS
Upper Columbia River Steelhead (*Oncorhynchus mykiss*)	Threatened	NMFS
Pygmy rabbit (*Brachylagus idahoensis*)	Endangered	USFWS
Bald eagle *(Haliaeetus leucocephalus)*	Threatened	USFWS
Bull trout *(Salvelinus confluentus)*	Threatened	USFWS
Ute ladies'-tresses *(Spiranthes diluvialis)*	Threatened	USFWS

Bald Eagle

Bald eagles (*Haliaeetus leucocephalus*) occur along the Columbia River and its tributaries. Suitable habitat includes areas that are close to water and provide a suitable food resource, such as anadromous or resident fish, waterfowl or carrion and where human disturbance is not excessive. Bald eagles are known to inhabit the Potholes and Moses Lake areas during the winter months.

In the Pacific Northwest, bald eagles typically nest in multi-layered, coniferous forest stands with old growth trees located within one mile of large bodies of water. Factors such as relative tree height, diameter, species, form, and position on the surrounding topography, distance from the water and distance from disturbance appear to influence nest site selection. Bald eagles usually nest in the same territories each year and often use the same nest repeatedly. Availability of suitable trees for nesting and perching is critical for maintaining bald eagle populations. All of the proposed alternatives have varying numbers of available nesting and perch trees.

Columbia Basin Pygmy Rabbit

Pygmy rabbits (*Brachylagus idahoensis*) were found in the Columbia Basin (Washington) and Great Basin (Oregon, Idaho, Montana, Wyoming, Nevada) of the United States (WDFW 2005). Historically, pygmy rabbits occurred in native shrub-steppe habitat in five counties in Washington. Six populations were known as recently as 1997. Approximately 23 rabbits were released in Douglas County in March of 2007 as part of a program to reestablish the species. (http://wdfw.wa.gov/do/newreal/release.php?id=mar0507a).

The pygmy rabbit is dependent upon sagebrush, primarily big sagebrush (*Artemisia tridentata*), and is usually found in areas where big sagebrush grows in very dense stands. Tall, dense sagebrush clumps are essential (WDFW 1995). While most of the alternatives have sagebrush, none of the alternatives has tall, dense stands of sagebrush.

Ute ladies'-tresses

Ute ladies'-tresses (*Spiranthus diluvialis*) is a plant species within the orchid family that was federally listed as a threatened species on January 17, 1992. It was discovered in Washington State for the first time in Okanogan County (USFWS 1998). Ute ladies'- tresses are found in moist soils near riparian areas, lakes, mesic to wet meadows, river meanders, and perennial spring habitats. This plant generally occurs within an elevation range between 1500 and 7000 feet, with the lower elevations in the western part of its range. The orchid generally occurs below montane forests, in open areas of shrub or grassland, or in transitional zones. It is considered a lowland species, typically occurring beside or near gradient – medium to large – streams and rivers. The plant is not found on steep mountainous parts of a watershed, nor out in the flats along slow meandering streams. This species tends to occupy grass, rush, sedge, and willow sapling dominated openings.

3.4 Historic Resources

Historic properties are defined as buildings, sites, structures, or objects that may have historical, architectural, archaeological, cultural, or scientific importance (36 CFR PART 800 ' 800.16(1)(1). A legislative and regulatory basis requires the identification, evaluation, protection, and management of historic resources in Federal undertakings. The following discussion is in response to the data needs required principally by the National Historic Preservation Act of 1966 (NHPA), as amended.

NHPA requires that Federal agencies complete inventories and site evaluation actions to identify cultural resources that may be eligible for listing on the National Register of Historic Places (National Register) and then ensure those resources "are not inadvertently transferred, sold, demolished, substantially altered, or allowed to deteriorate significantly." Regulations entitled "Protection of Historic Properties" (36 CFR 800) defines the process for implementing requirements of the NHPA, including consultation with the appropriate State Historic Preservation Office (SHPO) and Advisory Council on Historic Preservation.

The Archaeological Resources Protection Act of 1979 (ARPA) prevents the study agency from disclosing specific site locations. ARPA and the Native American Graves Protection and Repatriation Act of 1990 (NAGPRA) define the notification and tribal consultation processes the study agency must implement if human remains of Native American ancestry are inadvertently discovered during the course of an action on Federal land. NAGPRA also encourages agencies to have a discovery plan in place when actions will occur in an area that has the potential for human remains. Finally, NAGPRA defines a process for agencies to determine if recovered human remains are affiliated with federally recognized tribes and a process for disposition of affiliated remains.

3.4.1 Affected Environment

The nature of this undertaking is the establishment of a supplemental feed route for the Potholes Reservoir. The three possible routes are located on federal, state, and private property. All of the alternatives, excluding the no action alternative, involve some sort of construction or management activities that may cause ground disturbance and may therefore impact historic resources.

The area of potential effect (APE) includes all of the area in and surrounding the feed routes, including the Frenchman Hills Wasteway, Upper Crab Creek, and Pinto Dam. No direct or indirect effects outside of this area can be attributed to this project.

Literature Review and Known Historic Resources

Surveys and other investigations for historic resources have occurred in the general project area sporadically, beginning in the late 1940’s, largely because of the creation of the Columbia Basin Project. The River Basin Survey of the Smithsonian Institute surveyed the land to be inundated by both Banks Lake and Potholes Reservoir, and several sites were investigated (Drucker 1948). Surveys were conducted in the late 1970s by the University of Washington on numerous parcels of the Columbia Basin Project, including lands within the APE.

Reclamation has conducted a number of surveys in the CBP, three of which included lands within the APE:

- *A Cultural Resources Survey of Potholes Reservoir, Grant County, Washington* (Axton, Boreson and Regan 2000). This survey covered nearly 40,000 acres in the Potholes Reservoir area and identified ten sites and 48 isolated finds. The ten sites were all from the historic period and consisted of habitations, temporary habitations associated with sheep raising operations, and refuse dumps. The isolated finds were other historic artifacts, but also included some prehistoric lithic flakes. No significant historic properties were identified during this survey.

- *An Ethnographic Overview of the Potholes Reservoir Study Area of Central Washington* (Ellis and Fagan 2000). This report detailed the ethnographic history of the Potholes area and included information on the traditional and current American Indian use of the area.

- *A Cultural Resources Overview of the United States Bureau of Reclamation's Scattered Tracts/Potholes Study Area, Adams, Franklin, Grant, and Walla Walla Counties, Washington* (Gundy 1998). The study area for this report encompassed 313 non-contiguous parcels of land under Reclamation jurisdiction, totaling approximately 90,000 acres. The report identified 514 previously recorded sites within the study area from both the historic and prehistoric periods. These sites included lithic scatters, campsites, habitation, caves or rockshelters, cairns, quarries, burials, petroglyphs or pictographs, fish weirs, and shell deposits.

Context

Aboriginal groups known to have occupied or utilized the project area include a variety of Plateau groups: the San Poil, Nespelem, Middle Columbia Salish, Wanapum, Yakama, Lower Spokan, as well as others who frequented the Columbia and Snake River confluence (Ellis and Fagan 1999:18). However, the Columbia people were indigenous to the area, with settlements on and surrounding Moses Lake. The general area, including Moses Lake, provided excellent resource gathering opportunities including root crops, fish, turtles, and waterfowl, among other natural resources (Axton, Boreson and Regan 2000:1.5).

Euro-American exploration prior to1870 included fur traders, road and railroad surveyors, miners, freighters, and stockmen. Early settlers attempted raising livestock including cattle and horses; however, the lack of water and overgrazing caused the industry to decline. Dryland farming proved equally short-lived and unsuccessful (Boreson 1998: 3-4).

The Columbia Basin Project, authorized in 1933, was created to irrigate and attract settlement to the semi-arid and sparsely settled land of east-central Washington. The water diverted from the lake formed by Grand Coulee Dam, through Banks Lake, now irrigates more than 650,000 acres. Water first flowed onto project land in 1948 through pumps near Pasco, and in 1952 through the Main Canal. Winchester Wasteway is one of several channels that capture return flows of irrigation water for storage in Potholes Reservoir (Gundy 1998: 77-100).

The project area is in a part of the interior Columbia Basin characterized by rolling topography; xeric weather patterns; loamy to deep sandy, windblown soil; and vegetation dominated by bunchgrass and sagebrush. Human impacts to the study area include previously constructed weirs, ditches, dikes, and basins associated with the CBP. Additionally, a number of towns with varying populations are located within and surrounding the APE, including the largest two, Ephrata and Moses Lake.

3.4.2 Traditional Cultural Properties

Traditional Cultural Properties (TCPs) are addressed in the National Register Bulletin Guidelines for Evaluating and Documenting Traditional Cultural Properties (King and Parker 1998). A TCP is defined as a site eligible for inclusion in the National Register when it is associated with cultural practices or beliefs of a living community that are rooted in the community's history and are important in maintaining the continuing cultural identity of the community. Some TCPs co-occur with archaeological sites, while other TCPs may include landscape features or simple locations. Under the Archaeological Resource Protection Act, most TCP locations are considered confidential.

TCPs were identified in the above-mentioned reports, and included resource gathering sites, camps and villages, trails, medicinal and spiritual uses, and other traditional activities. However, no specific TCP survey has been conducted for this project.

3.5 Hydrology

This section is taken from a detailed hydrologic analysis of the proposed feed routes prepared by Reclamation. This report is available in Reclamation's office in Ephrata, WA.

3.5.1 Surface Water Affected Environment

Potholes Reservoir Operation and Existing Feed Route

There are three feed routes currently being used to deliver water into Potholes Reservoir. The primary route is through the ELC to Rocky Coulee Wasteway then into Upper Crab Creek, Moses Lake, and finally into Potholes Reservoir. The two secondary routes are through Lind Coulee Wasteway and through Frenchman Hills Wasteway. Water is spilled from the ELC to Lind Coulee Wasteway, which flows directly to Potholes Reservoir. The other secondary route spills water from the West Canal to the Frenchman Hills Wasteway, which also flows directly to Potholes Reservoir. The use of the existing feed routes is limited to spring and fall during the irrigation season when unused canal and wasteway capacity is available because of low irrigation demand. Current canal mean daily flows used to meet irrigation demands by month are shown in table 3-3. The capacities for Main, West, and East Low Canals are 10,000 cfs, 4800 cfs, and 4300 cfs respectively.

Table 3-3 Columbia Basin Project canal peak daily flows in cfs used to meet irrigation demands for the period of record 1996-2005

(90th percentile of Daily Mean Discharge in cfs with feed removed)			
Month	**Main Canal**	**East Low Canal**	**West Canal**
March	1300	300	300
April	4300	1500	2600
May	5200	1800	3500
June	7500	2900	4500
July	8600	3700	4700
August	6800	2800	4300
September	4200	1600	2900
October	2700	1000	2100

The existing feed routes are further limited by the need to leave space within the wasteways for emergency evacuation. To ensure the highest margin of safety, wasteway capacity is maximized during peak irrigation months by limiting feed operation during June, July, and August. The spring and fall feed capacities for Rocky Coulee, Lind Coulee, and Frenchman Hills wasteways are 2500 cfs, 400 cfs, and 150 cfs respectively. Current canal and wasteway capacity criteria limit the reliable maximum spring feed volume to 260,000 acre-feet.

Fall feed is further limited by the need to leave storage space in Potholes Reservoir to limit spill of spring runoff from Upper Crab Creek. Reclamation has rights to pass flood water down Lower Crab Creek to the extent that the flood releases made into Lower Crab Creek do not exceed flows that would have naturally occurred before the CBP facilities were constructed. The additional flow that could be spilled from Potholes Reservoir down Lower Crab Creek within the normal banks has been judged to be 50 to 100 cfs, depending on the time of year and other flows in the channel.

