Compensatory Mitigation & Stream Restoration Plan

Buffalo Mountain Surface Mine

WVDEP Permit No. S-5018-07

Hardee, Lee, and Tug River Districts
Mingo County, West Virginia

CONSOL of Kentucky Inc.
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Canonsburg, Pennsylvania 15317

June, 2010

Prepared by:

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EXECUTIVE SUMMARY

CONSOL of Kentucky Incorporated (CONSOL) proposes to implement the following Compensatory Mitigation and Stream Restoration Plan ("Mitigation Plan") to offset unavoidable structural and functional losses of waters of the United States (U.S.) from its Buffalo Mountain Surface Mine (WVDEP Permit No. S-5018-07). The mine permit area is located near the Town of Delbarton in central Mingo County, WV (Figure 1.1). The Buffalo Mountain Surface Mine proposes to extract bituminous coal reserves via a combined method of mining, including area, mountaintop, steep slope, contour, and limited auger/highwall mining, within its proposed 2,308-acres permit area. The proposed impact and mitigation stream reaches are located within the Miller Creek, Pigeon Creek, and Buffalo Creek watersheds in the Tug Fork River watershed (Hydrologic Unit Code 05070201) of the Big Sandy River basin, at approximately 34°44'07" latitude and 82°13'28" longitude.

The selection of the Preferred Alternative included measures to avoid and minimize impacts to jurisdictional waters of the U.S. The least environmentally damaging practicable alternative will require unavoidable permanent placement of excess overburden into valleys that contain waters of the U.S.; therefore, a Clean Water Act (CWA) Section 404 Permit will be required for the project.

Particularly because this project involved coordination with multiple agencies, private entities, and the public, a comprehensive, innovative Mitigation Plan has been developed. Using the most current regulatory guidance and protocols, the Mitigation Plan provides ample "credits" using multiple debit-credit accounting systems while also providing replacement of stream impacts on a linear-foot basis. One innovative component included in the Mitigation Plan is a wastewater treatment component that will not only serve to benefit the aquatic community, but also provide much needed human health benefits.

This approach includes the construction of wastewater collection lines and tap-ins for all of the residents of Hell Creek's watershed and a three-mile long force main to the Delbarton, WV wastewater treatment plant. Many of these residents do not have any wastewater treatment systems and others have poorly functioning systems; therefore, raw sewage and other household wastes are currently being released into Hell Creek, a perennial stream. Fecal coliform levels - an indicator of raw sewage - in Hell Creek are above state recommended levels for aquatic life. Sampling revealed a monthly average of 619 colonies per 100 mL, while the state water quality criteria dictate 200 colonies per 100 mL as the recommended maximum.

Implementation of this component of the Mitigation Plan will result in the treatment of approximately 1.25 million gallons of wastewater a year in the Hell Creek watershed and, if other residents and businesses avail themselves of tapping into the oversized force main, could result in of the treatment of approximately 5.76 million additional gallons of wastewater per year in Pigeon Creek (WV Infrastructure & Jobs Development Council).

ES.1 Goals and Objectives

The overall goal of this proposed Mitigation Plan is to offset impacts to jurisdictional waters of the U.S. associated with the Buffalo Mountain Surface Mine. This goal will be met through the following objectives:

1. Complying with all applicable guidance and regulations for implementing the CWA, including the *Compensatory Mitigation for Losses of Aquatic Resources; Final Rule* ("Final Rule," USEPA & USACE, 2008);
2. Restoring geomorphically stable conditions in the temporarily impacted channels, such that the correct stream type is in the appropriate valley type;
3. Establishing headwater drainage ways by designing channels on-site to transport the bankfull flow and create appropriate bedforms, while also providing habitat and riparian corridors;

4. Creating hydrologic connectivity by establishing stream channels from on-site establishment channels to off-site existing jurisdictional waters of the U.S., while preserving an existing and mature riparian zone; and
5. Restoring, enhancing, preserving, and improving water quality in the Hell Creek subwatershed of Pigeon Creek, specifically by:
    - Reducing the sediment load in sections of the subwatershed through stabilized streambanks and improved riparian areas;
    - Improving aquatic and terrestrial habitat through creation of riffles and pools (bedform diversity), in-stream cover, woody debris, restored terrestrial habitat, increased extent of natural areas, and improved aesthetics;
    - Improving landscape pathways for flora and fauna through restored and preserved perennial, intermittent, and ephemeral riparian corridors;
    - Improving overall water quality in the Hell Creek subwatershed through installed sewer lines and pump station that will transport untreated and poorly treated sewage to the Delbarton Wastewater Treatment Plant; specifically treating approximately 1.25 million gallons of untreated wastewater per year in Hell Creek.
6. Providing potential for future water quality improvements in the Pigeon Creek watershed by enhancing treatment capacity at the Delbarton Wastewater Treatment Plant and designing a three-mile force main extension that can accommodate future additional hookups from untreated and poorly treated waste streams along Pigeon Creek (WVWRI & CVI, 2008), which will potentially treat 5.76 million additional gallons of wastewater per year in Pigeon Creek.

ES.2 Summary of Impacts

A stream delineation was performed within the permit boundary and the surrounding areas to ensure that all waters of the U.S. were identified (Baker, 2008). USACE approved the jurisdictional determination on September 18, 2008. A total of nine (9) sub-watersheds of the Tug Fork River were identified within the waters of the U.S. that will be impacted. Impacts are detailed in Table ES.1, and the impact streams are shown on Figure 1.3.

The Buffalo Mountain Surface Mine permit includes an approximate original contour (AOC) variance to allow for the construction of the King Coal Highway (KCH) during surface mine reclamation activities. The KCH is an approved federal action with portions of the project under construction in Mercer and Mingo Counties, West Virginia. Following the circulation of the KCH Final Environmental Impact Statement (FEIS), the Federal Highway Administration (FHWA) issued the project's Record of Decision (ROD) on August 24, 2000 and will complete a written re-evaluation of the proposed project as required by FHWA regulations (23 CFR 771).

In order to implement best management practices (BMPs) and thereby reduce sediment loads, a series of two temporary drainage control structures will be installed downstream of the permanent structures, where feasible; in addition to implementing bottom-up construction techniques of the permanent fill structures to minimize exposure of earth and rock to the environment. In addition, several temporary road crossings will be installed throughout the permit area to maintain efficient operations at the surface mine.

