APPENDIX E
REGULATORY FRAMEWORK AND TMDL DEVELOPMENT

This appendix presents details about Grave Creek impairment determinations recorded on the State of Montana 303(d) list and documented within MDEQ files. This is followed by a discussion of applicable Montana Water Quality Standards and reference conditions, and a general description of how the standards and reference conditions are used in this plan to make updated water quality impairment determinations. The approach used within this plan for identifying solutions to impairments, including development of TMDLs and allocations, is also described.

E.1 Grave Creek 303(d) List Status

E.1.1 Recent 303(d) Listing Information

The Montana 303(d) list, published every other year within Montana's Integrated Water Quality Report (MDEQ, 2004), identifies the mainstem of Grave Creek from Foundation Creek downstream to the confluence of Grave Creek and Fortine Creek as impaired. Table E-1 provides a summary of the impairment information from both the 1996 and 2004 303(d) lists. The Montana 2004 303(d) list (MDEQ, 2004) is the most current EPA-approved list. Table E-1 includes information from the 1996 303(d) list to ensure accountability for all previously identified causes of impairment. Note that the 2004 list incorporates and expands upon all impairment information within the 1996 list.

The impairment level is "partial support" of aquatic life and cold-water fish versus a more severe "non-support status". Note that "recreation" has been identified as a beneficial use not fully supported on the more recent 2004 list. This is due to flow alteration (dewatering) conditions within the channel of lower Grave Creek.

Table E-1: List of Beneficial Use Impairments for Grave Creek (1996 and 2004).

Listed Stream and Number	List	Probable Causes	Probable Sources	Beneficial Uses Not Fully Supported (Partial Support)
Grave Creek (MT76D004-6)	1996	Flow Alteration Other Habitat Alterations Siltation	Agriculture Silviculture	Aquatic Life Cold water Fish
	2004	Bank Erosion Dewatering Fish Habitat Degradation Flow Alteration Other Habitat Alterations Siltation	Agriculture Grazing-related Sources Silviculture Logging Road Construction/ Maintenance Dam Construction Flow Regulation/ Modification Hydromodification	Aquatic Life Cold water Fish Recreation

The Table E-1 “probable causes” for 2004 is unnecessarily long. These “probable causes” include several sub-causes (MDEQ, 2004). Both “fish habitat degradation” and “bank erosion” are sub-causes of the “other habitat alterations” cause category. Also, “dewatering” is a sub-cause of the “flow alterations” cause category. Therefore, the 2004 primary cause categories can be summarized as “other habitat alterations”, “flow alterations” and “siltation”.

TMDL development is required for all waterbody pollutant combinations where a pollutant has been identified within the “probable causes” column on the 303(d) list. There are not any pollutants, such as sediment, temperature, or nutrients, explicitly identified within the “probable causes” column in Table E-1. Because MDEQ does not currently use “sediment” as a “probable cause” in the 303(d) list, other terminology is used to indicate conditions where excess sediment loading may be linked to impairment. Thus the “siltation” listing for Grave Creek is linked to a sediment pollutant impairment condition, typically from excess concentrations of fine sediment less than 6.35 mm and/or 2 mm in size within riffles and/or potential spawning locations.

Furthermore, the “other habitat alterations” cause can sometimes be linked to other pollutant loading impacts such as nutrients, temperature, or an excess coarse or total (coarse plus fine) sediment load. An excess coarse or total sediment load to a channel can lead to pool filling and overall loss of desirable aquatic life habitat. This linkage between loss of aquatic habitat and excess coarse or total sediment loading appears to be a potential “other habitat alterations” linkage in many reaches of Grave Creek and its tributaries. This suggests a potential need to pursue TMDL development for both fine sediment as well as coarse or total sediment loading for Grave Creek in order to effectively address the existing listing causes. This approach is consistent with EPA TMDL guidance (EPA, 1999); and the “sediment” definition in Montana’s Water Quality Standards (17.30.602.28), presented below in Table E-4. Note that any TMDL development is first preceded by a water quality impairment status update as discussed below in Section E.3.

The flow alteration cause falls under a category that does not require TMDL development (often referred to as “pollution”). Furthermore, some types of “other habitat alterations” may also be linked to non-pollutant type impairments where TMDL development is not required. An example of this would be fish passage blockage. Nevertheless, these “pollution” conditions represent probable impairments to cold-water fish and aquatic life and are addressed within this document.

E.1.2 Grave Creek Impairment Justifications

The information within the MDEQ SCD/BUD files for Grave Creek (MDEQ, 2004c) was sufficient for making the impairment determinations identified on the 303(d) list as discussed above in Section E.1.1. Below is a summary of information used for making the impairment determinations for the major cause categories described above.

E.1.2.1 Sediment and Habitat Alterations

Sediment and habitat alteration impacts linked to human activities within the watershed are described in several reports within the MDEQ SCD/BUD files for Grave Creek (MDEQ, 2004c). In one watershed analysis report (Bohn, 1998), it is stated:

> "A comparison of data between historic and existing conditions, reference and non-reference data, and reference conditions from data compiled from other sources (e.g., regional conservation strategies, literature) suggests that present fish habitat conditions in Grave Creek are generally in fair to poor condition. For example, many of the reaches lacked sufficient in-channel large woody debris. This, in turn, affected the number and quality of pool habitats. Accelerated peak flows from upslope vegetation removal and large amounts of small bed material made scour depths sufficient in some areas to effectively wash out redds during spring runoff. However, the departure from 'reference' in many critical reaches was not excessive, suggesting that alteration in land management techniques and restoration of the physical habitats have a high likelihood of success.
>
> The cause of degraded conditions on public lands stem from U.S. Forest Service management activities in the watershed beginning in the early 1950's and extending through the 1980's. Early spruce harvesting occurred along riparian areas, removing large diameter trees for sawlogs thereby reducing the number of large trees needed for recruitment. Early harvesting also increased the routing efficiency of the watershed by constructing an extensive skid trail network in and around first order tributaries. Factors contributing to degraded conditions on private land include converting riparian communities to pasture, urban development along the riparian corridor, and channel realignment."