The Standing Operating Procedures for Potholes Reservoir state that inflows will not normally be spilled unless water levels exceed the end-of-month rule curve shown in table 3-4. To minimize spill from a 100-year flood event requires an October ending storage elevation of 1027.2 feet.

Table 3-4 Potholes Reservoir Winter End-of-Month Elevation Guidelines in feet to minimize spill to Lower Crab Creek

End-of-Month Elevation Guideline, in feet				
Oct	**Nov**	**Dec**	**Jan**	**Feb**
1033.3	1037.6	1040.6	1043.3	1045.6

*Standing Operating Procedures O'Sullivan Dam Section 5 Flood Operating Criteria, page 4-5

Table 3-5 Potholes Reservoir winter natural runoff volume for return periods in acre-feet Volumes computed from Upper Crab Creek and Rocky Ford Creek inflows to Moses Lake between December and March

Runoff Volume acre-feet				
100 yr	**50 yr**	**25 yr**	**10 yr**	**2 yr**
157,000	127,000	101,000	71,500	30,400

* Volumes based on period-of-record 1949-2005

By limiting Potholes Reservoir end of October elevation to 1032.0 feet, which provides storage for a 25-year Upper Crab Creek runoff event, the fall feed capacity is limited to approximately 90,000 acre-feet. Combining the maximum spring feed of 260,000 acre-feet with the fall limit of 90,000 acre-feet, the annual reliable feed capacity is 350,000 acre-feet. The current annual feed capacity is equal to the Potholes Reservoir dry-year return and runoff supply shortage estimated at 350,000 acre-feet.

Alternatives 2A and 2B - Crab Creek Ephemeral and Perennial

Upper Crab Creek is a natural stream that begins east of Davenport with a drainage area of 3,080 square miles above Moses Lake. Upper Crab Creek at the Irby gage flows year-round but only during times of high water flows into Brook Lake. Upper Crab Creek also flows year-round beginning near Moses Lake because of springs and irrigation return flows. However, between Brook Lake and Gloyd Spring inflow, the stream has intermittent flows. Table 3-6 shows the historic mean daily discharge of Crab Creek at the USGS Irby station (Site 12465000) located approximately 18 miles upstream of Brook Lake.

Table 3-6 USGS gage station Crab Creek at Irby percentile of daily mean discharge in cfs for the period of record 1943-2005

Month	99th	98th	95th	90th	50th	10th
January	1516	1112	500	239	18	1
February	2009	1500	794	509	92	6
March	1516	1092	646	388	125	35
April	440	338	270	200	78	22
May	227	190	114	89	35	13
June	374	146	69	50	25	9
July	82	64	43	31	17	5
August	52	32	28	22	11	3
September	40	25	21	16	7	2
October	36	30	20	15	6	2
November	46	30	22	16	5	2
December	212	60	39	26	6	1

Another gaging station is located on Crab Creek 3.5 miles upstream from Moses Lake (Site12467000). The historic mean daily discharges at this gage are shown in table 3-7. The flows are affected by return flows from irrigated area.

Table 3-7 USGS gage station Crab Creek near Moses Lake percentile of daily mean discharge in cfs for the period of record 1943-2005

Month	99th	98th	95th	90th	50th	10th
January	808	624	218	36	15	0
February	1055	829	517	350	16	0
March	1547	1200	651	409	55	6
April	562	407	260	190	44	7
May	222	186	138	92	33	12
June	226	168	88	80	39	14
July	119	113	104	90	46	2
August	132	128	121	107	53	1
September	136	132	127	109	53	1
October	117	113	104	92	48	0
November	85	79	67	56	29	0
December	49	47	41	36	19	0

Historically, sizable floods occur during the period December through March. Spring runoff from the Upper Crab Creek is highly variable and unpredictable. Upper Crab Creek spring floods range from a 2-year event of 322 cfs to a 100-year event of over 11,000 cfs, as shown in table 3-8.

Table 3-8 Upper Crab Creek weighted estimates of flood discharge for return periods in cfs for period of record 1943-1996

Station	100 yr	50 yr	25 yr	10 yr	2 yr
Crab Creek at Irby (12465000)	11,900	9390	7060	4370	810
Crab Creek near Moses Lake (12467000)	11,800	7480	4570	2160	322

* Sumiokia, S.S. and Kresch, D.L., and Kasnick, K.D., Magnitude and Frequency of Floods in Washington, Water-Resources Investigations Report 97-4277, USGS

A number of small lakes exist between Brook Lake and Moses Lake. Table 3-9 presents the approximate active volumes of these lakes. Volumes were estimated from the amount of water used to fill these lakes from controlled releases from Billy Clapp Reservoir. These lakes fill from flood runoff and then recede between flood events. These lakes dampen flood events from the watershed above Brook Lake before they enter Moses Lake.

Table 3-9 Upper Crab Creek lakes between Brook Lake and Moses Lake and their approximate active volumes in acre-feet

Lake	Active Volume (acre-feet)
Brook Lake	3200
Round Lake	2000
Willow Lake	700
Bar 40 Lake	0
Farm Unit Lake	400

Upper Crab Creek is a losing reach from Brook Lake to Moses Lake in those areas where it flows on top of glacial flood gravel deposits. Historic flow records for Crab Creek at Irby and near Moses Lake indicate the amount of water loss between Brook Lake and Moses Lake would be as shown in table 3-10. Seepage investigation confirmed the losses between Brook Lake and Moses Lake are about 60 percent for inflows to Brook Lake of 150 cfs.

Table 3-10 Estimated Upper Crab Creek losses between Brook Lake and Moses Lake from USGS gage records

Crab Creek Inflows to Brook Lake	Crab Creek Inflows to Moses Lake	Crab Creek Loss	Percent Loss
100	30	70	70%
200	100	100	50%
300	200	100	33%
400	290	110	28%
500	380	120	24%
1000	850	150	15%
2000	1780	220	11%

* Seepage investigation confirmed the losses between Brook Lake and Moses Lake are about 60% for inflows to Brook Lake of 150 cfs

Of the Crab Creek losses, about 90 percent occurs in the Adrian Reach between Brook Lake and Willow Lake. About 80 percent of the water lost to the Adrian Reach emerges at Rocky Ford

Spring within six to eight months and flows into Moses Lake. The remaining losses most likely emerge in other springs along Rocky Ford Creek and the Rocky Ford Arm of Moses Lake. Table 3-11 shows the historic mean daily discharge of Rocky Ford Creek stations (Site 12470500 and 12470600) located approximately 5 miles upstream of Moses Lake.

Table 3-11 USGS gage stations Rocky Ford Creek (12470500 or 12470600) percentile of daily mean discharge in cfs for the period of record 1943-2005

Month	99th	98th	95th	90th	50th	10th
January	102	87	82	77	58	40
February	104	97	87	74	54	37
March	161	126	102	85	51	34
April	206	146	126	102	54	33
May	197	142	131	106	61	35
June	176	129	123	106	69	37
July	163	121	117	110	78	41
August	154	120	111	106	83	45
September	142	117	106	104	85	48
October	137	113	105	99	80	50
November	127	106	98	92	75	48
December	114	97	89	84	66	45

* Rocky Ford Creek gage #12470500 was operated as a daily record site prior to 1991. After 1991, this gage site #12470500 and/or site #12470600 were reported as miscellaneous measurements, measured approximately every two months. Daily flows were estimated between miscellaneous measurements using linear interpolation.

About 10 percent of the Crab Creek losses occur in the Gloyd Reach between Willow Lake and Moses Lake. These losses most likely emerge in springs along the Rocky Ford Arm and Parker Horn Arm of Moses Lake. The loss percentages and return flows to Rocky Ford Spring were confirmed during a test flow of approximately 145 cfs that took place during the fall of 2006.

Alternative 3 – Frenchman Hills Wasteway

Water would be conveyed from Billy Clapp Reservoir via the Main Canal and West Canal to the Frenchman Hills Wasteway. The water would then be discharged through the Frenchman Hills Wasteway into Potholes Reservoir. Discharges are collected by Reclamation within the Frenchman Hills Wasteway at Road C SE. The mean daily discharges are listed in table 3-12.

Frenchman Hills Wasteway crosses under two county roads, Dodson and Road C SE. The existing Dodson Road crossing has a capacity of 1600 cfs and the Road C SE has a capacity of 500 cfs.

Table 3-12 Reclamation gage station on Frenchman Hills Wasteway at Road C SE percentile of daily mean discharge in cfs for the period of record 1996-2005

Month	90th	50th	10th
January	290	190	150
February	350	180	150
March	390	190	140
April	470	350	280
May	500	390	300
June	490	380	310
July	490	410	340
August	550	460	380
September	530	460	400
October	510	450	380
November	350	280	230
December	240	210	190

3.5.2 Ground Water Affected Environment

Groundwater is underground water found in pore spaces between grains of soil or rock or within fractured rock formations. Groundwater typically originates as precipitation that infiltrates through soil and underlying unsaturated geologic materials until reaching the water table. In the case of the CBP, water originates as irrigation.

This saturated zone is referred to as an aquifer, when it is capable of yielding sufficient water to a supply well. Saturated zones composed of coarse sands and gravels or those occupying large fractures in bedrock are generally the most productive aquifers. An aquifer is recharged by the process of infiltration and percolation of water to the zone of saturation. Surface water bodies and aquifers, particularly shallow aquifers, are often interconnected. Stream flow derived from groundwater discharge during low-flow periods is referred to as baseflow. Baseflow is important in maintaining year-round flow in streams fed by rain and snowmelt runoff.

Groundwater in the CBP is predominantly associated with the flood basalts of the Columbia River Basalt Group, but also with sediments that overlie or are interbedded with the basalts. The entire aquifer system underlies approximately 50,600 square miles of the Columbia Plateau in Washington, Oregon, and parts of northwest Idaho (Bauer 2000).

3.6 Vegetation

3.6.1 Affected Environment

Much of the project area has been modified by agricultural activities. Areas that have not been converted to agricultural land are typically classified as shrub-steppe. Shrub-steppe vegetative communities consist of one or more layers of perennial grass with a conspicuous but discontinuous overstory layer of shrubs. In the Crab Creek Subbasin, shrub-steppe also includes ‘meadowsteppe’ and ‘steppe’ habitats that may have a relatively low frequency of shrubs. The dominant shrubs include:

- Sagebrush (*Artemisia spp.*)
- Rabbitbrush (*Chrysothamnus spp*.)
- Bitterbrush (*Purshia tridentate*)
- Grease wood (*Sarcobatus spp*.)
- Spiny hopsage (*Grayia spinosa*)

The dominant grasses include native bunchgrasses (*Poa*, *Stipa*, and *Agropyron spp*.) and non-native downy brome (*Bromus tectorum*).

Riparian vegetation consists of:

- Willows (*Salix spp*.)
- Rose (*Rosa spp.*)
- Water birch (*Betula occidentalis*)
- Black cottonwood (*Populus angustifolia*)
- Aspen (*P. termuloides*)
- Hawthorn (*Crataegus douglasii*)
- Serviceberry (*Amelanchier anifolia*)

Vegetation conditions vary at each of the alternative locations, and range from relatively undisturbed shrub-steppe to fully developed agricultural land. Along Crab Creek, there are sections of riparian vegetation that should be increased by increases in the frequency of water being available. Most of the Frenchman Hills Wasteway is bordered by riparian vegetation even though much of the vegetation is invasive species.

