Lake Walcott

Marsh Creek and PNV Temperature TMDL Addendum

Draft

Department of Environmental Quality
January 2010

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Cover photo: Looking down on some of the 20 miles of riparian land adjacent to Marsh Creek. Photo by Jerry West, DEQ.

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Acknowledgments

Mark Shumar, DEQ Technical Services, prepared the PNV Temperature TMDLs, Marti Bridges, TMDL Program Manager helped with data analysis and evaluation of load calculations and methodology. The Lake Walcott WAG provided valuable input and review.

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Abbreviations, Acronyms, and Symbols

§303(d)	Refers to section 303 subsection (d) of the Clean Water Act, or a list of impaired water bodies required by this section
µ	micro, one-one thousandth
AU	assessment unit
AWS	agricultural water supply
BAG	Basin Advisory Group
BLM	United States Bureau of Land Management
BMP	best management practice
BOD	biochemical oxygen demand
BURP	Beneficial Use Reconnaissance Program
C	Celsius
CFR	Code of Federal Regulations
cfs	cubic feet per second
cm	centimeters
CWA	Clean Water Act
DEQ	Department of Environmental Quality
DO	dissolved oxygen
DWS	domestic water supply
EPA	United States Environmental Protection Agency
F	Fahrenheit
GIS	Geographical Information Systems
HUC	Hydrologic Unit Code
IDAPA	Refers to citations of Idaho administrative rules
IDFG	Idaho Department of Fish and Game
IDWR	Idaho Department of Water Resources
km	kilometer
km^2	square kilometer
LA	load allocation
LC	load capacity
m	meter
m^3	cubic meter
mi	mile
mi^2	square miles
MGD	million gallons per day
mg/L	milligrams per liter
mm	millimeter
MOS	margin of safety
n.a.	not applicable
NA	not assessed
NB	natural background
nd	no data (data not available)
NFS	not fully supporting
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NTU	nephelometric turbidity unit
PCR	primary contact recreation
ppm	part(s) per million
RMI	DEQ's River Macroinvertebrate Index
SBA	subbasin assessment
SCR	secondary contact recreation
SS	salmonid spawning
TDS	total dissolved solids
TKN	total Kjeldahl nitrogen
TMDL	total maximum daily load
TP	total phosphorus
TS	total solids
TSS	total suspended solids
t/y	tons per year
U.S.	United States
U.S.C.	United States Code
USFS	United States Forest Service
USGS	United States Geological Survey
WAG	Watershed Advisory Group
WBAG	*Water Body Assessment Guidance*
WBID	water body identification number
WLA	wasteload allocation
WQS	water quality standard

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Executive Summary

This Marsh Creek and PNV Temperature TMDL analysis has been developed to address the water bodies in the Lake Walcott Subbasin that have been placed on Idaho's current §303(d) list. The assessment describes the physical, biological, and cultural setting; water quality status; pollutant sources; and recent pollution control actions in the Lake Walcott Subbasin, located in southern Idaho.

Regulatory Requirements

This document has been prepared in accordance with federal and state regulations, as described in the following.

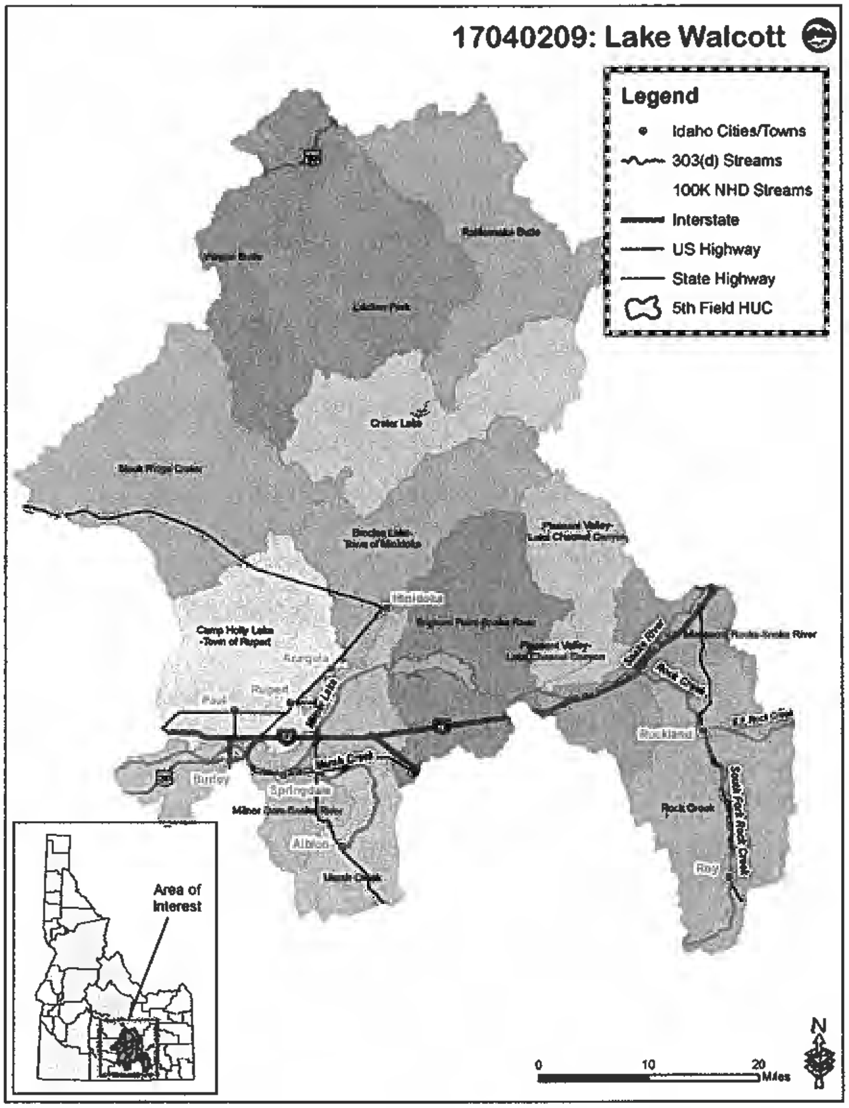
The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the CWA, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible. Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards). States and tribes must periodically publish a priority list (a "§303(d) list") of impaired waters. Currently this list must be published every two years. For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards.

The subbasin assessment (SBA) is an important first step leading to the TMDL. The starting point for this assessment was Idaho's current §303(d) list of water quality limited water bodies. Two reaches of Marsh Creek in the Lake Walcott Subbasin were listed and carried forward from the 1998 listing cycle:

- South Fork Rock Creek was an EPA temperature addition to the 1998 § 303 (d) list inadvertently left off the 2002 and 2008 lists.
- Lake Walcott is newly listed for mercury impairment but will be scheduled for a TMDL at a later date, along with other newer listings.

The SBA examines the status of §303(d) listed waters and defines the extent of impairment and causes of water quality limitation throughout the subbasin. The TMDL analysis quantifies pollutant sources and allocates responsibility for load reductions needed to return listed waters to a condition of meeting water quality standards.

Subbasin at a Glance



Subbasin Name and HUC Number	Lake Walcott - ID17040209	
303 (d) listed AUs	ID17040209SK002_07	Snake River - Minidoka Dam to Heyburn/Burley Bridge
	ID17040209SK003_03	Marsh Creek - source to mouth
	ID17040209SK003_04	Marsh Creek - source to mouth
	ID17040209SK004L_0L	Lake Walcott (Snake River)
	ID17040209SK011_02	Snake River - American Falls Reservoir Dam to Rock Creek
	ID17040209SK013_02	Craters of the Moon complex
	ID17040209SK013_03	Craters of the Moon complex
Pollutants of Concern	Sediment, mercury, combined biota/habitat bioassessments	
NPDES Permitted Facilities	None currently–no permitted point sources reside in the Marsh Creek drainage	
Approved TMDL	Lake Walcott TMDL (approved 2000)	
Other Related TMDLs	Rueger Springs Creek TMDL Addendum (2007) Fall Creek TMDL Addendum (2007)	
HUC = Hydrologic Unit Catalog No. AU = Assessment Unit number. NPDES = National Pollutant Discharge Elimination System.		

Key Findings

The purpose of the Marsh Creek and PNV Temperature TMDL is to establish water quality load allocations in Marsh Creek and several other streams as part of the overall Lake Walcott TMDL. This TMDL covers several temperature TMDLs expressed as potential natural vegetation (PNV) for tributaries as well as total phosphorus (TP) and *E. coli* TMDLs for Marsh Creek within the Lake Walcott HUC.

Marsh Creek is a §303(d) listed perennial water body in the 2008 Integrated Report, from its headwaters to its confluence with the Snake River. Marsh Creek discharges to the Snake River, which is §303(d) listed, and specific reaches of the Snake River have EPA approved TMDLs for total phosphorus (EPA, 2000). The new TMDLs are necessary to protect and restore the beneficial uses of Marsh Creek and other tributaries in the Lake Walcott subbasin.

The Marsh Creek and PNV Temperature TMDL is an addendum to the Lake Walcott TMDL, but it does not modify the existing EPA approved Lake Walcott TMDL from 2000.

Two creeks were placed on the 1998 §303d list of impaired waters by EPA for unknown pollutants (Table 1). The South Fork Rock Creek was later added to the 1998 list for reasons associated with temperature criteria violations. Calf Creek was also an EPA addition to the 1998 list for temperature, but this creek is not in the Lake Walcott Subbasin. Additional streams were examined based on new data and concerns for water temperature.

Additionally, mercury is also listed in the 2008 Integrated Report for the Snake River (Assessment Unit No. 17040209SK004L_0L for Lake Walcott) due to fish tissue analysis that showed a trophic level weighted mercury of 0.332 mg/kg. However, a TMDL for mercury will be forthcoming; and thus will not be addressed in this TMDL document at this time.

Table 1. Streams and pollutants for which TMDLs were developed.

STREAM	POLLUTANT(S)
Marsh Creek	Temperature
South Fork Rock Creek	Temperature
East Fork Rock Creek	Temperature
Howell Canyon Creek	Temperature
Rock Creek	Temperature
Little Creek	Temperature
Land Creek	Temperature
Warm Creek	Temperature
Cold Creek	Temperature
Copper Creek	Temperature
Spring Creek (Rock Creek tributary)	Temperature
Fall Creek	Temperature
Reuger Springs	Temperature
Cottonwood Creek	Temperature
Duck Creek	Temperature
Spring Creek (Marsh Creek area)	Temperature
Lanes Gulch	Temperature
Lake Walcott	Temperature

Effective shade targets were established for two listed creeks and sixteen other water bodies, added at the region's request, in the Lake Walcott Subbasin based on the concept that maximum shading under potential natural vegetation equals natural background temperature levels. Assessments of an additional three creeks (Ferry Hollow, Little Warm, and Dry Hollow Creeks) were requested by the region, but these creeks were determined to be dry, ephemeral washes and not evaluated further. Shade targets were derived from effective shade curves developed specifically for southern Idaho vegetation types. Existing shade was determined from aerial photo interpretation field verified with solar pathfinder data.

Most streams examined in this TMDL had excess solar loads greater than expected based on target shade levels. Marsh Creek and South Fork Rock Creek had the largest excess loads. Most other streams examined had relatively high levels of disturbance as well with the exception of Lanes Gulch, which was near target shade levels.

DEQ's proposed actions for the Marsh Creek AUs are as follows:

- ID17040209SK003_02: Full Support (Category 2). No further action by DEQ is required for this AU. However, DEQ intends to visit this AU in the future to determine if the full support status is still viable.
- ID17040209SK003_02A: Unassessed Waters (Category 3). DEQ will visit this AU in the future and assess the water quality status.
- ID17040209SK003_03: TMDL Required (Category 5). A TMDL is being written for this AU as part of this document. Once the TMDL is approved by EPA, the listing will be moved (in a future iteration of EPA's Integrated Report) from Category 5 to Category 4a with its defined pollutants.
- ID17040209SK003_04: TMDL Required (Category 5). A TMDL is being written for this AU as part of this document. Once the TMDL is approved by EPA, the listing will be moved (in a future iteration of EPA's Integrated Report) from Category 5 to Category 4a with its defined pollutants.

Unlisted but impaired AUs for temperature will receive PNV TMDLS.

Table 2 provides a summary of assessment outcomes for the assessment units (AU's) of concern.

Table 2. Summary of Assessment Outcomes.

WATER BODY NAME/ASSESSMENT UNIT	DRAINAGE: BOUNDARIES	POLLUTANT	TMDL(S) COMPLETED	RECOMMENDED CHANGES TO THE 2010 INTEGRATED REPORT	JUSTIFICATION	TMDL LOADS
Marsh Creek ID17040209SK003_03 ID17040209SK003_04	Marsh Creek: Source to Mouth (3rd & 4th Order Streams)	Combined Biota/Habitat Bioassessments, Temperature	TP, E. coli, temperature, TSS	Delist for Combined Biota/Habitat Bioassessments, Move TMDLs to 4a	303 (d) listed reaches now have TMDLs	
Marsh Creek/ ID17040209SK003_02	Marsh Creek: Source to Mouth (2nd Order Streams)	Temperature	Yes	NA	Existing Shade	
South Fork Rock Creek/ ID17040209SK009_02 ID17040209SK009_03 ID17040209SK009_04	South Fork Rock Creek: Source to Mouth (2nd, 3rd and 4th Order Streams)	Temperature	Yes	NA	Existing Shade	
Howell Canyon Creek/ ID17040209SK003_02 ID17040209SK003_02 ID17040209SK003_04A	Marsh Creek: Source to Mouth (2nd Order Streams & Unnamed Streams)	Temperature	Yes	NA	Existing Shade	
Rock Creek/ ID17040209SK008_04	Rock Creek: Confluence of South & East Forks to Mouth (4th Order Streams)	Temperature	Yes	NA	Existing Shade	
Little Creek/ ID17040209SK011_02 ID17040209SK011_03	Snake River – American Falls to Rock Creek (2nd and 3rd Order Streams)	Temperature	Yes	NA	Existing Shade	
Land Creek/ ID17040209SK003_02	Marsh Creek: Source to Mouth (2nd Order Stream)	Temperature	Yes	NA	Existing Shade	
Warm Creek/ ID17040209SK012_02	Warm Creek: Source to Mouth (2nd Order Streams)	Temperature	Yes	NA	Existing Shade	
Cold Creek/ ID17040209SK012_02	Warm Creek: Source to Mouth (2nd Order Streams)	Temperature	Yes	NA	Existing Shade	
Copper Creek/ ID17040209SK013_02 ID17040209SK013_03	Craters of the Moon Complex: Source to Mouth (2nd and 3rd Order Streams)	Temperature	Yes	NA	Existing Shade	
Spring Creek (Rock Creek tributary)/ ID17040209SK008_02 ID17040209SK008_03	Rock Creek: Confluence of South & East Forks to Mouth (2nd and 3rd Order Streams)	Temperature	Yes	NA	Existing Shade	

WATER BODY NAME/ASSESSMENT UNIT	DRAINAGE: BOUNDARIES	POLLUTANT	TMDL(S) COMPLETED	RECOMMENDED CHANGES TO THE 2010 INTEGRATED REPORT	JUSTIFICATION	TMDL LOADS
Fall Creek/ ID17040209SK007_02 ID17040209SK007_03	Fall Creek: Source to Mouth (2nd and 3rd Order Streams)	Temperature	Yes	NA	Existing Shade	
Reuger Springs/ ID17040209SK011_02	Snake River – American Falls Dam to Rock Creek (2nd Order Streams)	Temperature	Yes	NA	Existing Shade	
Cottonwood Creek/ ID17040209SK013_02 ID17040209SK013_03	Craters of the Moon Complex: Source to Mouth (2nd and 3rd Order Streams)	Temperature	Yes	NA	Existing Shade	
Duck Creek/ ID17040209SK002_02	Snake River – Minidoka Dam to Heyburn/Burley Bridge (2nd Order Streams)	Temperature	Yes	NA	Existing Shade	
Spring Creek (Marsh Creek area)/ ID17040209SK002_02	Snake River – Minidoka Dam to Heyburn/Burley Bridge (2nd Order Streams)	Temperature	Yes	NA	Existing Shade	
Lanes Gulch/ ID17040209SK006_02 ID17040209SK006_03	Snake River – Rock Creek to Raft River (2nd and 3rd Order Streams)	Temperature	Yes	NA	Existing Shade	

TP = Total Phosphorus. E. coli = Escherichia coli bacteria. TSS = Total Suspended Solids. NA = Not Applicable.

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1. Subbasin Assessment–Watershed Characterization

This document presents an addendum to the Lake Walcott SBA/TMDL that addresses the water bodies in the Lake Walcott Subbasin that have been placed on Idaho's 2008 §303(d) list.

1.1. Introduction—Regulatory Requirements

This document was prepared in compliance with both federal and state regulatory requirements, as described in the following.

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the CWA, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible.

Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards). States and tribes must periodically publish a priority list (a "§303(d) list") of impaired waters. For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards.

This document addresses water bodies in the Lake Walcott Subbasin that have been placed on Idaho's 2008 §303(d) list.

1.2. Public Participation and Comment Opportunities

The development of the Marsh Creek and PNV Temperature TMDL, Lake Walcott Marsh Creek and PNV Temperature TMDL Addendum included the following public participation:

- List public participation events.

1.3. Physical and Biological Characteristics

A detailed discussion of the physical and biological characteristics of the Subbasin is provided in the Lake Walcott SBA/TMDL approved by EPA in 2000. Characteristics specific to Marsh Creek are provided in the following.

1.3.1. Climate

A detailed climate discussion for the Subbasin is provided in the Lake Walcott SBA/TMDL approved by EPA in 2000.

1.3.2. Subbasin Characteristics

A detailed discussion of the subbasin characteristics is provided in the Lake Walcott SBA/TMDL approved by EPA in 2000.

1.3.3. Marsh Creek Description and Hydrologic Characteristics

The Lake Walcott TMDL describes Marsh Creek as originating in the Albion Mountains at 5,800 feet and draining the north side of the Albion Mountains (Lay 2000 [p 32, 50]). Its headwaters are on U. S. Forest Service lands, which then transition to a broad alluvial valley that is primarily privately owned. The basin (Figure 1) drains approximately 75,800 acres (Monek 2009 [p 1]).

Once Marsh Creek enters the privately owned land, much of its flow is diverted for agricultural uses (i.e. primarily irrigation). In addition, agricultural return flows enter the channel from numerous drains and canals along its length, providing continuous flow in the stream during certain times of the year. A large diversion dam located on the Skaggs Ranch (i.e. *Dewy Pond*; sometimes spelled *Dewey Pond*) is capable of legally drying Marsh Creek entirely during the summer months. Further, down the valley below the Dewy Pond, agricultural wastewater returns to Marsh Creek before it enters the Snake River in the Milner Pool area at River Mile 659.3 (near Parees Island on the Snake River).

Citing records from the U. S. Geological Survey (1967-74) for Gage Station 13082300, it is estimated that the Marsh Creek drainage produces about 15,000 acre feet of runoff per year (~21 CFS), of which a third is consumed for agriculture in the Albion Valley upstream of the USGS gage. Flow from the Skaggs Ranch to within one to two miles of the Snake River is infrequent. The final miles of Marsh Creek receive ground water or tail water from fields during the irrigation season and consequently, this segment of Marsh Creek flows year-round.

A discussion with the Burley Irrigation District (BID; Etcheverry 2009) indicates that the irrigation season generally runs from April 1 through October 15. During this season, BID conveys approximately 250 inches of water per day (or 5 CFS) through Marsh Creek if it is dry. If Marsh Creek is not dry, then the amount of water that BID conveys is less than 5 CFS adjusting for what is in the stream channel. For the most part the water that reaches the 750 East Road prior to discharge into the Snake River is made up of spring water and agricultural irrigation returns.

Additionally, it is important to recognize that Marsh Creek has an associated Marsh Valley groundwater system, sometimes referred to as Groundwater System No. 42. It likely exists within the sedimentary valley fill materials (i.e. Qs Aquifer), to which major sources of recharge are downward percolation of precipitation and snowmelt, runoff from surrounding uplands, and leakage from Marsh Creek and its tributaries (IDWR 1981).

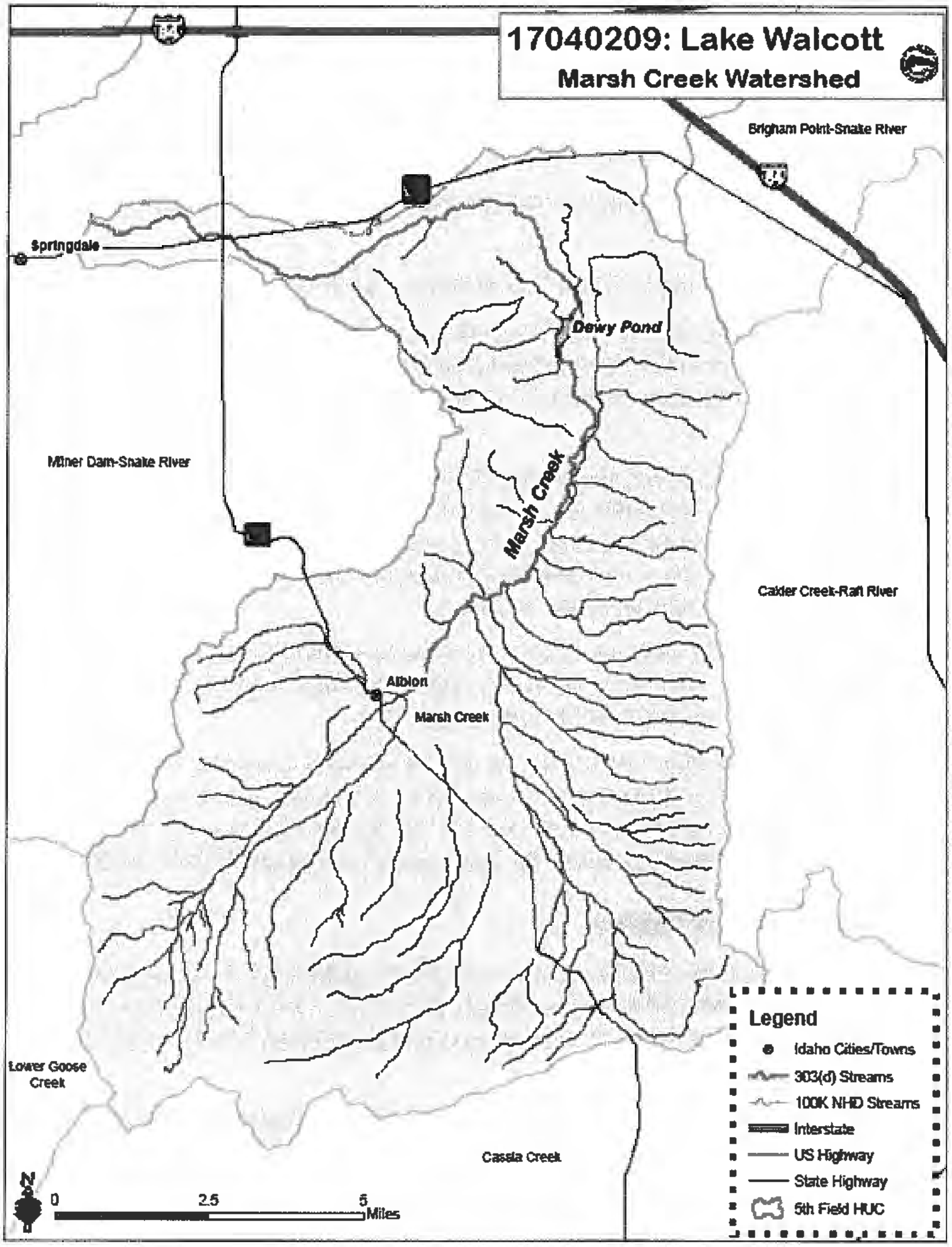

Figure 1. Marsh Creek Watershed in the Lake Walcott Subbasin.

Therefore, the overall hydrology of Marsh Creek is highly dependent on certain sources:

- Snowmelt and to a much lesser degree, stormwater
- Spring sources
- Irrigation diversions and conveyance

In general, the Marsh Creek drainage is considered a semi-arid, snowmelt driven catchment, with two hydrologic cycle primary periods of watering. These primary periods are greatly influenced by the tributaries to Marsh Creek (Howell Creek, Land Creek, etc.):

- The first primary period is a "period of wetting," when ground water contributes directly to surface stream flows.
- The second primary period is a "period of drying" when ground water contributes little-to-no to surface water flows.