The Bohn report goes on to further identify significant impacts from roads and large clearcuts within the watershed, particularly those used for the above referenced harvest activities. As part of the analysis of historical channel conditions, the report states: "this analysis revealed that over time, the condition of the channels have degraded as a result of upstream timber harvest, road failures, in-stream wood removal, and increased peakflows. Virtually every reach in the watershed has adjusted somewhat to the effects of these actions. For example, the average riffle width in lower Grave Creek went from 60 ft (18m) in 1947 to over 130 ft (40m) in 1992. During the 45 years of photographic record, the sinuosity went from 1.23 (1947) to 1.08 (1992). The widening and straightening of this reach has resulted in extreme bank erosion rates, pool filling, in-channel bar formation, and a decrease in low water depths. This response is typical throughout the basin. However the sensitivity of each reach varies by geomorphic unit."

In another report (Marotz and Fraley, 1986), reference is made to the apparent acceleration of bank erosion from grazing and forage production. It was concluded that livestock grazing, irrigation withdrawals, timber harvest and associated road building were sources of impairment. In a stream fishery data report (MFWP, 1985), road construction, logging and stock trampling were identified as factors limiting the fishery.

Another form of habitat alteration referred to in several reports (USFS, 1999a; Bohn, 1998; MFWP, 1985) is fish passage obstruction due to an irrigation diversion dam that was located in lower part of Grave Creek. A new irrigation diversion structure has been built and fish passage is no longer considered an impairment at this location.

E.1.2.2 Flow alteration

Flow losses due to irrigation diversions are of concern for cold-water fish, aquatic life, and recreation uses as identified within the MDEQ SCD/BUD files. Marotz and Fraley (1986) noted that the "water appropriations listed for Grave Creek total 80.8 cfs ...... if all water users exercise their rights to the fullest extent, the stream would be dewatered during most of the water year. It is unknown, however, what number of claims is valid or presently in use. A minimum discharge of 70 cfs is recommended for the low flow period from July 16 to March 31." The 70 cfs data was derived from a wetted perimeter-discharge relationship for five riffle transects on Grave Creek. To ensure an average depth of 0.5 feet for successful passage of spawning migrants, the authors suggest maintaining the 70 cfs flow during periods when such passage is needed. Furthermore, the MFWP Dewatered Stream List (1991) shows Grave Creek as being chronically dewatered from Glen Lake diversion dam to Fortine Creek. Flow for September 1986 was at 43 cfs (Marotz and Fraley, 1986). Similar low flow conditions were observed in lower Grave Creek by MDEQ assessment personnel during summer, 2003.

In addition to the water quality standards presented below, it is important to note that when dealing with flow alteration conditions the TMDL development section of Montana State Law (75-5-705) states "nothing in this part may be construed to divest, impair, or diminish any water right recognized pursuant to Title 85."

E.1.3 Water Quality Restoration Planning and TMDL Development Requirements

This water quality restoration plan identifies water quality goals and objectives to address the above-noted impairment causes at a minimum. Where excess pollutant loading is involved, TMDL development is incorporated into the water quality goals and objectives as part of the problem solving approach for excess pollutant loading conditions. Table E-2 summarizes the impairment cause categories, impairment linkages, 303(d) list linkages, and potential TMDL development requirements based on the listing information and rationale provided. It is important to note that Table E -2 is derived from the 303(d) list and updated MDEQ files, and was used for further assessment planning and data evaluation performed in Sections 4.0 and 5.0. As part of water quality restoration planning and TMDL development, this additional assessment data and analysis is used to update impairment determinations, as discussed below in Section E.3.

Table E-2: Impairment Cause Summary and Restoration Planning for Grave Creek.

Impairment Cause Category	Impairment Linkage	303(d) List Linkages	Potential TMDL Development Requirement
Siltation	Excess Fine Sediment	Siltation, Bank Erosion	Yes (contingent upon water quality impairment status update)
Other Habitat Alterations (pollutant conditions)	Excess coarse or total sediment	Other Habitat Alterations; Fish Habitat Degradation; Bank Erosion	Yes (contingent upon water quality impairment status update)
Other Habitat Alterations (non-pollutant conditions)	Loss of Fish Passage Capability; Loss of Large Woody Debris; possibly others	Other Habitat Alterations; Fish Habitat Degradation	No (water quality restoration planning still applies contingent upon water quality impairment status update)
Flow Alteration	Reduced Flow	Dewatering; Flow Alterations	No (water quality restoration planning still applies contingent upon water quality impairment status update)

E.2 Applicable Water Quality Standards

Water quality standards include: the uses designated for a waterbody, the legally enforceable standards that ensure that the uses are supported, and a non-degradation policy that protects the high quality of a waterbody. The ultimate goal of this water quality restoration plan, once implemented, is to ensure that all designated beneficial uses are fully supported and all standards are met. The water quality standards form the basis for impairment determinations and development of numeric values used for TMDL targets and other use support objectives. This section provides a summary of the applicable water quality standards for sediment and other conditions limiting cold-water fish as identified in Table E-2.

E.2.1 Classification and Beneficial Uses

Classification is the assignment (designation) of a single or group of uses to a waterbody based on the potential of the waterbody to support those uses. Designated

Uses or Beneficial Uses are simple narrative descriptions of water quality expectations or water quality goals. There are a variety of “uses” of state waters including: growth and propagation of fish and associated aquatic life; drinking water; agriculture; industrial supply; and recreation and wildlife. The Montana Water Quality Act (WQA) directs the Board of Environmental Review (BER, i.e., the state) to establish a classification system for all waters of the state that includes their present (when the Act was originally written) and future most beneficial uses (Administrative Rules of Montana (ARM) 17.30.607-616) and to adopt standards to protect those uses (ARM 17.30.620-670).