3.7 Geology/Soils (Erosion)

3.7.1 Affected Environment

During the Pleistocene Epoch, a huge ice sheet formed and moved southward from Canada into major south-trending valleys leading into what is now Washington, Idaho and Montana. The ice sheet blocked the Columbia River downstream of where Grand Coulee Dam is now located, and forced the water southward into the Columbia Basin. It also blocked water from the Montana area and formed a huge lake known as Glacial Lake Missoula. When the glacial lake in Montana filled and overtopped the ice sheet, the floodwater broke through the ice dams and vast quantities of water flowed violently across northeastern Washington and into the Columbia Basin area. As these floodwaters emptied into the Columbia Basin the landscape was scoured out, and the previous surface deposits were reworked and re-deposited. This landscape in the Columbia Basin area is known as the “Channeled Scablands.”

Crab Creek, in about the first 5 miles below Pinto Dam, follows a coulee eroded into basalt bedrock by glacial meltwater. The coulee bottom was subsequently filled with over 100 feet of unconsolidated sand, gravel, cobbles, and boulders. Where Crab Creek enters the Quincy Basin near Adrian, Washington, it then trends southeasterly toward Moses Lake, Washington. The glaciofluvial deposits thin toward the Willow Lake area about 3 miles away. At this location, there are numerous lakes over the shallow bedrock and the basalt outcrops along Crab Creek. The Rocky Ford arm of Moses Lake was formed by floodwaters as they exited the lower end of the Grand Coulee.

The Frenchman Hills Wasteway is relatively flat and is characterized by a meandering streambed within a wide marshy wetland. This area is covered by windblown sand up to about 100 feet thick. Beneath the sand and above the basalt bedrock is a mixture of lakebed sediment and glaciofluvial deposits.

3.8 Water Quality

Water Quality is defined by its capability to support beneficial water uses. These uses include domestic water supply, livestock watering, irrigation, aquatic life, recreation, navigation, aesthetics, etc. A water quality problem occurs when the beneficial or intended use of the waterbody is impaired. Chemical, physical, and biological parameters are usually used to measure water quality. Common parameters include bacteria, dissolved oxygen (DO), nutrients, pH, sedimentation, turbidity, temperature, electrical conductivity, and toxics (NRCS 2002).

The source water for the CBP is pumped from Lake Roosevelt behind Grand Coulee Dam into Banks Lake. The water is then delivered throughout the CBP by means of canals and laterals. A system of drains and wasteways return water to lakes and reservoirs in the upper portion of the project area where it is directed south into the southern portion of the project.

3.8.1 Affected Environment

Water quality has been monitored since the 1950s by Reclamation. The parameters of primary interest for this project include temperature, DO, pH, phosphates, nitrogen affiliates, and total dissolved solids (TDS). This section will discuss the baseline conditions for these parameters in the project area.

Temperature

Many of the canals and laterals used to deliver water for crop irrigation are listed on the 303(d) list for temperature. The 303(d) list is a list of impaired water bodies in the State of Washington classified by the Washington Department of Ecology (Ecology). Impaired, meaning diminished quality, being a waterbody that cannot meet State standard criteria for an array of parameters is considered impaired.

The climate in the region mimics that of a desert, or “semi-arid,” being very hot and dry. Temperatures on the average range from 51°F to 83°F in the summer and 21°F to 36°F in the winter (Kurz 2006). The high and low temperatures of the water affect the temperature of the soil, which in turn affects seedling emergence, growth rate, time of maturity, and yields of various crops. Excessively high or low temperatures in irrigation water deter plant growth. It is not the temperature of the water per se that affects the plant growth, but the resultant temperature of soil to which it is applied.

Over the years, the water from Lake Roosevelt, Banks Lake, Billy Clapp Lake, and the Main Canal have exceeded the State standard for a number of reasons. Presently, the temperature standard ranges from 9.0 to 20.0°C depending on the designated uses and criteria for fresh water aquatic life. An explanation of the designated criteria and uses can be found in WAC 173-201A-200 section 210 (Ecology 2006).

There is no water quality data for upper Crab Creek, with the exception of Irby. Temperature issues occur during the summer and winter at Irby; they range between 19.9°C and 22.3°C for the summer and 0.7°C and 2.7°C for the winter.

Water quality at Irby indicates temperatures exceed the State standards between 90 and a 100 percent of the time.

The historical data collected by Reclamation indicates the water quality at Road 7, which leads directly to the Parker Horn reach of Moses Lake, has issues with summer and winter temperatures. The range of summer temperatures are in the low 20s°C, and the winter temperatures are between 1°C and 3°C.

In addition, samples taken from the outlet of Moses Lake indicate that summer and winter temperatures are the only problem at this location. The summer temperatures range between 20.8°C and 24.6°C, and winter temperatures range between 3.2°C and 4.4°C.

The temperature for Rocky Ford Creek is also a problem during summer and fall. Temperatures range in the upper teens during the summer and between 5°C and 6°C in the winter.

Dissolved Oxygen

The DO parameter relates to the health of a water system and the aquatic organisms living within it. The production of a waterbody will aide in determining the optimal level of DO. If there is a significant amount of growth in a water system, the DO will be lower than if there is only a small amount of production. The oxygen supply in the water for the study area is dependent upon the temperature of the water. When the water temperature increases the oxygen concentration decreases, and when the water temperature decreases the oxygen concentration increases. Due to the range of temperatures in this region, maintaining the State standard for DO is difficult.

The State standard for DO has an optimal range of 6.5 mg/L to 9.5 mg/L depending upon the designated criteria and uses of the waterbody. In some cases relating to salmonids and their life stages, the range of the DO is wider. However, when the DO falls below 3mg/L an acute lethal limit for salmonids has been breached (Adams 1992; Ayers 1985; Canessa 1994; Hicks 2002; NAS 1972; NTAC 1968; NRCS 1997; EPA 1986; Ecology 1990; Ecology 2006; Welch 1992).

pH

The pH parameter, which is the potential of hydrogen, relates to the acid-base equilibrium in natural waters brought about by various dissolved compounds, salts, and gases. pH measures the concentration of hydrogen ions in a substance on a scale of 0 to 14. The scale range has the neutral point set in the center at 7.0; the values below 7.0 are acidic, and the values above 7.0 are alkaline.

Major components that influence the pH of a natural waterbody stem from the carbonate system. These components are carbon dioxide, carbonic acid, bicarbonate, and carbonate. Another influence on pH is how acids and bases break down or disassociate and shift the equilibrium of the water either towards the acid or base range.

Healthy waters range near 7.0 neutral, domestic waters range between 5.0-9.0, freshwater aquatic life ranges between 6.5-9.0, and marine aquatic life ranges between 6.5-8.5, with a 0.2 fluctuation outside of the normal range (Adams 1992; Ayers 1985; Canessa 1994; Hicks 2002; NAS 1972; NTAC 1968; NRCS 1997; EPA 1986; Ecology 1990; Ecology 2006).

Phosphorus

Phosphorus is an essential element for all living organisms, and is considered the most controllable. It is necessary for plant growth, and can become a nuisance if the total concentration of phosphorus is too high. Increased phosphorus levels will cause eutrophication of a water system especially those with little or no turn over. Eutrophication is what occurs when a lake has a high surface-to-volume-ratio and an abundance of nutrients producing heavy growth of aquatic plants and other vegetation. These lakes contain highly organic sediments, and may have seasonal or continuous low DO concentrations in deeper waters (NAS 1972).

Eutrophication

µg/L Levels necessary to prevent eutrophication:

- >100 in rivers
- >50 at stream/river mouth
- >25 in lakes, reservoirs, standing water
- >100 indirect discharge waterways

Eutrophication relates to the health of waterbodies. If the water is rich in nutrients that support a dense growth of algae and other organisms, the DO levels in the water are reduced due to the decay of plant life. This will subsequently kill other living organisms.

To prevent eutrophication, total phosphates as phosphorus (P) should not exceed 100 µg/L in any river system, or 50 µg/L in any stream at the point where it enters any lake, reservoir, or other standing waterbody, or 25 µg/L within the lake, reservoir, or other standing waterbody.

Another method to control the inflow of nutrients, particularly phosphates, is to assign an annual loading concentration to the receiving water. This is done by taking a particular water volume where the mean depth of the receiving water is in meters and is divided by the hydraulic detention time in years. Phosphorus loading takes into account all forms of phosphate and phosphorus and gives an estimated total concentration of how much phosphate/phosphorus is in the receiving water (Adams 1992; Ayers 1985; Canessa 1994; Hicks 2002; NAS 1972; NTAC 1968; NRCS 1997; EPA 1986; Ecology 1990; Ecology 2006; Welch 1992).

There is no water quality data for upper Crab Creek, with the exception of Irby. Water quality at Irby indicates phosphorus exceeds the State standards between 90 and a 100 percent of the time. At this time, there is no State standard for nitrates as nitrogen in surface waters; however, the levels in the water are high enough for eutrophication to occur.

The nitrates as nitrogen in the water range between 0.72 mg/L and 1.85 mg/L with the highest levels appearing in the winter when the flow is low. The phosphates have high levels with a range of 0.067 mg/L and .191 mg/L with the highest levels occurring during the summer months. However, due to the lack of perennial flow in upper Crab Creek there is no data addressing the water quality. There were four samples taken at three locations along the creek by Reclamation during the fall and winter of 2006 for the Supplemental Feed Route Study. The analyses of the samples show that there is neither nitrogen nor a phosphorus problem between Brook Lake and Parker Horn.

There do not appear to be any problems with phosphorus, but nitrate levels in the Parker Horn reach of Moses Lake range between 0.54 mg/L and 1.58 mg/L. Crab Creek at Highway 17 is much like Parker Horn with the exception that nitrates do not occur as frequently. However, when this occurs they exceed the levels of eutrophication. The range of the nitrates is between 0.96 mg/L and 3.25 mg/L.

Data indicates that the elevated phosphorus levels are coming subsurface via a shallow aquifer from Crab Creek above Brook Lake towards the Adrian Sink. When the water reappears at Rocky Ford Springs, the phosphorus is at the maximum natural level and remains so as the flow of water moves through Rocky Ford Creek into the Rocky Ford arm of Moses Lake. The water quality for nutrients at Rocky Ford Springs shows elevated levels of both nitrates and phosphates. Although phosphorus is found in sedimentary rock, the formations in the sink are of a different geological makeup. The nitrate levels range between 1.66 mg/L and 2.83 mg/L, and the total phosphorus levels range between 0.53 mg/L and 0.125 mg/L.

Nitrogen

High concentrations of nitrogen in a water system can cause aquatic plant growth to become a nuisance. However, nitrogen at recommended concentrations is essential for plant growth. Nitrogen, like phosphorus, will cause eutrophication of a water system especially those with little or no water turnover. Nitrogen found in surface waters takes several different forms and is an indicator of how recently a water system has been polluted.

Ammonia is one form of nitrogen found in surface water. Its concentrations can be acutely toxic to freshwater fish, depending on the species. Some species are more tolerant than others are; however, factors that also affect the toxicity include DO concentration, temperature, pH, carbon dioxide concentration, salinity, and the presence of other toxicants.

