> minimum flow of 300 cubic feet per second (cfs) during the months of July August, September, and October in the Gunnison River from the Redlands Diversion to the confluence of the Gunnison River with the Colorado River. Said flows include water necessary to maintain fish access to critical habitat in the Gunnison River below Redlands Diversion for authorized fish and wildlife purposes (providing suitable endangered fish habitat). During periods of drought when the 300 cfs below Redlands cannot be met, Reclamation will work with the Service and water users to attempt to maintain flows lower than 300 cfs below Redlands for endangered fish. The operation will remain in place until the Aspinall Operations Environmental Impact Statement is complete and Reclamation has issued a Record of Decision on Aspinall Operations to address endangered fish flows in the Gunnison and Colorado Rivers. Operations developed through the environmental impact statement and Endangered Species Act Section 7 consultation process will address long term flow requirements below the Redlands Diversion.

15-Mile Reach Programmatic Biological Opinion (Fish and Wildlife Service 1999b)—This biological opinion addressed the continuation of Reclamation operations and depletions in the Upper Colorado River Basin above the confluence with the Gunnison River; Reclamation's portion of 120,000 af/year of new depletions in the same area; and recovery actions in the Colorado River.

Paonia Project Biological Opinion (Fish and Wildlife Service 2002b)—This opinion, related to a temporary water service contract using temporary capacity in the sediment pool of Paonia Reservoir, calls for a portion of the water in the surplus capacity to be released during the spring spill period of the reservoir.

The Service has consulted on approximately 330 water projects/uses in the Gunnison Basin upstream from the Redlands Diversion. These projects included 11,918 af of new depletions and 171,148 af of existing depletions.

3.0 ENVIRONMENTAL BASELINE

3.1 Baseline

For purposes of this PBA, an environmental baseline was developed which includes the past and present impacts of all Federal, State, and private actions and other human activities in the action area; the anticipated impacts of all proposed projects in the action area that have already undergone formal Section 7 consultation under the ESA; and the impact of State or private actions contemporaneous with the consultation process. This baseline is a "snapshot" of species' health at a specified point in time. Under this baseline, the decision to construct the Aspinall Unit for Congressionally authorized purposes and the decisions to build and operate other basin water projects are past federal, state, or private actions, and by definition, they are part of the baseline.

This chapter provides a description of what is in the baseline, a description of baseline aquatic resources and geomorphology, and a description of baseline Aspinall Unit operations.

3.2 River Geomorphology

The Gunnison River is an alluvial, gravel-bed river in reaches important to the endangered fish. In general, changes in the river such as reduced peak flows, bank protection, and other factors which occurred in the 19th and 20th centuries reduced floodplain connectivity and simplified main-channel habitats.

Sediment inflow under pre-development conditions is unknown; however, it may have been considerably less than at present. It is possible that sediment inflows increased markedly around the beginning of the 20th century due to uncontrolled grazing, mining and timber harvesting and initial development of irrigated lands. Under baseline conditions, sediment inflow to the river has not significantly changed since construction of the Aspinall Unit. A large portion of the total sediment load now consists of silt and clay while bed load consists of sand and gravel-sized sediment. Pitlick et al. (1999) concluded that the key factor in maintaining river habitats was to assure that sediment entering critical habitat continues to be carried downstream so it would not accumulate and reduce channel complexity.

Present sediment inflows to the Gunnison River are significant. While spring peak flows have decreased in the river, sediment inflow to the river apparently has not (Pitlick et al. 1999, Pitlick and Cress 2000) because major sediment sources are downstream from the Aspinall Unit. Pitlick et al. (1999) estimated that the annual sediment load carried all the way through the Gunnison River dropped by more than 40% from 1964 to 1978—the net effect of this would be accumulation of sediment in the river channel causing a loss of channel complexity. Pitlick also noted that between 1979 and 1993 the annual sediment load of the river returned to pre-1964 conditions. Pitlick found that a given incremental increase in flow has a much greater effect on sediment movement at higher flows than at lower flows based on his work on the Colorado River.

Because the Gunnison River has a gravel bed and large-scale changes in the geomorphology of rivers generally come about only as a result of significant bed load transport, large floods are needed to create significant areas of new habitat. More moderate flows can maintain habitats, however.

Geomorphologists identify two important phases in sediment transport: initial motion and significant motion. Initial motion is the level that begins to remove fine sediments from the channel, including the interstitial spaces. Significant motion is characterized by continuous movement of most particles in the channel. Pitlick and Cress (2000) found that in the Gunnison River initial motion occurs at approximately half bankfull discharge and significant motion occurs at approximately bankfull discharge. "Flows equal to or greater than half bankfull are needed to mobilize gravel and cobble particles on a widespread basis, and to prevent fine sediment from accumulating. …Bankfull flows are sufficient to fully mobilize the bed material and thereby maintain the existing bankfull hydraulic geometry (Pitlick et al. 1999)."

In addition to the magnitude of flows, the duration of the flow is important in sediment transport. Based on field observations, Pitlick et al. (1999) recommended that to maintain habitat conditions, half bankfull and bankfull flows should occur with a long-term average equal to what occurred during 1978-1997. To improve habitat conditions the two threshold flows should occur with a long-term average equal to what occurred during 1993-1997. Required duration may best be determined through long-term monitoring.

Median values for initial and significant motion in various reaches of the Gunnison River between Delta and the Redlands Diversion were calculated to be 8,070 cfs and 14,350 cfs based on 54 cross sections. Initial motion begins at one site at 4,660 cfs and occurred at all 54 sites at 12,700 cfs. Bankfull motion begins at one site at 7,352 cfs but is not reached in the entire river until flows exceed 28,719 cfs (Pitlick et al. 1999). Table 6 provides information on the percentage of river cross sections that reach initial and bankfull motion at various river flows. Attachment 4 provides more detailed information on flow levels needed to reach half and bankfull levels at all 54 cross sections.