In general, between each primary period there is a period of transition:

- In the fall, the transition from drying to wetting starts with the infiltration of precipitation and some snowmelt elevating the rate of soil moisture accumulation to exceed evaporation and evapotranspiration ("ET"). During this transition, and throughout the winter, the soil moisture is maintained.
- In the spring, the wetting period reaches its zenith when the infiltration of snowmelt and precipitation saturate the soil as evidenced by the over land flow of water or runoff. As the soil becomes saturated, the condition of hydraulic connectivity occurs, resulting in down slope subsurface flows. Both the runoff and the down slope subsurface flows contribute to increased stream flows at the bottom of the drainage.

As spring turns to summer, runoff subsides despite there being sufficient soil moisture to maintain hydraulic connectivity and continued down slope subsurface flow. At this time, stream flows are declining, marking a transition from wetting to drying.

As summer progresses, the transition into the drying period becomes complete when evaporation and ET deplete the soil moisture until hydraulic connectivity is lost and down slope subsurface flows cease, causing further decline in stream flows. The drying period continues until fall when there is a transition into the wetting period and the cycle starts over again (IDWR 2004).

1.3.4. Stream Characteristics

Figure 2 summarizes average flow conditions at two locations on Marsh Creek—the first near the Albion USGS Gage (No. 13082300), above Skaggs Ranch (i.e. Dewy Pond), and the second just above the confluence with the Snake River (approximately 750 East Road). Comparing flows indicates the following:

- Average annual flow for the Near Albion site (based on N = 246 points of data) is 22.7 cfs; whereas the Near Confluence site (based on N = 136 points of data) is 8.1 cfs.
- The highest monthly average flow for the Near Albion site is in the month of January at 96.9 cfs; whereas the Near Confluence site ranges from 11.3 cfs to 14.5 cfs for the months of April, May, and June.
- The lowest recorded flow (minimum) for the Near Albion site has been zero for all the months of year except May (i.e. 0.1 cfs); whereas the Near Confluence site has been zero for the months of April, June and July.
- The greatest recorded flow (maximum) for the Near Albion site was 828.0 cfs on January 17, 1971.The greatest recorded flow (maximum) for the Near Confluence site was 63.3 cfs on April 29, 1997.

- When considering the amount of flow that moves from the Near Albion site to the Near Confluence site, approximately 82% of the average flow resides at the Near Albion site during the months of November through March, whereas approximately 30% of the average flow resides at the Near Albion site from April through October.

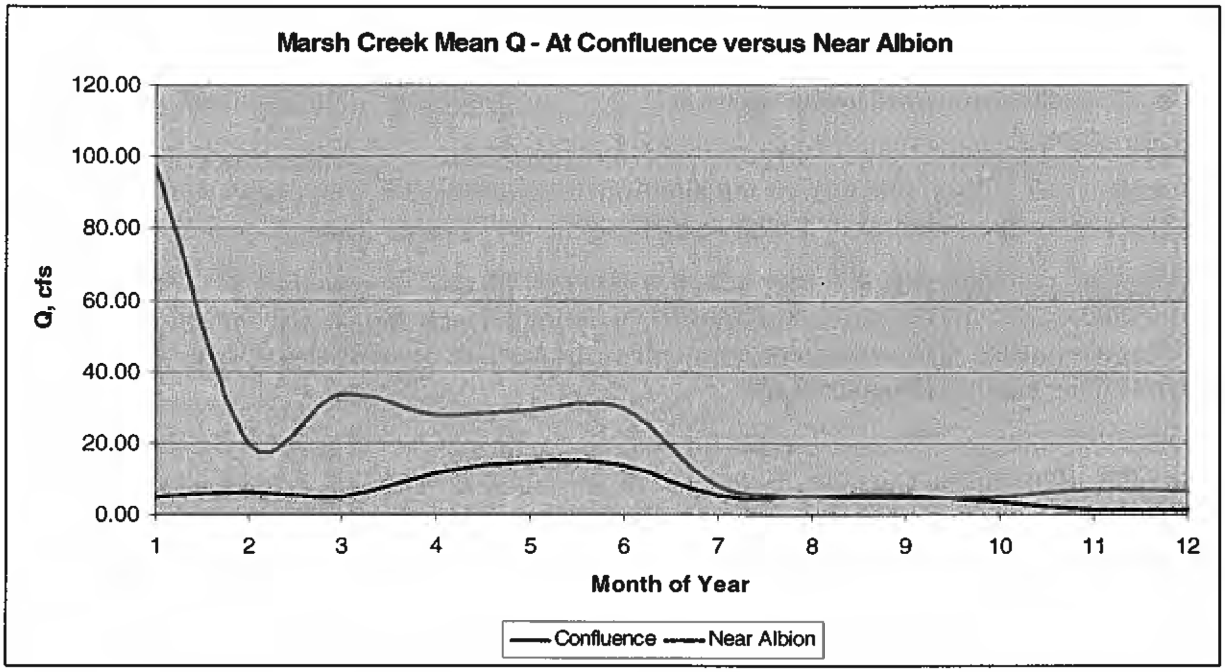

Figure 2. Marsh Creek Mean Flow (Q)–Near Confluence versus Near Albion

1.3.5. Assessment Units

Assessment Units (AUs) define the various stream reaches within the Lake Walcott HUC. AUs are groups of similar streams that have similar land use practices, ownership, or land management and define a subset of larger groupings as defined by Water Body IDs (WBIDs) and Hydrologic Unit Codes (HUCs). In addition, AUs are the basic unit used by the State of Idaho to report its water quality to EPA for the Clean Water Act §305(b) Requirements. AUs are treated as homogeneous units, so any designated uses, use support ratings and associated causes and sources of impairment apply to the entire AU.

The Marsh Creek Watershed (Figure 1) has four (4) AUs. The actions that were taken in the 2008 Integrated Report, and which will be taken by DEQ, are also considered in these AUs, as summarized in the following:

- ID17040209SK003_02: 1st and 2nd order tributaries to Marsh Creek. It includes the headwater portion of Marsh Creek; as well as the 1st and 2nd order portions of Land Creek, Brim Canyon, Howell Creek, Summit Creek, Cow Creek, Archer Spring Creek, Bridger Spring Creek and eight (8) unnamed streams.

  The 2008 Integrated Report contains the following for this AU: Marsh Creek, source to mouth, 170.84 miles, Category 2–Full Support. No additional action is currently required by DEQ under the TMDL process.

- ID17040209SK003_02A: Intermittent waters that are no longer tributaries to Marsh Creek.

The 2008 Integrated Report contains the following for this AU: Marsh Creek intermittent streams, 15.51 miles, Category 3–Unassessed Waters. DEQ will need to assess the water quality status of these intermittent streams at some time in the future based on available funding and resource constraints.

- ID17040209SK003_03: 3rd order stream segment of Marsh Creek and its 3rd order tributaries. It includes Marsh Creek from the headwaters to the confluence of Howell Creek; as well as the 3rd order portion of Howell Creek and the 3rd order portion of Summit Creek.

  The 2008 Integrated Report contains the following for this AU: Marsh Creek, source to mouth, 10.71 miles, Category 5–Impaired water requiring a TMDL, Combined Biota/Habitat Bioassessments. A TMDL is being written for this AU as part of this document.

- ID17040209SK003_04: 4th order stream segment of Marsh Creek and its 3rd order tributaries. It includes Marsh Creek from the confluence of Land Creek to the Snake River; as well s the 4th order portion of Howell Creek (from the confluence of Summit Creek to the confluence of Howell Creek into Marsh Creek).

  The 2008 Integrated Report contains the following for this AU: Marsh Creek, source to mouth, 17.81 miles, Category 5–Impaired water requiring a TMDL, Combined Biota/Habitat Bioassessments and unknown pollutants. A TMDL is being written for this AU as part of this document.

1.4. Cultural Characteristics

A detailed discussion of the cultural characteristics of the Subbasin is provided in the Lake Walcott SBA/TMDL approved by EPA in 2000.

2. Subbasin Assessment–Water Quality Concerns and Status

2.1. Water Quality Limited Assessment Units Occurring in the Subbasin

Section 303(d) of the CWA states that waters that are unable to support their beneficial uses and that do not meet water quality standards must be listed as water quality limited waters. Subsequently, these waters are required to have TMDLs developed to bring them into compliance with water quality standards.

2.1.1. Listed Waters since Original SBA/TMDL Approval

Table 3 shows the listed pollutants and the basis for listing for each 2008 §303(d) listed AU in the Lake Walcott Subbasin that has been added or carried forward since the publication of the SBA/TMDL approved by EPA in 2000.

Table 3. 2008 §303(d) Segments in the Lake Walcott Subbasin.

WATER BODY NAME	ASSESSMENT UNIT ID NUMBER	2008 §303(D) BOUNDARIES	POLLUTANTS	LISTING BASIS
Marsh Creek	ID17040209SK003 _03 and_04	Source to mouth	Combined Biota/Habitat Bio-Assessment	Carried from 1998 list as unknown
Snake River	ID17040209SK002 _07	Minidoka Dam to Burley Bridge	Sedimentation	Appears listed in error. Informational TMDL exists for sediment as an antidegradation measure.
Lake Walcott	ID17040209SK004L_0L	Lake Walcott of Snake River	Mercury (in fish tissue)	2008, fish tissue exceedance of WQS
Snake River	ID17040209SK011_02	American Falls Reservoir Dam to Rock Creek	Combined Biota/Habitat Bio-Assessment	Carried from 2002 list as unknown
Craters of the Moon Complex	ID17040209SK013_02 and _03	None identified	Combined Biota/Habitat Bio-Assessment	Carried from 2002 list/sites may not actually be part of Lake Walcott HUC but rather Big Lost River HUC. Sites appear listed in error.

Not all of the water bodies will require a TMDL. Waters newly listed in 2002 and 2008 may be deferred if insufficient data exists to develop a TMDL. However, a thorough investigation, using the available data, was performed before this conclusion was made.

2.2. Applicable Water Quality Standards and Beneficial Uses

Idaho water quality standards, defined in IDAPA 58.01.02, designate beneficial uses, and set water quality goals for the waters of the state.

Idaho water quality standards require that surface waters of the state be protected for *beneficial uses*, wherever attainable (IDAPA 58.01.02.050.02). These beneficial uses are interpreted as existing uses, designated uses, and presumed uses as briefly described in the following paragraphs. The *Water Body Assessment Guidance*, second edition (Grafe et al. 2002) gives a more detailed description of beneficial use identification for use assessment purposes.

2.2.1. Existing Uses

Existing uses under the CWA are "those uses actually attained in the waterbody on or after November 28, 1975, whether or not they are included in the water quality standards." The existing in-stream water uses and the level of water quality necessary to protect the uses shall be maintained and protected (IDAPA 58.01.02.050.02, .02.051.01, and .02.053). Existing uses include uses actually occurring, whether or not the level of quality to support fully the uses exists. A practical application of this concept would be to apply the existing use of salmonid spawning to a water that could support salmonid spawning, but salmonid spawning is not occurring due to other factors, such as dams blocking migration.

2.2.2. Designated Uses

Designated uses under the CWA are "those uses specified in water quality standards for each water body or segment, whether or not they are being attained." Designated uses are simply uses officially recognized by the state. In Idaho, these designated uses include aquatic life support, recreation in and on the water, domestic water supply, and agricultural uses. Water quality must be sufficiently maintained to meet the most sensitive use.

Designated uses may be added or removed using specific procedures provided for in state law, but the effect must not be to preclude protection of an existing higher quality use such as cold water aquatic life or salmonid spawning.

Designated uses are specifically listed for water bodies in Idaho in tables in the Idaho water quality standards (see IDAPA 58.01.02.003.27 and .02.109-.02.160, in addition to citations for existing uses).

2.2.3. Presumed Uses

In Idaho, most water bodies listed in the tables of designated uses in the water quality standards do not yet have specific use designations. These undesignated uses are to be designated. In the interim, and absent information on existing uses, DEQ presumes that most waters in the state will support cold water aquatic life and either primary or secondary contact recreation (IDAPA 58.01.02.101.01). To protect these so-called "presumed uses," DEQ will apply the numeric cold water criteria and primary or secondary contact recreation criteria to undesignated waters.

If in addition to these presumed uses, an additional existing use, (e.g., salmonid spawning) exists, because of the requirement to protect levels of water quality for existing uses, then the additional numeric criteria for salmonid spawning would additionally apply (e.g., intergravel dissolved oxygen, temperature). However, if for example, cold water aquatic life is not found to be an existing use, an use designation to that effect is needed before some other aquatic life criteria (such as seasonal cold) can be applied in lieu of cold water criteria (IDAPA 58.01.02.101.01).

Table 4. Beneficial uses of Section 303(d) listed streams.

Water Body/Assessment Unit	Beneficial Uses[a]	Type of Use (state if designated, existing, etc.)
Marsh Creek	CW, SS, PCR, SCR, AWS	existing
Lake Walcott	CW, PCR, DWS	designated
Snake River-SK011_02	CW, PCR DWS	designated
Craters of the Moon Complex	CW, SCR	presumed

[a] CW–cold water, SS–salmonid spawning, PCR–primary contact recreation, SCR–secondary contact recreation, AWS–agricultural water supply, DWS–domestic water supply

Table 5. Lake Walcott Subbasin beneficial uses of assessed, non-§303(d) listed streams.

Water Body/Assessment Unit	Beneficial Uses[a]	Type of Use (state if designated, existing, etc.)
Marsh Creek ID17040209SK003_03 ID17040209SK003_04		
Marsh Creek/ ID17040209SK003_02		
South Fork Rock Creek/ ID17040209SK009_02 ID17040209SK009_03 ID17040209SK009_04		
Howell Canyon Creek/ ID17040209SK003_02 ID17040209SK003_02 ID17040209SK003_04A		
Rock Creek/ ID17040209SK008_04		
Little Creek/ ID17040209SK011_02 ID17040209SK011_03		
Land Creek/ ID17040209SK003_02		
Land Creek/ ID17040209SK003_02		
Land Creek/ ID17040209SK003_02		
Warm Creek/ ID17040209SK012_02		
Cold Creek/ ID17040209SK012_02		
Copper Creek/ ID17040209SK013_02 ID17040209SK013_03		
Spring Creek (Rock Creek tributary)/ ID17040209SK008_02 ID17040209SK008_03		
Fall Creek/ ID17040209SK007_02 ID17040209SK007_03		
Reuger Springs		
Cottonwood Creek/ ID17040209SK013_02 ID17040209SK013_03		
Duck Creek/ ID17040209SK002_02		
Spring Creek (Marsh Creek area)/ ID17040209SK002_02		

Water Body/Assessment Unit	Beneficial Uses[a]	Type of Use (state if designated, existing, etc.)
Lanes Gulch/ ID17040209SK006_02 ID17040209SK006_03		

[a] CW–cold water, SS–salmonid spawning, PCR–primary contact recreation, SCR–secondary contact recreation, AWS–agricultural water supply, DWS–domestic water supply

2.3. Criteria to Support Beneficial Uses

Beneficial uses are protected by a set of criteria, which include *narrative* criteria for pollutants such as sediment and nutrients and *numeric* criteria for pollutants such as bacteria, dissolved oxygen, pH, ammonia, temperature, and turbidity (IDAPA 58.01.02.250).

Table 6 includes the most common numeric criteria used in TMDLs.

Figure 3 provides an outline of the stream assessment process for determining support status of the beneficial uses of cold water aquatic life, salmonid spawning, and contact recreation.

Table 6. Selected numeric criteria supportive of designated beneficial uses in Idaho water quality standards.

Designated and Existing Beneficial Uses				
Water Quality Parameter	**Primary Contact Recreation**	**Secondary Contact Recreation**	**Cold Water Aquatic Life**	**Salmonid Spawning (During Spawning and Incubation Periods for Inhabiting Species)**
Water Quality Standards: IDAPA 58.01.02.250				
Bacteria, ph, and Dissolved Oxygen	Less than 126 *E. coli*/100 ml[a] as a geometric mean of five samples over 30 days; no sample greater than 406 *E. coli* organisms/100 ml	Less than 126 *E. coli*/100 ml as a geometric mean of five samples over 30 days; no sample greater than 576 *E. coli*/100 ml	pH between 6.5 and 9.0 DO[b] exceeds 6.0 mg/L[c]	pH between 6.5 and 9.5 Water Column DO: DO exceeds 6.0 mg/L in water column or 90% saturation, whichever is greater Intergravel DO: DO exceeds 5.0 mg/L for a one day minimum and exceeds 6.0 mg/L for a seven day average
Temperature[d]			22 °C or less daily maximum; 19 °C or less daily average	13 °C or less daily maximum; 9 °C or less daily average Bull trout: not to exceed 13 °C maximum weekly maximum temperature over warmest 7-day period, June–August; not to exceed 9 °C daily average in September and October
			Seasonal Cold Water: Between summer solstice and autumn equinox: 26 °C or less daily maximum; 23 °C or less daily average	
Turbidity			Turbidity shall not exceed background by more than 50 NTU[e] instantaneously or more than 25 NTU for more than 10 consecutive days.	
Ammonia			Ammonia not to exceed calculated concentration based on pH and temperature.	
EPA Bull Trout Temperature Criteria: Water Quality Standards for Idaho, 40 CFR Part 131				
Temperature				7 day moving average of 10 °C or less maximum daily temperature for June - September

[a] *Escherichia coli* per 100 milliliters
[b] dissolved oxygen
[c] milligrams per liter
[d] Temperature Exemption - Exceeding the temperature criteria will not be considered a water quality standard violation when the air temperature exceeds the ninetieth percentile of the seven-day average daily maximum air temperature calculated in yearly series over the historic record measured at the nearest weather reporting station.
[e] Nephelometric turbidity units

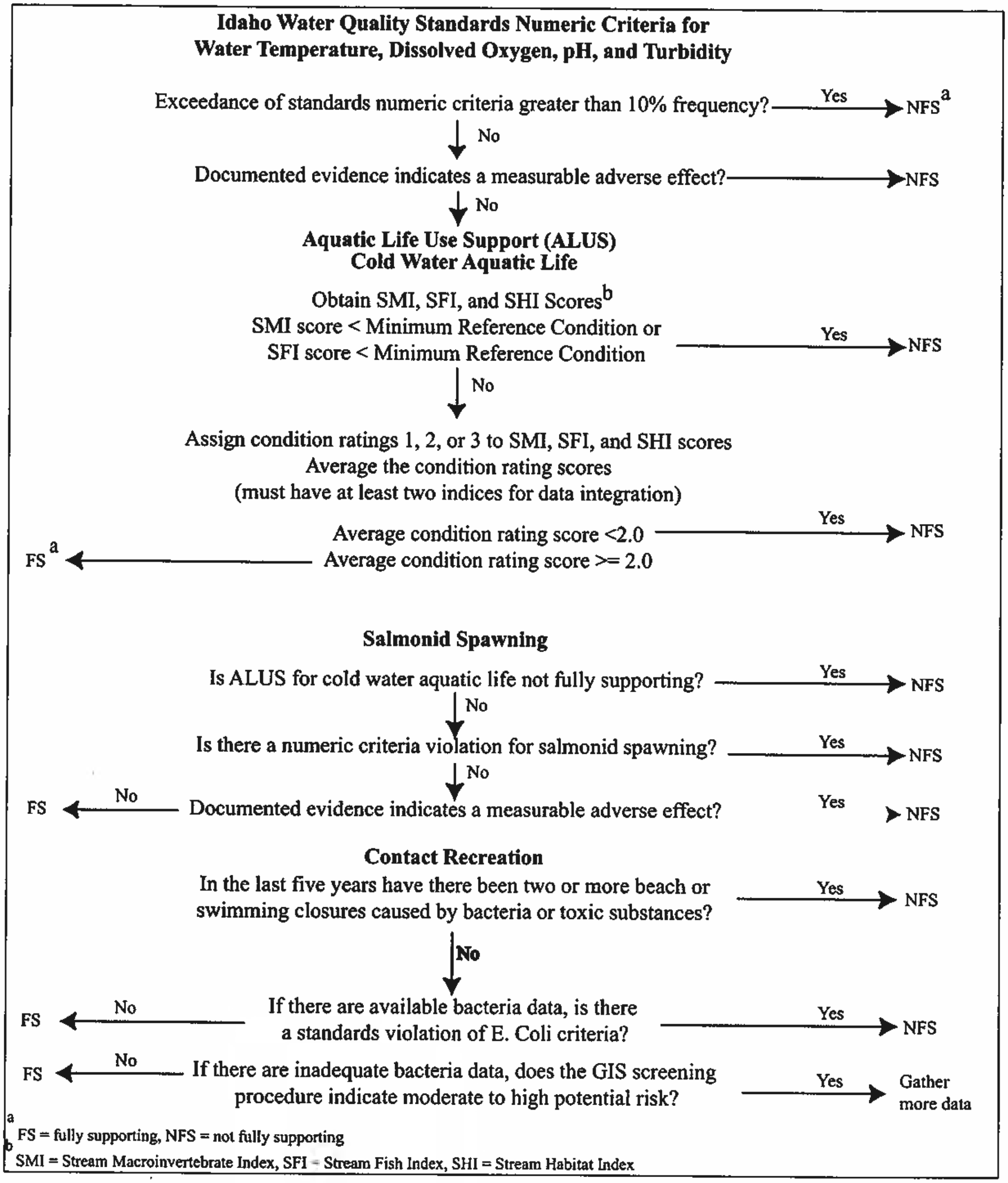

Figure 3. Determination Steps and Criteria for Determining Support Status of Beneficial Uses in Wadeable Streams: *Water Body Assessment Guidance*, Second Addition (Grafe *et al.* 2002)

DEQ electrofished Marsh Creek in 1994 about ¼ mile north of Albion, Idaho (1994STWFA025) and found the presence of book trout and Paiute sculpin. Then, in 1996-1997 the IDFG extensively surveyed Marsh Creek and several tributaries near Albion, Idaho and determined the presence of "brook trout, hatchery rainbow trout, mottled sculpin *Cottus bairdi*, redside shiners *Richardsonius balteatus*, and longnose dace *Rhinichthys cataractae*. The highest trout densities were found in reaches of higher gradients where there was a mix of habitat types" (IDFG 1997 [p

44]). Then, in 2000-2001, IDFG investigated the entrainment of fishery in Howell Creek (a tributary to Marsh Creek) due to a manmade pond; and determined the presence of brook trout and no other fish species (IDFG 2004 [pp 40 & 44]).

In addition, DEQ surveyed the water rights off of the IDWR Website for Marsh Creek and concludes that the primary water uses in Marsh Creek are irrigation, irrigation storage, domestic and stockwater Other minor uses include aesthetics, wildlife, mitigation and water quality improvement.

Therefore, DEQ concludes from this information that the existing beneficial uses of Marsh Creek are principally as follows:

- Cold Water Aquatic Life–from the headwaters to the mouth. The presence of brook trout in the stream is evidence that cold water habitat is present for their survival during certain times of the year.
- Salmonid Spawning–from the headwaters to the mouth. The presence of brook trout in the stream is evidence of salmonid survival during certain times of the year.
- Secondary Contact Recreation–from the headwaters to Dewy Pond. Although some recreational fishing has been noted, more fishing occurs below the Dewy Pond than above it. Kayaking has been noted towards the confluence of Marsh Creek into the Snake River.
- Primary Contact Recreation–from Dewy Pond to the mouth. Recreational fishing has been noted towards the confluence of Marsh Creek into the Snake River.
- Agricultural Water Supply–from the headwaters to the mouth. This is the dominant beneficial use along all of the private lands.

2.4. Summary and Analysis of Existing Water Quality Data

A detailed summary and analysis of previous existing water quality data for the Lake Walcott Subbasin is provided in the Lake Walcott SBA/TMDL approved by EPA in 2000. A summary of the available water quality for TSS, TP and E. coli is described in the following.

2.4.1. Sediment (as Total Suspended Solids or TSS)

A review of the available water quality data (from DEQ, ISCC, USGS and BID) indicates that approximately 9.4% of the TSS data (N = 235) exceeds or is equal to the recommended 50.0 mg/L TSS instream target as identified in the Lake Walcott TMDL. That target was advisory in nature and intended to prevent water quality degradation. The exceedances (N = 22) have a minimum value of 51.6 mg/L, an average value of 138.0 mg/L and a maximum value 472.0 mg/L. In general, these exceedances occur during April (n = 11 or 50% of the time), May (n = 8 or 36.4% of the time), June (n = 2 or 9.1% of the time) and July (n = 1 or 4.5% of the time). Figure 4 summarizes the TSS exceedances on a monthly basis based on the water quality monitoring data that was available to DEQ.

