



**Version: 2016**

## **CHRONOLOGICAL DROUGHT MANAGEMENT PLAN AMENDMENTS**

### **2002-2016**

#### **Addendum 2002 - Definition**

Flow trigger levels will be based on the Average Daily Flow measured in cubic feet per second (cfs). Therefore, flows will be reviewed the following day to determine trigger levels and fishing closures.

#### **Addendum 2002 - Publicity**

It is recognized that flow levels, forecasting, and angling closures affect local businesses and residents. Whenever possible, maps and specific locations will be included in press releases and other communications (MFWP website).

#### **Addendum 2004 - Publicity and Outreach**

The BHWC will issue weekly updates to irrigators during drought periods. Weekly updates will be provided in hard copy, electronic mailings, and on the BHWC website. In non-drought periods, the BHWC will issue regular updates as needed. The BHWC will work with MFWP on press releases and other public outreach efforts. The BHWC will work with local newspapers and televisions to secure flow updates in these communication mediums. The BHWC will issue an annual update in the form of a mailing (hard copy and electronic) which will include: a copy of the most recent Drought Management Plan, flow forecasting, updates on water conservation programs and assistance, and other related news items.

#### **Addendum 2004 - May 15- June 30 Wisdom Reach Flow Levels (J. Magee MFWP)**

##### Upper Reach:

160 cfs May 15 – June 30: When flows decrease below 160 cfs, a phone tree will be used to contact water users advising of flow conditions and encouraging conservation measures.

20 cfs: MFWP will close the upper river to fishing and will not conduct electrofishing surveys. (Subject to approval or change by the Fluvial Grayling Workgroup.)

##### **Rationale:**

1) The upper and lower wetted perimeter inflection points for the upper Big Hole River are 160 and 60 cfs respectively (MFWP 1989). The upper inflection point is the flow required to maximize standing crop. While this

flow may not be realistic in most years it should be the target goal for conservation measures. Maintaining this flow during grayling spawning and emergence in May and June will enhance survival and recruitment. Reduction of wetted perimeter is accelerated below the lower inflection point of 60 cfs. The flow goal for late summer and fall should be to maintain flows at 60 cfs or greater to avoid accelerated losses in standing crop. A minimum survival flow of 20 cfs will provide flows necessary to maintain a wetted channel, allow for migration into flow and temperature refugia, and allow survival of some portion of the population during brief, critical periods.

2) MFWP will not conduct electrofishing survey in the Wisdom West reach (Wisdom bridge downstream approximately 5 miles) if flows are less than 20 cfs and maximum daily temperatures are greater than 64°F.

### **Addendum 2004 - Thermal Series for the Middle Reach (R. Oswald, MFWP)**

**Rationale:** Last summer, we encountered extremely high water temperatures at the Sportsman's Park Thermograph (MFWP) in the Middle Reach. These temperatures often exceeded our Upper Reach Drought Plan standard of 70° F for more than 8 hours per day for 3 consecutive days. When we consulted the Drought Plan, we found a somewhat contradictory set of standards at the 3 triggers. That is, each flow trigger (100, 80, and 60 cfs) contained the same default thermal statement, i.e., "*or temperatures exceed 70° F for over 8 hours per day for 3 consecutive days.*" This left us with a situation in which the river would have closed to angling at any time we encountered the temperature standard at 100 cfs or less. Moreover, the only standard for reopening the river following closure was linked to seven consecutive days of flows greater than 80 cfs. Thus thermal closure at flows less than 80 cfs would have required the same reopening criteria as flows below 60 cfs. The alternative of changing "or" to "and" in the thermal series also didn't work because that would have rendered any temperature considerations redundant as the drought response actions would have defaulted to the flow triggers. In order to cope with the problem, we (MFWP) monitored key segments of the reach for biological indicators of thermal stress. In order to eliminate this problem in the future, I have drafted the following proposed Thermal set of Triggers for the Middle Reach. The set of Triggers parallels the series currently applied to the Upper Reach.