The proposed Buffalo Mountain Surface Mine's total impact (permanent and temporary) to jurisdictional stream length will be 51,866 LF (6.618 ac), including 41,651 LF (4.961 ac) of permanent impacts and 10,215 LF (1.657 ac) of temporary impacts. It should be noted that these impacts include both those directly attributable to the mining activities as well as those attributable to the proposed future highway construction within the Buffalo Mountain Surface Mine permit area. This joint approach provides for a more comprehensive mitigation solution for impacts to waters of the U.S. than would separate mitigation plans for the mining activities and the KCH.

Of the permanent impacts, approximately 29 percent are in perennial streams, 53 percent are in intermittent streams, and 17 percent are in ephemeral streams (Table ES.1). It was determined that increased flow at certain areas that typically exhibit intermittent or ephemeral flow actually display perennial characteristics as a result of groundwater collection in voids left by previous deep mine activity (Baker, 2008a).

Table ES.1
Impact Summary for the Buffalo Mountain Surface Mine

Sub-Watershed	Permanent Impact				Temporary Impact			
	Intermittent/Perennial		Ephemeral		Intermittent/Perennial		Ephemeral	
	LF	Acres	LF	Acres	LF	Acres	LF	Acres
Ruth Trace Branch (RTB)	5,495	0.583	2,433	0.168	1,064	0.159	--	--
Right Fork of Conley Branch (RFCB)	2,912	0.364	649	0.041	1,450	0.185	--	--
Left Fork of Conley Branch (LFCB)	1,762	0.188	390	0.027	585	0.072	--	--
Right Fork of Hell Creek (RFHC)	6,800	0.0.770	2,385	0.195	2,575	0.353	--	--
Left Fork of Hell Creek (LFHC)	9,889	1.529	899	0.069	2,210	0.486	--	--
Pigeonroost Creek (PRC)	4,275	0.615	245	0.018	1,134	0.255	55	0.001
Unnamed Tributary of Pigeon Creek (UTPC)	883	0.101	447	0.024	607	0.059	40	0.001
Unnamed Tributary of Stonecoal Branch (UTSCB)	100	0.009	--	--	--	--	--	--
Miller Creek (MC)	2,027	0.258	60	0.003	495	0.084	--	--
Total Impacts	**34,143**	**4.417**	**7,508**	**0.544**	**10,120**	**1.654**	**95**	**0.002**
Cumulative Total	**41,651 lf (4.961 ac)**				**10,215 LF (1.657 ac)**			
Grand Total	**51,866 LF (6.618 ac)**							

ES.3 Summary of Mitigation

CONSOL has chosen the permittee-responsible mitigation option as their most practicable means of providing compensatory mitigation. CONSOL has strategically selected compensatory mitigation sites within the impacted watersheds, and will implement a watershed-based approach, in accordance with the priorities established in the Final Rule (USEPA & USACE, 2008). Reaches selected for mitigation are shown in Figure 1.4. As summarized in Table ES.2, CONSOL proposes to use a combination of on- and off-site mitigation techniques, including restoration, establishment, enhancement, and preservation, as well as water quality improvements. These measures will offset unavoidable impacts, as determined through several techniques detailed in the following section.

Table ES.2
Summary of Mitigation Types

Mitigation Type	Kind	Description
On-Site Mitigation		
Restoration	In-Kind	Re-establishment restoration (as defined in 33 CFR 332.2) of the temporarily impacted areas.
Establishment	Out-of-Kind	Establishment of a new drainage network comprised of low gradient stream channels within post-mine drainage control areas.
Off-Site Mitigation		
Establishment	In-Kind	Establishment of high gradient stream channels that extend from the on-site establishment areas to existing jurisdictional waters of the U.S. to establish hydrologic connectivity.
Restoration	In-Kind	Rehabilitiation restoration (as defined in 33 CFR 332.2) of stream channel along residential areas of the Hell Creek subwatershed.
Enhancement	In-Kind	Enhancement of in-stream habitat and riparian vegetation upstream of the residential areas in the Hell Creek subwatershed.
Preservation	In-Kind	Preservation of natural, undisturbed high gradient streams in the Hell Creek subwatershed.
Water Quality Improvement	Out-of-Kind	Provision of public sewage treatment to the residents of the Hell Creek subwatershed by installing sewer lines and a pump station to connect to the Delbarton Wastewater Treatment Plant.

ES.3.1 Offset of Impact

On June 9, 2008, the *Compensatory Mitigation for Losses of Aquatic Resources; Final Rule* ("Final Rule") became effective (USEPA & USACE, 2008). As codified in 33 CFR 332.1 through 332.8 and 40 CFR 230.91 through 230.98, the Final Rule established revised requirements for mitigation to better ensure the offset of unavoidable adverse impacts associated with USACE permitted actions. To achieve offset, "the amount of required compensatory mitigation must be, to the extent practicable, sufficient to replace lost aquatic resource functions. In cases where appropriate functional or condition assessment methods or other suitable metrics are available, these methods should be used where practicable to determine how much compensatory mitigation is required. If a functional or condition assessment or other suitable metric is not used, a minimum one-to-one acreage or linear foot compensation ratio must be used" (33 CFR 332.3(f)(1)).

As detailed below, this Mitigation Plan uses two assessment metrics (the West Virginia Interim Functional Assessment Approach and the Virginia Unified Stream Methodology) to calculate debits and credits as well as a linear foot compensation ratio to ensure offset of impacts. This Mitigation Plan also uses additional assessment of functions to demonstrate offset.

ES.3.1.1 West Virginia Interim Functional Assessment Approach (IFAA)

The West Virginia IFAA protocol first involves calculating Functional Credit Units (FCUs) based on stream length and assessment of the following functional categories: hydrology, biogeochemistry, plant community, and habitat (USACE, 2007). Then FCUs for proposed impact reaches (debits) are compared to predict FCUs for proposed mitigation reaches (credits). This protocol was specifically designed for high gradient streams, i.e., ephemeral or intermittent streams with a channel gradient greater than four percent; therefore, another method was used to calculate debits and credits (see the following section regarding the USM). However, results of implementing the IFAA protocol are presented in this Mitigation Plan, as required by the USACE Huntington District.