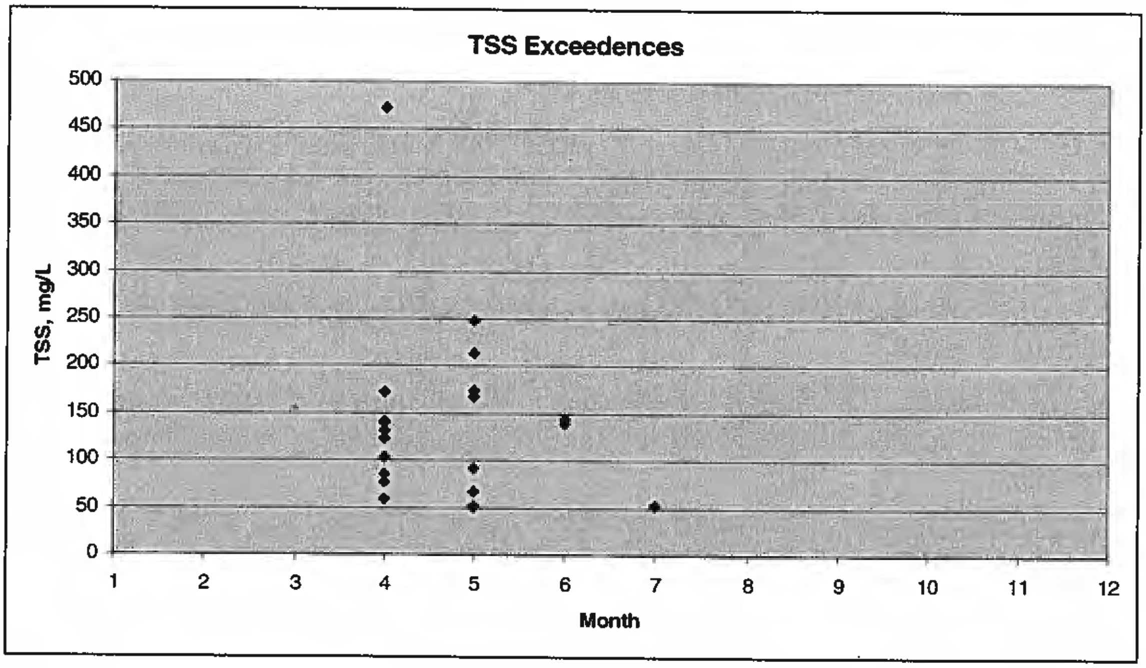

Figure 4. TSS Exceedances (≥ 50 mg/L) in Marsh Creek.

2.4.2. Total Phosphorus

Review of available water quality data (from DEQ, ISCC, USGS and BID) indicates that approximately 47.0% of the TP data (N = 230) exceeds or is equal to the 0.100 mg/L TP instream target defined by the Lake Walcott TMDL. The exceedances (N = 108) have a minimum value of 0.100 mg/L, an average value of 0.163 mg/L, and a maximum value 0.990 mg/L. In general, these exceedances occur year-round, but most occur from April through September, at 15.1% per month on average, with the least occurring October through March, at 1.6% per month on average. Figure 5 summarizes TP exceedances on a monthly basis based on the water quality monitoring data that was available to DEQ.

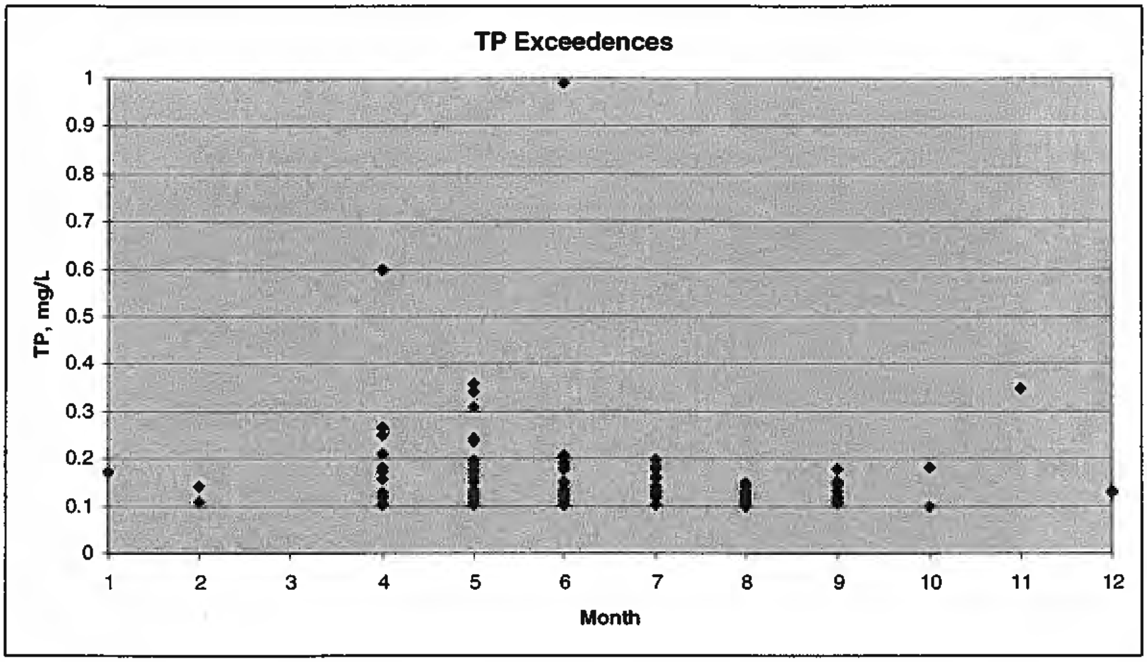

Figure 5. TP Exceedances (≥ 0.100 mg/L) in Marsh Creek.

2.4.3. *Escherichia coli* (*E. coli*)

For *E. coli*, levels that exceed the water quality standards (as defined in IDAPA §58.01.02) tend to degrade the beneficial uses of primary and secondary contact recreation (depending on the specific water body). In the case of *primary contact recreation*, this may include uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and SCUBA diving, surfing, white water activities, fishing, or use of natural hot springs. In the case of *secondary contact recreation*, this may include the uses of water for recreational activities involving proximity to water, but not normally involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, aquatic life study, hunting, sight-seeing, or aesthetic enjoyment in conjunction with any of the above activities. In many cases the persistence of excess levels of *E. coli* may indicate a change in the chemical, physical, or biological integrity of the water body in question. Excess *E. coli* levels also are an indicator (but not necessarily the cause) of eutrophication. Under such conditions, public exposure where recreation is occurring may make such activities inadvisable until excess levels are at safe standards before recreational activities may occur.

Review of available water quality data (from DEQ, ISCC, USGS and BID) indicates that approximately 28.7% of the E. coli data (N = 115) exceeds or is equal to the 406 cfu/100 mL instantaneous instream target defined by the Lake Walcott TMDL. The exceedances (N = 33) have a minimum value of 410.0 cfu/100 mL, an average value of 1,040.6 cfu/100 mL, and a maximum value 2,400.0 cfu/100 mL. In general, these exceedances occur from April through September, at 16.7% per month on average. Figure 6 summarizes the *E. coli* exceedances on a monthly basis based on the water quality monitoring data that was available to DEQ.

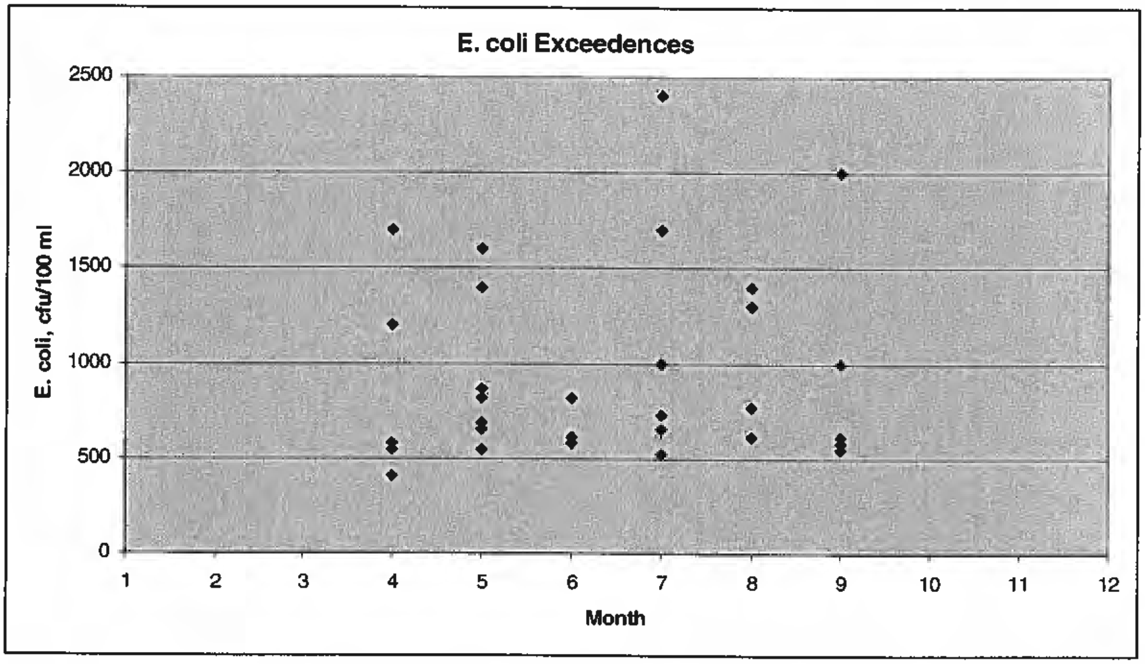

Figure 6. ***E. coli*** **Exceedances (≥ 406 cfu/100 mL) in Marsh Creek.**

2.5. Data Gaps

A detailed discussion of data gaps for the Lake Walcott Subbasin is provided in the Lake Walcott Subbasin SBA/TMDL approved by EPA in 2000.

Update as necessary.

3. Subbasin Assessment–Pollutant Source Inventory

3.1. Sources of Pollutants of Concern

The Marsh Creek TMDL provides load allocations for total suspended solids (TSS), total phosphorus (TP) and Escherichia coli (E. coli), the primary pollutants-of-concern. A temperature TMDL for Marsh Creek and several other stream reaches that are unlisted but impaired for temperature are also included in this document.

A review of the available water quality data for Marsh Creek for TSS, TP, E. coli and temperature indicates these are the primary pollutants-of-concern. Because no known point sources exist that discharge to Marsh Creek, DEQ concludes that the main pollutant sources are associated with nonpoint sources. These sources appear to be associated with land use and land ownership, and include the following:

- Forested lands - primarily in the headwaters portion of Marsh Creek. The primary pollutant-of-concern is TSS.
- Recreation–primarily on private lands along Marsh Creek. Recreational fishing is known to exist below the Dewy Pond. The primary pollutants are sediment and E. coli; especially where streambanks have been denuded.
- Rangeland grazing - primarily on private lands along Marsh Creek. Unmanaged cattle water in Marsh Creek when off-site watering is unavailable. The primary pollutants-of-concern are sediment and E. coli.
- Irrigated agriculture - as diversions and private ditch discharges from the headwaters to the confluence into the Snake River. The primary pollutants are sediment, TP and E. coli.
- Private lands–primarily along most of the Marsh Creek corridor with the exception of the USFS headwaters portion. The primary are sediment, TP and E. coli.
- Confined feeding operations (as feedlots or dairies)–The Marsh Creek watershed has small private "backyard" type feedlots and dairies, rather than the large permitted operations. These are primarily located near Declo, Idaho. However, near Albion, Idaho there exists a private elk ranch. The primary pollutants are sediment, TP and E. coli.
- Construction–Construction activities are known to exist along Marsh Creek that are associated with home development, roadway repairs and culvert replacements. The primary pollutant-of-concern is sediment.
- Roads–Above Albion, Idaho several dirt roads are associated along Marsh Creek. At Albion, Idaho State Highway 77 crosses Marsh Creek in Albion. Then, from Albion to the Dewy Pond several dirt roads are associated along Marsh Creek. From the Dewy Pond to Declo, Idaho several dirt roads are associated along Marsh Creek. At Declo, Idaho State Highways 77 and 81 cross Marsh Creek. Finally, from Declo to the confluence with the Snake River, several dirt roads are associated along Marsh Creek. The primary pollutant-of-concern for roads is sediment in runoff that reaches the stream.

- Stream crossings (inclusive of bridges and culverts)–Numerous stream crossings are known to cross Marsh Creek from the headwaters to its confluence with the Snake River. Approximately ten stream crossing are known above the Dewy Pond; and 9 stream crossings are known below the Dewy Pond. The primary pollutant is sediment.
- Mining (inclusive of sand and gravel facilities)–In the Marsh Creek watershed there exist small private gravel pits that are exempt from the surface mining act but are allowed as land use only. Two commercial pits (reclamation leases) exist south of Albion between the Albion Valley and Conner Summit. Towards the Conner Creek area there exist one mineral lease for surface rock only and one Idaho Transportation Department (ITD) lease (that is totally reclaimed) on Bureau of Land Management (BLM). The primary pollutant is sediment.
- Urban runoff (from the towns of Albion and Declo)–The Marsh Creek stream channel crosses Main Street in Albion, Idaho and potentially receives runoff during the high flow portion of the year when the snowmelt occurs. Marsh Creek also crosses State Highways 81 (the Declo-Springdale Highway) and 77 (the Interstate 84 to Declo Road) where it potentially receives runoff during the high flow portion of the year when the snowmelt occurs. The primary pollutants are sediment, TP and E. coli.
- Rural runoff–periodic to severe flooding problems are known to exist in Marsh Creek and Land Creek near Albion, Idaho due mainly to heavy rain, rapid snowmelt, or ice jams. (Cassia County Comprehensive Plan 2006 [p 37]). The primary pollutants are sediment, TP and E. coli.
- Diversions (inclusive of reservoirs and manmade lakes)–An investigation of IDWR water rights indicates that Marsh Creek is the primary source water to much of the irrigated land that is associated with the local agricultural community; followed by stockwater and domestic use. Diversions account for much of the water in Marsh Creek being 100% diverted at times from the creek. The primary pollutant-of-concern is sediment.
- Septic systems–privately owned lots with the intent to build homes that are not hooked up to sewage treatment in Albion or Declo are required to maintain a private septic tank system in accordance with the rules and regulations of Cassia County Zoning. The primary pollutants are TP and E. coli.

3.2. Data Gaps

Copy from the Lake Walcott Subbasin SBA/TMDL approved by EPA in (Year).

Update as necessary.

3.2.1. Point Sources

There are no point sources in the Marsh Creek drainage.

3.2.2. Nonpoint Sources

All sources in the Marsh Creek drainage are non point source.

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4. Monitoring and Status of Water Quality Improvements

There is limited data in the Marsh Creek drainage. A wetlands restoration project took place. However, projects specific to water quality protection within the drainage appear limited.

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5. Total Maximum Daily Load(s)

A TMDL prescribes an upper limit (or *load capacity*) on discharge of a pollutant from all sources to assure water quality standards are met. This load capacity (LC) can be represented by an equation:

LC = MOS + NB + LA + WLA

Where:

> Current load (LC) = the current concentration of the pollutant in the water body
>
> MOS = margin of safety. Because of uncertainties regarding quantification of loads and the relation of specific loads to attainment of water quality standards, 40 CFR Part 130 requires a margin of safety, which is effectively a reduction in the load capacity available for allocation to pollutant sources.
>
> NB = natural background. When present, NB may be considered part of load allocation (LA), but it is often considered separately because it represents a part of the load not subject to control. NB is also effectively a reduction in the load capacity available for allocation to human-made pollutant sources.
>
> LA = the load allocation for all nonpoint sources
>
> WLA = the wasteload allocation for all point sources

A load is a quantity of a pollutant discharged over some period; numerically, it is the product of concentration and flow. Due to the diverse nature of various pollutants and the difficulty of strictly dealing with loads, federal rules allow "other appropriate measures" to be used when necessary. These "other measures" must still be quantifiable and relate to water quality standards, but they allow flexibility to deal with pollutant loading in more practical and tangible ways. The rules also recognize the particular difficulty of quantifying nonpoint loads and allow "gross allotment" as a load allocation where available data or appropriate predictive techniques limit more accurate estimates. For certain pollutants whose effects are long term, such as sediment and nutrients, EPA allows for seasonal or annual loads.

5.1. In-stream Water Quality Targets

This section describes in-stream water quality targets for Marsh Creek (sediment, nutrients, and bacteria) and temperatures associated with potential natural vegetation.

5.1.1. Marsh Creek Sediment, Nutrients, and Bacteria

The numeric and narrative water quality targets that will be used to achieve water quality standards are based in part on assumptions contained in the EPA approved Lake Walcott TMDL. These instream targets are as follows:

- Sediment (TSS). Rock Creek (in Power County) has an assigned TSS instream target of 50 mg/L as a monthly average and a daily maximum of 80 mg/L to allow for natural variability (see Lay 2000 [p 128, Section 3.1.5.1]). This same approach was applied to the East Fork Rock Creek (see Lay 2000 [p 128, Section 3.1.6.1]). The application of this TSS instream target (i.e. monthly average of 50 mg/L and a daily maximum of 80 mg/L) is applied to Marsh Creek primarily because Marsh Creek is impaired as a consequence of nonpoint source activities.

- Nutrients (TP). The application of U. S. EPA "Blue Book" recommendation of 0.100 mg/L TP in free flowing streams was applied as the Marsh Creek TP instream target. This approached was used in the Lake Walcott TMDL (see Lay 2000 [p 143, Section 3.4.3]).
- Bacteria (E. coli). E. coli has been incorporated as a water quality standard (IDAPA §58.01.02.251.01) for primary recreation at 406 CFU/100 mL as an instantaneous sample and 126 CFU/100 mL as a geometric mean. Therefore, the application of the primary contact recreation geometric mean (126 CFU/100 mL) will be applied on Marsh Creek to meet beneficial uses.

5.1.2. Potential Natural Vegetation (PNV) Temperature TMDL

For the Lake Walcott temperature TMDL, we utilized a potential natural vegetation (PNV) approach. The Idaho water quality standards include a provision (IDAPA 58.01.02.200.09), which establishes that if natural conditions exceed numeric water quality criteria, exceedance of the criteria is not considered to be a violation of water quality standards. In these situations, natural conditions essentially become the water quality standard, and the natural level of shade and channel width become the target of the TMDL. The instream temperature that results from attainment of these conditions is consistent with the water quality standards, even though it may exceed numeric temperature criteria. (See Appendix B for further discussion of water quality standards and background provisions.)

The PNV approach is described in the following, as are the procedures and methodologies to develop PNV target shade levels and estimate existing shade levels. For a more complete discussion of shade and its affects on stream water temperature, the reader is referred to the South Fork Clearwater Subbasin Assessment and TMDL (Dechert, 2004)

5.1.2.1. Potential Natural Vegetation for Temperature TMDLs

There are several important contributors of heat to a stream, including ground water temperature, air temperature, and direct solar radiation (Poole and Berman 2001). Of these, direct solar radiation is the source of heat that is most likely to be controlled or manipulated. The parameters that affect or control the amount of solar radiation hitting a stream throughout its length are shade and stream morphology. Shade is provided by the surrounding vegetation and other physical features such as hillsides, canyon walls, terraces, and high banks.

Stream morphology affects how closely riparian vegetation grows together and water storage in the alluvial aquifer. Streamside vegetation and channel morphology are factors influencing shade, which are most likely to have been influenced by anthropogenic activities, and which can be most readily corrected and addressed by a TMDL.

Depending on how much vertical elevation also surrounds the stream, vegetation further away from the riparian corridor can provide shade. However, riparian vegetation provides a substantial amount of shade on a stream by virtue of its proximity.

We can measure the amount of shade that a stream enjoys in a number of ways. *Effective shade*, that shade provided by all objects that intercept the sun as it makes its way across the sky, can be measured in a given spot with a solar pathfinder or with optical equipment similar to a fish-eye lens on a camera. Effective shade can also be modeled using detailed information about riparian plants and their communities, topography, and the stream's aspect.

In addition to shade, *canopy cover* is a similar parameter that affects solar radiation. Canopy cover is the vegetation that hangs directly over the stream, and can be measured using a densiometer, or estimated visually either on site or on aerial photography. All of these methods tell us information about how much the stream is covered and how much of it is exposed to direct solar radiation.

Potential natural vegetation (PNV) along a stream is that riparian plant community that has grown to an overall mature state, although some level of natural disturbance is usually included in our development and use of shade targets. The PNV can be removed by disturbance either naturally (wildfire, disease/old age, wind-blown, wildlife grazing) or anthropogenic (domestic livestock grazing, vegetation removal, erosion).

The idea behind PNV as targets for temperature TMDLs is that PNV provides a natural level of solar loading to the stream without any anthropogenic removal of shade producing vegetation. Anything less than PNV results in the stream heating up from anthropogenic additional solar inputs.

We can estimate PNV from models of plant community structure (shade curves for specific riparian plant communities), and we can measure existing vegetative cover or shade. Comparing the two will tell us how much excess solar load the stream is receiving, and what potential there is to decrease solar gain. Streams disturbed by wildfire require their own time to recover. Streams that have been disturbed by human activity may require additional restoration above and beyond natural recovery.

Existing shade or cover was estimated for the twenty water bodies from visual observations of aerial photos. These estimates were field verified by measuring shade with a solar pathfinder at systematically located points along the streams (see below for methodology). PNV targets were determined from an analysis of probable vegetation at the streams and comparing that to shade curves developed for similar vegetation communities in other TMDLs.

A shade curve shows the relationship between effective shade and stream width. As a stream gets wider, the shade decreases as the vegetation has less ability to shade the center of wide streams. As the vegetation gets taller, the more shade the plant community is able to provide at any given channel width. Existing and PNV shade was converted to solar load from data collected on flat plate collectors at the nearest National Renewable Energy Laboratory (NREL) weather stations collecting these data. In this case, the Pocatello station was used. The difference between existing and potential solar load, assuming existing load is higher, is the load reduction necessary to bring the stream back into compliance with water quality standards (Appendix B). PNV shade and loads are assumed to be the natural condition, thus stream temperatures under PNV conditions are assumed to be natural (so long as there are no point sources or any other anthropogenic sources of heat in the watershed), and are thus considered to be consistent with the Idaho water quality standards, even though they may exceed numeric criteria.

5.1.2.2. Pathfinder Methodology

The solar pathfinder is a device that allows one to trace the outline of shade producing objects on monthly solar path charts. The percentage of the sun's path covered by these objects is the effective shade on the stream at the spot that the tracing is made. To adequately characterize the effective shade on a reach of stream, ten traces should be taken at systematic or random intervals along the length of the stream in question.

At each sampling location, the solar pathfinder should be placed in the middle of the stream about the bankfull water level. Follow the manufacturer's instructions (orient to true south and level) for taking traces. Systematic sampling is easiest to accomplish and still not bias the location of sampling. Start at a unique location such as 100 m from a bridge or fence line and then proceed upstream or downstream stopping to take additional traces at fixed intervals (e.g. every 50m, every 50 paces, etc.). One can also randomly locate points of measurement by generating random numbers to be used as interval distances.

It is a good idea to measure bankfull widths and take notes while taking solar pathfinder traces, and to photograph the stream at several unique locations. Pay special attention to changes in riparian plant communities and what kinds of plant species (the large, dominant, shade producing ones) are present. Additionally or as a substitution, one can take densiometer readings at the same location as solar pathfinder traces. This provides the potential to develop relationships between canopy cover and effective shade for a given stream.

5.1.2.3. Aerial Photo Interpretation

Canopy coverage estimates or expectations of shade based on plant type and density are provided for natural breaks in vegetation density, marked out on a 1:100K or 1:250K hydrography. Each interval is assigned a single value representing the bottom of a 10%-canopy coverage or shade class as described below (*adapted from the CWE process, IDL, 2000*). For example, if we estimate that canopy cover for a particular stretch of stream is somewhere between 50% and 59%, we assign the value of 50% to that section of stream. The estimate is based on a general intuitive observation about the kind of vegetation present, its density, and the width of the stream.

Typical vegetation type (Table 7) shows the kind of landscape a particular cover class usually falls into for a stream 5 meters wide or less. For example, if a section of a 5-meter wide stream is identified as 20% cover class, it is usually because it is in agricultural land, meadows, open areas, or clearcuts. However, that does not mean that the 20% cover class cannot occur in shrublands and forests, because it does on wider streams.

Table 7. Typical vegetation by cover class.