Based on Pitlick et al.'s (1999) work and using gage data available between 1897 and 1965, the frequency of years where half bankfull flows occurred dropped from 76 % pre-Aspinall Unit to 44 % post-Aspinall Unit. Frequency of bankfull years dropped from 45 % to 6 %. In addition the average number of days per year that flows of 8,070 occurred dropped from 26.6 to 14.5; the range changed from 0-71 to 0-74 days. For flows of 14,350 cfs or more, average number of days per year dropped from 6.5 to 2.5 and the range changed from 0-35 to 0-29 days.

Milhous (1998) conducted an intensive river morphology study on a 1-mile reach of the Gunnison River near RM 38. Twenty cross sections were established in the 1-mile reach. Based on measurements over a 3-year period several sediment transport levels were estimated:

- Flush fine sediments from the surface of the bed – 12,535 cfs
- Remove gravel from pools – 17,000 cfs
- Scour side channels – 7,415 cfs
- Prevent fine sediments from being deposited on riffles where spawning would occur – 950 cfs.

Table 6. Gunnison River: percentage of cross sections reaching initial motion and bankfull thresholds at various flows in critical habitat reach.

Flow (cfs)	Percentage of cross sections reaching thresholds	
	Initial Motion (half bankfull)	Significant Motion (bankfull)
5,000	7	0
6,000	19	0
7,000	33	0
8,000	46	2
8,070	50	2
9,000	69	4
10,000	81	6
11,000	81	13
12,000	94	26
13,000	100	28
14,000	100	46
14,350	100	50
15,000	100	61
16,000	100	67
20,000	100	81

Differences between the Milhous and Pitlick studies result from large bed material in Milhous's study reach. The flow level Milhous determined for preventing fine sediments from being deposited in riffle areas is important during spawning periods to prevent fines from smothering embryos or eggs that might be deposited in the gravels.

Pitlick (1999) also estimated initial motion and bankfull flows for a Colorado River reach downstream from the Gunnison River represented by the Colorado-Utah stateline gage. Initial motion was estimated at 18,538 cfs and bankfull flow at 34,957 cfs. The frequency of years that initial motion was reached decreased from 71 % to 61 % between the pre- and post-Aspinall periods. The frequency of years that bankfull flow was reached decreased from 29 % to 21 %. These changes would reflect water developments in the upper Colorado River in addition to Aspinall Unit operations.

3.3 Past Water Uses and Reservoir and River Operations

Early water uses in the Gunnison Basin were for mining and irrigation. By 1900, most of the readily available sources of irrigation water had been developed by private individuals and small irrigation companies (Colorado Water Conservation Board 1962). Prior to the 1960's, Taylor Park Reservoir was the largest regulating reservoir in the basin, although there were numerous smaller reservoirs on Grand Mesa and elsewhere. By 1960, agricultural water depletions in the basin were estimated at 312,000 af (Colorado Water Conservation Board 1962) and there were additional depletions from domestic uses and reservoir evaporation.

In the 1960-1990 period, several moderately sized reservoirs (Table 1) were constructed in the basin including Ridgway, Paonia, Crawford, and Silver Jack.

The Aspinall Unit was constructed in the 1960-1980 period. Primary water storage at the Aspinall Unit occurs in the uppermost and largest reservoir, Blue Mesa. Water can be released from the reservoirs through the powerplants and/or river outlets (bypasses). As designed, spillway use is limited to periods when the reservoirs have reached high contents. Spillway use at Blue Mesa and Morrow Point is very infrequent. Due to the relatively small powerplant/bypass capacity at Crystal Dam, spills occur more frequently. In general, operation of the Aspinall Unit has changed the natural river flow pattern by storing spring peak flows and increasing flows during the remainder of the year. The effect of these past operations is included in the environmental baseline.

Table 7 summarizes statistics on the Aspinall Unit facilities.

Table 7. Aspinall Unit statistics.

Capacities (acre-feet)	Blue Mesa	Morrow Point	Crystal
Dead storage	111,200	165	7,700
Inactive storage	81,070	74,905	4,650
Active storage	748,430	42,120	12,890
Live storage*	829,500	117,025	17,540
Total storage	940,700	117,190	25,240
Outlet capacities (cfs)			
Powerplants (max)	2,600-3,400	5,000	2,150
Powerplant bypass	4,000-5,100	1,400-1,600	1,900-2,200
Combined powerplant and bypass(max)	6,100	6,500	4,350
Spillway	34,000	41,000	41,350

*-Live storage is the combination of the active and inactive storage. It represents storage that physically can be released from the reservoir.

-Blue Mesa Reservoir shares one penstock for both river outlet and powerplant releases; the combined releases of these two are constrained to about 6,100 cfs.

-The hydraulic capacities shown in the table assume full reservoir conditions. At lower elevations, the hydraulic capacity would be less. Also system efficiencies may affect the hydraulic capacity.

-Full capacity may not always be available due to scheduled maintenance, equipment malfunction, or power system reserve requirements.

-There are no specific recreation or fishery pools in the reservoirs.

Reclamation manages water at the Aspinall Unit within certain sideboards that include annual snowpack conditions, downstream senior water rights, minimum downstream flow requirements, powerplant and outlet capacities, reservoir elevation goals, fishery management recommendations, dam safety considerations, and others. Certain sideboards are non-discretionary such as honoring senior water rights and flood control, while others such as reservoir elevation criteria to reduce landslides are given a high priority

To conserve water for later use and to provide drought protection, an operational goal is to fill Blue Mesa. Full reservoir is 7,519.4 feet; however, operations are designed to reach around 7,517 feet (or less, dependent on forecast) which provides a safety factor for controlling the reservoir in case of sudden high inflow events due to heavy rains or high rate of snowmelt. Another operational goal is to draw Blue Mesa down to an elevation of 7,490 by December 31st to reduce the chance of ice jams and associated flooding upstream.