Table ES.3 presents the total FCUs for each of the proposed permanent and temporary impacts to high gradient intermittent and ephemeral reaches. The West Virginia IFAA protocol was also applied to each of the high gradient intermittent and ephemeral reaches proposed for mitigation, and the results are also shown in Table ES.3. As per direction from the USACE in the Huntington District, the IFAA was additionally applied to the on-site establishment channels which will have less than a four percent grade. Calculation of debits and credits excludes perennial reaches.

Results from the IFAA analysis indicate that 120,605 FCUs will be lost because of the project. However, based on the IFAA analysis of the mitigation streams, a gain of 138,529 FCUs is predicted. Therefore, the proposed mitigation will provide a net gain of 17,923 FCUs. With respect to high gradient intermittent and ephemeral reaches, it is anticipated that the mitigation plan will exceed the required offset of functional losses.

Table ES.3
Summary of FCUs at the Proposed High Gradient Intermittent and Ephemeral Impact Areas

Impact & Mitigation Areas	Pre-existing FCUs					
	Total Linear Feet	Hydrology Functions	Biogeochemical Functions	Plant Community Functions	Habitat Functions	Total FCUs
Proposed Impact Area						
Mine Through/ Permanent Impacts	29,724	28,152	28,118	27,050	27,108	110,428
Temporary Impact	2,783	2,459	2,459	2,365	2,430	10,177
Total (ft)	**32,507**	**Total FCUs**				**120,605**
Proposed Mitigation Area						
On-Site Restoration	2,783	2,453	2,459	2,232	2,285	9,429
On-Site & Off-Site Establishment	45,423	33,521	26,756	31,020	28,762	120,060
Off-Site Preservation	2,596	2,281	2,279	2,087	2,393	9,040
Total (ft)	**50,802**	**Total FCUs**				**138,529**
Net Gain Linear Feet	**18,295**	**Net Gain FCUs**				**17,923**

* It should be noted that only high gradient mitigation reaches are assessed with the IFAA. As per direction from the USACE in the Huntington District, however, the IFAA was additionally applied to the on-site establishment channels which will have less than a four percent grade.
** It should be noted, that this net gain of linear feet just considers the reaches applied to the IFAA protocol. For calculation of the total linear footage debit/credit, see Section ES.3.1.4.

ES.3.1.2 Virginia Unified Stream Methodology (USM)

Because the IFAA does not generally provide a functional assessment of perennial or low gradient streams, CONSOL has also applied the USM (USACE, 2007a) to assign credits and debits for mitigation. The USM includes a methodology for assessment of the function of headwater streams and provides an integrated framework for determination of impacts and mitigation credit assessment on both high and low gradient streams of all flow regimes (i.e., perennial, intermittent, and ephemeral).

Table ES.4 provides a summary of the USM compensation requirements and credits. Results from the USM analysis show that the total compensation requirement (CR) for impacts to streams equals 57,427 CR, and that the total compensation credits (CC) produced from mitigation activities is predicted to be 37,908, leaving a debit of 19,519 CC. This debit will be compensated for by implementing a water quality improvement plan within the off-site mitigation watershed (Hell Creek). These improvements will account for 34 percent of the mitigation compensation for the Buffalo Mountain Surface Mine project.

Table ES.4
Buffalo Mountain Surface Mine Virginia Unified Stream Methodology (USM)

Stream Name	Length of Impact (L_I) (feet)	Compensation Requirement (CR)	% Total
Buffalo Mt. Impact Streams	51,866	57,427	--
Total L_I	**51,866**	**57,427**	--
Stream Name	**Comp. Length (L_c) (feet)**	**Compensation Credit (CC)**	**% Total**
On-Site Establishment	29,079	10,759	18.7%
Off-Site Establishment	16,345	6,048	10.5%
On-Site Restoration	10,215	11,645	20.3%
Off-Site LFHC & RFHC (Rest, Enh, Pres)	14,323	9,456	16.5%
Total	**69,962**	**37,908**	**66.0%**
Water Quality Improvement	--	--	34.0%
Net Remaining	**18,096**	**-19,519**	**100%**

ES.3.1.3 Additional Functional Measurements

In addition to using the debit/credit metrics of the IFAA and USM protocols, CONSOL considered the existing functions provided by the impacted stream reaches and the anticipated functions that will be provided in the mitigation reaches after implementation of the Mitigation Plan. This additional assessment provides another means of ensuring offset because: 1) it was conducted on a different list of functions than that used for the IFAA protocol, and 2) it was based on functions rather than conditions, as with the USM. The additional measurements provide a more qualitative, wholistic assessment of what is being lost and gained than the calculations performed for the debit/credit protocols.

In September 2006, Fischenich (2006) developed a functional framework defining 15 primary functions for the sustenance of stream and riparian ecosystems, while also providing a hierarchy of importance. For the purposes of this Mitigation Plan, CONSOL has used a simplified functional categorization, dividing Fishenich’s 15 functions into five main categories: hydrology, hydraulics, geomorphology, biology, and water quality. Each of the five categories can be measured by standard scientific assessments and engineering models. CONSOL assessed each of the stream function categories at both the impact and proposed mitigation areas for the Buffalo Mountain Surface Mine.

Table ES.5 lists the categories of functions along with the measurements, models, and methodologies used in their assessment. The following sections provide a summary of the assessment results. The table notes how mitigation will provide functional lift, when applicable.