COVER CLASS	TYPICAL VEGETATION TYPE ON 5-METER WIDE STREAM
0 = 0 – 9% cover	agricultural land, denuded areas
10 = 10 –19%	agricultural land, meadows, open areas, clearcuts
20 = 20 – 29%	agricultural land, meadows, open areas, clearcuts
30 = 30 – 39%	agricultural land, meadows, open areas, clearcuts
40 = 40 – 49%	shrublands/meadows
50 = 50 – 59%	shrublands/meadows, open forests
60 = 60 – 69%	shrublands/meadows, open forests
70 = 70 – 79%	forested
80 = 80 – 89%	forested
90 = 90 –100%	forested

It is important to note that the visual estimates made from the aerial photos are strongly influenced by canopy cover. It is not always possible to visualize or anticipate shade characteristics resulting from topography and landform. We assume that canopy coverage and shade are similar based on research conducted by Oregon DEQ.

The visual estimates of 'shade' in this TMDL will be field verified with a solar pathfinder. The pathfinder measures effective shade and is taking into consideration other physical features that block the sun from hitting the stream surface (e.g. hillsides, canyon walls, terraces, anthropogenic structures). The estimate of 'shade' made visually from an aerial photo does not always take into account topography or any shading that may occur from physical features other than vegetation. However, research has shown that shade and cover measurements are remarkably similar (OWEB, 2001), reinforcing the idea that riparian vegetation and objects proximal to the stream provide the most shade.

5.1.2.4. Stream Morphology

Measures of current bankfull width or near stream disturbance zone width may not reflect widths that were present under PNV. As impacts to streams and riparian areas occur, width-to-depth ratios tend to increase such that streams become wider and shallow. Shadow length produced by vegetation covers a lower percentage of the water surface in wider streams, and widened streams can also have less vegetative cover if shoreline vegetation has been eroded away.

The only factor not developed from the aerial photo work described previously is channel width (i.e., NSDZ or Bankfull Width). Accordingly, this parameter must be estimated from available information. We use regional curves for the major basins in Idaho, data compiled by Diane Hopster of Idaho Department of Lands (Figure 7), to estimate natural bankfull width. For each stream evaluated in the loading analysis, bankfull width is estimated based on drainage area and the Upper Snake curve. Additionally, existing width is evaluated from available data.

For the loading analysis, if the stream's existing width is wider than that predicted by the Upper Snake curve displayed in Table 8, then the Figure 7 estimate of bankfull width is used in the loading analysis for natural width. If existing width is smaller, then existing width is used in the loading analysis for natural width. East Fork Rock Creek is an exception where existing width is wider near the headwaters of the stream and thins as it gets closer to the mouth of the stream due to water being removed from the stream for irrigation. In most cases, the Upper Snake Figure estimates are used for natural bankfull width in most segments of each stream's loading analysis. Notable exceptions include the SF Rock Creek and Marsh Creek where existing widths tended to be smaller than the prediction.

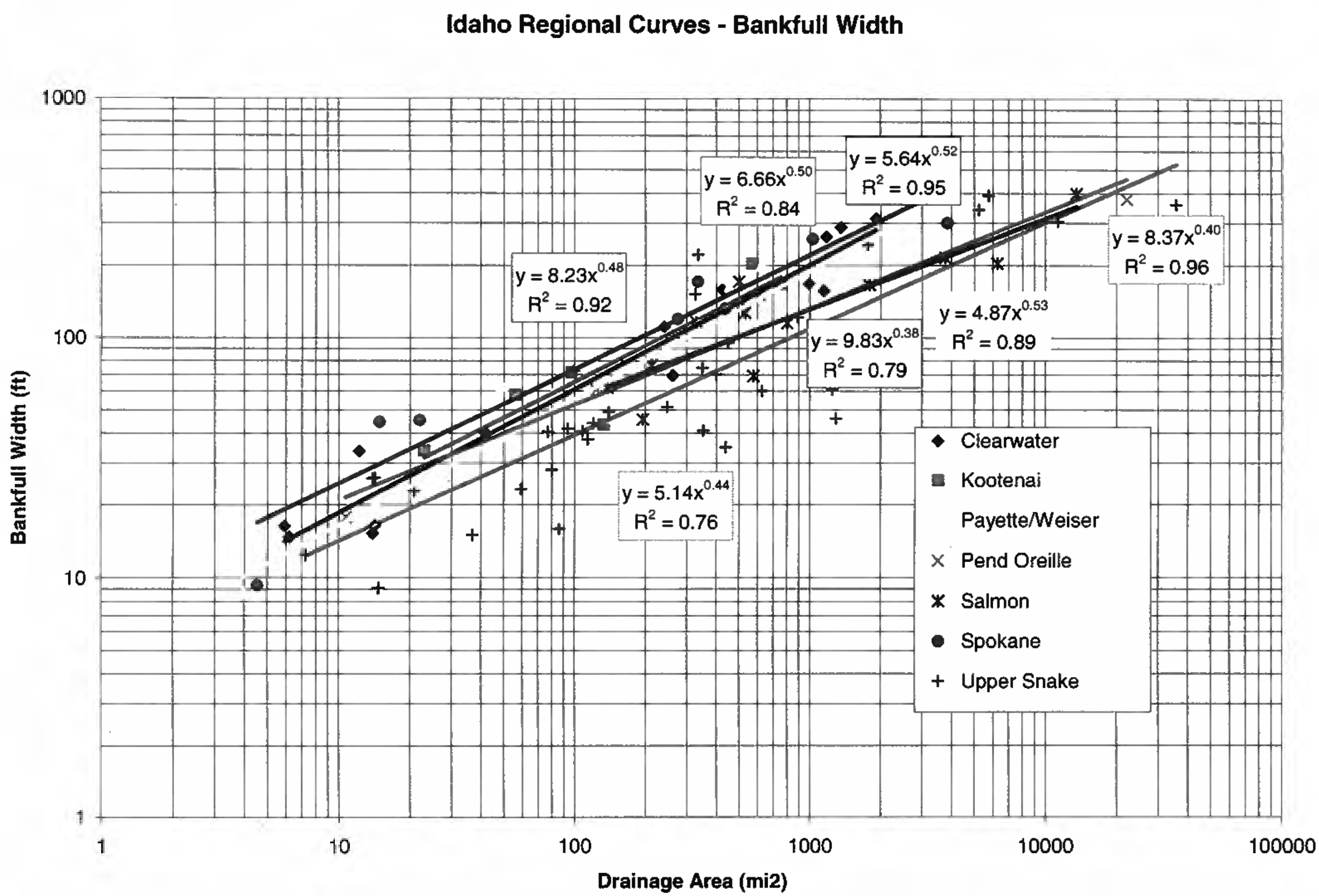

Figure 7. Bankfull Width as a Function of Drainage Area.

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Table 8. Regional Curve Estimates and Existing Measurements of Bankfull Width.

Location	area (sq mi)	US (m)	existing (m)
Reuger Springs @ mouth	0.17	1	
Cold Creek below the big bend	6.6	4	2.62
Cold Creek @ mouth	11.93	5	
Warm Creek below Cold Creek	12.07	5	
Warm Creek @ mouth	16.06	5	
Little Creek downstream of Hwy	2.84	2	2.1
Little Creek in middle	4.96	3	
Little Creek @ mouth	10.19	4	
EF Rock between Howard and Mill	12.14	5	7.9
EF Rock at Pathfinder Site 1	12.87	5	12.8
EF Rock at Pathfinder Site 2	13.81	5	6.6
EF Rock @ road crossing past Hwy	26.37	7	1.67
EF Rock Creek @ mouth	27.16	7	
Spring above top road X-ing, midway up	7.66	4	1.42
Spring Creek @ mouth	7.95	4	
SF Rock above first fork	5.98	3	2.68
SF Rock 2.5 miles above Roy	14.35	5	2
SF Rock above Warm Springs	156.4	14	4.93
SF Rock Creek @ mouth	219.02	17	
Rock below L-shape road off Hwy	314.25	20	3.67
Rock Creek @ mouth	324.17	20	3.32
Fall Creek @ mouth	14.28	5	
Lanes Gulch @ mouth	13.76	5	
Marsh @ Forest Service boundary	1.88	2	3.55
Marsh Creek above Land Creek	22.95	6	
Marsh Creek above Howell Can.	47.73	9	
Marsh below Howell Canyon	72.96	10	6.03
Marsh 1.6 miles below Howell Canyon	79.03	11	6.23
Marsh 3 miles below Howell Canyon	82.28	11	5.27
Marsh Creek @ mouth	118.38	13	
Land @ Forest Service boundary	1.42	2	3.5
Land above Pine Canyon	no data	no data	6.77
Howell Canyon @ Bennet Springs	2.37	2	5.73
Howell above road X-ing and Pine Creek	3.56	3	5.32
Howell Canyon .5 miles below Pine	5.53	3	3.23
Howell Canyon @ mouth	24.99	6	
Cottonwood above 2nd trib. from top	1.96	2	3.98
Cottonwood Creek above road	2.88	2	
Cottonwood below last tributary	5.34	3	2.02
Cottonwood Creek @ mouth	6.97	4	
Copper downstream of 1st tributary	4.59	3	2.37
Copper above small pond	8.3	4	2.03
Copper Creek @ mouth	16.11	5	
Spring Creek (Marsh area) @ mouth	48.85	9	
Duck Creek @ mouth	7.06	4	
green = low existing			
yellow = high existing			

5.1.3. Design Conditions

Streams examined in this document are found in five sub-ecoregions in the Northern Basin and Range, the Idaho Batholith, and the Snake River Plain Level III Ecoregions of McGrath et al. (2001). Streams on the southern side of the Snake River are found in the Northern Basin and Range Level III Ecoregion. Of those streams, streams to the east and southeast of Lake Walcott [Reuger Springs, Cold, Warm, Little, East Fork Rock (Figure 8), South Fork Rock Creek (Figure 9), Rock, Spring, Fall Creek (**Figure 10**), and Lanes Gulch (**Figure 11**)] and a portion of the top of Marsh Creek are found in the Sagebrush Steppe Valleys Level IV Ecoregion. This ecoregion is dominated by sagebrush grassland and has less available water than other parts of the Snake River Plain. Grazing is the main land use in the area.

Streams to the southwest of Lake Walcott [Marsh, Land, and Howell Canyon (**Figure 11**) Creeks] are found in the Dissected High Lava Plateau Level IV Ecoregion. This region is characterized by alluvial fans, rolling plains and steep canyons. Sagebrush grassland is common with scattered woodlands on the rocky upland areas.

Copper and Cottonwood (**Figure 13**) Creeks lie approximately fifty miles to the north of Lake Walcott and are found in the Foothill Shrublands Level IV Ecoregion of the Idaho Batholith Level III Ecoregion. Raised land features such as hills and benches in this area are generally dry, treeless and dominated by shrubs and grasses.

Additionally, the lower portion of Marsh Creek, Spring Creek and Duck Creek are found in the Magic Valley Level IV Ecoregion of the Snake River Plain Level III Ecoregion. The soils are aridic and the native vegetation is sagebrush and bunchgrass. Overwatering of sprinkler irrigated croplands in the Eastern Snake River Basalt Plains Ecoregion has created raised ground water levels and artificial wetlands in the Magic Valley Ecoregion.

Lake Walcott is found in the Eastern Snake River Basalt Plains Level IV Ecoregion of the Snake River Plain Level III Ecoregion. This area is characterized by shallow, stony soils and widespread rangeland with the natural vegetation being sagebrush and bunchgrass.

Riparian vegetation along streams varies greatly from high elevation Douglas fir (*Psuedotsuga mentziesii*) or lodgepole pine (*Pinus contorta*) forests and quaking aspen (*Populus tremuloides*) stands (**Figure 14**) to waterbirch (**Figure 15**), willow or grass/sagebrush dominated areas at lower elevations. Some lower elevation areas in wide, flat valleys also have black cottonwood (*Populus trichocarpa*) dominated riparian areas (**Figure 16**). Generally the mid elevation willow communities are lumped into a yellow willow (*Salix lutea*) type, and lower elevation willow communities are dominated by a coyote willow (*S. exigua*) type. Grass-dominated or grass/sagebrush-dominated (**Figure 17**) communities, identified according to the proximity of upland sagebrush plants to the stream, occur where stream flows are too low to accommodate the larger riparian vegetation types.

Figure 8.East Fork Rock Creek at campsite.

Figure 9. South Fork Rock Creek at Kuper Road.

Figure 10. Fall Creek headwaters.

Figure 11. Lanes Gulch upper portion below dry section.

Figure 12. Howell Canyon Creek at solar pathfinder site

Figure 13. Cottonwood Creek drainage.

Figure 14. Aspen dominated riparian on Cottonwood Creek.

Figure 15. Waterbirch community on East Fork Rock Creek.

Figure 16. Typical black cottonwood community (Land Creek).

Figure 17. Typical grass/sagebrush riparian type (South Fork Rock Creek).

5.1.4. Target Selection

To determine potential natural vegetation shade targets for the Lake Walcott Subbasin streams, effective shade curves developed specifically for southern Idaho were examined. In particular we used shade curves (Table 9 through Table 19) from the southern Idaho Non-forest group developed from data by Hansen and Hall (2002), and the subalpine fir, lodgepole pine and Douglas fir PVG shade curves developed for the Sawtooth National Forest (Southwest Idaho Eco-group - Payette NF, Boise NF, and Sawtooth NF). Effective shade curves include percent shade on the vertical axis and stream width on the horizontal axis. As a stream becomes wider, a given vegetation type loses its ability to shade wider and wider streams. Targets are based on averaging the individual curves for the three aspects (N/S, E/W, and NE/SW/NW/SE) for any given community type.

5.1.4.1. Shade Curves

Table 9. Shade Targets for the Subalpine Fir Vegetation Type at Various Stream Widths

High Elev Subalpine Fir (PVG 11)	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m	11m	12m	13m
0/180 aspect	94	91	88	85	80	74	68	63	59	56	53	50	48
45/135/225/315 aspect	94	92	89	85	80	75	69	65	60	57	54	51	48
90/270 aspect	95	93	88	85	81	76	70	65	59	54	50	46	43
Target (%)	**94**	**92**	**88**	**85**	**80**	**75**	**69**	**64**	**59**	**56**	**52**	**49**	**46**

Table 10. Shade Targets for the Lodgepole Pine Vegetation Type at Various Stream Widths

Persistent Lodgepole (PVG 10)	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m	11m	12m	13m
0/180 aspect	96	94	91	87	81	75	70	65	61	58	55	52	49
45/135/225/315 aspect	96	94	91	86	81	76	70	65	62	58	55	52	49
90/270 aspect	97	95	90	87	83	76	70	64	59	54	49	45	42
Target (%)	**96**	**94**	**91**	**87**	**82**	**76**	**70**	**65**	**61**	**57**	**53**	**50**	**47**

Table 11. Shade Targets for the Douglas Fir Vegetation Type at Various Stream Widths

Cool, Dry Douglas Fir (PVG 4)	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m	11m	12m	13m
0/180 aspect	94	92	90	86	82	75	69	65	61	57	54	51	49
45/135/225/315 aspect	95	93	90	86	82	76	71	66	62	59	55	52	50
90/270 aspect	95	94	90	87	84	79	73	67	62	56	52	48	44
Target (%)	**95**	**93**	**90**	**86**	**83**	**77**	**71**	**66**	**62**	**57**	**54**	**50**	**48**

Table 12. Shade Targets for the Rocky Mountain Juniper Vegetation Type at Various Stream Widths

Rocky Mtn Juniper	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m	11m	12m	13m
0/180 aspect	100	99	97	95	91	88	85	82	78	75	72	70	67
45/135/225/315 aspect	100	99	97	94	91	88	84	80	77	73	70	67	63
90/270 aspect	100	99	98	96	93	90	85	76	68	62	57	53	49
Target (%)	**100**	**99**	**97**	**95**	**92**	**89**	**85**	**79**	**74**	**70**	**66**	**63**	**60**

Table 13. Shade Targets for the Aspen Vegetation Type at Various Stream Widths

Aspen	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m	11m	12m	13m
0/180 aspect	99	99	99	96	93	90	86	82	78	75	71	68	65
45/135/225/315 aspect	100	99	99	96	93	89	85	81	77	73	69	65	62
90/270 aspect	100	99	99	97	95	91	84	76	67	61	56	52	48
Target (%)	**100**	**99**	**99**	**96**	**94**	**90**	**85**	**80**	**74**	**70**	**65**	**62**	**58**

Table 14. Shade Targets for the Cottonwood Vegetation Type at Various Stream Widths

Black cottonwood	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m	11m	12m	13m
0/180 aspect	97	97	96	96	94	91	88	85	82	78	74	70	67
45/135/225/315 aspect	98	97	96	96	94	91	88	85	81	76	72	68	64
90/270 aspect	97	97	97	96	95	93	91	87	78	71	65	61	56
Target (%)	**97**	**97**	**96**	**96**	**94**	**92**	**89**	**86**	**80**	**75**	**70**	**66**	**62**

Table 15. Shade Targets for the Water Birch Vegetation Type at Various Stream Widths

Water birch	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m	11m	12m	13m
0/180 aspect	92	90	88	83	73	66	60	55	50	47	44	41	38
45/135/225/315 aspect	93	90	88	83	74	66	60	55	50	46	43	40	37
90/270 aspect	94	93	92	84	73	64	55	49	44	40	37	34	32
Target (%)	**93**	**91**	**89**	**83**	**73**	**65**	**58**	**53**	**48**	**44**	**41**	**38**	**36**

Table 16. Shade Targets for the Yellow Willow Vegetation Type at Various Stream Widths

Yellow willow	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m	11m	12m	13m
0/180 aspect	88	75	60	51	45	39	35	32	29	26	24	22	21
45/135/225/315 aspect	88	74	58	48	42	36	32	29	26	24	22	20	19
90/270 aspect	91	71	50	38	31	27	23	20	18	17	15	14	13
Target (%)	**89**	**73**	**56**	**46**	**39**	**34**	**30**	**27**	**24**	**22**	**20**	**19**	**18**

Table 17. Shade Targets for the Coyote Willow Vegetation Type at Various Stream Widths

Coyote willow	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m	11m	12m	13m	14m	15m	16m
0/180 aspect	94	87	74	64	56	50	45	41	37	34	31	29	27	25	24	23
45/135/225/315 aspect	94	86	72	61	53	47	42	37	34	31	29	26	25	23	22	20
90/270 aspect	95	89	64	50	41	34	30	27	24	22	20	18	17	16	15	14
Target (%)	**94**	**87**	**70**	**58**	**50**	**44**	**39**	**35**	**32**	**29**	**27**	**24**	**23**	**21**	**20**	**19**

Table 18. Shade Targets for the Grass/Sagebrush Vegetation Type at Various Stream Widths

Graminoid/Sagebrush	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m	11m	12m	13m
0/180 aspect	71	46	33	25	20	17	15	13	12	10	9	9	8
45/135/225/315 aspect	68	41	28	21	17	14	12	11	10	9	8	7	7
90/270 aspect	55	29	20	15	12	10	9	8	7	6	6	5	5
Target (%)	**65**	**39**	**27**	**20**	**16**	**14**	**12**	**11**	**10**	**8**	**8**	**7**	**7**

Table 19. Shade Targets for the Grass Vegetation Type at Various Stream Widths

Graminoid	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m	11m	12m	13m
0/180 aspect	62	38	26	20	16	14	12	10	9	8	7	7	6
45/135/225/315 aspect	58	33	22	17	14	11	10	9	8	7	6	6	5
90/270 aspect	45	23	16	12	10	8	7	6	5	5	4	4	4
Target (%)	**55**	**31**	**21**	**16**	**13**	**11**	**10**	**8**	**7**	**7**	**6**	**6**	**5**

5.1.5. Monitoring Points

The accuracy of the aerial photo interpretations were field verified with a solar pathfinder during the summer of 2008 at 4 sites on 3 streams. The results of these field observations are presented in Appendix C (Table C- 2). Overall, our original aerial photo interpretations were slightly over-estimating existing shade with an average difference of 18% ± 11.78 (mean ± 95% C.I.). These results were used to calibrate our eye and aerial photo interpretations were corrected accordingly. Existing shade levels presented in this document reflect those corrections.

Effective shade monitoring can take place on any reach throughout the streams in this TMDL and be compared to estimates of existing shade seen on Figure 18 through Figure 23 (see additional figures C-2, C-5, C-8, C-11, and C-14 in Appendix C) and described in Table 20 through Table 37. Those areas with the largest disparity between existing shade estimates and shade targets should be monitored with solar pathfinders to verify the existing shade levels and to determine progress towards meeting shade targets. It is important to note that many existing shade estimates have not been field verified, and may require adjustment during the implementation process. Stream segments for each change in existing shade vary in length depending on land use or landscape that has affected that shade level. It is appropriate to monitor within a given existing shade segment to see if that segment has increased its existing shade towards target levels. Ten equally spaced solar pathfinder measurements within that segment averaged together should suffice to determine new shade levels in the future.

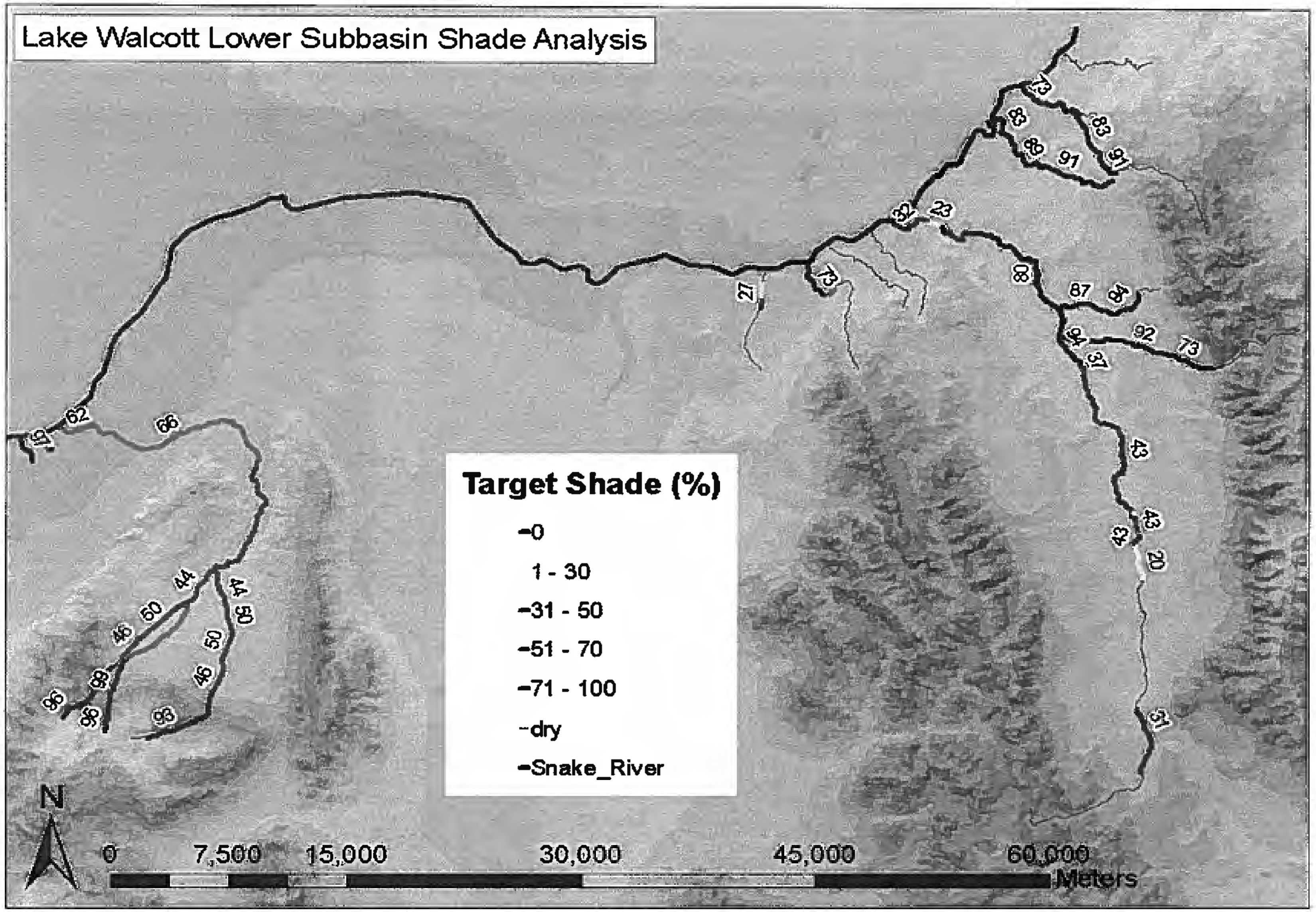

Figure 18. Figure 2. Target Shade for Lower Lake Walcott Subbasin.