Montana, unlike many other states, uses a watershed based classification system with some specific exceptions. As a result, *all* waters of the state are classified and have designated uses and supporting standards. All classifications have multiple uses and in only one case (A-Closed) is a specific use (drinking water) given preference over the other designated uses. Some waters may not actually be used for a specific designated use, for example as a public drinking water supply, however the quality of that waterbody must be maintained suitable for that designated use. When natural conditions limit or preclude a designated use, permitted point source discharges or non-point source activities or pollutant discharges may not make the natural conditions worse.

Modification of classifications or standards that would lower a water’s classification or a standard (i.e., B-1 to a B-3), or removal of a designated use because of natural conditions can only occur if the water was originally misclassified. All such modifications must be approved by the BER, and are undertaken via a Use Attainability Analysis (UAA) that must meet EPA requirements (40 CFR 131.10(g), (h) and (j)). The UAA and findings presented to the BER during rulemaking must prove that the modification is correct and all existing uses are supported. An existing use cannot be removed or made less stringent.

Descriptions of Montana’s surface water classifications and designated beneficial uses are presented in Table E-3. All waterbodies within the Grave Creek TPA are classified as B-1 (17.30.607). Waters classified B-1 are to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply (17.30.623[1]).

Table E-3: Montana Surface Water Classifications and Designated Beneficial Uses.

Classification	Designated Uses
A-CLOSED CLASSIFICATION:	Waters classified A-Closed are to be maintained suitable for drinking, culinary and food processing purposes after simple disinfection.
A-1 CLASSIFICATION:	Waters classified A-1 are to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment for removal of naturally present impurities.

Table E-3: Montana Surface Water Classifications and Designated Beneficial Uses.	
Classification	Designated Uses
B-1 CLASSIFICATION:	Waters classified B-1 are to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.
B-2 CLASSIFICATION:	Waters classified B-2 are to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and marginal propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.
B-3 CLASSIFICATION:	Waters classified B-3 are to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.
C-1 CLASSIFICATION:	Waters classified C-1 are to be maintained suitable for bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.
C-2 CLASSIFICATION:	Waters classified C-2 are to be maintained suitable for bathing, swimming and recreation; growth and marginal propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.
C-3 CLASSIFICATION:	Waters classified C-3 are to be maintained suitable for bathing, swimming and recreation; growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl and furbearers. The quality of these waters is naturally marginal for drinking, culinary and food processing purposes, agriculture and industrial water supply.
I CLASSIFICATION:	The goal of the State of Montana is to have these waters fully support the following uses: drinking, culinary and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and propagation of fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

E.2.2 Standards

In addition to the Use Classifications described above, Montana's water quality standards include numeric and narrative criteria as well as a nondegradation policy.

<u>Numeric</u> surface water quality standards have been developed for many parameters to protect human health and aquatic life. These standards are in the Department Circular WQB-7 (MDEQ, 2004a). The numeric human health standards have been developed for parameters determined to be toxic, carcinogenic, or harmful and have been established at levels to be protective of long-term (i.e., life long) exposures as well as through direct contact such as swimming.

The numeric aquatic life standards include chronic and acute values that are based on extensive laboratory studies including a wide variety of potentially affected species, a variety of life stages and durations of exposure. Chronic aquatic life standards are protective of long-term exposure to a parameter. The protection afforded by the chronic standards includes detrimental effects to reproduction, early life stage survival and growth rates. In most cases the chronic standard is more stringent than the corresponding acute standard. Acute aquatic life standards are protective of short-term exposures to a parameter and are not to be exceeded.

High quality waters are afforded an additional level of protection by the nondegradation rules (ARM 17.30.701 et. seq.,) and in statute (75-5-303 MCA). Changes in water quality must be “non-significant” or an authorization to degrade must be granted by the Department. However under no circumstance may standards be exceeded. It is important to note that, waters that meet or are of better quality than a standard are high quality for that parameter, and nondegradation policies apply to new or increased discharges to that the waterbody.

Narrative standards have been developed for substances or conditions for which sufficient information does not exist to develop specific numeric standards. The term “Narrative Standards” commonly refers to the General Prohibitions in ARM 17.30.637 and other descriptive portions of the surface water quality standards. The General Prohibitions are also called the “free from” standards; that is, the surface waters of the state must be free from substances attributable to discharges, including thermal pollution, that impair the beneficial uses of a waterbody. Uses may be impaired by toxic or harmful conditions (from one or a combination of parameters) or conditions that produce undesirable aquatic life. Undesirable aquatic life includes bacteria, fungi and algae.

The standards applicable to sediment, which is the only pollutant identified on the 303(d) list for the Grave Creek Planning Area, are summarized below. In addition to the below sediment standards, the beneficial use support standard (17.30.623[1]) for a B-1 Stream, as defined above, can apply to other conditions, often linked to pollution, limiting aquatic life. These other conditions can include impacts from dewatering/flow alterations or impacts from habitat modifications not linked directly to excess sediment concentrations.

Sediment

Sediment (i.e., coarse and fine bed sediment) and suspended sediment are addressed via the narrative criteria identified in Table E-4. The relevant narrative criteria do not allow for harmful or other undesirable conditions related to increases above naturally occurring levels or from discharges to state surface waters. This is interpreted to mean that water quality goals should strive toward a reference condition that reflects a waterbody’s greatest potential for water quality given current and historic land use activities where all reasonable land, soil, and water conservation practices have been applied and resulting conditions are not harmful, detrimental or injurious to beneficial uses (see definitions in Table E-4).

Table E-4: Applicable Rules for Sediment Related Pollutants.