Table ES.5
Summary of Identified Functions Assessed for the Buffalo Mountain Surface Mine

Category	Sub-Category	Function	Measurement	Model and/or Reference
1.Hydrology	1. Rainfall / Runoff Relationship	Contributes to channel development and size. Produces a range of discharges from baseflow to flood flows. Includes the channel forming discharge. For perennial and some intermittent streams the bankfull discharge creates the long-term stable channel morphology.	Measures the amount of water received by a channel. Discharge estimates are typically made for the 2, 5, 10, 25, 50, and 100 year storm events	IFAA; TR-55; HEC-HMS; Regional Curves
2. Hydraulics	2. Stage-Discharge Relationships	Transport of water at varying stages from baseflow to flood flows. Affects the size and shape of the channel.	Velocity, shear stress, stream power	Mannings equation, HEC-RAS
3. Geomorphology	3a. Sediment Transport	The ability of a stream to move the sediment size and load so that over time the bed does not aggrade or degrade.	Sediment transport competency and capacity	HEC-RAS; Andrews 1984; Rosgen 2006
	3b. Bedform Diversity	Creation of riffles or steps, pools, runs, and glides. Affected by all functions above.	Percent riffle and pool, profile depth variability, grain size distributions	IFAA; RBP; USM; (Rosgen 2006)
	3c. Channel Stability	The ability of a stream to remain stable without incising or aggrading.	Dimension, pattern, and profile; Channel evolution	BHR, ER, W/D, RC/W, MWR, P-P spacing, BEHI; Rosgen 2006
4. Biology	4a. Aquatic Habitats	Supports aquatic life for macroinvertebrates.	Habitat assessment studies, Large woody debris surveys, Macroinvertebrate	IFAA; RBP; WVSCI; USM; Davis et al. 2001
	4b. Terrestrial Habitats	A riparian corridor provides bank stability, wood recruitment for the stream, and habitat for terrestrial animals. It also provides a wildlife corridor.	Habitat assessment studies, Large woody debris surveys, Vegetation surveys	IFAA; RBP; USM; CVS-EEP; Davis et al. 2001; Mills & Stevenson, 1999
5. Water Quality	5a. Basic Chemistry	Basic chemistry, such as pH, dissolved oxygen, and conductivity, along with other metals provide a snap shot of water quality and the ability to support aquatic life.	Physical and chemical water quality analysis	RBP
	5b. Nutrient cycling	The downstream processing of organics and nutrients, including decomposition and retention.	% shredders, Degree of organic pollution, large woody debris surveys	WVSCI; RBP; HBI; Davis et al. 2001

Proposed Impact & On-Site Restoration Areas

The following is a summary of important findings for each of the functions in the impact and on-site mitigation areas.

Hydrologic and Hydraulic Functions

The proposed impact tributaries in the Buffalo Mountain Surface Mine project area are characterized by first and second order high gradient streams. Because of the gradient and prior disturbance of the impacted streams, specifically the ephemeral channels, existing data indicate that channel forming discharge theory may not be as applicable in these higher gradient channels. Field evidence also suggests that these channels were likely created by human disturbance and are highly unstable. Approximately 29 percent of the proposed permanent stream impacts have flow year round due to deep mine water sources. The additional flow has caused incision down to bedrock in many locations. Hydraulic analysis confirms the magnitude of a given return interval is larger for these smaller drainages.

Geomorphic Functions

The majority of the proposed impact channels are in v-shaped valleys with steep gradients. The lower gradient channels are located in alluvial fan and debris cone valleys. Rosgen stream types are generally A, Aa+, B, Ba, and F, with mostly cobble and gravel beds and bedrock grade control.

Channels with colluvium (i.e., large boulders) from mass waste of the hillslopes and those with bedrock channel bottoms were vertically stable. Other channels, however, were not as vertically stable having bank height ratios (BHRs) greater than 1.2 and reaching 6.3 (Appendix E). Most channel reaches were laterally stable with the exception of a few Rosgen A channels, which had erosion rates slightly higher (0.038 – 0.048 tons/ft/yr) than reference data in similar sized watersheds, which show natural erosion rates of 0.030 tons/ft/yr (Baker, project data). Bank erosion is often associated with high stream banks. This may be a result of past channel incision / enlargement resulting from timbering and former residential areas.

Bedform diversity, defined by the presence of a step-pool bed in high gradient channels is minimal within the project area tributaries. The high gradient channels are almost all step/riffle or cascades with minimal pool presence until the gradient becomes shallower. Reference data collected in similar settings show that pool frequency increases with decreasing channel gradient. The data found that on average pools become less frequent in steeper A channel types compared to lower gradient B channel types.

Biotic Functions

Habitat assessments showed a general lack of epifaunal substrate and cover; some excess sediment deposition from past logging and access road disturbances in the subwatersheds; and a general lack of bedform diversity or velocity depth regimes.

Riparian vegetation consists of cove deciduous hardwood trees in the lower reaches and upland hardwoods in the upper reaches with heavy canopy cover. Overall, percent vegetation cover was consistent throughout the watersheds, as the cover was relatively heavy (greater than 90 percent).

As evident by the number of piece counts, piece score per foot, the number of debris dams, and the debris dams score per foot, large woody debris (LWD) is not abundant in these channels. The lack of LWD increases instability of the channel, decreases retention of organic matter and nutrients, and decreases the amount of habitat for aquatic and terrestrial fauna.

Benthic macroinvertebrates analysis found an overall “fair” to “very good” West Virginia Stream Condition Index (WVSCI) rating. The percent of shredders (10 percent) was low throughout the proposed impact area when compared to the 25 percent shredders reported in other upper piedmont channels (Marques, 1998). Therefore, it seems likely that decomposition rates and, hence, nutrient cycling may not be as effective in proposed impact streams as in undisturbed natural headwater streams. Overall, the modified Hilsenhoff Biotic Index (mHBI) scores indicated good water quality.

Overall fisheries resources were low in numbers, biomass, and diversity. Predominately pollution tolerant species were collected.

Water Quality Functions

During the single sampling date collections, water chemistry constituents were within recommended ranges for freshwater organisms, with the exception of some elevated iron and acidic pH levels in the proposed impact areas,. Elevated iron and pH levels did not negatively impact benthic macroinvertebrate communities in the proposed impact areas. Existing conductivity levels collected in the Spring of 2006, showed levels ranged from 44 µS/cm to 171 µS/cm throughout the proposed project area and downstream reaches, while levels of conductivity in the receiving stream, Pigeon Creek, ranged from 269 µS/cm to 536 µS/cm. Existing conductivity levels collected in the Fall of 2006, showed levels ranged from 47 µS/cm to 211 µS/cm throughout the proposed project area and downstream reaches, while levels of conductivity in the receiving stream, Pigeon Creek, ranged from 809 µS/cm to 1,000 µS/cm.