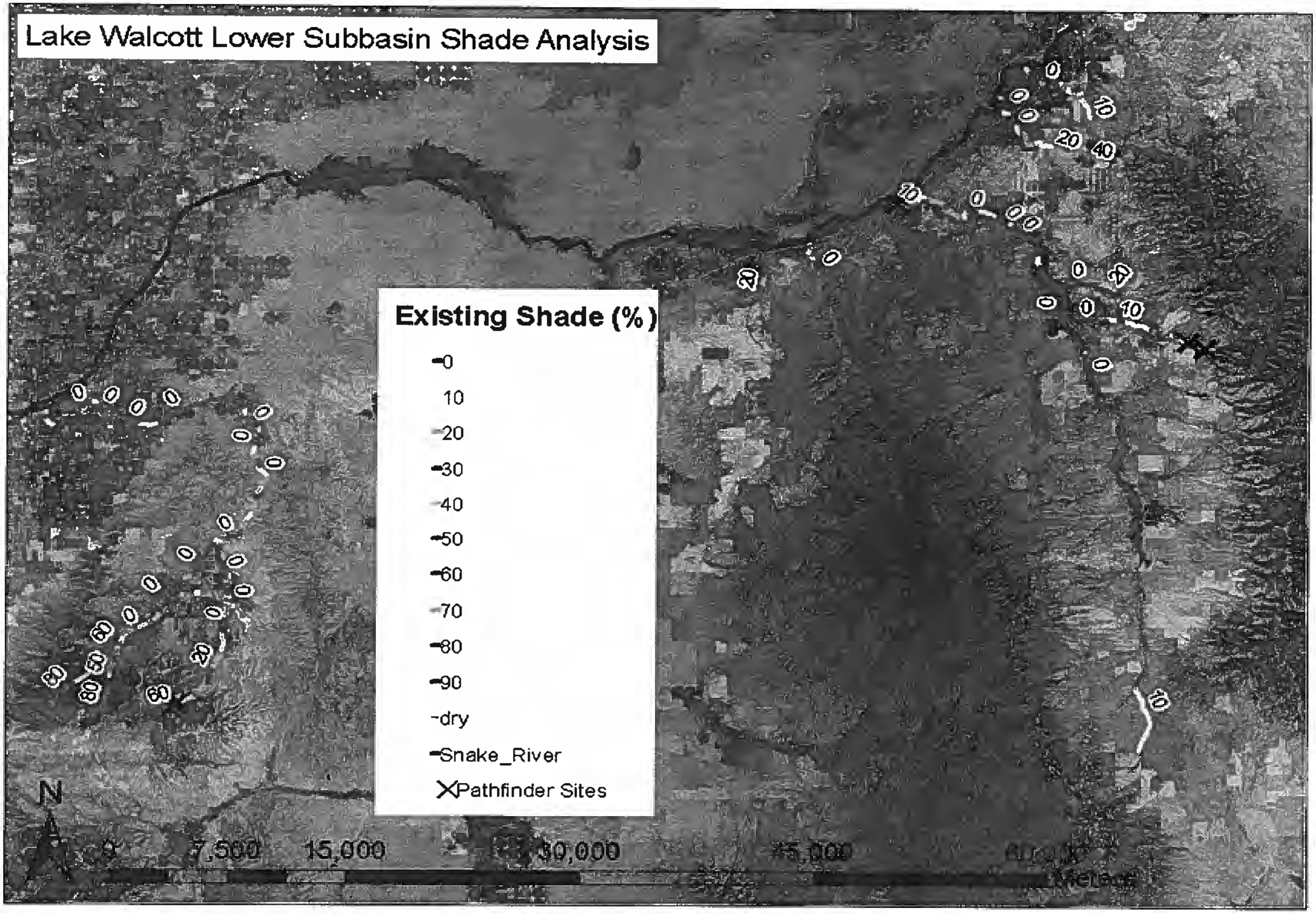

Figure 19. Figure 3. Existing Cover Estimated for Lower Lake Walcott Subbasin by Aerial Photo Interpretation.

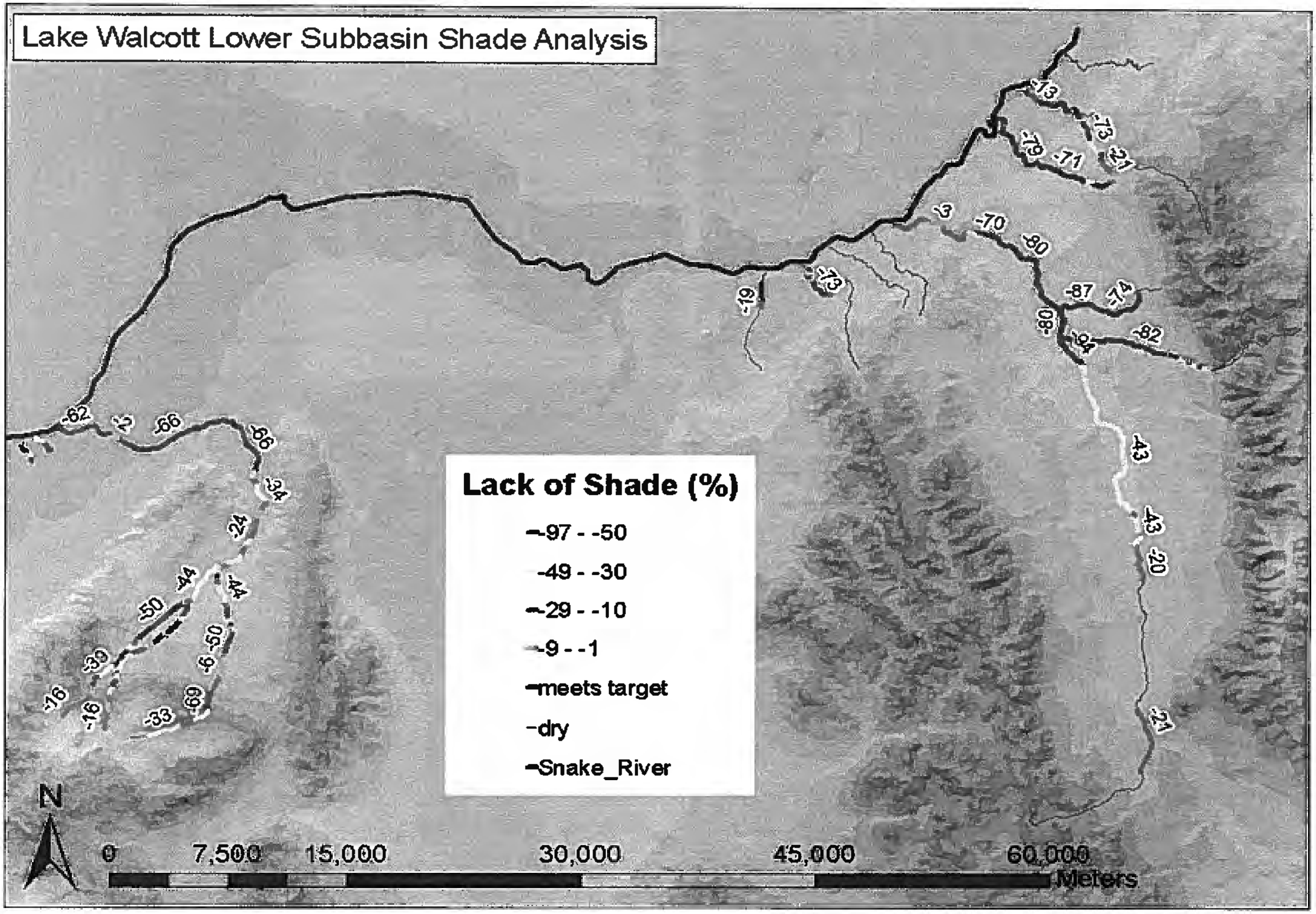

Figure 20. Figure 4. Lack of Shade (Difference Between Existing and Target) for Lower Lake Walcott Subbasin.

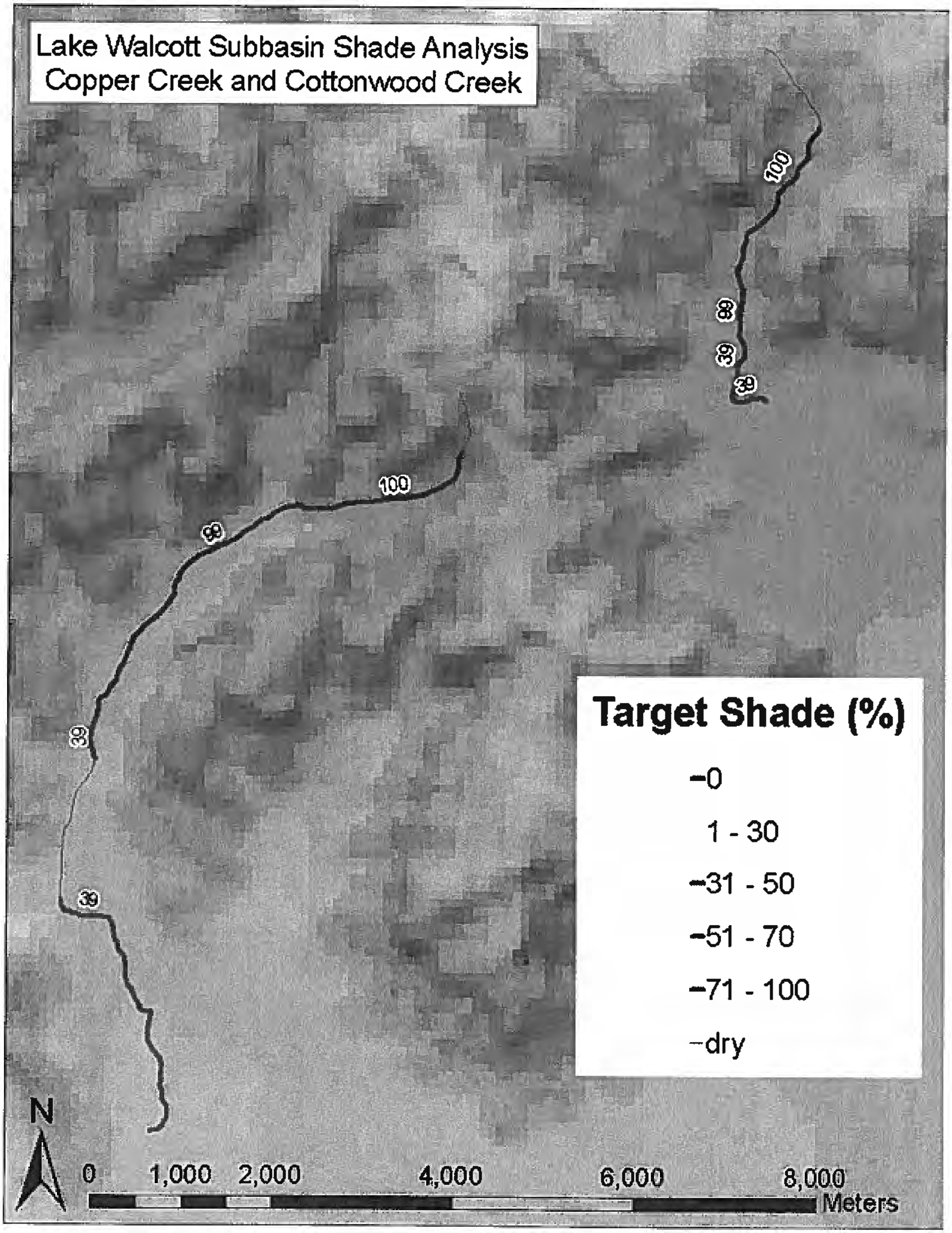

Figure 21. Figure 5. Target Shade for Copper Creek and Cottonwood Creek (Upper Lake Walcott Subbasin).

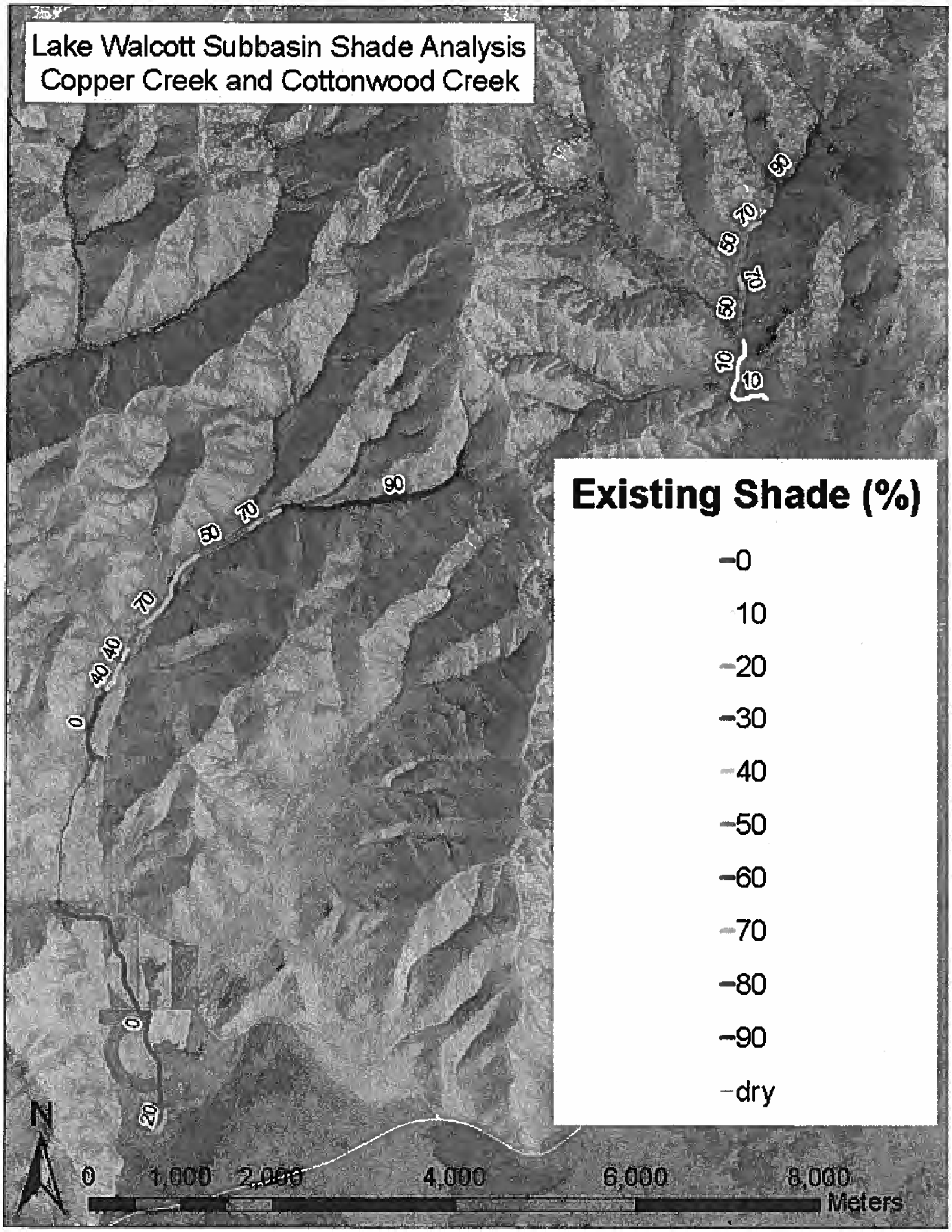

Figure 22. Figure 6. Existing Cover Estimated for Copper Creek and Cottonwood Creek (Upper Lake Walcott Subbasin) by Aerial Photo Interpretation.

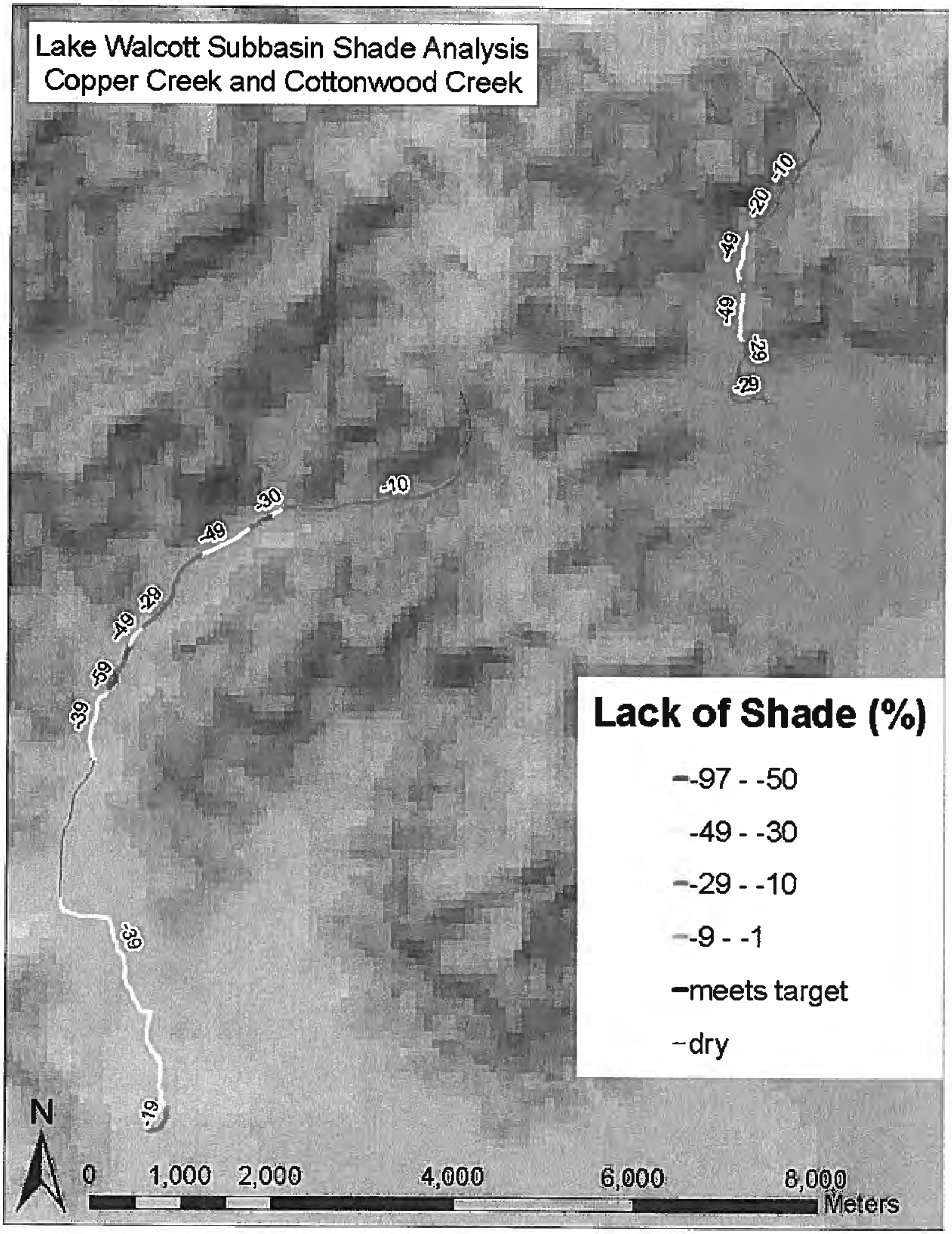

Figure 23. Figure 7. Lack of Shade (Difference Between Existing and Target) for Copper Creek and Cottonwood Creek (Upper Lake Walcott Subbasin).

Table 20. Table 13. Existing and Potential Solar Loads for Marsh Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Marsh Creek
ID17040209SK003_02														
1010	0.8	1.188	0.96	0.2376	-0.95	1	1	1010	1199.88	1010	239.976	-959.904	-16	lodgepole pine - PVG10
1410	0.7	1.782	0.94	0.3564	-1.4256	3	2	4230	7537.86	2820	1005.048	-6532.812	-24	
420	0.9	0.594	0.94	0.3564	-0.2376	3	2	1260	748.44	840	299.376	-449.064	-4	
ID17040209SK003_03														
180	0.9	0.594	0.94	0.3564	-0.2376	3	2	540	320.76	360	128.304	-192.456	-4	lodgepole pine - PVG10
160	0.7	1.782	0.94	0.3564	-1.4256	3	2	480	855.36	320	114.048	-741.312	-24	
250	0.3	4.158	0.99	0.0594	-4.0986	3	3	750	3118.5	750	44.55	-3073.95	-69	aspen
130	0.6	2.376	0.99	0.0594	-2.3166	3	3	390	926.64	390	23.166	-903.474	-39	
320	0.4	3.564	0.99	0.0594	-3.5046	3	3	960	3421.44	960	57.024	-3364.416	-59	
1220	0.6	2.376	0.99	0.0594	-2.3166	4	3	4880	11594.88	3660	217.404	-11377.476	-39	
890	0.6	2.376	0.56	2.6136	0.2376	4	3	3560	8458.56	2670	6978.312	-1480.248	0	yellow willow
620	0.5	2.97	0.46	3.2076	0.2376	4	4	2480	7365.6	2480	7954.848	589.248	0	
690	0.1	5.346	0.46	3.2076	-2.1384	4	4	2760	14754.96	2760	8852.976	-5901.984	-36	
540	0.2	4.752	0.46	3.2076	-1.5444	4	4	2160	10264.32	2160	6928.416	-3335.904	-26	
730	0.5	2.97	0.46	3.2076	0.2376	4	4	2920	8672.4	2920	9366.192	693.792	0	
2430	0	5.94	0.5	2.97	-2.97	5	5	12150	72171	12150	36085.5	-36085.5	-50	coyote willow
320	0.6	2.376	0.5	2.97	0.594	5	5	1600	3801.6	1600	4752	950.4	0	
430	0	5.94	0.5	2.97	-2.97	5	5	2150	12771	2150	6385.5	-6385.5	-50	
100	0.2	4.752	0.5	2.97	-1.782	5	5	500	2376	500	1485	-891	-30	
340	0.2	4.752	0.44	3.3264	-1.4256	6	6	2040	9694.08	2040	6785.856	-2908.224	-24	
2960	0	5.94	0.44	3.3264	-2.6136	6	6	17760	105494.4	17760	59076.864	-46417.536	-44	
ID17040209SK003_04														
680	0.1	5.346	0.44	3.3264	-2.0196	6	6	4080	21811.68	4080	13571.712	-8239.968	-34	coyote willow
610	0.2	4.752	0.44	3.3264	-1.4256	6	6	3660	17392.32	3660	12174.624	-5217.696	-24	
680	0	5.94	0.44	3.3264	-2.6136	6	6	4080	24235.2	4080	13571.712	-10663.488	-44	
330	0.1	5.346	0.44	3.3264	-2.0196	6	6	1980	10585.08	1980	6586.272	-3998.808	-34	
350	0	5.94	0.44	3.3264	-2.6136	6	6	2100	12474	2100	6985.44	-5488.56	-44	
730	0.2	4.752	0.44	3.3264	-1.4256	6	6	4380	20813.76	4380	14569.632	-6244.128	-24	
790	0.1	5.346	0.44	3.3264	-2.0196	6	6	4740	25340.04	4740	15767.136	-9572.904	-34	
1290	0.2	4.752	0.44	3.3264	-1.4256	6	6	7740	36780.48	7740	25746.336	-11034.144	-24	
600	0.3	4.158	0.44	3.3264	-0.8316	6	6	3600	14968.8	3600	11975.04	-2993.76	-14	
500	0.4	3.564	0.44	3.3264	-0.2376	6	6	3000	10692	3000	9979.2	-712.8	-4	
1040	0.2	4.752	0.44	3.3264	-1.4256	6	6	6240	29652.48	6240	20756.736	-8895.744	-24	
1120	0.1	5.346	0.44	3.3264	-2.0196	6	6	6720	35925.12	6720	22353.408	-13571.712	-34	
560	0	5.94	0.44	3.3264	-2.6136	6	6	3360	19958.4	3360	11176.704	-8781.696	-44	
540	0.2	4.752	0.44	3.3264	-1.4256	6	6	3240	15396.48	3240	10777.536	-4618.944	-24	
690	0.1	5.346	0.44	3.3264	-2.0196	6	6	4140	22132.44	4140	13771.296	-8361.144	-34	
560	0	5.94	0	5.94	0	340	340	190400	1130976	190400	1130976	0	0	reservoir
750	0	5.94	0.66	2.0196	-3.9204	12	12	9000	53460	9000	18176.4	-35283.6	-66	cottonwood
360	0.1	5.346	0.66	2.0196	-3.3264	12	12	4320	23094.72	4320	8724.672	-14370.048	-56	
1180	0	5.94	0.66	2.0196	-3.9204	12	12	14160	84110.4	14160	28597.536	-55512.864	-66	
370	0.1	5.346	0.66	2.0196	-3.3264	12	12	4440	23736.24	4440	8967.024	-14769.216	-56	
7250	0	5.94	0.66	2.0196	-3.9204	12	12	87000	516780	87000	175705.2	-341074.8	-66	
1160	0.1	5.346	0.62	2.2572	-3.0888	13	13	15080	80617.68	15080	34038.576	-46579.104	-52	
1600	0	5.94	0.62	2.2572	-3.6828	13	13	20800	123552	20800	46949.76	-76602.24	-62	
690	0.6	2.376	0.62	2.2572	-0.1188	13	13	8970	21312.72	8970	20247.084	-1065.636	-2	
1240	0	5.94	0.62	2.2572	-3.6828	13	13	16120	95752 8	16120	36386.064	-59366.736	-62	
260	0.1	5.346	0.62	2.2572	-3.0888	13	13	3380	18069.48	3380	7629.336	-10440.144	-52	
2780	0	5.94	0.62	2.2572	-3.6828	13	13	36140	214671.6	36140	81575.208	-133096.392	-62	
							Total	537,450	2,989,840	533,170	1,964,516	-1,025,324	-34	