#### Temperature (July 15 – September 1)

Step 1: When Temperatures exceed 70° F. for more than 8 hours per day for 3 consecutive days at the MFWP Sportsman's Park Thermograph and flows exceed 90 cfs at the USGS Mudd Creek Gage, a phone/email tree is used to contact outfitting businesses and a news release is issued advising publics and anglers of potentially stressful conditions to the fishery and encouraging anglers to seek other destinations (reservoirs, mountain lakes and streams, spring creeks, etc.).

Step 2: When flows are 70 – 90 cfs at the USGS Mudd Creek Gage and temperatures exceed 70° F. for more than 8 hours per day for 3 consecutive days, and evidence of thermally induced stress to the fishery occurs\*, MFWP will close the Middle Reach to fishing. News releases will be issued and a phone/email tree will contact local outfitting businesses. The Middle Reach will remain closed to fishing until temperatures do not exceed 70° F. for more than 8 hours per day for 3 consecutive days and flows are greater than 80 cfs for 7 consecutive days.

\* Thermally induced stress as observed by trained, experienced observers may include any of the following: observed mortality in significant numbers of Age I and older mountain whitefish and other salmonid species in lieu of other logical sources of mortality; outbreaks of stress related piscid diseases such as Bacterial Furunculosis; extraordinary concentrations of fish in thalweg or riffle tailout habitats; hyperactivity (e.g. gasping, rolling, jumping, etc.) of large, concentrated numbers of fish; and frenzied feeding activity at inappropriate times and under inappropriate conditions.

Step 3: When flows are 70 cfs or less at the USGS Mudd Creek Gage and temperatures exceed 70° F. for more than 8 hours per day for 3 consecutive days, MFWP will close the Middle Reach to fishing. News releases will be issued and a phone/email tree will contact outfitting businesses. The Middle Reach will remain closed until temperatures do not exceed 70° F. for more than 8 hours per day for 3 consecutive days and flows are greater than 80 cfs for 7 consecutive days.

**Addendum 2005 – Voluntary Angling Limits (R.Oswald, MFWP)**

Modify the Second Trigger language to request anglers “voluntarily limit their angling activities to earlier, cooler hours of the day”. **Rationale:** It does not necessarily make sense to limit angling to morning hours because differing climatic conditions and flow regimes result in high water temperatures well before noon on some days, while other days exhibit cool water temperatures well into the early afternoon. This approach sends the message to consider the temperature *and* time of day as diminishing flows compound stress on the system.

**Addendum 2007 - Proposal to Replace Original Language in the Drought Plan with the Accepted Amendments.**

**Rationale:** The current format of the Drought Management Plan is confusing. The initial read lists criteria that are no longer in affect and the Amendments in the back appear to contradict the Plan. **Recommendation:** The original language of the Plan should be replaced by the current appropriate Amendments. Maintain the list of Amendments in the back of the Plan to maintain the history and reasoning behind the changes.

**Addendum 2007 (a) –Split the Lower Reach into Two Reaches and Incorporate a Thermal Series into the New Lower Reach (R. Oswald, MFWP)**

**Rationale:** The present reach from Dickie Bridge to the mouth is 71 miles in length and spans a very wide range in flows, species composition, and thermal regime. A single set of triggers often spans a flow range of 200 cfs or more and temperature ranges of 8 degrees or more. Moreover, trout species domination downstream of Melrose favors brown trout (which data show to be more severely affected by low flows than rainbow trout, which increase in dominance upstream from Melrose).

**Recommendation:** Split current reach from Melrose Bridge (Salmon Fly Fishing Access) (about 33 miles downstream and 38 miles upstream) into the Dickie Bridge to Melrose Bridge Reach and the Melrose Bridge to the Confluence with the Jefferson River Reach. In the Melrose Bridge to Mouth Reach, maintain original flow triggers generated below the WETP Minimum Flow. Return Dickie Bridge to Melrose Bridge Reach to original 1994 calculations of 260 -200 -140 cfs (see Addendum 2007(b)). Incorporate a series of Thermal Triggers similar to those in place for the upper reaches of the river to be measured at MFWP Thermographs at Notch Bottom and at Melrose Gage.