The five generators at the three dams of the Aspinall Unit are capable of generating up to 283 megawatts of electricity. Morrow Point has the largest capacity—its generators produce more than twice as much electricity as those at Blue Mesa. The Western Area Power Administration (Western) markets electricity generated by the Aspinall Unit in conjunction with power from Glen Canyon and Flaming Gorge Dams and other plants of the Colorado River Storage Project as part of an integrated system that provides electricity to all states of the Colorado River Basin. The upstream powerplants of the Aspinall Unit (Blue Mesa and Morrow Point) are critical in that they are operated to provide load following and peaking power. Crystal Reservoir then is committed as a regulation reservoir to stabilize releases to the Gunnison River. Peaking operations at Blue Mesa and Morrow Point help meet demands for electricity that change on an hourly, daily, and weekly basis.

The environmental baseline includes Aspinall Unit operational conditions before efforts were made to "bundle" surplus or risk of spill water into spring peaks for endangered fish. Spills and bypasses occur under the baseline; however, there is no effort to manage this water for specific endangered species needs. To the extent possible, water forecasted to be spilled or bypassed is released early in the year through the powerplants. Essentially, under the environmental baseline the Aspinall Unit is operated to maximize water storage and hydropower production, and minimize flow variations in the Gunnison River downstream from Crystal Dam.

Baseline hydrology conditions are discussed in Section 3.4 of the assessment while baseline conditions of listed species are presented in Section 4.0. Under the baseline:

- Existing spring flood control operations are continued (using discretion and being proactive to maintain flows below 14,000 cfs or normally considerably less at Delta [Delta City area above the Uncompahgre confluence]). Flood control operations would continue to be coordinated with the city and county of Delta. The Corps of Engineers flood control manual requires that efforts are made to keep flows below 15,000 cfs.

- Blue Mesa winter icing elevation target--7490 feet at end of December—is met to reduce chances of ice jams causing upstream flooding in the Gunnison area, for example in the Dos Rios subdivision area.

- Peaking power operations conducted at Morrow Point and Blue Mesa continue with flows downstream from Crystal regulated through uniform releases to offset impacts of peaking operations upstream. Blue Mesa releases range from 0 to 3,400 cfs and Morrow Point releases from 0 to

5,000 cfs. During Crystal spills, variations in Morrow Point peaking releases are reduced to avoid large daily fluctuations downstream from Crystal.

- Operations continue to meet 300 cfs downstream from the Gunnison Tunnel except in certain cases of significant drought (as determined by reservoir elevation projections) and during Aspinall Unit emergencies when flows may be reduced to 200 cfs as measured at the USGS Gage below the Gunnison Tunnel. Such a decision would be made only after coordinating with the State of Colorado and other interested parties.

- Morrow Point and Crystal Reservoirs' daily fluctuations are limited by landslide criteria.

- Existing contracts and agreements are honored; these documents include provisions for operations in extreme conditions of drought and flooding. There is discretion for operations during emergencies, regular maintenance activities, and extraordinary maintenance.

- Existing water and power contracts from the Aspinall Unit are part of the baseline (note that CRSP power contracts are not "unit specific" but apply to integrated project facilities). Water contracts have flexibility under water shortage conditions.

- The baseline continues to meet power system requirements of the North American Electrical Reliability Council and the Western Electricity Coordinating Council such as generation control, voltage regulation, black start capability, and reserves. For example, Aspinall Unit operations--such as Morrow Point peaking--can be used in emergency situations to prevent major power problems in the West.

- Consistent with authorized purposes, the Aspinall Unit is operated subject to water laws and water rights as decreed under Colorado water law and the Law of the River.

- Existing depletions in the Gunnison River Basin from the exercise of private and public water rights under Colorado law (including evaporation, diversions, transpiration, etc) continue as part of the baseline.

- The estimated portion of the 60,000 af subordination (Aspinall rights subordinated to water uses in the Gunnison Basin upstream from Crystal Dam) being used at this time (8,600 af in place now).

- For purposes of the environmental baseline, it is assumed that projected water uses with completed ESA and NEPA compliance are occurring. This would include full Dallas Creek Project depletions (and Dolores

Project depletions which are now fully developed from the Dolores River) and also include existing contracts with the Upper Gunnison Water Conservancy District and with private and public water users for Blue Mesa water.

- The baseline recognizes that one of the purposes of the Aspinall Unit is "…storing water for beneficial consumptive use, making it possible for the States of the Upper Basin to utilize, consistently with the provisions of the Colorado River Compact, the apportionments made to and among them in the Colorado River Compact and the Upper Colorado River Compact, respectively…".

This use is compatible with the Recovery Program which has a goal of fish recovery and water development. Under the proposed action, "remaining project yield" (not precisely known, but approximately 300,000 af minus subordination water use and existing water contracts) will continue to be stored or go downstream on an interim basis and be modeled as such. It will be recognized that this remaining water may very well be developed in the future, upstream or downstream from the Unit, pursuant to the Colorado River and Upper Colorado River Basin Compacts, and subject to and consistent with the Unit's authorized purposes and other applicable laws. The State of Colorado has identified significant needs through the State Water Supply Initiative process and has significant consumptive use depletions remaining for use under the Colorado River Compact of 1922 and the Upper Colorado River Basin Compact and a portion of this would legally be available for development using sources in the Gunnison Basin. The unused portion of the Unit yield would not be relied on as part of any permanent solution that seeks to provide releases for flow recommendations or any subsequent modifications to them.

The potential use of remaining Unit yield is not modeled because specific foreseeable proposals are not available. Alternative would recognize that consumptive use up to a total of 300,000 af of project yield may be used in the future under Colorado's compact entitlements and its use would not be precluded by the proposed action. When future water sales or uses of portions of the "remaining project yield: from the Unit are proposed, the proposals will be evaluated under NEPA.

If Reclamation determines the proposed sale or use may adversely affect a listed species, ESA consultation will commence. If the Recovery Program has made sufficient progress implementing the Recovery Action Plan, then implementation of the Recovery Program may serve as reasonable and prudent measures or reasonable and prudent alternatives, as appropriate. The Section 7 consultation, sufficient progress, and historic projects agreement for the Upper Colorado River Basin Recovery Implementation

Program, as revised in 2000, provides information on ESA compliance for future projects, such as use of Aspinall Unit yield.