Table 21. Table 14. Existing and Potential Solar Loads for South Fork Rock Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	SF Rock Creek
						ID17040209SK009_02								
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5080	0.1	5.346	0.31	4.0986	-1.2474	2	2	10160	54315.36	10160	41641.776	-12673.584	-21	grass
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
						ID17040209SK009_03								
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
						ID17040209SK009_04								
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
21140	0	5.94	0.2	4.752	-1.188	4	4	84560	502286.4	84560	401829.12	-100457.28	-20	grass/sagebrush
130	0.1	5.346	0.5	2.97	-2.376	5	5	650	3474.9	650	1930.5	-1544.4	-40	coyote willow
3300	0	5.94	0.94	0.3564	-5.5836	5	5	16500	98010	16500	5880.6	-92129.4	-94	cottonwood
							Total	151,130	658,087	151,130	451,282	-206,805	-44	

Table 22. Table 15. Existing and Potential Solar Loads for East Fork Rock Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	East Fork Rock Creek
ID17040209SK010_03														
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
140	0.2	4.752	0.73	1.6038	-3.1482	8	5	1120	5322.24	700	1122.66	-4199.58	-53	waterbirch
310	0.7	1.782	0.73	1.6038	-0.1782	8	5	2480	4419.36	1550	2485.89	-1933.47	-3	
290	0.4	3.564	0.73	1.6038	-1.9602	12	5	3480	12402.72	1450	2325.51	-10077.21	-33	
340	0.7	1.782	0.73	1.6038	-0.1782	8	5	2720	4847.04	1700	2726.46	-2120.58	-3	
200	0.2	4.752	0.73	1.6038	-3.1482	8	5	1600	7603.2	1000	1603.8	-5999.4	-53	
520	0.3	4.158	0.73	1.6038	-2.5542	7	5	3640	15135.12	2600	4169.88	-10965.24	-43	
90	0	5.94	0.73	1.6038	-4.3362	7	5	630	3742.2	450	721.71	-3020.49	-73	
140	0.4	3.564	0.73	1.6038	-1.9602	7	5	980	3492.72	700	1122.66	-2370.06	-33	
90	0.2	4.752	0.73	1.6038	-3.1482	7	5	630	2993.76	450	721.71	-2272.05	-53	
110	0.4	3.564	0.73	1.6038	-1.9602	7	5	770	2744.28	550	882.09	-1862.19	-33	
160	0.2	4.752	0.73	1.6038	-3.1482	7	5	1120	5322.24	800	1283.04	-4039.2	-53	
320	0.4	3.564	0.73	1.6038	-1.9602	7	5	2240	7983.36	1600	2566.08	-5417.28	-33	
200	0.2	4.752	0.73	1.6038	-3.1482	7	5	1400	6652.8	1000	1603.8	-5049	-53	
90	0.4	3.564	0.73	1.6038	-1.9602	7	5	630	2245.32	450	721.71	-1523.61	-33	
70	0.2	4.752	0.73	1.6038	-3.1482	7	5	490	2328.48	350	561.33	-1767.15	-53	
70	0.4	3.564	0.73	1.6038	-1.9602	7	5	490	1746.36	350	561.33	-1185.03	-33	
240	0.1	5.346	0.73	1.6038	-3.7422	6	5	1440	7698.24	1200	1924.56	-5773.68	-63	
220	0.6	2.376	0.73	1.6038	-0.7722	6	5	1320	3136.32	1100	1764.18	-1372.14	-13	
350	0.2	4.752	0.92	0.4752	-4.2768	6	6	2100	9979.2	2100	997.92	-8981.28	-72	cottonwood
170	0	5.94	0.92	0.4752	-5.4648	6	6	1020	6058.8	1020	484.704	-5574.096	-92	
420	0.2	4.752	0.92	0.4752	-4.2768	6	6	2520	11975.04	2520	1197.504	-10777.536	-72	
90	0	5.94	0.92	0.4752	-5.4648	5	6	450	2673	540	256.608	-2416.392	-92	
1170	0.1	5.346	0.92	0.4752	-4.8708	5	6	5850	31274.1	7020	3335.904	-27938.196	-82	
210	0.4	3.564	0.92	0.4752	-3.0888	4	6	840	2993.76	1260	598.752	-2395.008	-52	
760	0.1	5.346	0.92	0.4752	-4.8708	4	6	3040	16251.84	4560	2166.912	-14084.928	-82	
230	0	5.94	0.92	0.4752	-5.4648	4	6	920	5464.8	1380	655.776	-4809.024	-92	
940	0.1	5.346	0.89	0.6534	-4.6926	3	7	2820	15075.72	6580	4299.372	-10776.348	-79	
750	0	5.94	0.89	0.6534	-5.2866	3	7	2250	13365	5250	3430.35	-9934.65	-89	
150	0.1	5.346	0.89	0.6534	-4.6926	2	7	300	1603.8	1050	686.07	-917.73	-79	
860	0	5.94	0.89	0.6534	-5.2866	2	7	1720	10216.8	6020	3933.468	-6283.332	-89	
330	0.3	4.158	0.89	0.6534	-3.5046	2	7	660	2744.28	2310	1509.354	-1234.926	-59	
1100	0	5.94	0.89	0.6534	-5.2866	3	7	3300	19602	7700	5031.18	-14570.82	-89	
							Total	62,060	249,094	74,400	57,452	-191,642	-57	

Table 23. Table 16. Existing and Potential Solar Loads for Howell Canyon Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Howell Canyon Creek
ID17040209SK003_02														
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	fir
2440	0.6	2.376	0.93	0.4158	-1.9602	5	2	12200	28987.2	4880	2029.104	-26958.096	-33	douglas fir - PVG4
850	0.7	1.782	0.93	0.4158	-1.3662	5	2	4250	7573.5	1700	706.86	-6866.64	-23	
1290	0.5	2.97	0.99	0.0594	-2.9106	3	3	3870	11493.9	3870	229.878	-11264.022	-49	aspen
1270	0.3	4.158	0.99	0.0594	-4.0986	3	3	3810	15841.98	3810	226.314	-15615.666	-69	
ID17040209SK003_03														
1430	0.2	4.752	0.46	3.2076	-1.5444	4	4	5720	27181.44	5720	18347.472	-8833.968	-26	yellow willow
1420	0.4	3.564	0.46	3.2076	-0.3564	4	4	5680	20243.52	5680	18219.168	-2024.352	-6	
270	0.3	4.158	0.46	3.2076	-0.9504	4	4	1080	4490.64	1080	3464.208	-1026.432	-16	
1750	0	5.94	0.5	2.97	-2.97	5	5	8750	51975	8750	25987.5	-25987.5	-50	coyote willow
ID17040209SK003_04A														
410	0.1	5.346	0.5	2.97	-2.376	5	5	2050	10959.3	2050	6088.5	-4870.8	-40	coyote willow
120	0.5	2.97	0.5	2.97	0	5	5	600	1782	600	1782	0	0	
520	0.1	5.346	0.5	2.97	-2.376	5	5	2600	13899.6	2600	7722	-6177.6	-40	
510	0	5.94	0.5	2.97	-2.97	5	5	2550	15147	2550	7573.5	-7573.5	-50	
130	0.5	2.97	0.5	2.97	0	5	5	650	1930.5	650	1930.5	0	0	
290	0	5.94	0.5	2.97	-2.97	5	5	1450	8613	1450	4306.5	-4306.5	-50	
240	0.2	4.752	0.44	3.3264	-1.4256	6	6	1440	6842.88	1440	4790.016	-2052.864	-24	
1900	0	5.94	0.44	3.3264	-2.6136	6	6	11400	67716	11400	37920.96	-29795.04	-44	
230	0.3	4.158	0.44	3.3264	-0.8316	6	6	1380	5738.04	1380	4590.432	-1147.608	-14	
290	0.6	2.376	0.44	3.3264	0.9504	6	6	1740	4134.24	1740	5787.936	1653.696	0	
520	0	5.94	0.44	3.3264	-2.6136	6	6	3120	18532.8	3120	10378.368	-8154.432	-44	
							Total	**75,450**	**323,083**	**65,580**	**162,081**	**-161,001**	**-30**	

Table 24. Table 17. Existing and Potential Solar Loads for Rock Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Rock Creek
ID17040209SK008_04														
5060	0	5.94	0.8	1.188	-4.75	6	9	30360	180338.4	45540	54101.52	-126236.88	-80	cottonwood
1150	0.1	5.346	0.8	1.188	-4.158	5	9	5750	30739.5	10350	12295.8	-18443.7	-70	
4230	0	5.94	0.8	1.188	-4.752	5	9	21150	125631	38070	45227.16	-80403.84	-80	
480	0.1	5.346	0.8	1.188	-4.158	4	9	1920	10264.32	4320	5132.16	-5132.16	-70	
890	0	5.94	0.8	1.188	-4.752	4	9	3560	21146.4	8010	9515.88	-11630.52	-80	
1620	0.1	5.346	0.8	1.188	-4.158	4	9	6480	34642.08	14580	17321.04	-17321.04	-70	
650	0	5.94	0.32	4.0392	-1.9008	4	9	2600	15444	5850	23629.52	8185.32	-32	coyote willow
1050	0.1	5.346	0.32	4.0392	-1.3068	4	9	4200	22453.2	9450	38170.44	15717.24	-22	
1420	0.2	4.752	0.32	4.0392	-0.7128	4	9	5680	26991.36	12780	51620.976	24629.616	-12	
390	0.5	2.97	0.74	1.5444	-1.4256	4	9	1560	4633.2	3510	5420.844	787.644	-24	rocky mtn. juniper
1510	0.2	4.752	0.32	4.0392	-0.7128	3	9	4530	21526.56	13590	54892.728	33366.168	-12	coyote willow
670	0.1	5.346	0.32	4.0392	-1.3068	3	9	2010	10745.46	6030	24356.376	13610.916	-22	
460	0.2	4.752	0.32	4.0392	-0.7128	3	9	1380	6557.76	4140	16722.288	10164.528	-12	
630	0.5	2.97	0.74	1.5444	-1.4256	3	9	1890	5613.3	5670	8756.748	3143.448	-24	rocky mtn. juniper
710	0.1	5.346	0.32	4.0392	-1.3068	3	9	2130	11386.98	6390	25810.488	14423.508	-22	coyote willow
							Total	**95,200**	**528,114**	**188,280**	**392,974**	**-135,140**	**-42**	

Table 25. Table 18. Existing and Potential Solar Loads for Little Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Little Creek
ID17040209SK011_02														
600	0.8	1.188	0.93	0.4158	-0.77	1	1	600	712.8	600	249.48	-463.32	-13	waterbirch
1080	0.4	3.564	0.93	0.4158	-3.1482	1	1	1080	3849.12	1080	449.064	-3400.056	-53	
740	0.6	2.376	0.93	0.4158	-1.9602	1	1	740	1758.24	740	307.692	-1450.548	-33	
700	0.3	4.158	0.91	0.5346	-3.6234	2	2	1400	5821.2	1400	748.44	-5072.76	-61	
1840	0.2	4.752	0.91	0.5346	-4.2174	2	2	3680	17487.36	3680	1967.328	-15520.032	-71	
1320	0.1	5.346	0.89	0.6534	-4.6926	3	3	3960	21170.16	3960	2587.464	-18582.696	-79	
1650	0.2	4.752	0.89	0.6534	-4.0986	3	3	4950	23522.4	4950	3234.33	-20288.07	-69	
ID17040209SK011_03														
940	0.1	5.346	0.89	0.6534	-4.6926	3	3	2820	15075.72	2820	1842.588	-13233.132	-79	waterbirch
780	0	5.94	0.83	1.0098	-4.9302	4	4	3120	18532.8	3120	3150.576	-15382.224	-83	cottonwood
140	0.9	0.594	0.83	1.0098	0.4158	4	4	560	332.64	560	565.488	232.848	0	
540	0.1	5.346	0.83	1.0098	-4.3362	4	4	2160	11547.36	2160	2181.168	-9366.192	-73	
480	0.6	2.376	0.83	1.0098	-1.3662	4	4	1920	4561.92	1920	1938.816	-2623.104	-23	
760	0	5.94	0.83	1.0098	-4.9302	4	4	3040	18057.6	3040	3069.792	-14987.808	-83	
310	0.2	4.752	0.83	1.0098	-3.7422	4	4	1240	5892.48	1240	1252.152	-4640.328	-63	
							Total	**31,270**	**148,322**	**31,270**	**23,544**	**-124,777**	**-56**	

Table 26. Table 19. Existing and Potential Solar Loads for Land Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Land Creek
ID17040209SK003_02														
1540	0.80	1.19	0.96	0.24	-0.95	1	1	1540.00	1829.52	1540.00	365.90	-1463.62	-16	lodgepole - PVG10
620	0.9	0.594	0.94	0.3564	-0.2376	2	1	1240	736.56	620	220.968	-515.592	-4	supalpine fir - PVG11
300	0.7	1.782	0.92	0.4752	-1.3068	3	2	900	1603.8	600	285.12	-1318.68	-22	
920	0.5	2.97	0.99	0.0594	-2.9106	4	2	3680	10929.6	1840	109.296	-10820.304	-49	aspen
320	0.3	4.158	0.99	0.0594	-4.0986	4	2	1280	5322.24	640	38.016	-5284.224	-69	
460	0.5	2.97	0.99	0.0594	-2.9106	4	2	1840	5464.8	920	54.648	-5410.152	-49	
100	0.4	3.564	0.99	0.0594	-3.5046	3	2	300	1069.2	200	11.88	-1057.32	-59	
370	0.5	2.97	0.99	0.0594	-2.9106	3	2	1110	3296.7	740	43.956	-3252.744	-49	
880	0.4	3.564	0.73	1.6038	-1.9602	3	2	2640	9408.96	1760	2822.688	-6586.272	-33	yellow willow
370	0.2	4.752	0.56	2.6136	-2.1384	3	3	1110	5274.72	1110	2901.096	-2373.624	-36	
460	0	5.94	0.56	2.6136	-3.3264	3	3	1380	8197.2	1380	3606.768	-4590.432	-56	
440	0.4	3.564	0.56	2.6136	-0.9504	3	3	1320	4704.48	1320	3449.952	-1254.528	-16	
480	0.2	4.752	0.56	2.6136	-2.1384	4	3	1920	9123.84	1440	3763.584	-5360.256	-36	
330	0.5	2.97	0.56	2.6136	-0.3564	4	3	1320	3920.4	990	2587.464	-1332.936	-6	
600	0.2	4.752	0.7	1.782	-2.97	4	3	2400	11404.8	1800	3207.6	-8197.2	-50	coyote willow
190	0	5.94	0.7	1.782	-4.158	4	3	760	4514.4	570	1015.74	-3498.66	-70	
340	0.5	2.97	0.58	2.4948	-0.4752	4	4	1360	4039.2	1360	3392.928	-646.272	-8	
1280	0	5.94	0.58	2.4948	-3.4452	4	4	5120	30412.8	5120	12773.376	-17639.424	-58	
200	0.2	4.752	0.58	2.4948	-2.2572	4	4	800	3801.6	800	1995.84	-1805.76	-38	
1230	0	5.94	0.58	2.4948	-3.4452	4	4	4920	29224.8	4920	12274.416	-16950.384	-58	
							Total	**36,940**	**154,280**	**29,670**	**54,921**	**-99,358**	**-39**	

Table 27. Table 20. Existing and Potential Solar Loads for Warm Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Warm Creek
						ID17040209SK012_02								
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
310	0.7	1.782	0.91	0.5346	-1.2474	2	2	620	1104.84	620	331.452	-773.388	-21	waterbirch
260	0	5.94	0.89	0.6534	5.2866	3	3	780	4633.2	780	509.652	-4123.548	-89	
180	0.3	4.158	0.89	0.6534	-3.5046	3	3	540	2245.32	540	352.836	-1892.484	-59	
140	0.6	1.188	0.89	0.6534	-0.5346	3	3	420	498.96	420	274.428	-224.532	-9	
60	0.6	2.376	0.73	1.6038	-0.7722	5	5	300	712.8	300	481.14	-231.66	-13	
340	0.1	5.346	0.73	1.6038	-3.7422	5	5	1700	9088.2	1700	2726.46	-6361.74	-63	
260	0.2	4.752	0.73	1.6038	-3.1482	5	5	1300	6177.6	1300	2084.94	-4092.66	-59	
90	0	5.94	0.73	1.6038	-4.3362	5	5	450	2673	450	721.71	-1951.29	-73	
70	0.2	4.752	0.73	1.6038	-3.1482	5	5	350	1663.2	350	561.33	-1101.87	-58	
100	0	5.94	0.73	1.6038	-4.3362	5	5	500	2970	500	801.9	-2168.1	-73	
380	0.2	4.752	0.73	1.6038	-3.1482	5	5	1900	9028.8	1900	3047.22	-5981.58	-58	
240	0.1	5.346	0.73	1.6038	-3.7422	5	5	1200	6415.2	1200	1924.56	-4490.64	-63	
200	0	5.94	0.73	1.6038	-4.3362	5	5	1000	5940	1000	1603.8	-4336.2	-73	
270	0.1	5.346	0.73	1.6038	-3.7422	5	5	1350	7217.1	1350	2165.13	-5051.97	-63	
480	0	5.94	0.73	1.6038	-4.3362	5	5	2400	14256	2400	3849.12	-10406.88	-73	
100	0.9	0.594	0.73	1.6038	1.0098	5	5	500	297	500	801.9	504.9	0	
200	0.2	4.752	0.73	1.6038	-3.1482	5	5	1000	4752	1000	1603.8	-3148.2	-53	
950	0.6	2.376	0.73	1.6038	-0.7722	5	5	4750	11286	4750	7618.05	-3667.95	-13	
560	0.1	5.346	0.73	1.6038	-3.7422	5	5	2800	14968.8	2800	4490.64	-10478.16	-63	
200	0.3	4.158	0.73	1.6038	-2.5542	5	5	1000	4158	1000	1603.8	-2554.2	-43	
							Total	26,080	110,086	26,080	37,554	-72,532	-50	

Table 28. Table 21. Existing and Potential Solar Loads for Cold Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Cold Creek
						ID17040209SK012_02								
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
320	0.9	0.594	0.93	0.4158	-0.1782	1	1	320	190.08	320	133.056	-57.024	-3	Waterbirch
1590	0.7	1.782	0.91	0.5346	-1.2474	2	2	3180	5666.76	3180	1700.028	-3966.732	-21	
180	0.2	4.752	0.89	0.6534	-4.0986	3	3	540	2566.08	540	352.836	-2213.244	-62	
1330	0.5	2.97	0.89	0.6534	-2.3166	3	3	3990	11850.3	3990	2607.066	-9243.234	-39	
1220	0.1	5.346	0.83	1.0098	-4.3362	4	4	4880	26088.48	4880	4927.824	-21160.656	-73	
500	0.4	3.564	0.73	1.6038	-1.9602	5	5	2500	8910	2500	4009.5	-4900.5	-33	
310	0.2	4.752	0.73	1.6038	-3.1482	5	5	1550	7365.6	1550	2485.89	-4879.71	-53	
500	0.1	5.346	0.73	1.6038	-3.7422	5	5	2500	13365	2500	4009.5	-9355.5	-63	
							Total	29,020	76,002	29,020	20,226	-55,777	-44	

Table 29. Table 22. Existing and Potential Solar Loads for Copper Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Copper Creek
ID17040209SK013_02														
700	0	0	0	0	0	1	1	700	0	700	0	0	0	dry
2320	0.9	0.594	1	0	-0.594	1	1	2320	1378.08	2320	0	-1378.08	-10	aspen
140	0.7	1.782	1	0	-1.782	1	1	140	249.48	140	0	-249.48	-30	
90	0.5	2.97	1	0	-2.97	1	1	90	267.3	90	0	-267.3	-50	
190	0.7	1.782	0.99	0.0594	-1.7226	2	2	380	677.16	380	22.572	-654.588	-29	
630	0.5	2.97	0.99	0.0594	-2.9106	2	2	1260	3742.2	1260	74.844	-3667.356	-49	
1080	0.7	1.782	0.99	0.0594	-1.7226	2	2	2160	3849.12	2160	128.304	-3720.816	-29	
230	0.5	2.97	0.99	0.0594	-2.9106	2	2	460	1366.2	460	27.324	-1338.876	-49	
160	0.4	3.564	0.99	0.0594	-3.5046	2	2	320	1140.48	320	19.008	-1121.472	-59	
170	0.7	1.782	0.99	0.0594	-1.7226	2	2	340	605.88	340	20.196	-585.684	-29	
180	0.4	3.564	0.99	0.0594	-3.5046	2	2	360	1283.04	360	21.384	-1261.656	-59	
370	0.6	2.376	0.99	0.0594	-2.3166	2	2	740	1758.24	740	43.956	-1714.284	-39	
490	0	5.94	0.39	3.6234	-2.3166	2	2	980	5821.2	980	3550.932	-2270.268	-39	grass/sagebrush
1260	0	0	0	0	0	2	2	2520	0	2520	0	0	0	dry
160	0	5.94	0.39	3.6234	-2.3166	5	5	800	4752	800	2898.72	-1853.28	-39	yellow willow
ID17040209SK013_03														
2850	0	5.94	0.39	3.6234	-2.3166	5	5	14250	84645	14250	51633.45	-33011.55	-39	yellow willow
360	0.2	4.752	0.39	3.6234	-1.1286	5	5	1800	8553.6	1800	6522.12	-2031.48	-19	
							Total	**29,620**	**120,089**	**29,620**	**64,963**	**-55,126**	**-38**	

Table 30. Table 23. Existing and Potential Solar Loads for Spring Creek (Rock Creek tributary).