Baseline water quality (BWQ) data collected over several months, however, showed, on average, elevated levels of dissolved aluminum throughout the proposed project area. There was one site in Conley Branch that had an average alkalinity level low, however pH levels were within recommened ranges. Othere water chemistry constituents were within recommened limits for freshwater organisms.

Proposed Off-Site Mitigation Areas

The following is a summary of important findings for each of the functions in the areas proposed for off-site mitigation.

Hydrologic and Hydraulic Functions

Overall hydrology has been altered by past land use practices, including mining, timbering, and gas exploration, and associated access roads throughout the Hell Creek subwatershed. By restoring the channels and their adjacent floodplain and riparian zones, overall rainfall/runoff relationships will improve, creating a functional lift in the streams. Hydrologic analysis indicates Hell Creek has a wide range of return intervals (<1.1 to 10), which can lead to channel instability.

In their current condition, the proposed off-site mitigation areas offer opportunity for functional lift with regard to hydrologic and hydraulic functions. The proposed mitigation will reduce channel incision and aggradation so that the channels carry only the bankfull discharge. All other flows will be spread onto an adjacent floodprone area (bankfull bench). This will provide functional lift by re-connecting the stream to the floodprone area.

The proposed off-site restoration and enhancement reaches in the Hell Creek subwatershed are characterized as 2nd and 3rd order low gradient perennial stream segments, while the preservation reaches are 1st and 2nd order, high gradient intermittent and ephemeral streams. This drainage network creates the necessary pathways for hydrologic connectivity and functional input into the Hell Creek stream system.

Geomorphic Functions

Throughout each of the Hell Creek mitigation reaches, channel gradients range from approximately 1.8 to 3.5 percent slope. The subwatershed is located in a v-shaped valley.

Rosgen stream types are generally Bc channels dominated by gravel beds. The streams have very poor bedform diversity with large pool-to-pool ratios reaching 34.4 in Reach D compared to designed ratios of 1.5 to 5.0. Widths of floodprone areas are small, with entrenchment ratios (ER) between 1.1 to 1.6 compared to the design ER of 1.3 to 2.6. Bank height ratios have exceeded the stable range of 1.0 to 1.2 in many locations, showing signs of incision. The current mitigation stream channels have easily erodible bank material and very sparse vegetation, including the invasive species, Japanese knotweed (*Polygonum cuspidatum*), which is causing lateral instability throughout the mitigation reaches.

In their current condition, the proposed off-site mitigation areas offer opportunity for functional lift with regard to geomorphic functions. Sloping back banks, while creating bankfull benches and expanding the floodprone width will maximize riparian vegetation zones to provide efficient functionality. In-stream structures will be installed for grade control and bedform diversity. The invasive species will be eradicated, while the eroded banks will be stabilized to decrease further erosion and thus decrease the production of excess sediment into the stream system. This restoration will improve substrate characterizations, increase dominant particle sizes (D50), and provide in-stream habitat for aquatic organisms. It has been demonstrated that restoration as proposed has been successful in these stream types (Rosgen, 2001; Sylte et al. 2000).

Biotic Functions

Habitat assessments in the restoration and enhancement reaches revealed that in-stream habitat was marginal. Low velocity depth regimes indicated both a lack of bedform diversity in regards to pool and riffle habitats and an excess of sediment deposition. Overall bank stability and vegetative buffers were marginal to sub-optimal. Riparian vegetation consisted of grasses and the invasive Japanese knotweed in the restoration reach and upland hardwoods in the enhancement reaches, with sporatic canopy cover. As evident by the number of piece counts, piece score per foot, the number of debris dams, and the debris dams score per foot, LWD is not very abundant in these channels. The lack of LWD increases instability of the channel, decreases retention of organic matter and nutrients, and results in less available habitat for aquatic and terrestrial fauna. The benthic macroinvertebrate WVSCI scores at the restoration reaches were in the “gray area” (a score between “fair” and “good”; 61 – 68), while the enhancement reaches had “very good” WVSCI scores (Table 3.26). The percent shredders were low in the assessed reaches: between one and eight percent compared to the 25 percent shredders typically found in other upper piedmont channels (Marques, 1998).

Overall fisheries resources were low in numbers, biomass, and diversity. Predominately pollution tolerant species were collected throughout the mitigation reaches.

In their current condition, the proposed off-site mitigation areas offer opportunity for functional lift with regard to biotic functions. Proposed enhancement and restoration will improve organic retention, in-stream habitat and pool frequency with the addition of wood and rock structures and increased bedform diversity (also a geomorphic functional lift). Open canopy areas will be revegetated, while invasive species will be eradicated and native species will be planted. With the increased habitat diversity anticipated as a result of mitigation measures, benthic macroinvertebrate and fisheries communities are expected to improve, assuming overall water quality remains within recommended ranges.

Water Quality Functions

With the exception of high fecal coliform levels throughout the off-site restoration reaches in Hell Creek, all other water chemistry constituents are within recommended ranges for freshwater organisms. Fecal coliform has shown to have negative effects on benthic macroinvertebrate communities (Moss, et. al; 1993), along with some strains having several harmful effects on humans (Loyalhanna, 2005, EPA, 2009). Fecal coliform is also used as an indication of other harmful pathogens and their presense in streams suggest possible health risks if the water is ingested (EPA, 1997).

In their current condition, the proposed off-site mitigation areas offer opportunity for functional lift with regard to water quality functions. The WVSCI score is expected to improve from the "gray area" ranking as a result of water quality improvement and improved habitat. Fisheries diversity and biomass is also expected to improve as a result of physical and chemical improvements.

ES.3.1.4 Linear Footage & Acreage Offset

In addition to offsetting impacted functions with similar types of functions to the affected resources as preferred in the Final Rule (2008), CONSOL has also demonstrated offset of impacts in terms of linear footage and acreage. Table ES.6 provides the inventory of project linear footage/acreage.