- The baseline includes Taylor Park 1975 and 1991 Agreements and the Taylor Park refill right in place. Up to approximately 100,000 af of Taylor Park water may be stored in Blue Mesa at any given time. Aspinall Unit is operated to protect Uncompahgre Project water stored in Blue Mesa under the Taylor Park Exchange Agreement. The Uncompahgre Project's Gunnison Tunnel and Dallas Creek Project's Ridgway Reservoir exchange continue in place.

- As a general guide, individual flow changes downstream from Crystal are planned to be the greater of 500 cfs or 15 % of flow when ramping up and the greater of 400 cfs or 15 % of flow when ramping down. Higher rates may be used to react to special circumstances, for example for flood control and emergencies or when canyon flows exceed 2,000 cfs.

- Gunnison Gorge flow decreases that could damage brown trout redds after October 15th are avoided when practical. Flow decreases or rapid flow changes are avoided after April 15th for rainbow trout spawning when practical.

3.4 Hydrology and Water Quality

3.4.1 Modeling

The baseline and the proposed changes in storage and release from the Aspinall Unit were modeled. The scope of the model encompasses the Gunnison River Basin from Blue Mesa Reservoir to the confluence with the Colorado River. RiverWare, a software modeling tool developed by CADSWES (University of Colorado) for the Bureau of Reclamation and the Tennessee Valley Authority for operations and planning studies of river basins and river systems, was used. The daily planning model, developed for initial analysis in 2002-2003 was updated in 2007. Various operations of the Aspinall Unit were modeled. The modeling period originally utilized a single 26-year trace from January 1975 through December 2000. The modeling period for this new analysis has been extended through December 2005 and now consists of a single 31-year trace. The model is used as a comparison and planning tool. The proposed action was modeled to determine river flows for the 1975-2005 study period and these flows were compared to modeled baseline flows. Results of modeling estimate conditions as if the baseline or proposed action were in place during the 1975-2005 period. Results are a general prediction of future conditions under the baseline or proposed action; however, actual future hydrology conditions will depend largely on future weather conditions. Additional information on modeling is found in Attachment 12.

3.4.2 River Flows

Table 8 presents modeled baseline peak flows and average monthly flows for the period of study at the Whitewater gage assuming the Aspinall Unit and other water projects in place and operating.

Table 8. Baseline river flows (average monthly cfs), Gunnison River at Whitewater, for period of record used in Biological Assessment analysis assuming Aspinall Unit and other water projects and uses in place and operating.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Peak daily mean for Year
1975	766	751	1326	3`93	6385	5467	3589	1937	2082	1993	1683	1650	8927
1976	1226	1286	1121	1678	3429	2484	1721	1120	1524	1628	1122	858	5130
1977	880	771	812	768	846	761	795	750	774	883	868	753	1581
1978	745	676	841	3581	6361	5805	2426	1319	1370	844	972	1149	10678
1979	1767	2711	2746	4571	9213	6919	2879	1680	1739	1635	1511	1412	15164
1980	1214	2580	1955	4225	9887	7174	2330	1305	1291	1007	1337	1518	13884
1981	1064	600	887	1337	1542	1393	1021	923	1181	1455	1083	823	3773
1982	1279	1388	1310	3463	6959	4748	2475	2077	2787	2731	2502	2443	9140
1983	1436	1360	1865	2839	8631	13662	7850	3138	2207	2477	2284	2582	20640
1984	2848	2630	2703	4968	13738	13722	6757	2894	2525	2998	2955	3180	20782
1985	2835	2360	2021	6747	10494	10121	3312	1567	2319	2723	2557	2655	15186
1986	2519	1744	3803	5796	8378	6447	5018	1995	2747	3378	3236	3305	10357
1987	2073	1885	2035	5198	6706	5877	2023	2088	2369	1851	1575	1569	9241
1988	1145	1301	1168	2309	2206	1901	1509	963	1351	1148	937	867	3436
1989	1027	1278	1790	2566	1805	1594	1442	1110	1258	1148	970	892	2465
1990	778	725	792	1007	1643	1662	1363	908	1156	1353	1163	1194	2574
1991	988	919	1042	1854	4985	4124	1937	1680	2073	1942	1702	1813	8412
1992	1135	956	1175	3314	3712	2731	2088	1702	1784	1961	1716	1396	6063
1993	1083	1325	2857	4991	12960	9242	3771	2220	2374	2650	2244	1969	20492
1994	1344	1230	1505	2167	3534	2830	1568	1251	1562	1771	1579	1518	4919
1995	1143	1056	2700	3797	8893	13680	12698	3043	2695	2780	2832	2762	19346
1996	1674	2286	2858	4046	5822	3341	1903	1541	2065	1956	1982	2079	7860
1997	2706	2739	2972	4431	8647	8757	3408	2517	3232	3188	2824	2730	11996
1998	1582	1469	2141	3646	7196	3200	2295	1545	1890	2049	1841	1732	9877
1999	1178	1159	1461	1383	3276	4499	2851	2882	2751	2468	2229	2188	6793
2000	1456	1464	1609	2764	2729	1831	1661	1141	1440	1623	1246	1133	4817
2001	1073	924	1176	1520	2939	2184	1817	1545	1841	1689	1403	1358	3487
2002	1069	911	904	1095	918	731	708	835	1097	1154	883	749	1153
2003	705	699	787	1169	2998	1809	629	767	1233	1020	859	753	5312
2004	754	730	1117	2039	2409	1543	1385	936	1325	1306	981	887	3413
2005	1206	1734	1578	4324	8022	4545	2184	1478	1686	1949	1528	1221	13574
Avg	1377	1408	1711	3122	5718	4993	2820	1641	1862	1895	1697	1650	

Development of water resources in the Gunnison Basin began in the late 19th Century, primarily for irrigation. Storage reservoirs were generally small and spring peak flows, while reduced, remained high. The extensive irrigation diversions significantly reduced summer and fall base flows and probably increased summer water temperatures and concentrations of pollutants.