Rule(s)	Standard
17.30.623(2)	No person may violate the following specific water quality standards for waters classified B-1.
17.30.623(2)(f)	No increases are allowed above naturally occurring concentrations of sediment or suspended sediment (except a permitted in 75-5-318, MCA), settleable solids, oils, or floating solids, which will or are likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife.
17.30.623(2)(d)	The maximum allowable increase above naturally occurring turbidity is: five nephelometric turbidity units except as permitted in 75-5-318, MCA.
17.30.637(1)	State surface waters must be free from substances attributable to municipal, industrial, agricultural practices or other discharges that will.
17.30.637(1)(a)	Settle to form objectionable sludge deposits or emulsions beneath the surface of the water or upon adjoining shorelines.
17.30.637(1)(d)	Create concentrations or combinations of materials that are toxic or harmful to human, animal, plant, or aquatic life.
17.30.602(17)	“Naturally occurring” means conditions or material present from runoff or percolation over which man has no control or from developed land where all reasonable land, soil, and water conservation practices have been applied.
17.30.602(21)	“Reasonable land, soil, and water conservation practices” means methods, measures, or practices that protect present and reasonably anticipated beneficial uses. These practices include but are not limited to structural and nonstructural controls and operation and maintenance procedures. Appropriate practices may be applied before, during, or after pollution-producing activities.
17.30.602.(28)	“Sediment” means solid material settled from suspension in a liquid; mineral or organic solid material that is being transported or has been moved from its site of origin by air, water or ice and has come to rest on the earth’s surface, either above or below sea level; or inorganic or organic particles originating from weathering, chemical precipitation or biological activity.

It should be noted that reasonable land, soil, and water conservation practices are not always accomplished by using best management practices (BMPs) (MDEQ, 1999). BMPs are land management practices that provide a degree of protection for water quality, but they may not be sufficient to achieve compliance with water quality standards and protect beneficial uses. Therefore, reasonable land, soil, and water conservation practices generally include BMPs, but additional conservation practices may be required to achieve compliance with water quality standards and restore beneficial uses.

Temperature

Although no temperature impairment has been identified in Grave Creek, fishery impacts from elevated temperatures are a possibility in the lower part of Grave Creek given the habitat alterations and dewatering conditions. Montana's temperature standards address a maximum allowable increase above "naturally occurring" temperatures to protect the existing temperature regime for fish and aquatic life. Additionally, Montana's temperature standards address the maximum allowable rate at which temperature changes (i.e., above or below naturally occurring) can occur to avoid fish and aquatic life temperature shock.

For waters classified as B-1 the maximum allowable increase over naturally occurring temperature (if the naturally occurring temperature is less than 67º Fahrenheit) is 1° (F) and the rate of change cannot exceed 2°F per hour. If the natural occurring temperature is greater than 67º F, the maximum allowable increase is 0.5º F (ARM 17.30.623(e)).

E.2.3 Reference Conditions

E.2.3.1 Reference Conditions as Defined Within Appendix A of the State of Montana 303(d) List (MDEQ, 2004)

MDEQ uses the reference condition to determine if narrative water quality standards are being achieved. The term "reference condition" is defined as the condition of a waterbody capable of supporting its present and future beneficial uses when all reasonable land, soil, and water conservation practices have been applied. In other words, reference condition reflects a waterbody's greatest potential for water quality given historic land use activities.

MDEQ applies the reference condition approach for making beneficial use-support determinations for certain pollutants (such as sediment) that have specific narrative standards. All classes of waters are subject to the provision that there can be no increase above naturally occurring concentrations of sediment and settleable solids, oils, or floating solids sufficient to create a nuisance or render the water harmful, detrimental or injurious. These levels depend on site-specific factors, so the reference conditions approach is used.

Also, Montana water quality standards do not contain specific provisions addressing nutrients (nitrogen and phosphorous), or detrimental modifications of habitat or flow. However, these factors are known to adversely affect beneficial uses under certain conditions or combination of conditions. The reference conditions approach is used to determine if beneficial uses are supported when nutrients, flow or habitat modifications are present.

Waterbodies used to determine reference condition are not necessarily pristine or perfectly suited to giving the best possible support to all possible beneficial uses. Reference condition also does not reflect an effort to turn the clock back to conditions that may have existed before human settlement, but is intended to accommodate natural variations in biological communities, water chemistry, etc. due to climate, bedrock, soils, hydrology and other natural physiochemical differences. The intention is to differentiate between natural conditions and widespread or significant alterations of biology, chemistry or hydrogeomorphology due to human activity. Therefore, reference conditions should reflect minimum impacts from human activities. It attempts to identify the potential condition that could be attained (given historical land use) by the application of reasonable land, soil and water conservation practices. MDEQ realizes that presettlement water quality conditions usually are not attainable.

Comparison of conditions in a waterbody to reference waterbody conditions must be made during similar season and/or hydrologic conditions for both waters. For example, the TSS of a stream at base flow during the summer should not be compared to the TSS of reference condition that would occur during a runoff event in the spring. In addition, a comparison should not be made to the lowest or highest TSS values of a reference site, which represent the outer boundaries of reference conditions.

The following methods may be used to determine reference conditions:

Primary Approach

- Comparing conditions in a waterbody to baseline data from minimally impaired waterbodies that are in a nearby watershed or in the same region having similar geology, hydrology, morphology, and/or riparian habitat.
- Evaluating historical data relating to condition of the waterbody in the past.
- Comparing conditions in a waterbody to conditions in another portion of the same waterbody, such as an unimpaired segment of the same stream.

Secondary Approach

- Reviewing literature (e.g. a review of studies of fish populations, etc. that were conducted on similar waterbodies that are least impaired.
- Seeking expert opinion (e.g. expert opinion from a regional fisheries biologist who has a good understanding of the waterbody's fisheries health or potential).
- Applying quantitative modeling (e.g. applying sediment transport models to determine how much sediment is entering a stream based on land use information, etc.).

MDEQ uses the primary approach for determining reference condition if adequate regional reference data are available and uses the secondary approach to estimate reference condition when there are no regional data. MDEQ often uses more than one approach to determine reference condition, especially when regional reference condition data are sparse or nonexistent.