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Spring Creek (Rock Creek tributary)
ID17040209SK008_02														
1900	0	0	0	0	0	1	1	1900	0	1900	0	0	0	dry
1820	0.2	4.752	0.94	0.3564	-4.40	1	1	1820	8648.64	1820	648.648	-7999.992	-74	coyote willow
ID17040209SK008_03														
160	0.2	4.752	0.94	0.3564	-4.3956	1	1	160	760.32	160	57.024	-703.296	-74	coyote willow
4490	0	5.94	0.87	0.7722	-5.1678	2	2	8980	53341.2	8980	6934.356	-46406.844	-87	
350	0	5.94	0	5.94	0	2	2	700	4158	700	4158	0	0	[illegible]
							Total	**13,560**	**66,908**	**13,560**	**11,798**	**-55,110**	**-78**	

Table 31. Table 24. Existing and Potential Solar Loads for Fall Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Fall Creek
ID17040209SK007_02														
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
710	0.3	4.158	0.55	2.673	-1.485	1	1	710	2952.18	710	1897.83	-1054.35	-25	grass
260	0.1	5.346	0.21	4.6926	-0.6534	3	3	780	4169.88	780	3660.228	-509.652	-11	
1560	0	5.94	0.73	1.6038	-4.3362	5	5	7800	46332	7800	12509.64	-33822.36	-73	waterbirch
240	0.4	3.564	0.73	1.6038	-1.9602	5	5	1200	4276.8	1200	1924.56	-2352.24	-33	
110	0.2	4.752	0.73	1.6038	-3.1482	5	5	550	2613.6	550	882.09	-1731.51	-53	
ID17040209SK007_03														
120	0.2	4.752	0.73	1.6038	-3.1482	5	5	600	2851.2	600	962.28	-1888.92	-53	waterbirch
100	0.4	3.564	0.73	1.6038	-1.9602	5	5	500	1782	500	801.9	-980.1	-33	
350	0.2	4.752	0.73	1.6038	-3.1482	5	5	1750	8316	1750	2806.65	-5509.35	-53	
300	0.4	3.564	0.73	1.6038	-1.9602	5	5	1500	5346	1500	2405.7	-2940.3	-83	
							Total	23,470	78,640	23,470	27,851	-50,789	-41	

Table 32. Table 25. Existing and Potential Solar Loads for Reuger Springs.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Reuger Springs
260	0.2	4.752	0.56	2.6136	-2.14	15	15	3900	18532.8	3900	10193.04	-8339.76	-36	cottonwood
480	0.1	5.346	0.56	2.6136	-2.7324	15	15	7200	38491.2	7200	18817.92	-19673.28	-46	
							Total	11,100	57,024	11,100	29,011	-28,013	-41	

Table 33. Table 26. Existing and Potential Solar Loads for Cottonwood Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Cottonwood Creek
ID17040209SK013_02														
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
910	0.9	0.594	1	0	-0.594	2	1	1820	1081.08	910	0	-1081.08	-10	aspen
400	0.8	1.188	1	0	-1.188	3	1	1200	1425.6	400	0	-1425.6	-20	
160	0.7	1.782	0.99	0.0594	-1.7226	3	2	480	855.36	320	19.008	-836.352	-29	
590	0.5	2.97	0.99	0.0594	-2.9106	4	2	2360	7009.2	1180	70.092	-6939.108	-49	
110	0.7	1.782	0.99	0.0594	-1.7226	3	2	330	588.06	220	13.068	-574.992	-29	
580	0.5	2.97	0.99	0.0594	-2.9106	3	2	1740	5167.8	1160	68.904	-5098.896	-49	
230	0.1	5.346	0.39	3.6234	-1.7226	2	2	460	2459.16	460	1666.764	-792.396	-29	grass/sagebrush
ID17040209SK013_03														
880	0.1	5.346	0.39	3.6234	-1.7226	2	2	1760	9408.96	1760	6377.184	-3031.776	-29	grass/sagebrush
							Total	11,340	27,995	7,600	8,215	-19,780	-31	

Table 34. Table 27. Existing and Potential Solar Loads for Duck Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Duck Creek
ID17040209SK002_02														
490	0.3	4.158	0.97	0.1782	-3.98	2	2	980	4074.84	980	174.636	-3900.204	-67	cottonwood
90	0.6	2.376	0.97	0.1782	-2.1978	2	2	180	427.68	180	32.076	-395.604	-37	
370	0.5	2.97	0.97	0.1782	-2.7918	2	2	740	2197.8	740	131.868	-2065.932	-47	
200	0.3	4.158	0.97	0.1782	-3.9798	2	2	400	1663.2	400	71.28	-1591.92	-67	
570	0.4	3.564	0.97	0.1782	-3.3858	2	2	1140	4062.96	1140	203.148	-3859.812	-57	
50	0.9	0.594	0.97	0.1782	-0.4158	2	2	100	59.4	100	17.82	-41.58	-7	
190	0.6	2.376	0.97	0.1782	-2.1978	2	2	380	902.88	380	67.716	-835.164	-37	
							Total	**3,920**	**13,389**	**3,920**	**699**	**-12,690**	**-46**	

Table 35. Table 28. Existing and Potential Solar Loads for Spring Creek (Marsh Creek area).

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Spring Creek (Marsh Creek area)
ID17040209SK002_02														
70	0.1	5.346	0.97	0.1782	-5.17	2	1	140	748.44	70	12.474	-735.966	-87	cottonwood
90	0.4	3.564	0.97	0.1782	-3.39	2	1	180	641.52	90	16.038	-625.482	-57	
220	0	5.94	0.97	0.1782	-5.7618	2	1	440	2613.6	220	39.204	-2574.396	-97	
220	0.1	5.346	0.97	0.1782	-5.1678	2	1	440	2352.24	220	39.204	-2313.036	-87	
320	0.4	3.564	0.97	0.1782	-3.3858	2	2	640	2280.96	640	114.048	-2166.912	-57	
30	0.9	0.594	0.97	0.1782	-0.4158	3	2	90	53.46	60	10.692	-42.768	-7	
310	0.6	2.376	0.97	0.1782	-2.1978	3	2	930	2209.68	620	110.484	-2099.196	-37	
180	0.5	2.97	0.96	0.2376	-2.7324	3	3	540	1603.8	540	128.304	-1475.496	-46	
							Total	**3,400**	**12,504**	**2,460**	**470**	**-12,033**	**-59**	

Table 36. Table 29. Existing and Potential Solar Loads for Lanes Gulch Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Lanes Gulch
ID17040209SK006_02														
4790	0	0	0	0	[illegible]	1	1	4790	0	4790	0	0	0	dry
ID17040209SK006_03														
520	0	0	0	0	[illegible]	1	1	520	0	520	0	0	0	dry
860	0.2	4.752	0.27	4.3362	-0.4158	2	2	1720	8173.44	1720	7458.264	-715.176	-7	grass/sagebrush
990	0.3	4.158	0.27	4.3362	0.1782	3	3	2970	12349.26	2970	12878.514	529.254	0	
820	0	0	[illegible]	0	[illegible]	5	5	4100	0	4100	0	0	0	dry
							Total	**14,100**	**20,523**	**14,100**	**20,337**	**-186**	**-4**	

Table 37. Table 30. Existing and Potential Solar Loads for Lake Walcott.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Lake Walcott
ID17040209SK004L_0L														
16220	0	5.94	0	5.94	0.00	2200	2200	35684000	211962960	35684000	211962960	0	0	water
							Total	35,684,000	211,962,960	35,684,000	211,962,960	0	0	

5.1.6. Monitoring Points

Update as necessary.

5.2. Load Capacity

The loading capacity (LC) is the greatest amount of loading that a water body can receive without violating water quality standards. In the case of Marsh Creek, the LC is dictated, in great measure, by the flow that eventually discharges into the Snake River as the receiving §303(d) listed water body. For the Snake River to meet water quality standards, it is imperative that the tributaries to the Snake River meet water quality standards as well. Otherwise, attainment of water quality standards (and beneficial uses) may not be achieved in the Snake River. Marsh Creek must also meet its beneficial uses because it is also a §303(d) listed water body.

Based on flow estimates derived from the DEQ, the ISCC, the BID and the USGS, DEQ estimated an average flow near the confluence with the Snake River (primarily at the 750 East Road) of 8.1 cfs. The range of this estimate is from 0.0 cfs (minimum value) to 68.3 cfs (maximum value).

Based on the Lake Walcott TMDL provisions for instream water quality standards (or targets), the Marsh Creek LC for TSS, TP and E. coli is defined as follows:

5.2.1. Sediment (TSS).

The water quality target for TSS is 50 mg/L (average monthly) in the tributaries. Marsh Creek average flow is estimated at 8.1 cfs. Therefore, based on the TMDL formula for calculating the LC for TSS for Marsh Creek:

TSS LC = Water Quality Target x Flow, cfs x 5.4
TSS LC = 50 mg/L TSS x 8.1 cfs x 5.4
TSS LC = 2,187.0 lb/day TSS

The factor 5.4 in the TSS LC algorithm is simply a conversion factor to lb/day loads from mg/L concentration using a flow in cfs. This conversion factor is associated with TMDL loads.

5.2.2. Nutrients (TP).

The recommended instream water quality target for TP is 0.100 mg/L. Therefore, based on the TMDL formula for calculating the LC for TP for Marsh Creek:

TP LC = Water Quality Target x Flow, cfs x 5.4
TP LC = 0.100 mg/L TP x 8.1 cfs x 5.4
TP LC = 4.37 lb/day TP

5.2.3. Bacteria (E. coli).

The primary recreational standard is 126 CFU/100 mL geometric mean based on a minimum of five (5) samples taken every three (3) to five (5) days over a 30-day period at equal intervals between samples. The "trigger" for this target will be an instantaneous value of 406 E. coli organisms/100 mL based on the primary contact recreational standard (IDAPA

§58.01.02.251.01.b.i). Therefore, based on the TMDL formula for calculating LC of E. coli for Marsh Creek:

E. coli LC = Water Quality Target x Flow, cfs x 0.02445
E. coli LC = 126 cfu/100 mL E. coli x 8.1 cfs x 0.02445
E. coli LC = 25.0 cfu^9/day E. coli

5.3. Estimates of Existing Pollutant Loads

Regulations allow that loadings "...may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading," (Water quality planning and management, 40 CFR § 130.2(I)). An estimate must be made for each point source. Nonpoint sources are typically estimated based on the type of sources (land use) and area (such as a subwatershed), but may be aggregated by type of source or land area. To the extent possible, background loads should be distinguished from human-caused increases in nonpoint loads.

- Summarize or reference method(s) of estimation. Put details in an appendix. Be sure to reference the appendix.
- Describe the data used and all assumptions made
- Discuss sources and degree of uncertainty in estimates
- Be sure to consider seasonal variation in loads characteristic of each source type
- Present loading rates for each parameter
    - What is background load and extent to which it is purely background or aggregated with other nonpoint loads. Remember "background" load is a load that is not reducible.
    - Wasteloads from point sources (if there are any). Summarize these in a table by source (location, type, load [annual range, if known], NPDES permit number, etc.).
    - Loads are from nonpoint sources. Summarize these in a table by subbasin and/or land use (location, type, load [annual range if possible], estimation method).

Table 38. Current loads from nonpoint sources in Lake Walcott Subbasin.

Load Type	Location	Load	Estimation Method

5.4. Load Allocation

The load allocation (LA) is the portion of the receiving water's LC attributed either to existing or future nonpoint sources (NPS) of pollution. It can also be attributed to natural background (NBK) sources. Therefore, we may generally describe the LA in the following equation:

LA = NPS + NBK

5.4.1. Marsh Creek Load Allocation

For nonpoint sources of pollution, the Lake Walcott TMDL (Lay 2000 [p 105, Section 2.3.1.6]) states: "Land use within the [*Marsh Creek*] watershed are: 4% dryland agriculture, 8.6% forest practices, 0.3% irrigated gravity flow, 12.5% sprinkler irrigated crop lands, 1% urban areas, and 73.2% rangeland. Land ownership is a mix of: 27.2% USBLM lands, 17.2% USDAFS administered lands, 50.9% private deeded ground, and 4.6% State land."

To define the LA for Marsh Creek, the starting point is with the LC. The LC, as previously described (Section IV) is the greatest amount of loading that the water body can receive without violating water quality standards. By definition, the components that make up the LC cannot be individually or accumulatively greater than the LC itself. Consequently, the LA for nonpoint sources combined with the WLA for point sources must be less than the LC. Also, woven into each WLA and LA is the element of future growth, or consideration for future growth, as an assumption in the TMDL process.

To these components must be added the definition of "available load" (AL), which represents the load that is actually available for allocation between point sources and nonpoint sources after the uncertainty component is considered. That uncertainty component is best defined as the margin of safety (MOS), which is further described in Section VII. Essentially, the available load is the LC minus the MOS, therefore:

LC = (NPS + NBK) + WLA + MOS = LA + WLA + MOS
AL = LA + WLA = LC–MOS
LA = LC–MOS–WLA = LC–(MOS + WLA)

Based on these equations, we can establish the LA for Marsh Creek using the TMDL

LA formula for TSS, TP and E. coli as follows:

TSS LA = LC–(MOS + WLA)
TSS LA = 2,187.0 lb/day TSS–(218.7 lb/day + 218.7 lb/day)
TSS LA = 1,749.6 lb/day TSS

TP LA = LC–(MOS + WLA)
TP LA = 4.37 lb/day TP–(0.44 lb/day + 0.44 lb/day)
TP LA = 3.49 lb/day TP

E. coli LA = LC–(MOS + WLA)
E. coli LA = 25.0 cfu^9/day E. coli–(2.5 cfu^9/day + 2.5 cfu^9/day E. coli)
E. coli LA = 20.0 cfu^9/day E. coli

Within the structure of the Marsh Creek TMDL, the LA was further divided into the following four (4) general categories:

- Permitted Nonpoint Source Facilities. The first general category deals with permitted nonpoint source facilities associated with the Federal Energy Regulatory Commission (FERC) permitted hydropower facilities; all land application facilities (LAFs) that may or may not require a permit from the state; and all confined feeding operations (CFOs) that may or may not require an NPDES permit from EPA for a 24-hour, 25 year storm event.

- Agriculture and Grazing Lands. The second general category deals with all agricultural lands (inclusive of irrigated and non irrigated lands farmlands); grazing on public lands and state lands; private land ownership that includes all nonpoint source activities; and those activities that are more closely related to the Marsh Creek stream corridor that are not necessarily associated with the other sub components of this second general category.
- Stormwater Construction Activities. The third general category deals with all construction-type activities that may require a Construction General Permit from EPA (depending on the size of the land disturbing area), which may have a direct impact to Marsh Creek; thus requiring erosion and sediment controls. This third category utilizes a 2% reserve from the overall nonpoint source category, which would revert back to the general nonpoint source category once the construction activity is finished. Precedence and justification for this 2% approach may be shown in Buhidar (2005). Calculations for this category are summarized as follows:

  Construction Activities = Pollutant LA x 2%

  TSS Construction Activities = TSS LA x 2%
  TSS Construction Activities = 1,749.6 lb/day x 2%
  TSS Construction Activities = 35.0 lb/day TSS

  TP Construction Activities = TP LA x 2%
  TP Construction Activities = 3.49 lb/day x 2%
  TP Construction = 0.07 lb/day TP

  E. coli Construction Activities = E. coli LA x 2%
  E. coli Construction Activities = 20.0 cfu^9/day x 2%
  E. coli Construction Activities = 0.4 cfu^9/day E. coli

  The definition of construction activities as defined under the TMDL process has to do with any land disturbing activity (i.e. > 1 acre) which has the potential to create erosion and sedimentation; and which activities require a Construction General Permit from EPA. It is not limited to just septic systems associated with rural subdivisions or other similar ventures which normally are not associated with such land disturbances. This identification of construction activities is a component of nonpoint sources and is a requirement under the TMDL process. In addition, the application of the 2% for stormwater construction activities is primarily for activities that that occur within the stream corridor of Marsh Creek (as a 2-mile corridor measured as 1-mile buffers on both sides of the stream).

- Natural Background (NBK). Marsh Creek is a spring fed system that emanates from the "presence of a shallow unconfined alluvium aquifer in the Albion Basin that is hydraulically connected to Marsh Creek" (IDWR 2006 [p 8]). Natural background effects are discussed in Section IX; and were determined to be 5% of the LC.

In terms of future growth for nonpoint sources, no specific allocation was set aside for this component; therefore the, allocation for future growth for nonpoint sources is zero. However, as a general consideration, it is noted that future growth of the Marsh Creek watershed that incorporates a land use change (such as agricultural or grazing lands being converted to subdivision developments) may occur. Such changes or any similar to it will still be considered a part of the overall nonpoint source category that is associated with the LA and must demonstrate compliance with the overall water quality goals of the Marsh Creek TMDL to be in compliance with the Lake Walcott TMDL.

5.4.1.1. Margin of Safety

A 10% margin of safety (MOS) was used to account for any lack of knowledge or uncertainty concerning the relationship between effluent limitations and water quality. The 10% MOS is taken from the LC. Therefore, based on the TMDL formula for calculating the MOS for TSS, TP and E. coli is as follows:

TSS MOS = TSS LC x 10%
TSS MOS = 2,187.0 lb/day TSS LC x 10%
TSS MOS = 218.7 lb/day

TP MOS = TP LC x 10%
TP MOS = 4.37 lb/day TP LC x 10%
TP MOS = 0.44 lb/day

E. coli MOS = E. coli LC x 10%
E. coli MOS = 25 cfu^9/day E. coli LC x 10%
E. coli MOS = 2.5 cfu^9/day

5.4.1.2. Seasonal Variation

Seasonal variation is a component of a TMDL. The application of a seasonal component into the TMDL for Marsh Creek was not considered because little information existed to allow for it. Therefore, the seasonal variation is zero. However, it is reasonable to assume that future iterations of the Marsh Creek TMDL may require seasonal considerations and are therefore deferred until more information is provided to justify this.

5.4.1.3. Reasonable Assurance

Providing reasonable assurance that point sources and nonpoint sources will meet the LC of

Marsh Creek is a necessary requirement of the Marsh Creek TMDL to meet the beneficial uses of Marsh Creek and of the Snake River. By determining the LC for Marsh Creek (for TSS, TP and E. coli) and by allocating allowable limits within the LC is the first step towards providing reasonable assurance that the LC can be met by both the point sources and the nonpoint sources (assuming both sources meet their water quality targets). The second step is described as follows:

- Point Sources. As previously described in Section V, no known point sources exist at the present time that discharge into Marsh Creek. However, WLAs were derived for possible future point sources. These WLAs were derived within the limits of the LC for Marsh Creek; and therefore provide a reasonable assurance that these WLAs are within the instream water quality standards for Marsh Creek to meet beneficial uses.
- Nonpoint Sources. Nonpoint sources will receive LAs that are below and within the LC of the Marsh Creek water body. The LC is specifically set up to meet the beneficial uses of Marsh Creek and of the Snake River. Therefore, DEQ-TFRO in conjunction with the land management agencies will coordinate with public and private land ownerships to incorporate water quality cleanup projects specifically targeted to reducing erosion and sediment sources

since TSS makes up 80% of the TSS LC in the nonpoint source category (as shown in Table 2). Associated with this is 80% of the E. coli that is attributable to the nonpoint source category.

The third step includes the development of management strategies (via implementation planning) both the point source (when and if they become viable) and nonpoint source industries that support reasonable assurances in meeting the water quality standards and beneficial uses of Marsh Creek and the Snake River jointly. This planning will commence immediately with input from the Lake Walcott Watershed Advisory Group.

5.4.1.4. Background

Natural processes contribute pollutant loads. These natural processes have been identified as natural background and included barren/rock, wetlands, riparian lands, and water. Natural background conditions are identified and described in IDAPA §58.01.02.010.56 as "*The physical, chemical, biological, or radiological conditions existing in a water body without human sources of pollution within the watershed. Natural disturbances including, but not limited to, wildfire, geologic disturbance, diseased vegetation, or flow extremes that affect the physical, chemical, and biological integrity of the water are part of natural background conditions. Natural background conditions should be described and evaluated taking into account this inherent variability with time and place.*" In the case of the Marsh Creek watershed and its natural background conditions that may affect the water quality of Marsh Creek, DEQ chose 5% to be allocated from the LC to NBK sources. However, it should be noted that DEQ does not know what the actual NBK levels are for Marsh Creek; and recognizes that the 5% value is very conservative considering the human development that has occurred in the Marsh Creek watershed for nonpoint sources. Therefore,

TSS MOS = TSS LC x 5%
TSS MOS = 2,187.0 lb/day TSS LC x 5%
TSS MOS = 109.4 lb/day

TP MOS = TP LC x 5%
TP MOS = 4.37 lb/day TP LC x 5%
TP MOS = 0.22 lb/day

E. coli MOS = E. coli LC x 5%
E. coli MOS = 25 cfu^9/day E. coli LC x 5%
E. coli MOS = 1.3 cfu^9/day

5.4.1.5. Reserve

The wasteload allocation (WLA) is the portion of the receiving water's LC that is allocated to one of its existing or future point sources of pollution. The WLA is the allocation for an individual point source that ensures that the level of water quality to be achieved by the point source is derived from and complies with all applicable water quality standards.

The Lake Walcott TMDL (Lay 2000 [p 105, Section 2.3.1.6]) states: "There are no NPDES permitted dischargers in this watershed. The Cities of Albion and Declo have total containment lagoons with land application of wastes." At the present time (2009), the following exists:

- The City of Albion is sewered and has 2 lagoons and discharges to a land application site. No discharge occurs to Marsh Creek.
- The City of Declo is sewered and has a total containment lagoon (evaporates in the summer months) but does not have a land application site. No discharge occurs to Marsh Creek.
- No other sewered facility exists that is associated with Marsh Creek at the present time.

All rural homes have their wastewater treatment associated with private septic systems. Although no discharge is presently occurring from the Cities of Albion and Declo into Marsh Creek, DEQ chose to allocate for the future in the event that either City increases in size sufficiently to warrant such discharge into Marsh Creek.

Table 39 describes the population of the Cities of Albion and Declo from 2000 through 2005. In general, both cities have shown a decline in population by 2 and 3 people through the described time. Essentially, little growth has occurred for either city since 2000.

Table 39. Census population for the Cities of Albion and Declo

Census	City of Albion	City of Declo
2000	262	338
2001	263	339
2002	263	338
2003	262	337
2004	259	334
2005	258	332
Mean 2000-2005	261	336
Standard Deviation 2000-2005	± 2	± 3
Source: For the City of Albion–http://www.localcensus.com/city/Albion/Idaho. For the City of Declo–http://www.localcensus.com/city/declo/Idaho.		

DEQ chose to allocate 10% of the LC for purposes of future point source growth in the Marsh Creek watershed. Mean populations (2000-2005) were taken for both Cities and summed (597 population). Using this sum, the City of Albion was allocated 43.7% of the allocation (i.e. 261/597 x 100%), and the City of Declo was allocated 56.3% of the allocation (i.e. 336/597 x 100%).

Therefore,

WLA = 10% x LC

<u>Total Suspended Solids</u>:

TSS WLA = 10% x 2,187.0 lb/day TSS
TSS WLA = 218.7 lb/day TSS
City of Albion = 43.7% x 218.7 lb/day TSS = 95.6 lb/day TSS (for future use)
City of Declo = 56.3% x 218.7 lb/day TSS = 123.1 lb/day TSS (for future use)

<u>Total Phosphorus</u>:

TP WLA = 10% x 4.37 lb/day TP
TP WLA = 0.44 lb/day TP
City of Albion = 43.7% x 0.44 lb/day TP = 0.19 lb/day TP (for future use)
City of Declo = 56.3% x 0.44 lb/day TP = 0.25 lb/day TP (for future use)

<u>Escherichia Coli</u>:

E. coli WLA = 10% x 25.0 cfu^9/day E. coli
E. coli WLA = 2.5 cfu^9/day E. coli
City of Albion = 43.7% x 2.5 cfu^9/day E. coli = 1.1 cfu^9/day E. coli (for future use)

City of Declo = 56.3% x 2.5 cfu^9/day E. coli = 1.4 cfu^9/day E. coli (for future use)

Again, the point of this exercise is to preliminarily establish possible WLAs for the Cities of Albion and Declo for future point source pollution (as allowed by the TMDL process under the Clean Water Act). Currently, there is no indication that either City would ever consider discharging into Marsh Creek. At such time, either City (or any other point source) would need to consult with DEQ and EPA to determine if discharging to Marsh Creek would be allowed.

5.4.1.6. Construction Storm Water and TMDL Waste Load Allocations

The Clean Water Act requires operators of construction sites to obtain permit coverage to discharge storm water to a water body or to a municipal storm sewer. In Idaho, EPA has issued a general permit for storm water discharges from construction sites. In the past storm water was treated as a non-point source of pollutants. However, because storm water can be managed on site through management practices or when discharged through a discrete conveyance such as a storm sewer, it now requires a National Pollution Discharge Elimination System (NPDES) Permit.

5.4.1.7. The Construction General Permit (CGP)

If a construction project disturbs more than one acre of land (or is part of larger common development) that will disturb more than one acre), the operator is required to apply for permit coverage from EPA after developing a site-specific Storm Water Pollution Prevention Plan.

To obtain the Construction General Permit operators must develop a site-specific Storm Water Pollution Prevention Plan (SWPPP). The operator must document the erosion, sediment, and pollution controls they intend to use, inspect the controls periodically and maintain the best management practices (BMPs) through the life of the project

When a stream is on Idaho's § 303(d) list and has a TMDL developed DEQ may incorporate a gross WLA for anticipated construction storm water activities. TMDLs developed in the past that did not have a WLA for construction storm water activities will also be considered in compliance with provisions of the TMDL if they obtain a Construction General Permit (CGP) under the NPDES program and implement the appropriate Best Management Practices.

Typically, there are specific requirements you must follow to be consistent with any local pollutant allocations. Many communities throughout Idaho are currently developing rules for post-construction storm water management. Sediment is usually the main pollutant of concern in storm water from construction sites. The application of specific best management practices from *Idaho's Catalog of Storm Water Best Management Practices for Idaho Cities and Counties* is generally sufficient to meet the standards and requirements of the General Construction Permit, unless local ordinances have more stringent and site specific standards that are applicable.