Construction of storage reservoirs, including the Aspinall Unit, increased significantly in the second-half of the 20th century and greatly reduced spring peak flows while tending to increase base flows from early to mid-20th century levels (Figure 5 in Section 4.3). Tyus and Saunders (2001) concluded that the Aspinall Unit resulted in extreme alteration of historic flows in the Gunnison River.

The Aspinall Unit has not significantly changed the annual volume of water flowing downstream but has changed the flow pattern. The Aspinall Unit's operation has tended to increase flows from August through March or April and to reduce flows in May through July. Extreme low flows in the lower Gunnison have largely been eliminated. Prior to operation of the Aspinall Unit, average monthly flows at Whitewater were often below 900 cfs and occasionally below 200.

3.4.3 Water Quality

Butler (2000) summarized water quality data for the Gunnison River in critical habitat under baseline conditions. Three parameters were reported to exceed State water-quality standards (for which 85th percentile concentrations exceeded numeric standards) for the Gunnison River-sulfate, total iron, and selenium. Other constituents occasionally exceed standards but the 85th percentiles were less than the standards. Water released from the Aspinall Unit is of very high quality and tends to dilute inflows of pollutants from tributaries such as the North Fork and Uncompahgre rivers. Overall, operations of the Aspinall Unit have improved chemical water quality conditions in the critical habitat of endangered fish. Attachment 5 contains detailed water quality data collected by the U.S. Geological Survey at the Whitewater gage and in the Colorado River in critical habitat.

Of the elements that exceed state standards, selenium is of concern to fish and wildlife resources. Potential biological effects of selenium concentrations are discussed in Section 4.3. It is estimated that deep percolation and seepage of water from irrigation and irrigation systems contribute about 90 % of the groundwater that mobilizes selenium in the basin (Reclamation 2006). It is estimated that 60 % or more of the selenium loading measured at the Whitewater gage originates from an area encompassing the Uncompahgre River basin and the service area of the Uncompahgre Irrigation Project; the remainder from private water uses, other federal projects and natural inputs. Loading is highest from newly irrigated lands and gradually subsides. Selenium loading to the Gunnison River primarily results from canal/lateral seepage and deep percolation from irrigated fields, lawns, and ponds. Runoff from desert lands with Mancos shale derived soils is another source. The majority of the loading to the Gunnison River occurs on the east side of the Uncompahgre Valley and the majority of the loading to the Colorado River occurs in the Grand Valley. Hamilton (1999) reported that selenium concentrations in the early part of the 20th century were significantly higher in major rivers and tributaries than at present and hypothesized that these extreme concentrations may have played a significant role in the decline of the fish. Concentrations in the Gunnison River as high as 80 ppb were reported during this period (NIWQP display based on Hamilton 1999).

Attachment 6 includes graphs of dissolved selenium concentrations from 132 samples taken at various flows between 1976 and 1998 at the Whitewater Gage. The graph shows a general inverse correlation between flow rate and selenium concentration. However, the corresponding selenium concentration varied widely at flows under 4,000 cfs. For instance, the maximum recorded selenium concentrations corresponding to flows greater than 4,000 cfs was 3 ppb while at flows between 2,000 and 3,000 cfs concentrations varied from 1 to 10 ppb. The median value for these samples was 5 ppb; the Colorado chronic water quality standard for selenium is 4.6 ppb. Attachment 6 also contains tables of average monthly, average annual, maximum annual and minimum annual selenium concentrations through the study period for baseline and the proposed action.

Concentrations of selenium in the lower Gunnison River and elsewhere in the Colorado River Basin may be a concern for endangered fish. During informal consultation, the Service has requested that selenium issues be addressed in this PBA.

Beginning in the late 1980's, Reclamation, the Service, the U.S. Geological Survey and others participated in the National Irrigation Water Quality Program (NIWQP) to identify selenium sources and problems and to implement solutions. The NIWQP determined that "Selenium concentrations in the lower Gunnison River are at levels that adversely affect reproduction in selenium sensitive species including some aquatic birds and endangered fish." The Service (1994) recommended *in situ* studies to help determine whether trace elements such as selenium are limiting razorback survival in the Gunnison. Concerns were also noted in certain backwaters of the Green and mainstem Colorado River and in the Colorado downstream from the Gunnison confluence. Further, in a December 1998 memo, Region 6 of the Service stated the "The Service believes that the remediation of selenium impacts is one of several factors that needs to be addressed as part of the overall effort to recover the Colorado River endangered fishes."

In August 2002 the Service published Recovery Goals for the razorback sucker and Colorado pikeminnow which include:

> "Selenium is hypothesized as contributing to the decline of the endangered fishes of the Colorado River Basin (U.S. Fish and Wildlife memorandum, December 22, 1998). It is a water quality factor that may inhibit recovery by adversely affecting reproduction and recruitment (Stephens et al. 1992; Hamilton and Waddell 1994; Hamilton et al. 1996; Stephens and Waddell 1998; Osmundson et al. 2000a). Selenium concentrations in certain areas of the basin (e.g., Green River near Jensen, Utah; Gunnison River downstream from the Uncompahgre River confluence; and upper Colorado River downstream from Palisade, Colorado) exceed those shown to impact fish and wildlife elsewhere, and, although results are inconclusive as to exposure thresholds that cause specific effects, some studies suggest deleterious effects on razorback

> sucker and Colorado pikeminnow. The National Irrigation Water Quality Program is addressing selenium issues in the upper basin by implementing remediation projects to reduce selenium levels in areas of critical habitat. The adverse effects of selenium contamination on razorback sucker reproduction and survival will be reevaluated before downlisting and necessary protection will be implemented before delisting."

In 1998, the NIWQP began actions to mitigate selenium impacts both in the lower Gunnison River basin and in the Grand Valley in the vicinity of Grand Junction. However, funding for the NIWQP was suspended in 2004.