E.2.3.2 Development of Reference Conditions for the Grave Creek Watershed

E.2.3.2.1 Stream Potential Given Historic Land Uses

As discussed above, the reference condition reflects a waterbody's greatest potential for water quality given historic land use activities. It attempts to identify the potential condition that could be attained (given historical land use) by the application of reasonable land, soil and water conservation practices. This "potential" terminology is consistent with the use of the term "capability," and both terms are used interchangeably in this document. It is anticipated that MDEQ will change to the use of this "stream capability" terminology instead of "stream potential given historic land use activities."

For many streams such as those in the upper portions of the Grave Creek Watershed, recovery from historic land use activities that led to elevated sediment loading and removal of riparian vegetation is possible, even though full recovery may take decades. This recovery then represents the greatest potential because existing and future forest activities, including timber harvest, can still be pursued in a way that will allow recovery via the application of BMPs and all reasonable land, soil and water conservation practices.

In lower Grave Creek, land uses may preclude recovery to the historic condition of a multiple thread channel across much of the lower drainage bottom as described in Section 2.11. Nevertheless, there is evidence that the stream's greatest potential within the constraints of a single thread channel and existing and future land uses is one where fish habitat and overall water quality conditions can be significantly improved. This is supported by the Bohn (1998) analysis showing significant negative departure in fish habitat indicators between 1947 and 1992, by the potential for improvements in riparian protection along lower Grave Creek, and by the success of physical restoration projects discussed in Section 8.0.

E.2.3.2.2 Use of Statistics for Developing Reference Values or Ranges

Reference value development must consider natural variability as well as variability that can occur as part of field measurement techniques. Statistical approaches are commonly used to help incorporate variability. One statistical approach is to compare stream conditions to the mean (average) value of a reference data set to see if the stream condition compares favorably to this value or falls within the range of one standard deviation around the reference mean. The use of these statistical values assumes a normal distribution, whereas water resources data tend to have a non-normal distribution (Hensel and Hirsch, 1995). For this reason, another approach is to compare stream conditions to the median value of a reference data set to see if the stream condition compares favorably to this value or falls within the range defined by the 25^{th} and 75^{th} percentiles of the reference data. This is a more realistic approach than using one standard deviation since water quality data often include observations considerably higher or lower than most of the data. Very high and low observations can have a misleading impact on the statistical summaries if a normal distribution is incorrectly assumed, whereas statistics based on a non-normal distributions are far less influenced by such observations.

Figure E-1 is an example boxplot type presentation of the median, 25^{th} and 75^{th} percentiles, and minimum and maximum values of a reference data set. In this example, the reference stream results are stratified by two different stream types. Typical stratifications for reference stream data may include Rosgen stream types, stream size ranges, or geology. If the parameter being measured is one where low values are undesirable and can cause harm to aquatic life, then measured values in the potentially impaired stream that fall below the 25^{th} percentile of reference data are not desirable and can be used to indicate impairment. If the parameter being measured is one where high values are undesirable then measured values above the 75^{th} percentile can be used to indicate impairment.

The use of a non-parametric statistical distribution for interpreting narrative water quality standards or developing numeric criteria is consistent with EPA guidance for determining nutrient criteria (EPA, 2000). Furthermore, the selection of the applicable 25^{th} or 75^{th} percentile values from a reference data set is consistent with ongoing MDEQ guidance development for interpreting narrative water quality standards where it is determined that there is “good” confidence in the quality of the reference sites and resulting information (MDEQ, 2004e). If it is determined that there is only a “fair” confidence in the quality of the reference sites, then the 50^{th} percentile or median value should be used, and if it is determined that there is “very high” confidence, then the 90^{th} percentile of the reference data set should be used. Most reference data sets available for water quality restoration planning and related TMDL development, particularly those dealing with sediment and habitat alterations, would tend to be “fair” to “good” quality. This is primarily due to a the limited number of available reference sites/data points available after applying all potentially applicable stratifications on the data, inherent variations in monitoring results among field crews, the potential for variations in field methodologies, and natural yearly variations in stream systems often not accounted for in the data set.

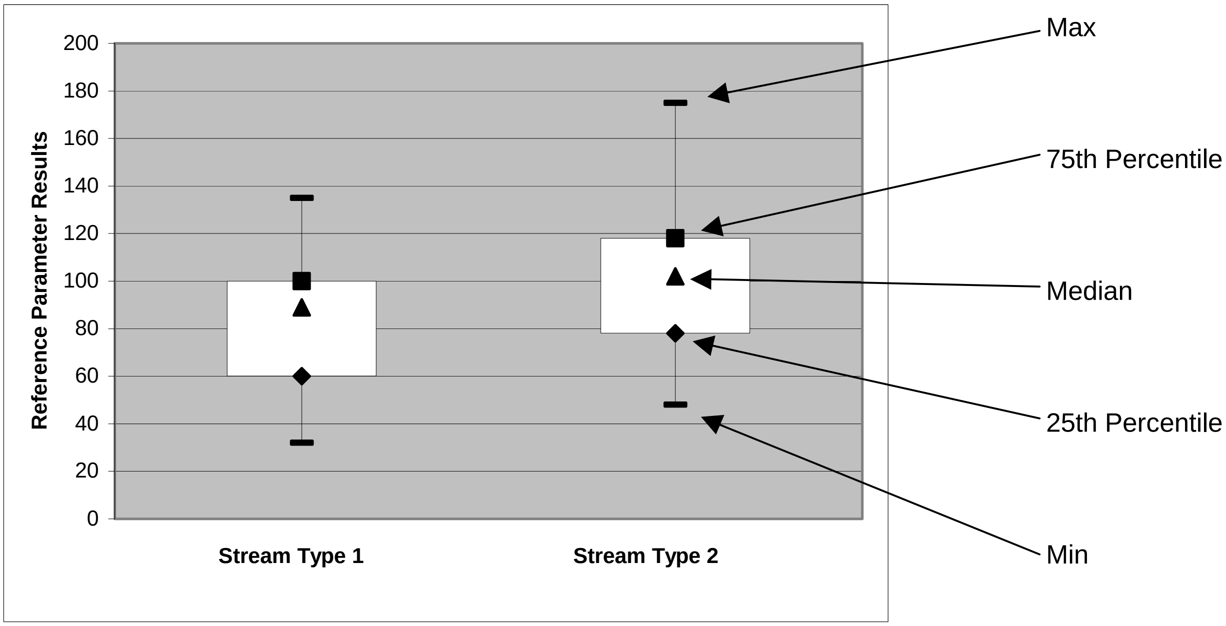

Figure E-1: Boxplot Example for Reference Data.