Ammonia enters surface waters as a waste product and when combined with oxygen is oxidized into nitrites. These nitrites are further oxidized to nitrates. This process is known as nitrification. General values used for assessing the ammonia concentration within a water system are:

- low concentration, 0.015 to 0.03 mg/L
- moderate, 0.03 to 0.10 mg/L
- high 0.10 mg/L or greater

Nitrate and nitrite levels that would have no adverse effects on warm water fish are:

- nitrate nitrogen at or below 90 mg/L
- nitrite nitrogen at or below 5 mg/L
- nitrite nitrogen at or below 0.06 mg/L for the protection of salmonids

The EPA (Environmental Protection Agency) has established a maximum contaminant level for nitrates in drinking water as 10 mg/L. Total nitrogen should include nitrate-nitrogen, ammonia-nitrogen, and organic-nitrogen.

The literature values for irrigation water as they relate to total nitrogen range from below 5 mg/L for slight to no restriction on use, 5-30 mg/L for moderate restriction on use, and above 30 mg/L for severe restriction on use (Adams 1992; Ayers 1985; Canessa 1994; Hicks 2002; NAS 1972; NTAC 1968; NRCS 1997; EPA 1986; Ecology 1990; Ecology 2006; Welch 1992).

Total Dissolved Solids

Salinity, or the concentration of salt, can be problematic for crop and forage production if concentrations in the soil or in irrigation water exceed salt tolerance levels. Salt accumulation breaks down soil structure and reduces water infiltration, as well as being toxic to crops. High salt concentrations in streams and lakes can also harm freshwater flora and fauna by creating osmotic stress that reduces water available for plants (NRCS 2002). Osmotic stress occurs when the concentration of molecules in solution outside of the cell is different from that inside the cell. When this happens, water flows either into or out of the cell by osmosis, thereby altering the intracellular environment. Hyperosmotic stress causes water to diffuse out of the cell, resulting in cell shrinkage, which can lead to DNA and protein damage, cell cycle arrest, and ultimately cell death. In other words, it leads to wilting and death in plants.

Total dissolved solids (TDS), total dissolved salt content, and electrical conductivity are interchangeable terms conveying similar information only with differing numerical values. Their major significance is the potential limiting factor large concentrations of dissolved solids have on domestic, industrial, and irrigation waters. The solids originate from the natural weathering process of soil and rock; the inorganic anions that occur from this process are carbonate, bicarbonate sulfates, chlorides, and nitrates, and the inorganic cations are calcium, magnesium, sodium, and potassium.

There is no set standard for carbonates; however, literature values for bicarbonate are 91.5 ug/L for unrestricted use and 339 ug/L for moderate to restricted use. The EPA standard for sulfates and chlorides is 250 mg/L for each in domestic waters. As for the cations, there are no set standards, although sodium values are listed in several literature passages as 69-207 mg/L.

The suggested TDS value from the literature is below 450mg/L. Due to the high expense of the TDS analysis, the electrical conductivity is analyzed more often with a literature value of 700 uS/cm. Semi-arid regions such as the Columbia Basin are more likely to have higher concentrations of salts due to evaporation exceeding precipitation. Another important factor for consideration, oxygen saturation levels are decreased as the concentration of salts in the water increase (Adams 1992; Ayers 1985; Canessa 1994; Hicks 2002; NAS 1972; NTAC 1968; NRCS 1997; EPA 1986; Ecology 1990; Ecology 2006; Welch 1992).

3.9 Land Use

The terms "land use" and "land cover" are used in this section to classify human uses of the land and natural vegetation zones, respectively. Imagery taken in 2002 and field inspections were used to inventory land use in the four areas of study surrounding the ELC. Grant County tax roll information was used to determine public and private ownership of land that may be impacted by selection of an alternative.

Table 3-13: Land Cover Acreages by Alternatives within the 1000 cfs Inundation Zone

	1 **No Action**	**2A/2B** **Crab Creek**	**4** **Frenchman Hills**
Open Water		224	432
Palustrine Wetland		533	635
Sand Dune			202
Shrub-steppe < 10% shrub		741	292
Shrub-steppe >= 10% shrub		415	367
Shrub-steppe (4 + 5)			
Cropland		343	535
Forest/Shrub		78	246
Barren		88	67
Snow			
CRP			
Total by Area		***2422***	2776
Total by Alternative		***2422***	2776

* Acreages based on Landstat imagery classified in the 2000 TMLC Study

A land cover study primarily based on Landstat Thematic Mapper (TM) imagery was completed by the WDFW in 2000 to assess shrub-steppe in Eastern Washington (TMLC Study). The TMLC Study classified land cover into 11 classes that included: open water, palustrine wetland, sand dune, shrub-steppe less than 10 percent cover, shrub-steppe more than or equal to 10 percent cover, shrub-steppe (combined), cropland, forest/shrub, barren, snow, and conservation reserve program (table 3-13). Landstat TM imagery was used to identify nine of the land cover classes previously listed. The palustrine wetland class was derived from USFW National Wetland inventory data. Data from the Natural Resource Conservation Service was used to compile the conservation reserve program land cover class. Overall accuracy of the Landstat TM developed land classes was assessed at nearly 93 percent.

3.9.1 Affected Environment

Alternative 1 – No Action:

The alternatives considered in this report are contained within that portion of the Crab Creek Subbasin situated in Grant County, Washington. Within this defined area, agricultural, residential, and recreation are the primary land uses.

Agriculture is the dominant land use in the Crab Creek Subbasin. The CBP provides for the irrigation of approximately 670,000 acres of land. A large portion of the CBP is within the Crab Creek Subbasin. Land-scale conversion of the predominant shrub-steppe land cover to cropland began in the late 1800s and expanded when irrigation became widespread after the damming of the Columbia River in the 1930s. Residential land use is currently expanding at the expense of both agriculture and natural land covers. The area in and around Moses Lake, the main population center within the Crab Creek Subbasin, is experiencing rapid growth. Land set aside for recreational activities by the State and Federal government is a third major land use within the Crab Creek Subbasin.

Alternatives 2A and 2B - Crab Creek Ephemeral and Perennial

Land use surrounding the northern portion of middle Crab Creek is mostly agricultural with increasing shrub steppe land cover south of Road 18 NE. The 10,000 acre Gloyd Seeps Wildlife Area is located about midway between Moses Lake and Stratford. This public land is owned by WDFW and Reclamation. The wildlife area is managed by WDFW, pursuant to a 25-year management agreement with Reclamation, for wildlife habitat and wildlife related recreation.

The two Crab Creek alternatives encompass a wide diversity of land covers. Land cover types that predominate in the area include: open water/wetlands, shrub steppe, and agriculture. Residential use becomes prevalent along the southern reach of middle Crab Creek as it approaches Moses Lake.

State Highway 28, Stratford Road, and a number of smaller county and private roads run through or are situated near middle Crab Creek. The Burlington Northern Rail Road has an active line that runs east to west through the towns of Adrian and Stratford in the northern portion of middle Crab Creek. An inactive rail line that connects Adrian with the town of Wheeler is to the east of the middle Crab Creek channel. The Grant County Airport is located west of the channel.

Reclamation has flowage easements in the southern portion of middle Crab Creek and other reserved rights in the middle Crab Creek channel. During March, April, and May, Reclamation utilizes its easement rights and releases up to 2400 cfs into the southern portion of middle Crab Creek.

Alternative 3 – Frenchman Hills Wasteway:

This 68-mile long water delivery route extends from Billy Clapp Lake to Potholes Reservoir though the West Canal and Frenchman Hills Wasteway. Supplemental feed water will stay within the confines of these facilities during the first 51.5 miles of a conveyance to Potholes Reservoir. Analysis of canal cross-sections and terrain profiles indicate, however, that supplemental feed water will overtop the Frenchman Hills Wasteway in the last 16.5 miles before it is delivered to Potholes Reservoir.

Within this inundated area, primary land cover types can be summarized as consisting of a mix of open water/wetlands, shrub steppe, agriculture, forest/shrub, and sand dune.

3.10 Recreation

3.10.1 Affected Environment

Alternative 1 – No Action

Within the Crab Creek Subbasin, recreation is an important land use. Land used for authorized recreational purposes is mostly owned by Reclamation and the State. The majority of the larger tracts are managed by the WDFW for habitat and recreational purposes. Activities typically engaged in on these larger tracts include hunting, fishing, and viewing wildlife.

A significant portion of the Coulee Corridor Scenic Byway is within the Crab Creek Subbasin. The Byway features more than half of the State’s 365 bird species.

Alternatives 2A and 2B - Crab Creek Ephemeral and Perennial

The 10,000 acre Gloyd Seeps Wildlife Area is located about midway between Moses Lake and Stratford. Public land within Gloyd Seeps is administered by WDFW and Reclamation. The Wildlife Area is managed by WDFW, pursuant to a 25-year management agreement with Reclamation, for wildlife habitat and wildlife related recreation. Gloyd Seeps is also a designated Coulee Corridor Scenic Byway site. The most northerly access point is located at the intersection of Road 20 NE and Road E.

Other parcels of Reclamation land, not under WDFW management, are open to the public for hunting, fishing, viewing watch-able wildlife, and other activities. There are few recreational opportunities located in the southern portion of middle Crab Creek, as most of the shoreline is in private ownership.

Alternative 3 – Frenchman Hills Wasteway

Public land along the Frenchman Hills Wasteway is mostly owned by Reclamation and the State, and managed by WDFW for habitat and recreational purposes. Major recreational activities include hunting, fishing, and observable wildlife. The Wasteway area is a destination for visitors from throughout the United States and when considered along with recreation areas in the vicinity supplies recreational opportunity for numerous visitors each year. Previous surveys show that more than half of all visitors come from the Puget Sound area.

Three Coulee Corridor Scenic Byway sites are located along the Wasteway. The Dodson-Frenchman's access point, located at the intersection of Dodson Road and Frenchman Hills Road, is a minimum basic facilities site with parking and bathrooms that affords access to recreation along the Frenchman Hills Wasteway. This area is cited in a number of nationwide birding guides as a premier birding area.

There are also other primitive access sites consisting of unpaved roads and parking to the east of Dodson Road.

3.11 Hazardous and Toxic Materials

3.11.1 Affected Environment

The acquisition of residential, agricultural, or industrial property has inherent risks of the property containing solid wastes or hazardous and toxic materials. Each parcel proposed for acquisition in the development of an additional feed route will require an Environmental Site Survey prior to the completion of the transaction. Existing Federal laws, policies, and regulations govern the property review process.

Solid Waste

Grant County operates a landfill south of Ephrata that accepts about 95 percent of the county's garbage. Public and industrial refuse is taken to this sanitary landfill or to local transfer sites operated by Consolidated Disposal Service Incorporated. These sites are permitted by the Ecology to operate under EPA's Resource Conservation and Recovery Act (RCRA) regulations for solid waste. Some industrial wastes require special disposal in permitted hazardous waste disposal facilities; for instance, drycleaner solvent wastes. However, neither of the solid waste landfills in the County are RCRA-permitted hazardous waste landfills. Solid waste landfills may accept small quantities of hazardous wastes from households, but the cumulative amount of these hazardous wastes are mostly unknown. Many landfills throughout the country have become Superfund sites because they release hazardous constituents to the environment.

Along the proposed routes, small garbage dumps created prior to the opening of permitted landfills could exist. These landfills probably would contain general wastes or farm waste materials, including empty pesticide containers and household hazardous wastes. One transfer facility is located within the proposed routes.

Septic Systems

Larger cities and towns in the Columbia Basin have sanitary wastewater treatment plants. In areas outside town or city limits, most homes are on septic systems. When properly operating, septic systems treat bacteria and filter nutrients from the water within the confines of the treatment system. Under certain conditions, such as high water table and poor soil conditions, septic systems do not operate properly and could result in sanitary wastes being discharged into groundwater or, more commonly, into surface water. These conditions may require the closure or relocation of these systems to protect both ground water and surface water.