In 1997, the Colorado Water Quality Control Commission (Commission) lowered the state selenium standard for aquatic life to 4.6 ppb in the lower Gunnison River to be consistent with the EPA national standards. The Commission also requested that a group of local, state, and federal agencies organize and work to specifically reduce selenium loading.

As a result, the Gunnison Basin Selenium Task Force (Task Force) was formed in 1998 to address exceedance of the State's water quality standard for selenium in four stream segments including the lower Gunnison River. The Task Force is "a group of private, local, state and Federal interests committed to finding ways to reduce selenium in the affected reaches while maintaining the economic viability and lifestyle of the lower Gunnison River basin." Task Force members include City of Delta, City of Montrose, Colorado Department of Health and Environment, Colorado Division of Water Resources, Colorado Division of Wildlife, Colorado River Water Conservation District, Colorado Soil Conservation Board, Colorado State University Cooperative Extension, commercial farmers, ranchers, and dairymen, Delta County Commissioners, Delta County Health Department, Delta Soil Conservation District, High Country Citizens Alliance / Sierra Club, Montrose County Commissioners, Natural Resources Conservation Service, Shavano Soil Conservation District, Towns of Hotchkiss and Paonia, Uncompahgre Valley Water Users Association, Reclamation, the Service, the U.S. Geological Survey and others. The Task Force staff has recently been funded by the Colorado River Water Conservation District and Reclamation. Additional funding in earlier years was acquired through grant programs.

In addition to specific selenium reduction activities, extensive salinity-control activities have been underway in the lower Gunnison River basin as well as along the mainstem Colorado in the Grand Valley and in the Green River basin. These activities also contribute to the reduction of selenium loading.

Significant salinity control efforts began first in the Grand Valley where 246 miles of canals and laterals have been lined or placed in pipe and 34,565 acres have been treated with on-farm measures. Although targeted at salinity reduction, these projects also reduce selenium loading. In addition, backwater areas at the Orchard Mesa and Colorado River Wildlife Areas have been treated under NIWQP to reduce selenium concentrations in areas used by endangered fish and these efforts have been partially successful.

The first improvements in the Lower Gunnison area occurred under the Natural Resources Conservation Service's salinity control programs and later under the EQIP. Work generally involved on-farm irrigation efficiency improvements aimed at reducing deep percolation and salt loading. The EQIP remains active in the lower Gunnison basin. The major practices being installed are underground pipelines, ditch lining, land leveling, irrigation water control structures, sprinkler systems, gated pipe, and surge irrigation systems**.** Approximately $54 million has been expended to reduce salinity loading by 88,000 tons per year through fiscal year 2007. Unquantified reductions in selenium loading have also very likely occurred due to this work.

During the early 1990's, Reclamation implemented a project to replace the use of Uncompahgre Project canals and laterals carrying winter livestock water with a system of piped domestic water delivery facilities; and this reduced seepage throughout the Uncompahgre Valley. This program had a total cost of $24 million and reduced the loading of an estimated 41,000 tons of salt annually and an unquantified amount of selenium.

Beginning in 1998, targeted selenium control projects in the lower Gunnison River Basin have been developed through the efforts of the Reclamation-funded NIWQP, the Gunnison River Basin Selenium Task Force, and Uncompahgre Valley Water Users Association (UVWUA). Successful applications have been awarded project funding by the CRBSCP. This funding has been supplemented by NIWQP funding and in-kind services from the UVWUA. An initial lateral piping project was constructed south of Montrose in the Montrose Arroyo drainage (Phase I, East Side Laterals Project). The USGS reported significant selenium and salinity load reductions as a result of this project. Based on the success of that project, additional projects (Phases 2 and 3) have been funded by the CRBSCP, supplemented by Congressional "write-ins" for selenium control and continued in-kind services from UVWUA. These projects involve the piping of unlined irrigation laterals on the east side of the Uncompahgre Valley, the highest selenium loading area in the lower Gunnison River Basin. Approximately 51 miles of irrigation laterals on the east side of the Uncompahgre Valley have been placed in pipe, or are presently funded for piping, to reduce salt and selenium loading. This effort is summarized in Table 9.

Figure 2 indicates a general reduction in selenium concentrations in recent years, probably as a result of activities discussed above. The increase in concentrations in the 2002-2004 period results from the extreme drought and low water conditions in that timeframe.

Table 9. Status of East Side Uncompahgre Valley Laterals Project***.**

Phase	Original length of piped laterals (miles)	Salt reduction (tons/yr)	Salinity Program Funding ($)	Selenium Funding ($)	Total Funding(1) ($)
1	8.5	2,300	695,366	550,809	1,246,175
2	20.5	6,100	2,133,000		2,133,000
				1,706,000	1,706,000
3	10.5	2,300	1,262,561		1,262,561
4	11.4	3,651	2,002,285	800,000	2,802,285
total	50.9	14,351	$6,093,212	$3,056,809	$9,150,021

*Total Funding does not include resources and in-kind services contributed by the Uncompahgre Valley Water Users Association.