The above 25th – 75th percentile statistical approach has several considerations:

1. It is a simple approach that is easy to apply and understand.
2. About 25% of all streams would naturally fall into the impairment range. Thus, it should not be applied unless there is some linkage to human activities that could lead to the observed conditions. Where applied, it must be noted that the stream's potential may prevent it from achieving the reference range as part of an adaptive management plan.
3. About 25% of all streams would naturally have a greater water quality potential than the minimum water quality bar represented by the 25th to 75th percentile range. This may represent a condition where the stream's potential has been significantly underestimated. Adaptive management can also account for these considerations.
4. Obtaining reference data that represents a naturally occurring condition, as defined above in Table E-4, can be difficult, particularly for larger waterbodies with multiple land uses within the drainage. This is because all reasonable land, soil and water conservation practices may not be in place in many larger water bodies across the region. Even if these practices are in place, the proposed reference stream may not have fully recovered from past activities, such as riparian harvest, where reasonable land, soil and water conservation practices were not applied.
5. A stream should not be considered impaired unless there is a relationship between the parameter of concern and the beneficial use such that not meeting the reference range is likely to cause harm or other negative impacts to the beneficial use as described by the water quality standards in Table E-4. In other words, if not meeting the reference range is not expected to negatively impact aquatic life, cold water fish or other beneficial uses, then an impairment determination should not be made based on the particular parameter being evaluated. Figure E-2 shows example

relationship between a parameter of concern and a beneficial use (aquatic life in this example). Relationships that show an impact to the beneficial use can be used to justify impairment based on the above statistical approach.

As identified in (2) and (3) above, there are two types of errors that can occur due to this or similar statistical approaches where a reference range or reference value is developed. 1) A stream could be considered impaired even though the naturally occurring condition for that stream parameter does not meet the desired reference range. 2) A stream could be considered not impaired for the parameter(s) of concern because the results for a given parameter fall just within the reference range, whereas the naturally occurring condition for that stream parameter represents much higher water quality and beneficial uses could still be negatively impacted. The implications of making either of these errors can be used to modify the above approach, although the approach used will need to be protective of water quality to be consistent with MDEQ guidance and water quality standards (MDEQ, 2004e). Either way, adaptive management is applied to this water quality plan and associated TMDL development to help address the above considerations. This adaptive management is further defined in later sections of this document.

Where the data does suggest a normal distribution, or reference data is presented in a way that precludes use of non-normal statistics, then the above approach can be modified to include the mean plus or minus one standard deviation to provide a similar reference range with all of the same considerations defined above.

In some cases, there is very limited reference information and applying a statistical approach like above is not possible. Under these conditions the limited information can be used to develop a reference value or range, with the need to note the greater level of uncertainty and perhaps a greater level of future monitoring as part of the adaptive management approach. These conditions can also lead to more reliance on secondary type approaches for reference development as defined in Section E.2.3.1.