Building Materials

Structures located within the proposed feed routes, or in close proximity may require removal. Buildings older then 20 years have the potential of containing high levels of toxic materials such as lead, asbestos, PCBs, and mercury. These materials are known to be hazardous to human health and the environment. Other contaminates from treated wood products such as railroad ties used for fence post or landscape materials also contain high levels of creosote a known carcinogen. All of these materials when used for the intended purpose are considered safe if they are not disturbed. If a structure must be removed and it contains these substances, a determination of the material fate must be made.

3.12 Other Issues

3.12.1 Indian Trust Assets

25 Code of Federal Regulations Chapter 1, Part 115, Subsection 115.002 (2001) defines Indian Trust Assets (ITAs) as "trust lands, natural resources, trust funds, or other assets held by the federal government in trust for Indian tribes and individual Indians. Trust land(s) means any tract or interest therein that the United States holds in trust status for the benefit of a tribe or an individual Indian" (United States 2001: 343).

Examples of ITAs include land, minerals, instream flows, water rights, and hunting and fishing rights. A defining characteristic of an ITA is that these assets cannot be alienated, sold, leased, or used for easements without approval from the United States.

The United States has a trust responsibility to protect and maintain rights reserved to Indian Tribes or individuals originating from treaties, statutes, and executive orders. This trust responsibility requires that Federal agencies take reasonable actions to protect trust assets when administering programs under their control.

Historically, the government and the Tribes have offered varied opinions as to what constitutes an ITA, and which tribe holds title to those ITAs. This document neither judges the validity of, nor defines the rights claimed by any Tribal government or member.

While the majority of ITAs are located on-reservation, ITAs also occur off reservation. Consequently, several American Indian Tribes and bands have interests in the project area. The majority of the area in and surrounding the alternatives is within lands ceded in the Yakama Treaty of June 9, 1855. The treaty established the Yakama Reservation and reserved rights and privileges to hunt, fish, and gather roots and berries on open and unclaimed lands to the 14 signatory Tribes and bands.

In addition to the Yakama Nation, the Spokane Tribe of Indians, Wanapum, the Nez Perce Tribe, and the Confederated Tribes of the Colville Indian Reservation may also have interests in the project area.

No ITAs have been identified within the project area.

3.12.2 Sacred Sites

Executive Order 13007, dated May 24, 1996, instructs Federal agencies to promote accommodation of access and protect the physical integrity of American Indian sacred sites. Sacred site means any specific, discrete, narrowly delineated location on Federal land that is identified by an Indian tribe, or Indian individual determined to be an appropriately authoritative representative of an Indian religion, as sacred by virtue of its established religious significance to, or ceremonial use by an Indian religion. A sacred site can only be identified if the Tribe or appropriately authoritative representative of an Indian religion has informed the agency of the existence of a site.

No sacred sites have been identified in the project area.

3.12.3 Environmental Justice

A Presidential Executive Order 12898 and the Departmental Environmental Justice Policy require that Federal agencies consider the impacts of the Department of Interior's actions on minority and low-income populations and communities, as well as the equity of the distribution of benefits and risks of those decisions.

No known minority or low-income populations or communities are located within the area impacted by this project.

4.0 ENVIRONMENTAL CONSEQUENCES

This chapter discusses the environmental consequences of implementing each of the alternatives. The chapter is organized by relevant resource topics, with the impacts of all alternatives combined under resource headings. This chapter also summarizes mitigation efforts where applicable.

4.1 Fish and Wildlife

4.1.1 Impacts of Alternative 1 - No Action

Fish

Under this alternative, aquatic habitat conditions in Billy Clapp Reservoir, middle Crab Creek, Frenchman Hills Wasteway, Moses Lake, and Potholes Reservoir will likely remain stable or be slightly degraded.

Fisheries within Billy Clapp Reservoir will likely continue to decline at a rate similar to that of recent years. The current hydrograph and water operations of Billy Clapp Reservoir limit the establishment of a consistent fishery. Water elevations fluctuate quickly with the onset and termination of irrigation flows. Water quality, along with primary and secondary production data do not exist for Billy Clapp Reservoir. However, high volumes of water entering the lake from Banks Lake most likely transport nutrients and plankton that are susceptible to flow. The low relative abundance of walleye is most likely indicative of low natural production and high water clarity, which are sub-optimal for walleye forage success. Levels of natural production are currently unknown since seeding is presumed to occur annually through entrainment from Banks Lake. Entrainment of fish into the lake is followed by entrainment of fish from the lake. The rates of entrainment are unknown, but most likely determine the success of annual fisheries.

The lack of perennial flows will continue to limit the establishment of an effective fishery in most of middle Crab Creek. Flows from springs throughout the system will remain perennial and vary with irrigation season and the resultant re-charging of local groundwater. Trout fisheries will remain where perennial flows exist while other areas will continue to provide warm water fisheries. It is likely that the springs that feed this system will continue to have good water quality; however, in some areas low flows and aquatic weed growth may contribute to diminished fingerling survival. The introduction and expansion of carp populations through this system may decrease habitat conditions for other more desirable species.

Conditions for fish in Moses Lake, and Frenchman Hills Wasteway will likely remain stable. Common carp will continue to dominate the system and game fish populations are not expected to change drastically. Water quality issues will continue to be of concern in Moses Lake with high levels of nutrients facilitating increased primary productivity, resulting in low DO levels. These factors, when combined with high summer water temperatures, will continue to contribute to small, localized fish kills, but are not anticipated to have major negative impact to fish populations. Frenchman Hills Wasteway will continue to function as a mixed species fishery.

Habitat conditions are not anticipated to change dramatically in Potholes Reservoir. Nevertheless, it is anticipated that populations of panfish will continue to decline. Although plants that provide cover and facilitate foraging opportunities for fish are increasing along the shoreline, current management results in summer water levels that cause fish to move to open water with less cover where they are vulnerable to predation. Predation as a result of expanding smallmouth bass and walleye populations, angler harvest, and an increasing population of piscivorous birds, will contribute to inconsistent or low recruitment panfish populations in the future.

Wildlife

Under this alternative, habitat conditions for wildlife are expected to be stable or slightly improved. The project area will continue to serve as an important waterfowl breeding area and as a resting and feeding area for waterfowl during spring and fall migrations. Management of the project will continue to provide habitat for shorebirds and neo-tropical migrants.

Some development of private lands, especially shoreline areas around Moses Lake, is anticipated. These developments may cause a localized decrease in wildlife habitat value. However, much of the land within the project area is under public ownership and managed as wildlife habitat. Current management plans call for the continued implementation of weed control, habitat improvements, and planting of wildlife food plots. Measures such as these will preserve and improve wildlife habitat values on these lands.

4.1.2 Impacts of Alternative 2A - Crab Creek Perennial

Fish

Implementation of this alternative would result in the establishment of a 100 cfs year-round baseflow from the 4’x4’ gate at Billy Clapp Reservoir with an additional release of up to 500 cfs during the period of April 1 to June 1. The year-round baseflow of 100 cfs would result in a winter drawdown of Billy Clapp Reservoir from the traditional level of 1320 feet to a level of 1300 feet. The proposed drawdown under this alternative may result in stranding kokanee as the lake elevation drops. Entrainment of fish from Billy Clapp Reservoir currently occurs at an unknown rate. Discharge of feed from the reservoir through the 4x4 gate is likely to cause additional entrainment and may result in a decrease in the productivity of the reservoir’s fishery.

Establishment of a controlled perennial flow from Billy Clapp Reservoir to Moses Lake could provide the opportunity for a multitude of fisheries enhancements. If the baseflow remains in a defined channel, a riparian zone would likely become established along the entire length of middle Crab Creek, which would help minimize erosion, reduce water temperatures, and improve water quality. Conditions for the establishment of a high quality stream-type trout fishery, similar to that of nearby Rocky Ford Creek, could result if carp can be successfully controlled. The additional flow during April and May of each year may slow the establishment of a quality riparian zone by contributing to accelerated erosion during the initial stages of perennial stream channel establishment and may increase the time it takes to develop a quality fishery throughout the area. The sediment transport study completed by CH2M Hill does not anticipate sediments to be transported to Moses Lake in any great volume.

Existing water control structures and natural barriers to fish movement have also not been subject to a sustained flow of water similar to that proposed. The structures have endured periodic high flows that exceed flows anticipated by Reclamation action. The stability of the structures at Homestead, Magpie, and Gloyd Seeps may deteriorate because of inundation, allowing invasive species such as carp and bullfrogs, to access previously uncontaminated areas. Repairs or replacement of these structures will be considered in the management plan for the Wildlife Area. Lone Springs will be protected from inundation by the additional water at its upper end. Flows proposed for Crab Creek will be contained within the banks of the 2-year frequency event flows. Establishment of a perennial flow will also eliminate areas where the streambed has traditionally gone dry and will allow access for carp and bullfrogs through the entire Middle Crab Creek area.

The waters of Rocky Ford Creek contain high amounts of phosphorous that appear to come from sources above Brook Lake. However, as the water Reclamation will add to the creek is being added at Brook Lake, below the area of high phosphorous, it is anticipated that there will be no increased loading of phosphorous to the creek and Moses Lake.

Conditions for fish in Potholes Reservoir are not expected to differ from those described above for the No Action Alternative.

Wildlife

One of the primary concerns for this alternative is that inundation resulting from the 500 cfs April 1-June 1 and possibly the 100 cfs baseflow is likely to facilitate the invasion of carp and bullfrogs into areas that may currently support leopard frog populations. Introduction of these species could result in increased predation, competition for resources, and eventually, the extirpation of leopard frogs from middle Crab Creek. Conversely, flooding of low-lying areas during the spring pulse feed may also create dispersed leopard frog breeding areas that could result in an increased population level if predatory species are kept in balance. To address this concern, the wildlife agencies and Reclamation will develop a management plan that will include measures to protect leopard frog habitat.

Expansion of the riparian zone along middle Crab Creek associated with the establishment of a perennial flow regime would provide additional hiding and thermal cover for mammals, game birds, and neo-tropical migrants. Nesting cover for bird species would also be enhanced. The addition of perennial water to the middle Crab Creek system would also allow managers to utilize water control structures throughout the course of the year to provide enhanced habitat conditions for breeding and migrating waterfowl.

For Billy Clapp Reservoir, Moses Lake, and Potholes Reservoir, implementation of this alternative is not expected to result in habitat conditions for wildlife that differ significantly than those described above for the No Action Alternative.

4.1.3 Impacts of Alternative 2B – Crab Creek Ephemeral

Fish

Similar to Alternative 2A, discharge of feed from Billy Clapp Reservoir through the 4x4 gate at Pinto Dam is likely to cause additional entrainment of fish from the reservoir and may result in a decrease in the productivity of the fishery. However, winter lake levels would not be subject to a drawdown below the traditional level of 1320 feet.

Mapping conducted by Reclamation indicates that a flow of 650 cfs would inundate several areas that currently have perennial water but are isolated from the main Crab Creek channel. Inundation would subject those areas to invasion by undesirable species such as carp and bullfrogs, and would be detrimental to existing fish populations.

Conditions for fish in Potholes Reservoir are not expected to differ from those described above for Alternative 2A.