Table ES. 6
Buffalo Mountain Surface Mine Linear Footage/Acreage Inventory

Proposed Impacts	Linear Feet	Acres
Permanent Impacts	41,651	4.961
Temporary Impacts	10,215	1.657
DEBIT	**51,866**	**6.618**
Temporal Impacts[1]	15,560	--
TOTAL DEBIT	**67,426**	**6.618**
Proposed Mitigation		
No Net Loss of Linear Feet Mitigation		
On-Site Establishment	29,079	3.826
Off-Site Establishment	16,345	1.973
On-Site Restoration	10,215	1.657
TOTAL	**55,639**	**7.456**
Supplemental & Temporal Loss Mitigation		
Off-Site Enhancement	4,098	1.308
Off-Site Restoration[2]	4,944	2.122
Off-Site Preservation	5,281	1.141
Water Quality Improvement	--	--
TOTAL	**14,323**	**4.570**
TOTAL CREDIT	**69,962**	**12.026**
Excess	**2,536**	**5.408**

[1] An additional 30 percent of the total impact is added to compensate for temporal losses during the operation. Ten percent for every five years is provided for the total 15-year mine life.
[2] Water Quality Improvement segment.

ES.4 Mitigation Design

ES.4.1 On-Site Restoration

CONSOL is proposing to restore 10,215 LF (1.657 ac) of temporarily impacted stream channel on the reclaimed mine lands within the Buffalo Mountain Surface Mine permit area. The temporary impact areas include twenty-one drainage control structures and six road crossings. Because mitigation of these channels is not expected to occur for approximately 15 years, CONSOL proposes to provide an additional 10,356 LF of mitigation off-site to offset temporal loss. As detailed in the Mitigation Plan, design rationale has been planned for the on-site restoration reaches; however, detailed design criteria and plan views will not be developed until the sites near the construction phase.

Natural stream channel design techniques (USDA-NRCS, 2007b; Chapter 11 Rosgen Geomorphic Channel Design) will be implemented to ensure the reconstructed channels obtain the appropriate stream types for their valley settings. All restoration practices will take place during periods of low flow. Both reference channels and those streams in their natural states before disturbances will be used to define existing function for restoration design. These data along with additional reference and regional curve data will allow for the reconstruction of streams to their approximate original state or better.

The primary objectives of the on-site restoration mitigation are to restore the streams' dimension, pattern, and profile to physical conditions that are expected to:

1) Transport the adequate size and amount of sediment,
2) Increase bedform diversity,
3) Create stable bed forms (i.e., decreasing incision and sediment pollutant loading),
4) Increase and improve aquatic habitat,
5) Provide floodplain benefits (i.e., storage and groundwater recharge), and
6) Provide hydrologic connectivity to jurisdictional waters of the U.S.

ES.4.2 On- and Off-Site Establishment

CONSOL is proposing to establish 29,079 (3.826 ac) of stream on-site and 16,345 LF (1.973 ac) of stream off-site. The identification of the on-site establishment sites was based on the following selection criteria:

- located on the down-dip side of the reclaimed permit area to increase the likelihood of intermittent flow;
- will not require connectivity into jurisdictional waters by means of a groin ditch;
- sufficiently sized to allow appropriate dimensions (i.e., entrenchment ratio, width/depth ratio) for each specific drainage area to be designed as a Rosgen Bc channel; and
- within an area with a high probability for securing protective riparian buffer easements.

Areas identified to establish off-site channels were selected based on the following selection criteria:

- located in a natural valley setting;
- access in one or more locations to provide grade control to reduce incison and sediment deposition downstream;
- establishment stream will hydrologically connected to jurisdictional waters of the U.S.; and
- an area within which the probability of securing landowner acceptance of protective riparian buffer easements was high.

The on-site establishment channels will flow hydrologically either into the off-site establishment channels, which will connect to existing jurisdictional waters of the U.S., or directly into jurisdictional waters of the U.S. Off-site establishment will take place within the Pigeon Creek, Miller Creek, and Buffalo Creek watersheds adjacent to the permit area.

Because the construction of the on-site establishment channels will occur during different stages of the mining operation, CONSOL will provide excess mitigation credits off-site by implementing restoration, enhancement, preservation, and water quality improvements within the Hell Creek subwatershed (summarized in other sections). This mitigation in the Hell Creek subwatershed is expected to occur within one year after the first impacts to jurisdictional waters of the U.S. have occurred.

The size of the bankfull channels will be determined by using regional curves and applying natural stream channel design techniques (USDA-NRCS, 2007b). Establishment of streams on-site will involve creating a new drainage network comprised of low gradient stream channels within post-mine drainage control areas. The size of the established on-site channels will be of a different Rosgen stream classification than the existing channels because the post-mine slopes will be lower; the size of the established off-site channels will be of the same Rosgen stream classifications as streams that will have been mined-through. Each establishment channel, both on-site and off-site, will include a riparian zone on both sides of the stream. The stream and its associated riparian buffer will be protected in prepetutiy through the use of a deed restriction.

The primary objectives of the establishment mitigation are to construct streams that:

1) Have stable dimension, pattern, and profiles with access to a floodprone area
2) Are hydrologically connected to jurisdictional waters of the U.S.
3) Will provide structure and function to offset loss of these parameters, and will
4) Result in "no net loss" of stream length.

ES.4.3 Off-Site Restoration and Enhancement

CONSOL is proposing to restore 4,944 LF (2.122 ac) of stream channel off-site, and to enhance 4,098 LF (1.308 ac) of stream channel off-site, all within the Hell Creek subwatershed which is adjacent to the permit area.

Restoration will occur following installation of the proposed sewer line, which will be buried approximately one to two feet below the streambed (see the Section ES.4.5 below). Enhancement will occur immediately upstream from the restoration reaches, and extend upstream to the on-site restoration of the drainage control structures.

Restoration will return the channels to a Rosgen Bc classification and will include installation of structures to provide grade control and aquatic habitat while protecting the stream banks. Riparian buffers will be planted on expanded floodplain areas; their width will be maximized to the extent possible between the stream bank and the parallel county road. Enhancement will provide greater in-stream habitat and wider riparian buffer zones for aquatic and terrestrial communities in these reaches.

The off-site restoration reaches will have a sewer line easement for protecting the sewer line and riparian buffer within that easement. Conversations with the WV Division of Highways and adjacent landowners have also been initiated to protect the proposed restoration reaches for any disturbances. The enhancement reaches, located immediately upstream, will be preserved in perpetuity with deed restrictions encompassing a 50-foot riparian buffer on both stream sides.