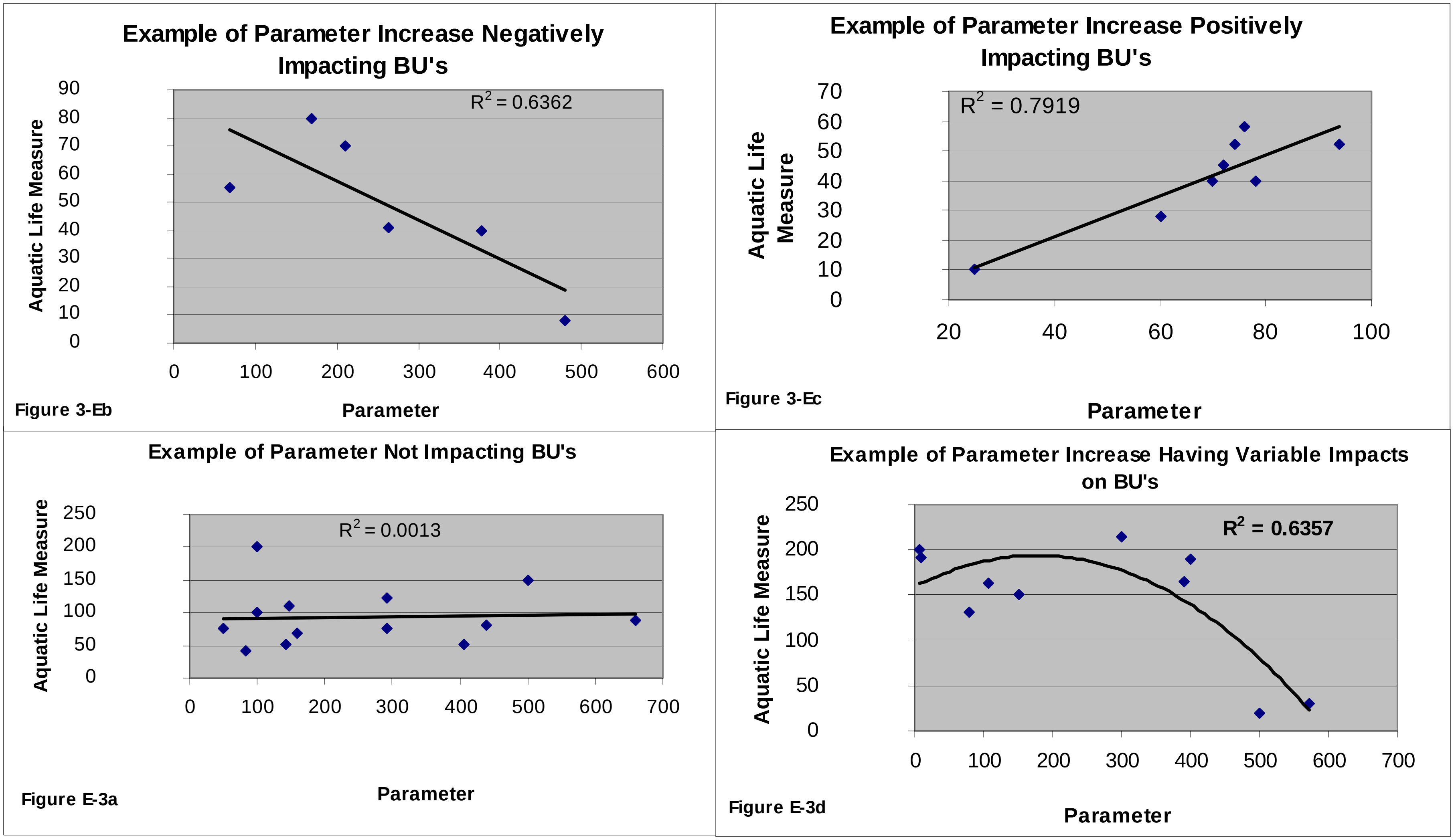

Figure E-2: Examples of Various Ways Which a Given Parameter Can Influence Aquatic Life or Other Beneficial Uses.

E.3 Application of Water Quality Standards and Reference Conditions

The water quality standards and reference condition approach is used in this and other water quality restoration plans to develop an updated water quality impairment status. This includes the steps defined below. Figure E-3 is a flow chart of this process.

1) Present water quality data for the Grave Creek Watershed. This includes looking at water quality data from both Grave Creek and significant tributaries to provide a better overall understanding of watershed health and to help identify potential reference conditions within the watershed. Focus is on physical water quality parameters that provide the best linkages between sediment and/or habitat alterations and the potentially impacted beneficial uses of cold-water fish and associated aquatic life. These parameters include stream channel and fish habitat conditions such as pool frequency, width to depth ratio, and percent fine sediment in spawning areas. This information is presented in Section 4.0.
2) Develop water quality reference values for the Grave Creek Watershed using the guidance presented above. These reference values will tend to focus on the parameters that provide the best indicator of beneficial use support for the sediment and habitat alterations of concern. The development of water quality reference values is presented in Section 5.1.
3) Use the reference values to define beneficial use support conditions that must be met to satisfy water quality standards. Where there is a link to excess sediment loading impacts, beneficial use support conditions are presented as “targets” consistent with TMDL development terminology. The development of these beneficial use support conditions is presented in Section 5.2.
4) Compare the existing water quality data from waterbodies in the Grave Creek Watershed to targets and use support objectives. This comparison, referred to as a departure analysis, is used for making final water quality impairment determinations. Section 5.3 presents this comparison and Section 5.4 provides the updated water quality impairment status.