Wildlife

Inundation resulting from the 650 cfs April 1-June 1 flow is likely to facilitate the invasion of carp and bullfrogs into areas that may currently support leopard frog populations. Introduction of these species could result in increased predation, competition for resources, and eventually the extirpation of leopard frogs from middle Crab Creek. It is likely that carp and bullfrogs will become stranded in isolated pools and eventually perish as Crab Creek dries down after feed is stopped. This may keep these predatory species populations under control, allowing the leopard frog population within middle Crab Creek to remain viable.

For Billy Clapp Reservoir, Moses Lake, and Potholes Reservoir, implementation of this alternative is not expected to result in habitat conditions for wildlife that differ significantly than those described above for the No Action Alternative.

4.1.4 Impacts of Alternative 3 – Frenchman Hills Wasteway

Fish

A March 29 through May 18, feed of an additional up to 700 cfs through the Frenchman Hills Wasteway would probably have few fisheries benefits. Increased flows are likely to attract additional numbers of carp and walleye into the wasteway during this time. Isolated ponds are likely to be inundated resulting in the introduction of carp to areas that currently provide significant populations of warmwater fish (mostly bass, bluegill) and very good fisheries. Inundation of the wasteway is shown in CH2MHill's report.

The increased flow may also lead to enhanced walleye reproduction, further increasing the predator population of Potholes Reservoir and leading to shifts in other fish populations. WDFW is currently trying to decrease predator populations in Potholes Reservoir, especially walleye.

Wildlife

The temporary increase in water levels may lead to a minor loss of shrub-steppe habitat and an associated increase in the width of the riparian zone along the wasteway. Expansion of the riparian influence may lead to a minor increase in encroachment of non-native invaders, such as Russian olive and purple loosestrife. Conversely, increased riparian influence may also result in an increase in hiding and thermal cover as well as food base for neo-tropical birds, mammals, and amphibians. It is not expected that these changes will result in any measurable alteration of wildlife use of the area.

Inundation of the isolated ponds along the wasteway may have negative impacts on breeding waterfowl and shorebirds. Because of the limited riparian area surrounding the wasteway, higher water levels may inundate areas of good nesting cover forcing these birds to select nesting sites with less cover and increasing the likelihood of predation. The introduction of carp into the isolated ponds would lead to decreased emergent vegetation, decreased food supply, and reduced cover, further decreasing the likelihood of brood success. While implementation of this alternative may have some negative impacts to locally reproducing populations of waterfowl and shorebirds, it is not expected to reduce the ability of the area to function as an important stopover area for these species during migration periods.

Mitigation

While some of the alternatives may have a negative impact on fish and wildlife within the project area, overall fish benefits are generally positive. Additionally, the action alternatives (2A, 2B, 3, and 4) may provide the possibility for additional habitat improvement opportunities. Reclamation will work with state and Federal wildlife agencies to develop a management plan for development of additional habitat values based on increased water transported in the preferred alternative route.

Other measures, including noxious weed treatment, would occur as necessary.

4.2 Threatened and Endangered Species

4.2.1 Bald Eagle

The project areas for the action alternatives are within agricultural areas or areas with minimal suitable habitat for bald eagles. Alternatives 2A and 2B would bring additional flows to the upper reaches of Crab Creek and the potential for increases in resident fish population. This increases the potential for bald eagle prey, and may attract birds to the area.

Construction activities associated with the action alternatives do not require the removal or alteration of suitable habitat. Reclamation concludes that the proposed action will have no effect on bald eagles or potential habitat.

4.2.2 Columbia Basin Pygmy Rabbit

None of the alternatives contain potential suitable habitat for Pygmy rabbit.

4.2.3 Ute ladies'-tresses

All of the alternative locations exhibit some of the required habitat for Ute ladies'-tresses. However, none of the alternatives provides sufficient habitat, or all of the required elements to sustain the species.

Table 4-1: Effect Determinations on Threatened and Endangered Species

Species	Effect Determination
Chinook Salmon (*Oncorhynchus tshawytscha*)	No Effect
Steelhead (*Oncorhynchus mykiss*)	No Effect
Pygmy rabbit (*Brachylagus idahoensis*)	No Effect
Bald eagle *(Haliaeetus leucocephalus)*	No Effect
Bull trout *(Salvelinus confluentus)*	No Effect
Ute ladies'-tresse *(Spiranthes diluvialis)*	No Effect

4.3 Historic Resources

The proposed action meets the requirements for a "federal undertaking" as defined in 36 CFR § 800.15 *Protection of Historic Properties.* As defined, the level of inventory and identification of historic resources for the proposed action are commensurate with the nature of the undertaking. Since the action alternative requires ground disturbance associated with the establishment of an alternate feed route, further investigation is required. Additionally, a literature review, cited above, identifies surveys that have identified historic properties near the proposed project area. These surveys indicate the probability or potential for further historic properties in the area in general, therefore additional investigations are necessary.

To fulfill the requirements of Section 106 of NHPA, a survey to identify historic properties (including Traditional Cultural Properties) and subsequent reporting must be completed prior to implementation of the preferred alternative. This report will include a literature review, results of a field survey, evaluation of identified resources, and mitigation. Additionally, Reclamation will consult with the Washington State Historic Preservation Officer (SHPO), and all appropriate Indian Tribes in preparation of this report.

4.3.1 Impacts of Alternative 1 - No Action

This alternative will not affect historic resources since this alternative includes no new construction and does not alter current operations. This alternative would require no further investigation, evaluation, or mitigation.

4.3.2 Impacts of Alternative 2A, 2B - Crab Creek (Perennial and Ephemeral)

These alternatives have the potential to affect Historic Properties, since both involve new construction of facilities, and changes in flow in upper Crab Creek. Previous investigations along Crab Creek indicate a moderate probability of historic resources within the project area. Institution of this alternative will require a Section 106 review of the impacted area to determine the presence of historic properties.

4.3.3 Impacts of Alternative 3 – Frenchman Hills Wasteway

These alternatives have the potential to affect Historic Properties, since it involves modifications of road crossings, and changes in flow in the Frenchman Hills Wasteway. Because ground disturbance associated with this alternative is relatively minor, impacts to historic resources are not anticipated. Institution of this alternative will require a Section 106 review of the impacted area to determine the presence of historic properties.

4.3.4 Mitigation

If the Reclamation survey identifies historic properties, including TCPs, eligible for inclusion on the National Register that may be affected by the chosen alternative, Reclamation will work with the SHPO to determine a course of action. If impacts to the eligible historic property cannot be avoided, mitigation measures would be formulated in coordination with the SHPO.

Additionally, if historic resources are discovered during construction, all activities will cease and a Reclamation archeologist will be contacted. If the site is determined eligible for inclusion on the National Register, mitigation measures will be prepared in conjunction with the SHPO. Work will not resume until mitigation has been completed.

Finally, the Native American Graves Protection and Repatriation Act establishes the rights of Native American groups to human remains of Native American ancestry and certain associated cultural objects recovered from Federal or Indian lands. The act also establishes procedures and consultation requirements for intentional excavation or accidental discovery of Native American remains on federal or Tribal lands.

4.4 Hydrology

4.4.1 Surface Water

Impacts of Alternative 1 - No Action

Without a supplemental route, the East Low Canal will continue to carry, through Rocky Coulee Wasteway, about 210,000 acre-feet of feed water annually. Rocky Coulee Wasteway will continue to feed over 90,000 acre-feet in the fall, which results in carrying Potholes Reservoir to elevation 1032 on October 31. Having Potholes Reservoir at this elevation at the end of October limits the available spring runoff volume to 101,000 acre-feet. This available volume just equals the 25-year spring runoff inflow volume.

The ELC will continue to be used starting sometime in late August with the fall feed program, which is during periods of potential high demands. The West Canal and Lind Coulee Wasteway will each continue to carry about 21,000 acre-feet of feed during the spring.

Impacts of Alternative 2A, 2B - Crab Creek (Perennial and Ephemeral)

For these alternatives, water would be discharged from Billy Clapp Reservoir to Brook Lake and routed down middle Crab Creek, increasing the volume of water typically conveyed down the creek. The rate of flow released from Billy Clapp Reservoir into Crab Creek would range from 100 to 650 cfs. This would increase the flow below Willow Lake to slightly above the 2-year recurrence interval peak discharge at Rd 7 NE which is 322 cfs (USGS 2006) but in the higher reach of the creek the increase would be below the 2-year peak discharge. The channel forming flow is much higher above Adrian with loss to the ground-taking place throughout the reach. A 2-year flood is the approximate “channel forming” flow that creates the channel shape. As the area of the creek where higher flows will occur already has a more stable shoreline due to existing full time flows “channel forming flows will occur only where there is stable shorelines thereby limiting the amount of sediment transport to Moses Lake.

Some of the water discharged into Crab Creek will infiltrate into groundwater, reducing the increase in flow in Crab Creek. The ground water is expected to resurface in Rocky Ford Creek, increasing surface water flow in that creek. The amount that will infiltrate is a function of the flow rate in Crab Creek. Infiltration is expected in ranges from 60 percent to 20 percent based on the low to high flow rates respectively. Rocky Ford Creek is expected to increase by 60 to 80 cfs, averaged of the year, with a year-round base release from Billy Clapp Reservoir of 100 cfs. Rocky Ford Creek is expected to increase by 20 to 40 cfs, averaged over the year, with spring releases from Billy Clapp Reservoir of 650 cfs.

Increased flows in Crab Creek will increase the flow of Rocky Ford Creek. Tests indicate that the delay between water entering the gravels along Crab Creek and water emerging in Rocky Ford Creek is approximately 6 weeks. As stated elsewhere approximately 80% of the water lost in Crab Creek shows up in Rocky Ford Creek with the rest entering Moses Lake from a number of other routes.

Both alternatives 2A and 2B will not change the peak flows from feed water in Crab Creek below the confluence of the Rocky Coulee Wasteway. Crab Creek will see increases in flow duration with both alternatives due to the extended time period when water will be flowing in the creek.

Impacts of Alternative 3 – Frenchman Hills Wasteway

An increase in flow in the Frenchman Hills Wasteway would occur in the feed route to Potholes Reservoir for that alternative. Road culverts at Road C SE will need to be replaced to allow the additional feed. A maximum feed of 700 cfs may be conveyed through Frenchman Hills Wasteway during the spring when sufficient space in the West Canal is available, and prior to the need to apply aquatic herbicides in the canal.

4.4.2 Ground Water

Short-term impacts to groundwater associated with the development of any of the three feed route alternatives would primarily be associated with construction or modification of feed water conveyance facilities. Short-term impacts to groundwater resources from construction or modification of facilities, could involve changes in groundwater levels and gradients during construction. If construction includes substantial groundwater control activities, required construction dewatering could temporarily reduce groundwater levels and availability in the alluvial aquifer and/or sedimentary aquifer system.

The addition of surface water in any of the lakes, canals, and wasteways for any of the Supplemental Feed Route alternatives may increase ground water levels along the route and near the impoundments due to an increased hydraulic head in the impoundments and seepage along the conveyance facilities.

Impacts of Alternative 1 - No Action

The East Low and West Canals have minor amounts of water loss do to seepage. It is expected that surface water to ground water interaction would not change by utilizing the current route. The majority of this water returns to Potholes Reservoir.

Impacts of Alternative 2A and 2B - Crab Creek Perennial and Ephemeral

The Crab Creek route is a natural waterway and will require minor channel modifications above the Crab Creek Siphon on the East Low Canal to help increase flows from Brook Lake. Given the hydraulic continuity between ground water and surface water over some reaches in the creek, it is expected that impacts may include short-term changes to shallow ground water levels and ground water/surface water interaction associated with channel modifications.