\*\*\*Consider adding an additional component for PM closure under any flows below 260 cfs when temperatures at Notch Bottom or Pennington Bridge exceed 72 degrees for more than 8 hours per day for 3 consecutive days. Lifting of closure when daily temperatures do not exceed 70 degrees for more than 8 hours per day for at least 3 consecutive days.

**Addendum 2007 (b) – Return Dickie Bridge to Melrose Bridge Reach Flow Triggers to Original 1994 Calculations of 260 -200 -140 cfs (R. Oswald, MFWP).**

The original triggers were generated from MFWP WETP Minimum Flow (and Instream Flow Reservation) of 260 cfs which represents a 40% depletion of wetted perimeter from the Upper Inflection Point Flow of 60 cfs. The original closure trigger was calculated to be 140 cfs, representing an additional 21% depletion in Wetted Perimeter from the minimum and closely approximating the August 95% Exceedence flow at the USGS Melrose

Gage. The second stage trigger represents the mid-point between the Upper and Lower Trigger Flows. Dropping the Stage 3 Closure Trigger from 150 to 140 cfs represents an additional loss in Wetted Perimeter of 5 feet and 4% of the total 21% depletion from the 260 cfs minimum. This would maintain a better biologically defensible base for the triggers and bring the Stage 3 (Closure) Trigger into compliance with current MFWP statewide Drought Policy. **Recommendation:** Adjust the Dickie Bridge to Melrose Bridge Reach Triggers as recommended.

**Addendum 2008 – Dickie Bridge to Melrose Reach: Reassign Official Plan USGS Gage Site from Melrose to Maiden Rock and Adjust Flow Plan Triggers back to ADF's of 250, 200, and 150 cfs with Angling Re-opening Trigger at 7 Consecutive Days at ADF's at or above 200 cfs.**

**Rationale:** In 2007, the DMP was modified to establish two new management reaches within the old Lower Reach. The Dickie Bridge to Melrose reach was established in recognition of improvements in streamflow and thermal conditions over surrounding reaches as a result of significant tributary input. BHWC obtained funding to re-establish the USGS Maiden Rock Gage Site commencing in Water Year 2008. This Gage site is within the treatment reach and more accurately reflects improved streamflows within the reach. Prior operation of the gage and last year's DNRC flow measurements indicate that the reach rarely declines below 175 cfs and largely maintains flows above 200 cfs within the Wise River to Melrose reach. Because flow triggers last year were predicated on readings outside the treatment reach, we recommend that the original DMP reach triggers of ADF's of 250, 200, and 150 cfs be re-established for the DMP actions.

**Addendum 2012: Add CCAA Note to Reaches I and II. Several Formatting and Logistical Updates.**

**CCAA Note for reaches I and II:** *Note:* Unique to the upper reaches of the Big Hole River is the implementation of the Candidate Conservation Agreement with Assurances (CCAA) for grayling restoration. While this program is in place, DNRC and MFWP will be responsible for contacting water users to engage in water conservation measures in response to the flow triggers specified for this reach. All other facets of this plan, including contacting outfitters, sportsmen, and the media, will be implemented as described below. For more information on the CCAA visit [http://www.fws.gov/mountain-prairie/species/fish/grayling/CCAA\\_June2006.pdf](http://www.fws.gov/mountain-prairie/species/fish/grayling/CCAA_June2006.pdf).

**Add bullet to "Public Education":** Encourage Big Hole watershed residents to reduce unnecessary water use (e.g. lawn watering, small irrigation systems, washing, etc.).

Update website addresses, contact information, and add footer.

**Two New Drought Management Sections Proposed for 2013:**

**1. Split Existing Melrose to Confluence with Jefferson River into two sections:** Melrose to Notch Bottom and Notch Bottom to Confluence with Jefferson River.

**Melrose to Notch Bottom:** Keep the existing parameters and triggers for drought related management for the Melrose to Confluence with Jefferson River section. Flow monitored at USGS gage at Notch Bottom and temperature by MFWP thermograph at Notch Bottom.