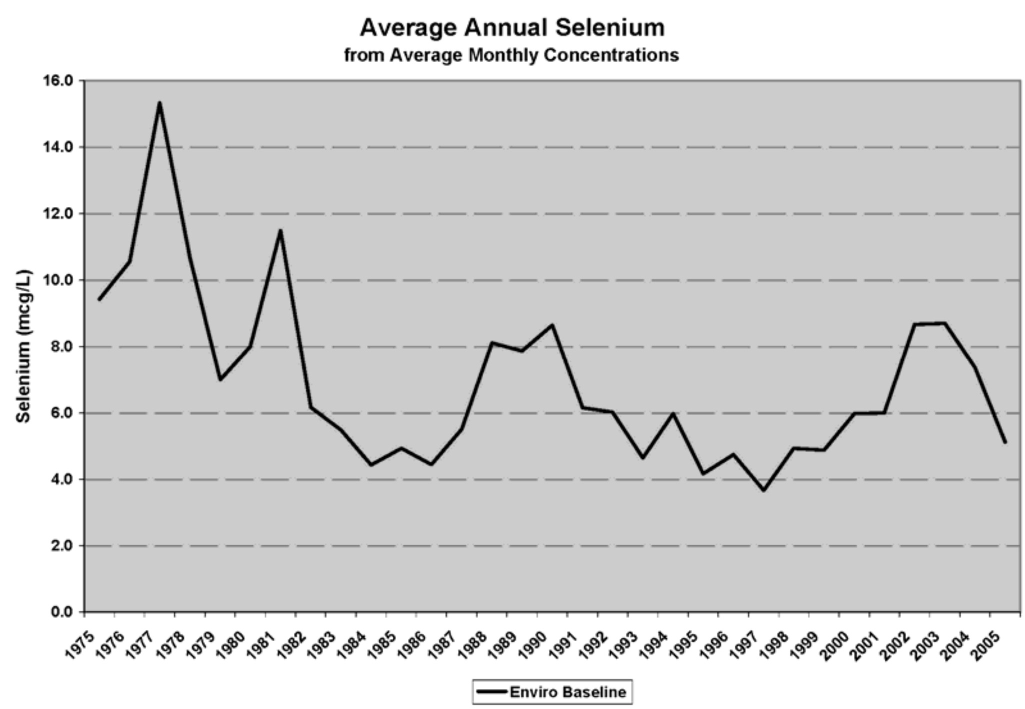

Fig 2. Baseline average annual selenium concentrations, Gunnison River at Whitewater gage.

In 2006, Reclamation in conjunction with the Task Force produced an appraisal-level report evaluating selenium remediation concepts for the lower Gunnison River Basin (Bureau of Reclamation 2006a). The purpose of the report was to determine the reasonableness of attaining certain water quality goals. The report identified two remediation alternatives.

Alternative 1: Water Quality Standard Attainment Plan to meet State water quality standard
Alternative 2: Endangered Species Protection Plan to meet the NIWQP goal for food organisms

Based on 1997-2001 streamflow levels, the following selenium reduction amounts were estimated for these two alternatives:

Alternative 1: Meet selenium water quality standards (85th percentile value of 4.6 ppb)

Meet standard at:	Load reduction needed
Uncompahgre River at Delta	5,630 pounds/year
Gunnison River at Whitewater	5,000 pounds/year

Notes: 1) these values are not additive; if 5,630 lbs/year is reduced in the Uncompahgre, the standard is met at Whitewater; 2) the period of record for this computation was 1997-2001; using a different period will likely change the required load reduction.

Alternative 2: Meet the NIWQP goal of 3 ppm in food organisms

Meet goal at:	Load reduction needed
Gunnison River at Whitewater	~ 13,000 pounds/year

Notes: 1) The 5-year average selenium load is about 7,600 pounds/year for the Uncompahgre River at Delta and 19,400 lbs. /year for Gunnison River at Whitewater.

The projected load reductions needed to meet the State Standard (Alternative 1) were based on detailed USGS studies and have a reasonable level of certainty. In the case of Alternative 2, the estimate of selenium reduction needed to meet 3 parts per million (ppm) is of much lower certainty, being based only on rough approximations developed by the NIWQP. Reclamation considers the selenium load reduction needed to meet the 3 ppm goal in food organisms to be unknown.

The 2006 report suggested that Alternative 1 - meeting the state water quality standard for selenium in the lower Gunnison and Uncompahgre Rivers - was technically attainable based on the selenium reduction needed for the 1997 to 2001 period of record. Alternative 1 includes piping 127 miles of laterals and lining 19 miles of canals on the east side of the Uncompahgre Valley along with significant on-farm and other improvements. Based on the 2006 report, it was projected that if all these improvements are implemented, selenium loads would be reduced by 4,300 to 6,100 pounds/year.

The quantification of the selenium reduction needed to meet the state standard in the lower Gunnison River is dependent on the hydrologic period of record selected. A 2008 study completed by the USGS (for use in developing the State's TMDL) uses a 2001-2005 period and documents the need to reduce the load by about 8,600 pounds per year to achieve the standard during that time period.

The availability of funding is the primary limiting factor in implementing selenium and salinity reduction plans. Additionally, the continuing implementation of beneficial salinity control projects is dependent on the competitive selection of such projects by the CRBSCP and supplementary funding provided via Congressional “write-ins” garnered by the UVWUA and others. The continuation of both the CRBSCP and EQIP are dependent on Congressional funding.

It should also be noted that urban/suburban growth and land-use changes are believed to significantly affect both selenium and salt loading in the area. Some trends appear to be downward, but growth that occurs on lands that were not previously irrigated (and leached) and new aesthetic or recreational ponds may be countering the trends. Studies are currently underway by the US Geological Survey to evaluate land use changes and effects on salinity and selenium loading. These studies are being funded through the CRBSCP.

Another water quality consideration, water temperature, can affect the life cycles of the fish. Early irrigation diversions and return flows probably tended to increase water temperatures in the Gunnison River and its major tributaries year-round. Later construction and operation of the Aspinall Unit has tended to lower downstream temperatures in the summer and raise them in the winter, due to hypolimnion releases from the reservoirs. Stanford and Ward (1983) reported that the river immediately downstream from the Aspinall Unit was several degrees warmer in the winter and 7-10 degrees C cooler in the summer. Before reservoir regulation, annual degree days increased from 2,895 to 4,132 between the East Portal and Whitewater; and after regulation increased from 1,361 to 3,432.

Table 10 presents recent temperature data from the Gunnison River collected under the Recovery Program. There is a general inverse correlation between flow and water temperature at Delta and Whitewater with higher releases resulting in lower water temperatures (for example, see 1993, 1995, and 1997 in Table 10), although this is not always true as other variables such as tributary flow and weather affect the temperatures also. Additional water temperature data and the relationship between temperatures at Crystal Dam and the Whitewater gage are found in Attachment 6. Spring and summer water temperatures in areas such as backwaters would be expected to be higher than in main channel areas.