Crab Creek is currently not a perennial waterway between Brook Lake and Gloyd Spring. Groundwater will be recharged along the creek’s natural route. From Brook Lake above Stratford, through Adrian, groundwater is present in gravels directly below the surface drainage of Crab Creek. Crab Creek loses much of its flow to groundwater in this reach. The Adrian reach extends from Brook Lake to Willow Lake, portions of normal flow and even moderately high flows of Crab Creek are absorbed by the gravels. Crab Creek is expected to loose 60 percent to 20 percent of low flow to high flow respectively in the Adrian Reach. About 80 percent of the ground water is expected to resurface in Rocky Ford Spring, which drains to Moses Lake, increasing surface water flow in that creek. The remaining amount is expected to emerge in other springs along the east shore of Moses Lake. Long-term changes to shallow groundwater are expected.

The Gloyd Reach extends from Willow Lake to Moses Lake; Crab Creek is expected to loose 10 percent to 1 percent of low flow to high flow respectively to this reach. This groundwater is expected to return to Moses Lake via the Parker Horn and/or Rocky Ford Arm. A long-term increase to shallow groundwater is expected and did occur in the Rd 10 NE area during the 2006 test flow.

Impacts of Alternative 3 – Frenchman Hills Wasteway

The Frenchman Hills option is not expected to require additional construction of conveyance facilities other than modification of road culverts. These modifications would have minimal potential to affect groundwater.

The majority of the Frenchman Hills route is unlined, open channel with no impoundments. Therefore, it is expected that surface water to ground water interaction and general canal seepage near this route would occur and could potentially increase because of additional water in the canal. Additional surface water in the Frenchman Hills Wasteway may slow the rate of ground water discharge into the wasteway.

Mitigation

The only anticipated mitigation of groundwater increases will be associated with Alternatives 2A and 2B. In both alternatives, there will be an increase to the flow in the Rocky Ford springs at the Trout Lodge Hatchery. If the increase is larger than existing facilities can handle, bypass facilities will be constructed. At the Road 10 NE area, emerging water from Crab Creek is affecting landowners and assistance with managing animal wastes and household wastes will be needed.

4.5 Vegetation

4.5.1 Impacts of Alternative 1 - No Action

Since the No Action Alternative requires no construction activities or change in operation, vegetation conditions will continue as-is under this alternative. Agricultural land use trends will continue, and riparian and shrub-steppe vegetation trends will remain unaffected.

4.5.2 Impacts of Alternative 2A and 2B - Crab Creek Perennial and Ephemeral

Implementation of this alternative would require some ground impacts associated with construction activities at various locations along the creek that may involve the removal of vegetation. However, the amount of vegetation removed is minimal except at the outlet to Brook Lake where the only significant amount of vegetation occurs and would need to be removed to allow for construction. Areas disturbed during construction will be re-vegetated with native vegetation where applicable.

Increased flows, either perennial or ephemeral, may lead to opportunities for riparian vegetation enhancement. Reclamation would work with landowners, including State, Federal, and private, to develop vegetation plans on a voluntary basis. Specifics of these plans would be developed on a case-by-case basis.

4.5.3 Impacts of Alternative 3 – Frenchman Hills Wasteway

Ground disturbance associated with this alternative is minimal, since no extensive construction is necessary. Vegetation removed for construction will be re-vegetated with native vegetation.

Additionally, the rise in water elevation in the wasteway would be minimal and does not appear to extend outside of existing riparian zones, it is anticipated that the riparian zone might expand with the additional water to replace any riparian vegetation lost to rising water.

4.6 Geology/Soils (Erosion)

4.6.1 Impacts of Alternative 1 - No Action

No impacts directly related to Reclamation’s activities are anticipated. Erosion may increase in either Crab Creek or Rocky Ford Creek due to periodic annual flooding.

4.6.2 Impacts of Alternative 2A and 2B - Crab Creek Perennial and Ephemeral

Potential erosion could be caused by either construction activities, or increased flows in Crab Creek. Due to relatively minimal construction activities, and flat topography of the area, increased erosion is not anticipated.

Typical construction-related impacts to geology and soils would occur in the construction areas. These include general activities like land clearing, cuts and fills, and installation of new roads for both construction activities and operation and maintenance access. These activities could cause ground disturbance, resulting in increased potential for erosion.

The coarse-grained soils native to the project area tend to slough until they approach about a 1:1 slope or become stabilized by vegetation. In addition, when disturbed and left on steep slopes, heavy rainfall will cause erosion.

This alternative would result in minimal erosion deposition downstream of Crab Creek. The streambed, characterized by numerous pond areas, was formed by the erosional and depositional character of the floodwaters. Because of the relatively low gradient and the ponded areas within this reach of Crab Creek, flows have ample areas to drop sediment load. This is supported by the sediment study in CH2MHill's report.

4.6.3 Impacts of Alternative 3 – Frenchman Hills Wasteway

Typical construction-related impacts to geology and soils would occur in the construction areas. These would include land clearing, cuts and fills, and re-routing of existing operation and maintenance access roads. These activities would disturb the ground and expose the areas to potential erosion.

Cut slopes in the sand will tend to slough until they approach about a 1:1 slope or become stabilized by vegetation. In addition, when disturbed and soil is left on steep slopes, heavy rainfall will easily cause erosion.

Feed flows through the Frenchman Hills Wasteway could ultimately result in minor additional erosion and deposition along the wasteway. The feed water would have no negative impacts since shifts in the wasteway currently occur in the meanders as the flows fluctuate and the heavy vegetation chokes the waterways.

4.6.4 Mitigation

Because none of the alternatives will cause a substantial increase in either erosion or deposition of eroded materials, no mitigation is planned or anticipated except for on-site measures used during construction of the various facilities.

4.7 Water Quality

None of the alternatives change the source of the water used to feed into Potholes Reservoir. Currently water is fed from Billy Clapp Reservoir through the Main Canal and ELC, down the Rocky Coulee Wasteway into Crab Creek and eventually into Moses Lake and Potholes Reservoirs. All of the other alternatives also take water from Billy Clapp Lake. Consequently, water quality for all of the alternatives is identical at the source. This analysis focuses on whether water quality is affected by the route in which it is carried to Moses Lake/Potholes Reservoir.

4.7.1 Impacts of Alternative 1 – No Action

Under this alternative Reclamation will not change the existing manner in which it feeds water to Potholes Reservoir. Water quality trends will likely remain the same as they have been in past years.

4.7.2 Impacts of Alternative 2A and 2B - Crab Creek Perennial and Ephemeral

The water quality for this alternative considers three water systems: Crab Creek, Rocky Ford Creek, and Moses Lake. Both of the creeks drain into Moses Lake. Crab Creek is a large watershed that historically has not had a perennial connection with Brook, Round, and/or Moses Lake. Under these alternatives, Crab Creek would flow from Brook Lake to Moses Lake either perennially or seasonally. Rocky Ford Creek would also see increased flows, again either perennially or seasonally, as feed water moves subsurface from Crab Creek to Rocky Ford Creek through the Adrian Sink.

Temperature

Changing a portion of the feed from Rocky Coulee Wasteway to Crab Creek is not expected to change water temperatures in Crab Creek, Rocky Ford Creek, Moses Lake, or Potholes Reservoirs. Temperatures in Moses Lake and Potholes are determined by the amount of surface area of the lakes exposed to solar radiation. This will not be affected by the change in the feed route. Temperatures in Rocky Ford Creek are largely determined by the temperatures of the springs, which form the creek, and solar radiation. Temperatures in the springs will be unaffected as they are determined by the substrate temperatures through which the water moves. Temperatures in Rocky Ford Creek, which warms because of solar radiation, should do so at a slightly slower rate because of the higher discharge from the spring. This should result in slightly cooler temperatures in the creek until it reaches equilibrium.

Since the upper portions of Crab Creek in the study area have only intermittent flows, there is little in the way of baseline temperature for this reach. Water under these alternatives would be released from the bottom of Billy Clapp Reservoir. Due to the shallow nature of the reservoir, and the rapid turnover rate it is not expected that the temperatures would be much cooler than the current feed water, which is removed from the surface of the reservoir. However, the release of cooler water would be beneficial. Water fed down Crab Creek after a few years will be transmitted in the channel with some riparian cover. This is different from the current feed route down the ELC and Rocky Coulee Wasteway, which have no riparian cover capable of shading the waterway. Again, this should provide some benefit for water temperatures.

Phosphorus

Routing additional flows down Crab Creek channel is not expected to add any potential pollutants to the water such as phosphorus or nitrogen. None of the feed water will be delivered for use and consequently it will not result in any additional inflows of return flow, drainage or the like. To the extent that existing activities that generate and deliver potential pollutants to this reach of Crab Creek are occurring, they will continue as they do under the No Action alternative with no change.

Delivery of phosphorus to Crab Creek and Moses Lake is a concern when routing additional water through the Adrian Sink into Rocky Ford Creek and into Moses Lake. Existing water quality data from Crab Creek at Irby indicates the water is high in nutrients that contribute to eutrophication, including phosphorus. Phosphorus is soluble in water under certain acidic conditions, or when other adhering nutrients, such as iron, calcium, and magnesium, are available. This is the case with the phosphorus at Irby.

Data indicates that the elevated phosphorus levels are coming subsurface via a shallow aquifer from Crab Creek above Brook Lake towards the Adrian Sink. When the water reappears at Rocky Ford Springs, the phosphorus is at the maximum natural level and remains so as the flow of water moves through Rocky Ford Creek into the Rocky Ford arm of Moses Lake. The water quality for nutrients at Rocky Ford Springs shows elevated levels of both nitrates and phosphates. The nitrate levels range between 1.66 mg/L and 2.83 mg/L, and the total phosphorus levels range between 0.53 mg/L and 0.125 mg/L.

The concern is whether routing additional water subsurface from Brook Lake to Rocky Ford Springs through the Adrian Sink could mobilize additional phosphorus. Mundorff et al. (1952) report that groundwater in the shallow aquifer between Brook Lake and Adrian Sink occupies a narrow, highly transmissive gravel paleochannel underlying the surface drainage of Crab Creek. This channel is bounded to the north and south by lower permeability flows of the Wanapum Basalt. The surface flow of Crab Creek is reportedly lost to the aquifer in this area under all but the most extreme flow conditions. Mundorff and coauthors stated that this water resurfaces further downgradient as discharge to the Rocky Ford Creek source springs, a conclusion supported by Bain (1985). "The spring water's ionic composition best matches groundwater samples with a comparatively short residence time in the shallow unconsolidated deposits of the aquifer system (with limited long-term contact with basalts)" (Pitz 2003).

Phosphorus is found naturally in sedimentary rock. As noted above the sink consists of alluvial materials confined by those of volcanic origin. Bain also found no available evidence for a natural stratigraphic source of phosphate that could explain the elevated phosphorus concentrations present in the groundwater feeding the spring (Bain 1987a). Consequently, it is unlikely that the phosphorus is coming naturally from the substrate in the Adrian Sink. This is supported in a study conducted by Pitz of the Department of Ecology concerning groundwater in the upper Crab Creek region; Cusimano and Ward (1998) suggest that agricultural land management practices in this drainage area was the most probable cause for the elevated nutrients in the discharging groundwater at Rocky Ford Springs (Pitz 2003). Bain (1987a) also concluded that the source of the nutrient was likely agricultural activities in the upper Crab Creek basin in upper Grant and Lincoln Counties.

Since substrate in the Adrian Sink does not appear to be the source of phosphorus in Rocky Ford Spring or Creek routing additional feed water through it should not cause it to increase.