**Notch Bottom to Confluence with Jefferson River:** Establish new drought monitoring section. Flow and temperature measured by USGS High Road Bridge Gage. Flow and temperature triggers and language would be the same as those existing for Melrose to Confluence with Jefferson River section. No additional data are available for instream flow recommendations for the lower river. However, only 3 perennial tributaries are present between the Melrose-Notch Section (e.g. Rock, Willow and Birch creeks) and the morphology of the river downstream of Kalsta Bridge is similar to that of the river downstream of the Notch. Therefore, we recommend the flow triggers for the Melrose to Mouth section be applied also to the proposed Notch to Mouth Section until such a time when these additional data become available. These flow triggers are 250, 200, and 150 cfs as measured at the "Hamilton Ditch nr Twin Bridges #06026420" USGS gage.

**Action:** The proposed drought management change is in draft form for comment in 2012 and proposed for inclusion in 2013.

## **2. Wise River Drought Management Section**

We proposed addition of Wise River to the Drought Management Plan for inclusion in 2013. Flow and temperature monitoring will begin 2012 and some historical data exists. In order to create triggers, we need an analysis of the wetted perimeter and initial flow and temperature data -- planned for 2012. A proposal for a Wise River Drought management section will be prepared in 2012 for comment and subsequent inclusion in 2013. Two considerations should be made when developing this section: 1. Should the Wise River DMP be separate from the Big Hole River DMP? 2. If/when the Big Hole River closes according to the DMP, does that increase pressure on Wise River? Perhaps the Wise River triggers need to be coordinated with Big Hole triggers to some extent.

### **2012V2:**

After further review in June 2012, we found several additional edits that were missed in the spring 2012 review. Since these edits did not change the intention of the plan, but did clarify implementation, a second version was produced July 2012.

### **Addendum 2013 - Changes made by BHWC DMP Review Committee**

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- New document formatting
- Amendments are removed from the DMP and stored in a separate document (this document) to shorten the DMP.
- The water temperature thermograph in Section II was previously located at the Mudd Creek bridge. Montana MFWP reported that the location of the thermograph makes downloading the data difficult and suggested moving the thermograph to Dickie Bridge. This move also allows temperatures to be reported at the end of the reach, rather than the middle of the reach.
- Section IV (previously Melrose Bridge to the Big Hole River confluence with the Jefferson River) was divided into two sections as proposed in 2012 - Section IV: Melrose Bridge to Notch Bottom and Section V: Notch Bottom to the Confluence with the Jefferson River. This change divides the section so that monitoring of flow and temperature triggers is more relevant to the irrigators in each section. Jim Olsen, MFWP met with irrigators located in Section V January 2013 regarding the proposed change and irrigators supported the changes.
- The communication and interworking between MFWP, DNRC, and BHWC regarding actions that occur when DMP triggers are reached and the wording included in each of the triggers were ironed out with intention of clarifying roles and responsibilities and allowing swift, accurate action when DMP triggers are reached. A decision tree was added to the DMP that outlines how the DMP may be implemented.
- The temperature triggers were re-written to produce greater clarity in implementation and stronger river protection. First, triggers were reduced from three triggers to two, thus removing the "warning" of conservation. Warnings should be adequate from flow triggers, and two warnings may caused confusion among the public. Second, the remaining two triggers were placed under MFWP jurisdiction. Rather than conservation being a recommended action, MFWP will mandate both a hoot-owl fishing hours restriction and, if needed, full river closure based on high water temperatures.
- The Wise River Drought Management Plan will require additional flow data. Flow and water temperature data collection will continue in 2013.
- Contact information was updated. A quick reference guide to sections and triggers was added to the DMP.

### **Addendum 2014**

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- Section V No Longer Provisional: In 2013 Section V: Notch Bottom FAS to the Mouth was add as provisional. The DMP reviewed its use in 2013 and determined that the continued use of Section V was warranted and therefore no longer provisional. Section V closure will re-open at 200cfs x 7 consecutive days
- Section V - Add Water Temperature Targets to Align with State Drought Plan: Section V was added in 2013 for flow targets only. The state drought plan mandates river fishing restrictions based on water temperature criteria and Section V was under temperature restrictions in 2013 despite not being listed in the DMP. Therefore, adding temperature targets aligns this plan with the state drought plan.