The primary objectives of the off-site restoration and enhancement mitigation are to:

1) Reduce sediment load through stabilized streambanks and improved riparian areas,
2) Improve aquatic habitat through added substrate, in-stream cover, and woody debris,
3) Increase extent of natural areas between the county road and stream,
4) Improve water quality reducing fecal coliform levels throughout Hell Creek, and
5) Improve aesthetics.

ES.4.4 Off-Site Preservation

In addition to the restoration, enhancement, and water quality efforts in the Hell Creek subwatershed, stable channels in their natural and undisturbed state will be preserved in perpetuity with a deed restriction within 120-days of permit receipt, further supporting the headwater drainage network and watershed restoration approach in the selected subwatershed. The preservation of undisturbed channels is crucial in the watershed approach to preserve existing high quality functions that are important to downstream reaches (Sedell et al, 1989; Pond et al. 2008; WVWRI & CVI, 2008). The preservation streams will be of the same stream type and classification as impacted channels, providing off-site, in-kind mitigation. The Mitigation Plan currently includes preservation of 5,281 LF (1.141 ac) of stream channel in the Hell Creek subwatershed. The preservation channels are located upstream of reaches proposed for restoration, enhancement, and water quality improvements with this Mitigation Plan.

The primary objectives of the off-site preservation mitigation are to:

1) Maintain undisturbed headwater drainage areas of the Hell Creek subwatershed,

2) Preserve pathways for flora and fauna in the Hell Creek subwatershed, and

3) Reduce chances for future disturbances that could affect the downstream channels proposed for restoration, enhancement, and water quality improvements.

In addition to the preservation of stream channel, which contributes to the offset of linear footage and acreage loss due to the proposed surface mine, the Mitigation Plan includes preservation of riparian buffers on either side of most mitigation stream channels. The preserved riparian buffer easements throughout the mitigation areas amount to approximately 117 acres of riparian preservation.

ES.4.5 Off-Site Water Quality Improvement

Because of the amount of wastewater contaminents (e.g., laundry products, household cleaners, human waste, etc.) in the lower portions of the Hell Creek subwatershed, many improvements proposed with this Mitigation Plan would be limited in their ability to improve biotic communities unless the Mitigation Plan also included water quality improvements.

The downstream portion of Hell Creek, located between its confluence with Pigeon Creek and a point upstream just past the residential area of Left Fork of Hell Creek, along with the downstream 1,063 feet of Right Fork of Hell Creek will be the areas targeted for water quality improvement. These channels will be temporarily impacted in order to install a sewer line for water quality treatment, and then restored at a 1:1 linear foot replacement ratio. Restoration is summarized above (Section ES.4.3). Because the mouth of Hell Creek is approximately three miles from the Town of Delbarton Wastewater Treatment Plant, it was determined that a gravity sewer line and associated pump station could be installed to pump the sewage approximately 13,000 LF from Hell Creek to the existing plant located on County Road 65.

The primary objectives of the off-site water quality improvement mitigation are to improve water quality in the Hell Creek subwatershed by installing sewer lines and a pump station to transport untreated and poorly treated sewage to the Delbarton Wastewater Treament Plant. In addition, through installation of the force main extension and providing the funding necessary to augment capacity at the Delbarton Wastewater Treatment Plant, this Mitigation Plan will provide the potential for future water quality improvements in the Pigeon Creek watershed. Additional homes and businesses along the three miles of the force main extension can be connected to the system in the future, thereby reducing fecal coliform and other pollution inputs to Pigeon Creek.

Together, the proposed restoration and water quality improvement project will maximize functional lift in this system with no additional cost to the Hell Creek community. The proposed project has the formal and/or informal support of the residents along Hell Creek, The Pigeon Creek Watershed Group, WVDEP, and The Town of Delbarton among others.

ES.5 Performance Standards and Monitoring

Monitoring will be conducted in order to 1) document project successes, and 2) identify failures for which a contingency plan (Section ES.6) must be implemented. Channel stability, stream functions, benthic macroinvertebrates, water quality, and vegetation survival will be monitored along each mitigation reach, with the exception of biotic monitoring in the ephemeral reaches, for a minimum of ten years following the completion of construction. Photographs taken before construction and annually throughout the monitoring period will be used to document success. Table ES.9 provides a list of each component that will be measured during monitoring along with the standard to determine success and the action to be taken if the standard is not met. Biotic standards are contingent upon water quality parameters' remaining within recommended ranges for freshwater organisms.

Table ES.9
Success Criteria and Monitoring Actions

Mitigation Component	Success Standard	Failure →	Action
Photographs Longitudinal photos Lateral photos	No substantial aggradation, degradation, or bank erosion; no evidence of structure failures (i.e., piping, fallen rock) that are determined to threaten overall stability or project success.	Substantial differences between as-built photographs and montiring photographs.	Remedial actions will need to be planned and approved on a case-by-case and site-specific basis (e.g., install additional structure, repair structure, reslope bank).
Geomorphic Cross sections Longitudinal profiles Pebble counts Stream Classification Stream Type	Minimal evidence of instability (down-cutting, deposition, bank erosion, increase in sediments); stream classification (i.e., ephemeral, intermittent, perennial) and stream type (Rosgen stream type) as predicted.	Substantial evidence of instability (BHR greater than 1.2 or less than 0.8, BEHI = 20 or greater); monitoring data outside range of design ratios (i.e. W/D ratio will not increase by more than 1.2 from design criteria, ER will be less than 1.3) (Appendix I & J).	Remedial actions will need to be planned and approved on a case-by-case and site-specific basis (e.g., install additional structure, repair structure, reslope bank).
Hydrology Crest Gages	Document cumulative bankfull events. At least 3 cumulative events recorded by year 10.	No bankfull events recorded. Should have at least one bankfull event by year 2.	Data (i.e. geomorphology, USGS hydrological data) need to be re-evaluated. Remedial actision will need planned if bankfull events should have occurred.
Habitat EPA's RBP HAV	Improve total HAV scores from baseline conditions.	Decrease total HAV scores from baseline conditions.	Remedial actions will need to be planned and approved on a case-by-case and site-specific basis (e.g., install additional structures, repair structures, revegetate).