5.4.1.8. Remaining Available Load/Reserve for Growth

Apportion remaining available load (future loading targets) to the extent possible taking into account both spatial (location) and temporal (seasonal) distribution of sources.

- Each point source must receive a wasteload allocation.
- Nonpoint sources can be allocated by subwatershed, land use category, responsibility for actions, or a combination (a.k.a. load allocation).

- Not all nonpoint sources need to be allocated a reduction so long as water quality targets can be met by the aggregate reductions of those sources that are prescribed a reduction in load.
- Allocations are best summarized in a table or tables.
- A time must be specified by which each (or all) allocations will be met.
- Pollutant trading may come after allocations have been made.
- Carefully consider a reserve for growth by further reducing LA or WLA to accommodate.

OVERALL TMDL TABLE BASED ON THE LOADING CAPACITY FOR MARSH CREEK

Table 2, the overall TMDL table, summarizes Sections IV, V, VI, VII and IX. This table is based on the water quality targets set for Marsh Creek on instream water quality targets for TSS (50.0 mg/L), TP (0.100 mg/L) and E. coli (126 CFU/100 mL). The flow provisions are based on average flows of 8.1 cfs for Marsh Creek (as described in Section II [Description and Hydrology of Marsh Creek]).

Table 2. Marsh Creek Overall TMDL Table

TMDL COMPONENTS	TSS, LB/DAY	TP, LB/DAY	E. COLI, CFU^9/DAY
NONPOINT SOURCES (80% of the Loading Capacity)			
FERC, LAFs, CFOs	0.0	0.0	0.0
Ag, Graze, Private, Corridor	1,605.2	3.20	18.3
Stormwater–Construction–2%	35.0	0.07	0.4
Natural Background Sources–5%	109.4	0.22	1.3
Sub Total	1,749.6	3.49	20.0
NPDES PERMITTED POINT SOURCES–Future Point Source Allocation (10% of the Loading Capacity)			
City of Albion (future)	95.6	0.19	1.1
City of Declo (future)	123.1	0.25	1.4
Sub Total	218.7	0.44	2.5
MARGIN OF SAFETY & LOADING CAPACITY			
Margin of Safety, 10%	218.7	0.44	2.5
Loading Capacity	2,187.0	4.37	25.0
E. coli = Escherichia coli. TSS = Total Suspended Solids. TP = Total Phosphorus. WLA = Wasteload Allocation for an NPDES permitted point source facility. Seasonal variation is not a component in the Marsh Creek TMDL at this time. FERC = Federal Energy Regulatory Commission permitted hydropower facilities. LAFs = Land Application Facilities. CFOs = Confined Feeding Operations like dairies and feedlots of all sizes. Ag = All agricultural cropland and farmland combined. Graze = All grazing lands. Private = All privately owned lands. Corridor = All stream corridor components associated with Marsh Creek. Seasonality is not a component that was considered in Table 3, as discussed in §VIII.			

Total Suspended Solids (TSS)

Relative to TSS, the overall nonpoint source category (1,749.6 lb/day TSS) represents 80% of the TSS LC. The point source category (218.7 lb/day TSS) represents 10% of the TSS LC. The remaining 10% is attributable to the TSS MOS. These values (TSS water quality targets) are based on meeting the TSS LC for Marsh Creek at an average flow of 8.1 cfs. These nonpoint source targets are appropriate given a water quality concentration target of 50.0 mg/L as TSS. This same logic and approach has been used in other TMDLs in Southcentral Idaho on nonpoint source streams with support from the nonpoint source community, agricultural industry stakeholders and the associated watershed advisory group.

Total Phosphorus (TP)

Relative to TP, the overall nonpoint source category (3.49 lb/day TP) represents 80% of the TP LC. The point source category (0.44 lb/day TP) represents 10% of the TP LC. The remaining 10% is attributable to the TP MOS.

Escherichia coli (E. coli)

Relative to E. coli, the overall nonpoint source category (20 cfu^9/day E. coli) represents 80% of the E. coli LC. The point source category (2.5 cfu^9/day E. coli) represents 10% of the E. coli LC. The remaining 10% is attributable to the E. coli MOS. IDEQ recognizes that general construction type activities do not of themselves generate E. coli as previously discussed in Section VI, item 3 (Stormwater Construction Activities). However, the ground disturbing aspects of those activities tend to promote land surface sedimentation and siltation into Marsh Creek which provides a source of E. coli as a direct impairment to the receiving water body, because E. coli may already be entrained in the sediment. That entrainment is associated with feces from warm blooded animals, which is the source of the E. coli. The recognition of these latent or unseen sources of E. coli is recognized all over Southcentral Idaho and therefore (and as a consequence of the TMDL process) encourages the nonpoint source community to apply best management practices on all ground disturbing activities that may have water quality impairment influences on the receiving water body.

Table 40. Point source wasteload allocations for Lake Walcott Subbasin.

Source	Pollutant	Allocation			Time Frame for Meetir Allocations
		Daily	Monthly	Annually	

Table 41. Nonpoint source load allocations for Lake Walcott Subbasin.

Source	Pollutant	Allocation			Time Frame for Meetir Allocations
		Daily	Monthly	Annually	

5.4.2. PNV Load Allocation

Because this TMDL is based on potential natural vegetation, which is equivalent to background loading, the load allocation is essentially the desire to achieve background conditions. However, to reach that objective, load allocations are assigned to non point source activities that have or may affect riparian vegetation and shade as a whole. Load allocations are therefore stream reach specific and are dependent upon the target load for a given reach.

Table 20 through Table 37 show the target or potential shade which is converted to a potential summer load by multiplying the inverse fraction (1-shade fraction) by the average loading to a flat plate collector for the months of April through September. That is the loading capacity of the stream and it is necessary to achieve background conditions. There is no opportunity to further remove shade from the stream by any activity without exceeding its loading capacity.

Additionally, because this TMDL is dependent upon background conditions for achieving WQS, all tributaries to the waters examined here need to be in natural conditions in order to prevent excess heat loads to the system.

Table 42 shows the total existing, total target, and excess heat load (kWh/day) experienced by each water body examined. The size of a stream influences the size of the excess load. Large streams have higher existing and target loads by virtue of their larger channel widths as compared to smaller streams. The table lists the tributaries in order of their excess loads highest to lowest. Therefore, large water bodies tend to be listed first and small water bodies tend to be listed last. Lake Walcott is an exception due to its target shade being zero.

Although the following analysis dwells on total heat loads for streams in this TMDL, it is important to note that differences between existing shade and target shade, as depicted in Lack of Shade Figures (Figure 20, Figure 23, and Figures C-3, C-6, C-9, C-12 and C-15), are the key to successfully restoring these waters to achieving WQS. Target shade levels for individual reaches should be the goal managers strive for with future implementation plans. Managers should key in on the largest differences between existing and target shade as locations to prioritize implementation efforts. Each loading table contains a final column that lists the difference between existing and target shade.

Table 42. Excess Solar Loads and Percent Reductions for All Tributaries.

Water Body	Total Existing Load (kWh/day)	Total Target Load (kWh/day)	Excess Load (kWh/day)	Average Lack of Shade (%)
Marsh Creek	2,989,840	1,964,516	1,025,324	-34
SF Rock Creek	658,087	451,282	206.805	-44
EF Rock Creek	249,094	57,452	191,642	-57
Howell Canyon Creek	323,083	162,081	161,001	-30
Rock Creek	528,114	392,974	135,140	-42
Little Creek	148,322	23,544	124,777	-56
Land Creek	154,280	54,921	99,358	-39
Warm Creek	110,086	37,554	72,532	-50

Cold Creek	76,002	20,226	55,777	-44
Copper Creek	120,089	64,963	55,126	-38
Spring Creek (Rock tributary)	66,908	11,798	55,110	-78
Fall Creek	78,640	27,851	50,789	-41
Reuger Springs	57,024	29,011	28,013	-41
Cottonwood Creek	27,995	8,215	19,780	-31
Duck Creek	13,389	699	12,690	-46
Spring Creek (Marsh Creek area)	12,504	470	12,033	-59
Lanes Gulch	20,523	20,337	186	-4
Lake Walcott	211,962,960	211,962,960	0	0

Marsh Creek has the largest excess load of those examined which is not surprising because it is one of the larger streams examined with large existing and target loads. Figure 20 and Figure C-15 show that Marsh Creek's riparian shade has been affected throughout a large portion of its watershed. South Fork Rock Creek has the next highest excess load, followed closely by East Fork Rock Creek, although East Fork Rock Creek's excess load is over 50% of its total existing load while South Fork Rock Creek's excess load is only around 31% of its total existing load. It should be noted that Duck Creek and Spring Creek (Marsh Creek area) are now merely agricultural return flows and not true perennial flowing creeks. Duck and Spring Creek have two of the lowest excess loads, but their excess loads are a much larger percentage of their total existing loads. Lane's Gulch has the lowest excess load, next to Lake Walcott, which has zero excess loading due to its target shade levels being zero percent. Most remaining creeks lack shade and have similar levels of disturbance relative to their size.

A certain amount of excess load and hence percent reduction is potentially created by the existing shade/target shade difference inherent in the loading analysis. Because existing shade is reported as a 10% class level and target shade is a unique integer, there is always a difference between them. For example, say a particular stretch of stream has a target shade of 86% based on its vegetation type and natural bankfull width. If existing shade on that stretch of stream were at target level, it would be recorded as 80% existing shade in the loading analysis because it falls into that existing shade class. There is an automatic difference of 6%, which could be real or potentially attributable to the margin of safety.

5.4.2.1. Wasteload Allocation

There are 23 NPDES permitted facilities listed in EPA's permit compliance system, however, it is not known how many of these facilities are no longer in operation. Eighteen of these NPDES facilities list a receiving water and presumable have or had a water discharge. Most facilities discharge to the Snake River or to canals/drains in the Burley/Rupert area. Three facilities discharge to streams identified in this TMDL, American Falls Fish Hatchery (Reuger Springs), Fall Creek Fish Hatchery (Fall Creek) and the City of Rockland WWTP (Rock Creek). It is unknown at this time if any of these facilities present a thermal discharge in need of a wasteload allocation. Should a point source be proposed that would have thermal consequence on these waters, then background provisions addressing such discharges in Idaho water quality standards (IDAPA 58.01.02.200.09 & IDAPA 58.01.02.401.03) should be involved (see Appendix B).

5.4.2.2. Margin of Safety

The margin of safety in this TMDL is considered implicit in the design. Because the target is essentially background conditions, loads (shade levels) are allocated to lands adjacent to these streams at natural background levels. Because shade levels are established at natural background or system potential levels, it is unrealistic to set shade targets at higher, or more conservative, levels. Additionally, existing shade levels are reduced to the next lower 10% class interval, which likely underestimates actual shade in the loading analysis. Although the loading analysis used in this TMDL involves gross estimations that are likely to have large variances, load allocations are applied to the stream and its riparian vegetation rather than specific NPS activities, and can be adjusted as more information is gathered from the stream environment.

5.4.2.3. Seasonal Variation

This TMDL is based on average summer loads. All loads have been calculated to be inclusive of the six-month period from April through September. This period was chosen because it represents the period when the combination of increasing air and water temperatures coincides with increasing solar inputs and increasing vegetative shade. The critical period is June when spring salmonids spawning is occurring, July and August when maximum temperatures exceed cold water aquatic life criteria, and September during fall salmonids spawning. Water temperature is not likely to be a problem for beneficial uses outside of this period because of cooler weather and lower sun angle.

5.4.2.4. Construction Storm Water and TMDL Waste Load Allocations

The Clean Water Act requires operators of construction sites to obtain permit coverage to discharge storm water to a water body or to a municipal storm sewer. In Idaho, EPA has issued a general permit for storm water discharges from construction sites. In the past storm water was treated as a non-point source of pollutants. However, because storm water can be managed on site through management practices or when discharged through a discrete conveyance such as a storm sewer, it now requires a National Pollution Discharge Elimination System (NPDES) Permit.

If a construction project disturbs more than one acre of land (or is part of larger common development) that will disturb more than one acre), the operator is required to apply for permit coverage from EPA after developing a site-specific Storm Water Pollution Prevention Plan.

In order to obtain the Construction General Permit operators must develop a site-specific Storm Water Pollution Prevention Plan. The operator must document the erosion, sediment, and pollution controls they intend to use, inspect the controls periodically and maintain the best management practices (BMPs) through the life of the project

When a stream is on Idaho's § 303(d) list and has a TMDL developed DEQ now incorporates a gross waste load allocation (WLA) for anticipated construction storm water activities. TMDLs developed in the past that did not have a WLA for construction storm water activities will also be considered in compliance with provisions of the TMDL if they obtain a CGP under the NPDES program and implement the appropriate Best Management Practices.

Typically there are specific requirements you must follow to be consistent with any local pollutant allocations. Many communities throughout Idaho are currently developing rules for post-construction storm water management. Sediment is usually the main pollutant of concern in storm water from construction sites. The application of specific best management practices from *Idaho's Catalog of Storm Water Best Management Practices for Idaho Cities and Counties* is generally sufficient to meet the standards and requirements of the General Construction Permit, unless local ordinances have more stringent and site-specific standards that are applicable.

5.5. Pollution Trading

Pollutant trading (also known as *water quality trading*) is a contractual agreement to exchange pollution reductions between two parties. Pollutant trading is a business-like way of helping to solve water quality problems by focusing on cost effective local solutions to problems caused by pollutant discharges to surface waters.

The appeal of trading emerges when pollutant sources face substantially different pollutant reduction costs. Typically, a party facing relatively high pollutant reduction costs compensates another party to achieve an equivalent, though less costly, pollutant reduction.

Pollutant trading is voluntary. Parties trade only if both are better off because of the trade, and trading allows parties to decide how to best reduce pollutant loadings within the limits of certain requirements.

Pollutant trading is recognized in Idaho's Water Quality Standards at IDAPA 58.01.02.054.06. Currently, DEQ's policy is to allow for pollutant trading as a means to meet total maximum daily loads (TMDLs), thus restoring water quality limited water bodies to compliance with water quality standards. The *Pollutant Trading Guidance* document sets forth the procedures to be followed for pollutant trading:

http://www.deq.idaho.gov/water/prog_issues/waste_water/pollutant_trading/pollutant_trading_guidance_entire.pdf

5.5.1. Trading Components

The major components of pollutant trading are *trading parties* (buyers and sellers) and *credits* (the commodity being bought and sold). Additionally, *ratios* are used to ensure environmental equivalency of trades on water bodies covered by a TMDL. All trading activity must be recorded in the trading database through the Idaho Clean Water Cooperative, Inc.

Both point and nonpoint sources may create marketable credits, which are a reduction of a pollutant beyond a level set by a TMDL:

- Point sources create credits by reducing pollutant discharges below NPDES effluent limits set initially by the waste load allocation.
- Nonpoint sources create credits by implementing approved best management practices (BMPs) that reduce the amount of pollutant run-off. Nonpoint sources must follow specific design, maintenance, and monitoring requirements for that BMP, apply discounts to credits generated if required, and provide a water quality contribution to ensure a net environmental benefit. The water quality contribution also ensures the reduction (the marketable credit), is surplus to the reductions the TMDL assumes the nonpoint source is achieving to meet the water quality goals of the TMDL.

5.5.2. Watershed-Specific Environmental Protection

Trades must be implemented so that the overall water quality of the water bodies covered by the TMDL are protected. To do this, hydrologically-based ratios are developed to ensure trades between sources distributed throughout TMDL water bodies result in environmentally equivalent or better outcomes at the point of environmental concern. Moreover, localized adverse impacts to water quality are not allowed.

5.5.3. Trading Framework

For pollutant trading to be authorized, it must be specifically mentioned within a TMDL document. After adoption of an EPA approved TMDL, DEQ, in concert with the Watershed Advisory Group (WAG), must develop a pollutant trading framework document as part of an implementation plan for the watershed that is the subject of the TMDL in order for trading to commence.

The elements of a trading document are described in DEQ's Pollutant Trading Guidance:

http://www.deq.idaho.gov/water/prog_issues/waste_water/pollutant_trading/pollutant_trading_guidance_entire.pdf.

5.6. Public Participation

House Bill 145 (HB145) has brought about changes in how WAGs are involved in TMDL development and review. The basic process for developing TMDLs and implementation plans is as follows:

1. BAG members are appointed by DEQ's director for each of Idaho's basins.
2. An "Integrated Report is developed by DEQ every two years that highlights which water bodies in Idaho appear to be degraded.
3. DEQ prepares to begin the SBA and TMDL process for individual degraded watersheds.
4. A WAG is formed by DEQ (with help from the BAG) for a specific watershed/TMDL.
5. With the assistance of the WAG, DEQ develops an SBA and any necessary TMDLs for the watershed.
6. The WAG comments on the SBA/TMDL.
7. WAG comments are considered and incorporated, as appropriate, by DEQ into the SBA/TMDL.
8. The public comments on the SBA/TMDL.
9. Public comments are considered and incorporated, as appropriate, by DEQ into the SBA/TMDL.
10. DEQ sends the document to the U.S. Environmental Protection Agency (EPA) for approval.
11. DEQ and the WAG develop, then implement, a plan to reach the goals of the TMDL.

DEQ will provide the WAG with all available information pertinent to the SBA/TMDL, when requested, such as monitoring data, water quality assessments, and relevant reports. The WAG will also have the opportunity to actively participate in preparing the SBA/TMDL documents.

Once a draft SBA/TMDL is complete, it is reviewed first by the WAG, then by the public. If, after WAG comments have been considered and incorporated, a WAG is not in agreement with an SBA/TMDL, the WAG's position and the basis for it will be documented in the public notice of public availability of the SBA/TMDL for review. If the WAG still disagrees with the SBA/TMDL after public comments have been considered and incorporated, DEQ must incorporate the WAG's dissenting opinion

Prior to finalization of the draft Marsh Creek TMDL, DEQ visited the Marsh Creek watershed and many of the nonpoint source landuse areas associated with the watershed to gather the necessary information for establishing the TMDL. DEQ also met with the Lake Walcott WAG to discuss the details of the TMDL. Then, DEQ conducted a 30-day public comment period from _____ through _____. Comments are found in Appendix X.

5.7. Implementation Strategies

5.7.1. Marsh Creek

5.7.1.1. Time Frame

5.7.1.2. Approach

5.7.1.3. Responsible Parties

5.7.1.4. Monitoring Strategy

5.7.2. PNV

Implementation strategies for TMDLs produced using potential natural vegetation-based shade and solar loading should incorporate the loading tables presented in this TMDL. These tables need to be updated, first to field verify the existing shade levels that have not yet been field verified, and secondly to monitor progress towards achieving reductions and the goals of the TMDL. Using the solar pathfinder to measure existing shade levels in the field is important to achieving both objectives. It is likely that further field verification will find discrepancies with reported existing shade levels in the loading tables. Due to the inexact nature of the aerial photo interpretation technique, these tables should not be viewed as complete until verified. Implementation strategies should include solar pathfinder monitoring to simultaneously field verify the TMDL and mark progress towards achieving desired reductions in solar loads.

DEQ recognizes that implementation strategies for TMDLs may need to be modified if monitoring shows that the TMDL goals are not being met or significant progress is not being made toward achieving the goals.

5.7.2.1. Time Frame

5.7.2.2. Approach

5.7.2.3. Responsible Parties

5.7.2.4. Monitoring Strategy

DEQ recognizes that implementation strategies for TMDLs may need to be modified if monitoring shows that the TMDL goals are not being met or significant progress is not being made toward achieving the goals.

5.7.3. Time Frame

The expected time frame for meeting water quality standards and/or beneficial uses.

5.7.4. Approach

The Marsh Creek TMDL is a part of the Lake Walcott Implementation Plan. DEQ is presently in the process of assessing potential water quality cleanup projects on Marsh Creek with the assistance of the Lake Walcott Watershed Advisory Group and the ISCC, BLM and USFS.

5.7.5. Responsible Parties

Identify the federal, state, and local governments; individuals; or entities that will be involved in or responsible for implementing the TMDL.

5.7.6. Monitoring Strategy

The overall purpose and intent of water quality monitoring is to assess beneficial use and water quality standards attainment on Marsh Creek. The monitoring plan that will be used on Marsh Creek will involve three approaches.

- First, DEQ intends to monitor (depending on available resources) Marsh Creek, especially as it pertains to any water quality cleanup projects (as referenced in Section XIII). Monitoring will include the flowing: (1) headwaters reach if applicable, and (2) just above the point of discharge into the Snake River. Flow monitoring of the Marsh Creek water body will be an important component in this monitoring scheme.
- Second, the Beneficial Use Reconnaissance Program (BURP) will be utilized to ascertain the status of beneficial uses on Marsh Creek as defined by the BURP protocols. The use of this process will be applied in the headwaters segment above Albion, Idaho; in the segment between Albion, Idaho and Dewy Pond; and, from Dewy Pond to the confluence with the Snake River.
- Third, other types of monitoring will be used that involves private landowners, public land management agencies, and the Idaho Soil Conservation Commission. Erosion assessments will be used as monitoring and implementation are further developed over the next 5 years.

5.8. Conclusions

5.8.1. PNV

The Lake Walcott subbasin has one water body 303d listed for temperature problems and another water body listed for unknown pollutants. An additional sixteen water bodies were examined at the region's request, and temperature TMDLs based on meeting riparian shade targets as a surrogate for temperature were produced. This TMDL examined the relationship between existing shade levels on streams and shade targets developed from vegetation typing in the region. Existing and target shade levels were converted to solar loads for an analysis of excess loading to streams.

Most streams examined in this TMDL lacked shade and had excess solar loads. Excess loads vary from 186 kWh/day for one of the smaller streams to more than 1 million kWh/day for

Marsh Creek, one of the listed and larger streams. Marsh Creek and South Fork Rock Creek had the largest excess solar loads. Most remaining water bodies examined had similar levels of disturbance, with the exception of Lanes Gulch which was near target levels. Duck Creek and Spring Creek (Marsh Creek area) have high reductions needed, but it should be noted that these streams are merely agricultural return flows.

Lack of shade and excess solar loads can result from a variety of circumstances, some natural such as wildfires, and some anthropogenic with varying degrees of permanency (e.g. paved roads versus partial vegetation removal). Managers should key in on the largest differences between existing and target shade as locations to prioritize implementation efforts, though each reach on each stream needs to be examined for possible corrective implementation. Some problems can be fixed and others cannot, and implementation strategies should take into account these realities.

Table 43. Table 32. Summary of assessment outcomes.

Water Body Segment/ AU	Pollutant	TMDL(s) Completed	Recommended Changes to §303(d) List	Justification
Marsh Creek/ ID17040209SK003_02 ID17040209SK003_03 ID17040209SK003_04	Temperature	Yes	n.a.	Existing Shade
South Fork Rock Creek/ ID17040209SK009_02 ID17040209SK009_03 ID17040209SK009_04	Temperature	Yes	n.a.	Existing Shade
East Fork Rock Creek/ ID17040209SK010_03	Temperature	Yes	n.a.	Existing Shade
Howell Canyon Creek/ ID17040209SK003_02 ID17040209SK003_02 ID17040209SK003_04A	Temperature	Yes	n.a.	Existing Shade
Rock Creek/ ID17040209SK008_04	Temperature	Yes	n.a.	Existing Shade
Little Creek/ ID17040209SK011_02 ID17040209SK011_03	Temperature	Yes	n.a.	Existing Shade
Land Creek/ ID17040209SK003_02	Temperature	Yes	n.a.	Existing Shade
Warm Creek/ ID17040209SK012_02	Temperature	Yes	n.a.	Existing Shade
Cold Creek/ ID17040209SK012_02	Temperature	Yes	n.a.	Existing Shade
Copper Creek/ ID17040209SK013_02 ID17040209SK013_03	Temperature	Yes	n.a.	Existing Shade
Spring Creek (Rock Creek tributary)/ ID17040209SK008_02 ID17040209SK008_03	Temperature	Yes	n.a.	Existing Shade

Fall Creek/ ID17040209SK007_02 ID17040209SK007_03	Temperature	Yes	n.a.	Existing Shade
Reuger Springs	Temperature	Yes	n.a.	Existing Shade
Cottonwood Creek/ ID17040209SK013_02 ID17040209SK013_03	Temperature	Yes	n.a.	Existing Shade
Duck Creek/ ID17040209SK002_02	Temperature	Yes	n.a.	Existing Shade
Spring Creek (Marsh Creek area)/ ID17040209SK002_02	Temperature	Yes	n.a.	Existing Shade
Lanes Gulch/ ID17040209SK006_02 ID17040209SK006_03	Temperature	Yes	n.a.	Existing Shade

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5.8.1.1. GIS Coverages

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