- Page 11: Remove "weekly" from updates as updates are provided as needed.
- Section I & II: Change flow target dates to April 1 (was May 1) to align with CCAA plans.
- Section III: Change end point from Melrose Bridge to MFWP Maiden Rock FAS. Flow & Temperature measured at Maiden Rock USGS Gage.
- Section IV: New Start Point is MFWP Maiden Rock FAS (was Melrose Bridge). Section III is now representative of river canyons and cold water inputs. Section IV now contains the entire wide, shallow Melrose section. Prior to this change, low flow conditions in Section III did not trigger closure because the measure point was upstream at Maiden Rock, where conditions were colder and flows higher. This change creates sections based on hydrologic similarity and similar flow conditions; additionally, targets are measured at the end of river sections. Therefore, DMP targets are more consistent. The Phone Tree was updated to reflect the section changes for Section III and IV. This does not dismiss the importance of Melrose Bridge for long-term data collection and reference for restoration success.
- Remove "Reach" titles from sections. Reach titles no longer needed.
- Wise River Drought Management section needs additional data and remains under consideration.
- Drought Committee sought addition of Real-Time Water Temperature to USGS gages in Section I, II and III. USGS will install April 2014. Temperature will be posted July-August-September annually. BHWC cover cost.
- Section II: Change Flow Target Measure Point to Dickie Bridge: Flows to be measured at the USGS Big Hole near Wise River (was USGS Mudd Creek). Flow targets were updated to reflect change in flow measure location. This change puts the flow measure point for this section at the end of the section and uses the same measure point for flow and temperature. The CCAA plan had already reviewed wetted perimeter and flow targets between Mudd Creek and Dickie Bridge. The information for the trigger change was provided by Mike Roberts, DNRC from the CCAA and reviewed by Jim Olsen, MFWP:

*"The establishment of flow targets for the five reaches of the Big Hole River between Dickie Bridge and Darkhorse Lake were based on MFWP's Wetted Perimeter Inflection Point Method (Leathe and Nelson, 1989). Upper and lower inflection points were previously determined by MFWP for the site located near Wisdom. Flow targets determined for the two upper sites, Little Lake Creek Road and Miner Creek Road, were based on one set of field measurements plugged into a cross-section analyzer program. Using this program and a calculated Manning's roughness coefficient, the program provides outputs that include wetted perimeter and flow. These outputs were calibrated using field measurements of the same parameters. Lack of sufficient data precluded an adequate determination of wetted perimeter data at the two lower segments, Mudd Creek and Dickie Bridge. The Big Hole River Drought Management Plan flow trigger, which is also based on wetted perimeter data, was used as the summer/fall minimum flow goal for the Mudd Creek site. To determine the summer/fall minimum at the Dickie Bridge site and the spring minimum flow goal at both sites, a simple drainage basin area calculation was applied to the previously established goals determined at Wisdom."*

Big Hole River site	Drainage Area <sup>1</sup>		Field Measurements <sup>2</sup> and Wetted P		Mannings n <sup>3</sup> and Wetted P		Montana Method mean annual minimum		
	area (sq-mi)	Upper (cfs)	Lower (cfs)	Upper (cfs)	Lower (cfs)	Upper (cfs)	Lower (cfs)	flow (cfs) <sup>4</sup>	flow (cfs)
Dickie Bridge	1600	445	167	n/a	n/a	n/a	n/a	731	219
Mudd Creek Br	1267	352	132	n/a	n/a	n/a	n/a	740	222
Wisdom Br	575	160	60	160	60	199	52	169	51
Little Lake Cr Br	364	101	38	96	44	135	24	60	18
Miner Creek Br	114	32	12	56	20	58	16	37	11

1- Flow triggers based on drainage area percentage of Wisdom site and Wisdom wetted perimeter levels.

2- 2004 streamflow measurements vs. wetted perimeter except Wisdom Br values which were previously determined.