3.4.4 Climate Change

In determining what future effects are reasonably certain to occur, Reclamation must determine the difference between future effects that are speculative, and effects that are likely to occur under the environmental baseline as compared to the proposed actions. The hydrologic and water quality models included variability designed to reflect conditions likely to occur over the 25 year time frame for this consultation. However, future climatic conditions could be warmer, wetter, cooler, or drier than the modeled conditions.

Table 10. Mean summer water temperature (degrees C) of the Gunnison River at the Delta and Whitewater gages, 1992-2000 (from McAda 2003).*

Year/Month/Mean Flow at Whitewater+	Gunnison River at Delta	Gunnison River at Whitewater	Year/Month/Mean Flow at Whitewater+	Gunnison River at Delta	Gunnison River at Whitewater
1992			1997		
Jun 2,819 cfs	16.1	17.9	Jun 8,184 cfs	13.2	12.6
Jul 1,806 cfs	17.6	20.3	Jul 3,595 cfs	16.2	18.1
Aug 1,716 cfs	17.5	20.6	Aug 2,474 cfs	17.7	19.7
Sep 1,570 cfs	15.4	17.9	Sep 3,257 cfs	15.8	17.1
1993			1998		
Jun 9,054 cfs		13.2	Jun 3,273 cfs	14.3	16.2
Jul 3,279 cfs		18.1	Jul 1,913 cfs	19.0	21.7
Aug 2,157 cfs		19.3	Aug 1,472 cfs	18.0	
Sep 2,377 cfs		16.1	Sep 1,879 cfs	15.7	
1994			1999		
Jun 2,567 cfs		19.0	Jun 3,549 cfs	15.0	
Jul 1,263 cfs		21.7	Jul 2,423 cfs	18.4	
Aug 1,276 cfs		21.8	Aug 3,418 cfs	16.5	
Sep 1,701 cfs		17.1	Sep 3,172 cfs	14.6	
1995			2000		
Jun 13,050 cfs	11.4	12.0	Jun 1,941 cfs	16.5	19.5
Jul 11,950 cfs	13.5	13.7	Jul 1,520 cfs	18.6	21.6
Aug 3,162 cfs	17.7	19.5	Aug 1,792 cfs	18.1	20.8
Sep 2,399 cfs	15.5	17.0	Sep 1,799 cfs	15.7	17.0
1996					
Jun 4,034 cfs	14.8				
Jul 2,283 cfs	17.7				
Aug 1,391 cfs	18.6				
Sep 2,022 cfs	15.0				

*Data were compiled from thermographs maintained by the Recovery Program
+Monthly mean flow at U.S.G.S. gage at Whitewater

There is some general consensus among the scientific community that the West will experience warmer temperatures, longer growing seasons, earlier runoff of snowmelt, and more precipitation occurring as rain rather than snow. Specific predictions for the Gunnison Basin are highly speculative; however, predictions for the overall Colorado River Basin natural flows have ranged between reductions of 6 to 45 percent over the next 50 years (Reclamation 2007). Recent reports (Ray et al 2008) suggest continued warming in Colorado with less clear trends in annual precipitation, although in general lower and earlier runoff is predicted.

In the long-term, the timing and quantity of runoff into the Aspinall Unit may be affected and may affect expected results from the baseline or implementation of the proposed action either in a positive or negative manner. It is possible that the frequency of dry and moderately dry type years will increase, thus reducing the ability of the rivers to move sediment and maintain or improve habitat conditions. Conversely the magnitude of runoff events could become more variable and extreme and still provide conditions for sediment movement.

The hydrology modeling for this assessment does not project future inflows, but rather relies on the historic record to analyze a range of inflows. As discussed elsewhere in this assessment, the inflow to the Aspinall Unit has historically been highly variable and operations under the proposed alternative are planned to address this variability. The study period used in this analysis includes drought periods and both extremely dry and extremely wet years. Because the action being considered does not involve new construction of storage facilities or outlet features, sizing of facilities in relation to future climate is not a consideration. In addition, neither the baseline nor the proposed action itself are viewed as having any effect on climate.

The proposed alternative also includes an adaptive management process, supported by Recovery Program monitoring, to address new information about the subject endangered fish, their habitat, reservoir operations, and river flows. Reclamation will also continue to support multi-faceted research on climate change (Reclamation 2007). If climate results in effects to the listed species or critical habitats that were not considered in this PBA, then Reclamation would reconsult.

3.4.5 Water Rights

Gunnison River Basin water use began in the 19th century with the establishment of numerous irrigation water rights by individuals, organizations, and government agencies. There are more than 5,000 water rights for direct flow diversions presently in use on the river and its tributaries for irrigation, recreation, and municipal and industrial uses. There are an estimated 264,000 acres of irrigated land in the Basin (Colorado Department of Natural Resources 2006). Significant senior diversion rights established prior to 1910 include the Gunnison Tunnel of the Uncompahgre Project (1,300 cfs) located 2 miles downstream from Crystal Dam and the Redlands Diversion (750 cfs), located on the Lower Gunnison River 3 miles upstream from the Colorado River confluence. The 1933 Federal reserved right for the Black Canyon of the Gunnison National Park, also downstream, is currently being quantified and is predicted to be compatible with the proposed action under this PBA.

In addition to water rights for direct diversions and instream flows, there are significant storage and hydropower rights in place on the Gunnison River. The largest single perfected storage right is the 952,000 acre-foot decree for Blue Mesa Reservoir. There are also numerous small reservoirs and several larger Reclamation project reservoirs on tributaries with storage rights: Taylor Park Reservoir on the Taylor River, Silver Jack Reservoir on Cimarron Creek, Crawford Reservoir on the Smith Fork, Paonia Reservoir on the North Fork, Ridgway Reservoir on the Uncompahgre, and Fruitgrowers Reservoir on Alfalfa Run (see Attachment 1).

4.0 GUNNISON RIVER AQUATIC RESOURCES

Prior to water development in the Gunnison River, the upper river supported Colorado River cutthroat trout along with speckled dace, flannelmouth and bluehead suckers, and less common roundtail chubs and perhaps mottled sculpin (Wiltzius 1978); however, by