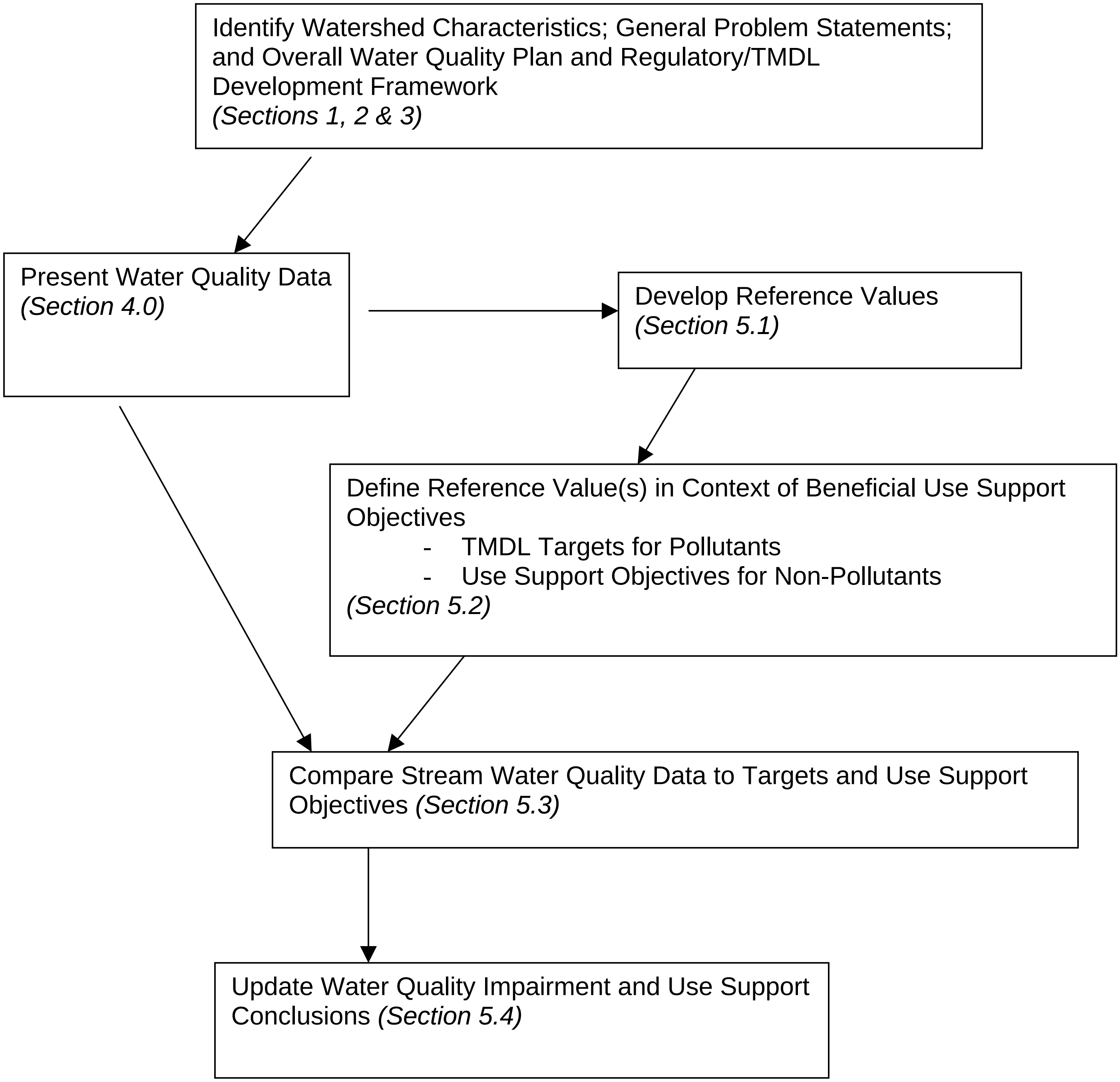

Figure E-3: Water Quality Restoration Planning Process for the Grave Creek Watershed – Initial Steps Through Updated Water Quality Impairment Status.

E.4 Restoration Objectives and TMDL Development

Once water quality impairment determinations are updated, solutions to any remaining or additional problems are developed within the context of restoration objectives and

TMDLs. In the Grave Creek Watershed, this includes the steps described below. Figure E-4 is a flow chart of this process.

1. Perform a detailed assessment to characterize the types, magnitudes, and locations of sources contributing to impairment conditions. This includes a sediment loading analysis for the Grave Creek Watershed. The detailed assessment is presented within Section 6.0.
2. Develop restoration objectives that define the actions that, if implemented, would lead to conditions where all TMDL targets and use support objectives are satisfied. For sediment (or any pollutant), this includes developing one or more TMDLs and presenting the restoration objectives in the form of load allocations that would lead to conditions where TMDL targets are satisfied. Non-TMDL restoration objectives are developed to address actions that would lead to conditions where use support objectives are satisfied. Restoration objectives and TMDLs are developed in Section 7.0.
3. Identify strategies for implementing this water quality plan. Also identify monitoring strategies to help track specific implementation activities, measure overall progress toward meeting beneficial use support objectives, and address uncertainties and monitoring gaps identified as part of this planning effort. Implementation strategies are identified in Section 8.0, and a monitoring strategy is developed in Section 9.0. The implementation and monitoring strategies are a key component of adaptive management.

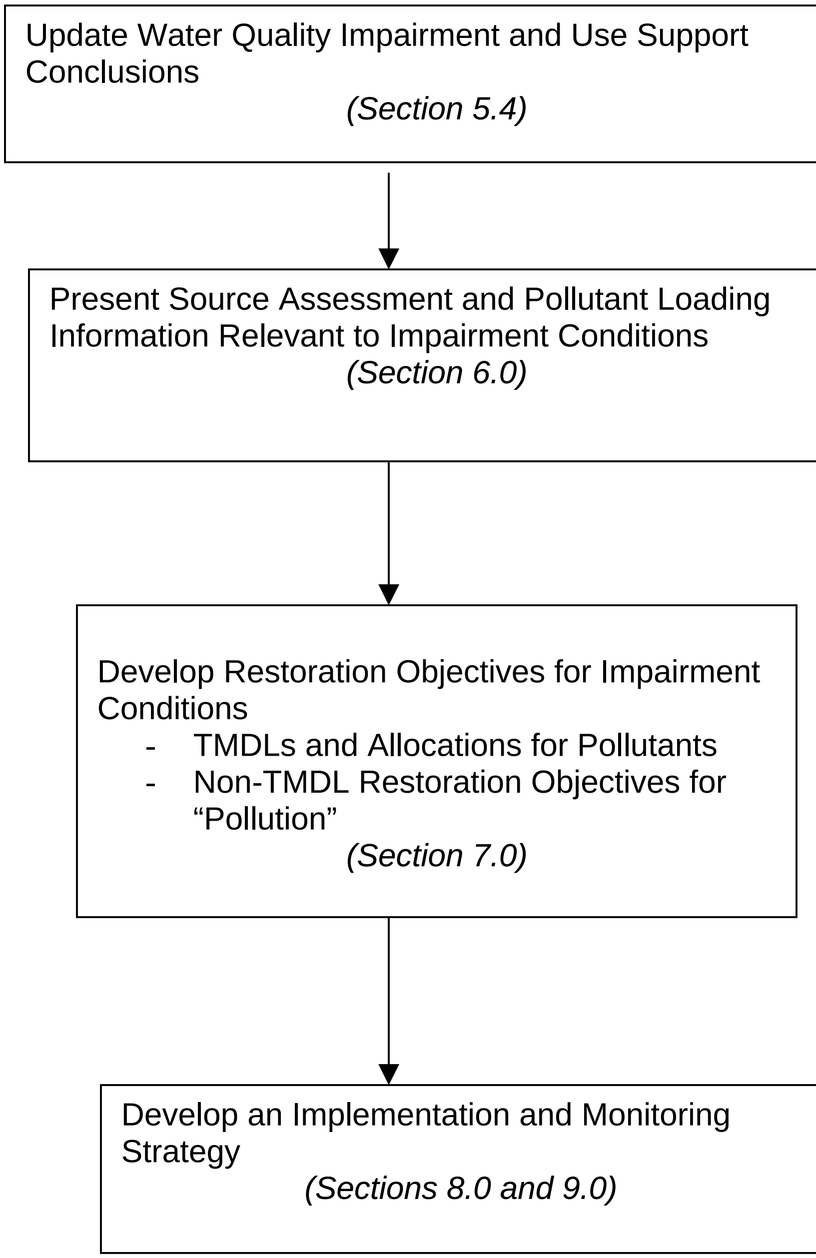

Figure E-4: Water Quality Restoration Plan and TMDL Development Process for Grave Creek Watershed - After Making Updated Impairment Status Determinations Through Final Plan Sections.