3- Used field-measured hydraulic data and USDA channel cross-section analyzer program XSPRO, output calibrated to field-measured flow and synthetically determined bankfull discharge.

4- Based on channel geometry (Parrett *et al* USGS WRIR 83-4046)

**Addendum 2015**

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- Section I: Location in title changed from Rock Creek to Saginaw Bridge on Skinner Meadows Road to prevent confusion related to river closures.
- Wise River Drought Management section needs additional data and remains under consideration.
- Contact information was updated.
- Whenever possible, low flows and angling closures will be announced via BHWC social media (e.g. Facebook, Twitter, Instagram, and/or LinkedIn).
- BHWC to meet with Montana Standard Natural Resources Reporter to discuss misreporting of gage locations (i.e. reporting Section I gage as Section II gage, which is confusing and misleading).
- BHWC is working with USGS and DNRC to figure out issue with Hamilton Ditch gage (i.e. a ditch upstream of the gage is taking out water above the gage, resulting in a skewed representation of Big Hole River outflow).

**Addendum 2016**

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- Section V: Add temperature to the re-open criteria to align with state water plan.
- Section IV: Increase all flow targets by 40cfs at USGS Glen in effort to maintain minimum 150cfs at USGS Melrose.
  - Previous target flow at Notch Bottom at 150cfs caused flows at Melrose to fall below the 150cfs target minimum, therefore the targets at Notch Bottom needed to be increased. An initial review suggested an increase between 30 and 40cfs could be adequate. Mike Roberts, DNRC Hydrologist analysis (table below) showed wide ranging differences year to year, resulting from variations in diversions, groundwater, precipitation, etc. During most intense drought periods, the difference can be as much as 30 to 80cfs. DNRC suggested a 30cfs target increase could be adequate to address the difference. An increase of 40cfs was selected and will be monitored in the future to see if this increase is adequate.

Big Hole River at Glen (06026210) minus Big Hole River at Melrose (06025500). Flows in cfs.

	Apr	May	Jun	Jul	Aug	Sep
2000	35	14	62	54	-1	26
2001	47	-17	12	74	-5	7
2002	-47	-97	129	70	42	47
2003	-18	36	226	84	37	31
2004	18	-44	-50	33	-3	15
2005	-17	-83	-127	-14	2	2
2006	-6	9	47	-38	-9	6
2007	-58	-120	-117	33	16	38
2012	38	79	86	32	25	10
2013	-70	-77	-13	4	-1	19
2015	-27	-152	-54	19	38	34
Avg Diff	-9	-41	18	32	13	21
Median of Mean Diff	-17	-44	12	33	2	19

- Documents reviewed and updated
- Update language “Fluvial Arctic Grayling Workgroup” to “Arctic Grayling Technical Workgroup, a part of Arctic Grayling Recovery Program”

Other:

- MFWP initially proposed increasing the re-opening criteria from 3 days to 5 or 7 days in order to decrease the potential for “yo-yo” of restrictions resulting in confusion among water users. Analysis completed. MFWP opted to keep the 3 days as it is consistent with MFWP state drought policy.
- Wise River DNRC real-time gage was installed October 2015 and will report during 2016. Total cost was near \$10,000, with \$6,000 paid by The Nature Conservancy and \$4,000 by Montana Trout Unlimited. This will support the establishment of drought response for Wise River.

- The USGS Hamilton gage location continues to be under review. MFWP pays the USGS fees for this gage. In 2015 the gage was turned off 9/30, while DMP triggers continue through 10/31. MFWP contacted. MFWP will change their USGS contract to keep the gage on through 10/31 beginning in 2016.

Discussions:

- Section IV: Current start point is MFWP Maiden Rock. Discussion from guiding community to move the start point downstream to potentially Salmon Fly FAS. The water at the beginning of Section IV remains cool while the end of the section and measure point at USGS Glen gage temperature rises to river fishing restriction criteria. Guides would like to continue to fish through the cooler waters of this section. BHWC has altered the drought plan and added USGS gage monitoring to the Big Hole so that measure points are at the end of sections – this would alter that plan. Monitoring of this phenomenon needed if this change were to be pursued.

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