Based on the data suggesting the phosphorus in Rocky Ford Creek is not coming from a natural source in substrate in the Adrian Sink and that it is likely coming subsurface from agricultural sources above Brook Lake which won't be altered by the feed program; this alternative will improve the overall quality of the water in Moses Lake. The concentration of the nutrients should not increase in the creek or the lake, and the water temperature could possibly decrease with a constant flow year around. With an increased flow to Moses Lake, the nutrients should be flushed through to Potholes Reservoir leaving the lake less vulnerable to eutrophication.

4.7.3 Impacts of Alternative 3 – Frenchman Hills Wasteway

The water quality for this alternative is much like that at the bifurcation. The spring water temperatures are moderate and range between 8.4°C and 15.8°C. Similar to the No Action alternative, in the early spring when water delivery begins, the dissolved oxygen levels range between 10.8 mg/L and 12.7 mg/L. The water quality is at its highest this time of the year.

4.7.4 Mitigation

Water monitoring will continue in all locations currently being monitored, with the possibility of new sample locations dependant on which alternative is chosen. However, since none of the proposed alternatives is expected to have a significant impact on water quality, no other mitigation is planned.

4.8 Land Use

Information in this section is further detailed in a Land Acquisition Plan prepared by Reclamation. This report is available in Reclamation's office in Ephrata, WA.

4.8.1 Impacts of Alternative 1 – No Action

Current land use/land cover patterns and trends would not be affected, since no new construction or management practices would occur.

4.8.2 Impacts of Alternatives 2A and 2B - Crab Creek Ephemeral and Perennial

Creek flows of 100, 400, and 650 cfs were modeled by Reclamation's Technical Service Center. The technique used in these simulations did not account for water losses due to creek bed permeability. Results indicated that there would be only small differences in predicted inundation levels at most locations along Crab Creek. Modeling results from the 650 cfs level were used to ensure that any likely detrimental effects would be cataloged.

The 650 cfs simulation indicates that approximately 2422 acres will be inundated if either alternative 2A or 2B is selected. Of this total 2422 acres, it appears that 757 acres (31.1%) may already be wet, as either open water or wetland. Another 1156 acres of land classified as shrub-steppe will be inundated, as well as 343 acres of cropland, 78 acres of forest/shrub, and 88 acres of barren land. The Road 16 NE crossing will be flooded. Chaparral Drive NE is on the edge of the inundation and may be affected by this alternative.

Based on county tax records, approximately 965 acres of the total 2422 acres within the inundated area is privately owned land (39.8%). These 965 acres are comprised of 178 separate tax parcels. Six structures occur within the potential inundation area. Reclamation has a number of flowage easements south of the intersection of Crab Creek and Rocky Coulee Wasteway. Roughly, 192 of the 965 privately owned acres with 10 residences being within the flowage easement. There is only a small difference in environmental consequences between these two alternatives.

4.8.3 Impacts of Alternative 3 – Frenchman Hills Wasteway

Approximately 2776 acres along the last 16.5 miles of this route will be inundated if this alternative is selected including inundation from existing use of the wasteway(see the CH2MHill report on the Frenchman Hills inundation). The TMLC Study classified 1067 acres (38.4%) within this inundated area as either open water or palustrine wetland. Land classified as shrub-steppe of less than 10 percent coverage and shrub-steppe of more than or equal to 10 percent coverage account for another 659 acres (23.7%). The 659 acres of shrub-steppe lands that will be inundated under this alternative are predominately located in two areas of flatter land on the western end of the Wasteway. Cropland, forest/shrub, sand dune, and barren land account for an additional 535, 246, 202, and 67 acres, respectively. Dodson Road, a major county road, runs north-south through the area of study.

Table 4-2: Land Acquisition by Alternatives

Alternative	1 No Action	2A/2B Crab Creek	3 Frenchman Hills
Activity Requiring Acquisition	N/A	Inundation	Inundation
Public Land [1]		1457	2239
No Acquisition Needed		192 [2]	284 [3]
Acquire Fee Estate			
Acquire Easement			
Acquire Fee or Easement		773	253
Structures Impacted [4]		6	
# Private Tax Parcels		178	13
Total by Area		2422	2776
Total by Alternative	0	2422	2776

*Acreages based on tax roll information, other areas calculated in GIS
[1] Public Land defined as real property owned by Federal, State, or municipal government entities.
[2] Based on estimation that existing easement rights are sufficient for privately-owned land located downstream of Crab Creek x Rocky Coulee WW; additional acquisitions of fee or easement may be needed within this area.
[3] Based on estimation that existing easement rights are sufficient; additional acquisitions of fee or easement may be needed within this area.
[4] Structures impacted is a preliminary count of structures upstream of Crab Creek x Rocky Coulee WW within or close to predicted inundation. There are an additional 10 residences downstream of Crab Creek x Rocky Coulee WW; these residences were not included in the chart due to factors explained in footnote 2.

4.9 Recreation

4.9.1 Impacts of Alternative 1 – No Action

Current recreational uses would not be affected, since no new construction or management practices would occur.

4.9.2 Impacts of Alternatives 2A and 2B - Crab Creek Ephemeral and Perennial

Approximately 2422 acres will be inundated if either Alternative 2A or 2B is selected. Based on county tax records, approximately 1457 acres of the total 2422 acres within the inundated area is publicly owned land (60.1%). This inundation will generally enhance habitat and increase recreational opportunities.

Due to higher water levels, some riparian vegetation will replace upland bird habitat. New upland habitat will likely re-establish itself adjacent to some of these newly inundated areas. Higher water levels would also make additional sections of the creek channel navigable.

It is anticipated that there will be an enhancement to the fishable creek because of increased water in Crab Creek and the instream ponds. During times of drought many of these ponds dry out, and with no flow, the fishery in many areas does not exist. With additional flow, these areas should see an improved fishery. The increase in open water should also attract and hold waterfowl, which will enhance available hunting.

These alternatives would require a winter drawdown of Billy Clapp Reservoir. This drawdown will probably result in an increased level of fish entrainment, including adult kokanee that may result in a slight decrease in the reservoir's fishery.

4.9.3 Impacts of Alternative 3 – Frenchman Hills Wasteway

Approximately 2239 acres of public land, as indicated by information obtained from the tax roll, are likely to be inundated. This public land is mostly owned by Reclamation and the State, and managed by WDFW for habitat and recreational purposes. Major recreational activities include hunting, fishing, and viewing viewable wildlife.

The Dodson-Frenchman's access point will not be affected by the higher water levels. However, other current access opportunities may be inhibited. The Coulee Corridor Scenic Byway sites will be affected by higher water levels. Most of the primitive sites east of Dodson Road will be partially flooded.

The inundation resulting from selection of this alternative will generally enhance wildlife habitat and improve recreational opportunities. Higher water levels would make new recreational access locations possible and additional sections of the wasteway navigable.

Mitigation

Repairs associated with higher water levels in the Frenchman Hills Wasteway will likely consist of grading new parking areas to replace lost area. No other mitigation is anticipated.

4.10 Hazardous and Toxic Materials

4.10.1 Impacts of Alternative 1 - No Action

It is the policy of Reclamation to ensure that contaminated property is never acquired, transferred, abandoned, or disposed and that the costs of remediation are assigned to the appropriate responsible party. Additionally, Reclamation prohibits unauthorized trash disposal and dumping. When sites are identified, and if warranted, reported to State authorities clean up would take place when funding is available.

This alternative would not increase the potential exposure to hazardous and toxic materials nor would it cause an unauthorized release of a hazardous or toxic material into the environment. However, proactive measures would not be implemented to remove potentially hazardous materials within the proposed routes.

4.10.2 Impacts of Alternatives 2A, 2B, and 3.

As property is identified for acquisition, an Environmental Site Survey will be conducted. Any materials or potential effects of hazardous substances that could be exposed to higher levels of surface or ground water would be removed prior to final implementation. This may include the removal of solid waste, closure of underground storage tanks or septic systems, and the removal of any structures, or other appropriate remedial action. The closer to human habitation to greater the likelihood that contaminated sites will be found. As much of the creek area is either open land or farming land, it is likely that there will be no major contamination. At Rd 10 NE, there are existing situations that will have to be addressed, including an existing dairy farm.

4.11 Other Issues

4.11.1 Indian Trust Assets

ITAs have not been identified near any of the proposed alternatives. None of the alternatives would have an impact on legal interests in property or rights held in trust by the Federal government for federally recognized Indian tribes or individual Indians. No impacts would occur on such ITA resources as land, minerals, instream flows, water rights, and hunting and fishing rights held in trust by the Federal government.

4.11.2 Sacred Sites

No impacts would occur to sacred sites because none have been identified near any of the proposed alternatives. If sacred sites were identified during implementation of this alternative, Reclamation would not limit access to these sites, and would take measures to protect their physical integrity.

4.11.3 Environmental Justice

None of the alternatives will have an impact on minority or low-income populations or communities, since none of these communities are known to be in the area.

4.12 Cumulative Impacts

Cumulative impacts are impacts on the environment that result from the incremental effects of the action when added to other past, present, and reasonably foreseeable future actions. This is regardless of what agency (Federal or non-federal), or person undertakes additional actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over time.

Before the creation of the CBP, human impacts in the project area were relatively limited. Inhabitants generally included Native American tribes, fur trappers, missionaries, and ranchers. Impacts associated with early inhabitation generally included minor agricultural/horticultural activities, minor habitation activities, and railroad improvements (Gundy 1998).

The landscape of the CBP has been significantly altered by human interaction with and alteration of the environment. Construction of the CBP involved the construction of impoundment reservoirs, irrigation canals and laterals, and other associated facilities. This also led to the establishment of numerous agricultural activities, and the founding of numerous towns and cities throughout the basin.

Impacts today are generally associated with irrigation activities and community development. Some future anticipated activities that may have impacts on the environment include:

- Future development:
  Potential of future residential and commercial development within and surrounding the project area.

- Moses Lake Total Maximum Daily Load:
  Department of Ecology program that measures various aspects of Moses Lake including sediment, phosphorus, Fecal Coliform Bacteria.

- Columbia River Partnership:
  A State program established because of the need for additional water development in Eastern Washington for economic advancement. Reclamation is assisting with some portions of the study, including the Potholes Supplemental Feed Route.

Future projects that Reclamation is conducting in the CBP area include:

- West Canal Study:
  Areas of West Canal near Ephrata, WA where emergent groundwater is potentially causing problems to the canal, and surrounding areas.

- Trail Lake Section Main Canal Study:
  This section of the Main Canal has problems with seepage. Reclamation will study alternatives to correct the problem.

4.12.1 Impacts of Alternative 1 - No Action

The No Action Alternative would provide water to Potholes Reservoir via existing feed routes, requiring no new construction or changes in project activities. However, if no new feed route is developed, reliability of the supply for the Potholes East Canal system is decreased. No other means for providing feed water are being developed, including the projects listed above. This could lead to negative impacts on various aspects of the southern end of the CBP, including economic and social effects to the South Columbia Basin Irrigation District and its customers.

Other than impacts to Potholes Reservoir, cumulative impacts to the CBP area are not anticipated from this alternative.

4.12.2 Impacts of Alternatives 2A, 2B, and 3

No other projects with similar construction activities or impacts are planned or anticipated in the project area. Implementation of any of these alternatives will not have similar environmental impacts on any known resources.

Each of the above-named actions either is in the process or may be in the process of conducting environmental review. These studies will identify potential impacts on the environment, and may include possible mitigation. To date, none of these studies has identified similar effects to resources discussed in this document.

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