Mitigation Component	Success Standard	Failure →	Action
<u>Vegetation</u> CVS-EEP Protocol for Recording Vegetation Canopy Cover: Densiometer Species Identification USEPA RBP HAV: Bank Vegetation Protection & Riparian Zone Width Parameters	450 stems per acre at end of year three and throughout monitoring period, 70% woody tree stems with no more than 25% soft mast producers; no invasive species; increase canopy cover from as-built conditions; HAV parameters are at least sub-optimal (with the exception of road paralleling areas).	Less than prescribed amount of trees per acre; Invasive species present; canopy cover not increasing from as-built conditions; HAV parameters below sub-optimal (with the exception of road paralleling areas).	Areas of less trees per acre will be re-planted with live stakes and bare rooted trees to achieve desired densities; invasive species will be manually or chemically removed.
<u>Biotic</u> USEPA RBP (benthics, fish)	A 5% increase in total WVSCI (benthic only) and species richness and biomass scores (fish only) at the end of year 10 from baseline conditions.	Lower metrics and values than baseline conditions.	Area shall be further investigated for other potential problems that may impact biotic assessments (e.g., water chemistry).
<u>Water Quality</u> Fecal Coliform	A decrease from baseline conditions in fecal coliform levels at the water quality improvement reaches.	Increase or no change in fecal coliform levels from baseline conditions at water quality improvement reaches.	Remedial measures shall be taken to evaluate the conditions of the system for need of repair.

Note: See List of Acronyms after the Table of Contents for acronym definitions.

ES.6 Contingency and Adaptive Management

ES.6.1 Contingency

This mitigation plan has been developed and presented such that a high level of success is anticipated. A post-mitigation monitoring plan will be followed as summarized in the previous section. In the unlikely event that successful mitigation of jurisdictional waters can not be achieved, CONSOL proposes the following contingencies:

<u>Revised Mitigation and/or Site Selection:</u> In addition to offsetting impacted functions with similar types of functions to the affected resources as preferred in the Final Rule (2008), CONSOL has also demonstrated offset of impacts in terms of linear footage and acreage.

<u>Submittal of In-Lieu Fees:</u> In the event that the company is unable to restore, establish, or preserve jurisdictional waters during the phases of their operations as proposed in this Mitigation Plan to the satisfaction of the USACE, the company may elect to pay in-lieu fees commensurate with the amount and quality of the existing jurisdictional waters that were lost.

<u>Mitigation Banking:</u> The company may elect in the future to purchase mitigation credits through an approved stream mitigation bank, if one is available in the same 8-digit HUC watershed. CONSOL may also utilize excess mitigation credits obtained from their other nearby projects, once they are deemed successful by the USACE.

<u>Preservation:</u> As a contingency for a failed mitigation plan, the company may elect to set aside, by conservation easement, deed restriction, or other protective measure, aquatic habitats that are

threatened by future land disturbances. The amount and types of aquatic resources to be protected shall be approved by the USACE

Peformance Bonds: CONSOL will post a performance bond payable to the WVDEP's Stream Restoration Fund in the amount of Seven Hundred Twenty-one Thousand Five Hundred Sixty Dollars ($721,560.00) to assure compensation for the impacts of waters of the State. Upon completion of the compensation project, the WVDEP will release the performance bond provided CONSOL will obtain a certification from a registered engineer that all compensation project work has been completed in accordance to the plans and specificiations and the state certification conditions.

ES.6.2 Adaptive Management

With the application of adaptive management, this mitigation plan is intended to survive well beyond the visible planning horizon, remaining viable and vital to any future planning efforts throughout the watershed.

Based on the monitoring results, if it is determined that an adaptive management plan needs to be implemented, the adaptive management steps will include (Salafsky et al. 2002):

- Defining a clear objective;
- Developing a plan to achieve the objective;
- Developing success criteria for the objective;
- Developing a revised monitoring plan to evaluate success;
- Using monitoring data to re-evaluate the plan and refine strategies in-case of a failure in the plan;
- Communicate results to clients and regulatory agencies.

The concept of adaptive management acknowledges the dynamic nature of natural systems and the changing state of knowledge and developing management strategies. Adaptive management involves not only acknowledging new information and making objective judgments regarding whether to change strategies to better achieve management objectives, but also learning from past efforts, using monitoring data, and re-evaluating current methods and practices. Methods and strategies that are currently used should always be refined once new and better information is available (Wilhere, 2002). If new information indicates an alternative strategy is effective, the plan should provide the flexibility and allow the latitude to pursue it. It is very difficult to predict what adjustments might be necessary in the future.

Additions or changes to this mitigation plan will occur only with the approval of the regulatory agencies, aside from specific structure locations or minor modifications during construction, of which will be documented and professionally certified in the final as-built surveys. In order to keep the plan document current and relevant, the following items will be reviewed on a regular basis:

- Changes to resource permitting requirements,
- Monitoring data from on-going programs,
- Other newly reported data coming to CONSOL's attention, and
- Reassessment of specific goals and whether or not they have been met.

ES.7 Site Protection

The Mitigation Plan was prepared in accordance with the December 24, 2002, USACE Regulatory Guidance Letter (RGL 02-2) and the new Wetlands Compensatory Mitigation Rule (USEPA&USACE, 2008). CONSOL has complied with the guidelines of RGL 02-2, providing more than a 1:1 linear foot replacement. In addition, CONSOL has provided both on-site and off-site mitigation to provide functional lift to streams in the Hell Creek watershed.

With the exception of the restoration reaches along Hell Creek that have residences along the stream, the current land owners at the proposed mitigation sites include Cotiga Development Company (Flourtown Road, Wyndmoor, PA 19118) and CONSOL of Kentucky Inc. (1000 CONSOL Energy Drive, Canonsburg, Pennsylvania 15317). Once negotiations with the current landowners are finalized, CONSOL will coordinate accordingly with the USACE and the Mingo County clerk to file any required documents or materials with the county.

Proposed deed restrictive easements with the landowners are still in negotiation, however they are to include the stream itself and associated riparian buffer. The on-site establishment areas are proposed to have 25-foot riparian buffer on both sides of the stream. The off-site establishment areas, on-site restoration areas, off-site enhancement areas, and off-site preservation areas will have a 50-foot riparian buffer on each side of the stream and the off-site restoration and water quality improvement reaches will have a 10-foot sewer line easement, which will include associated riparian zones on each side of the sewer line. The streams and their riparian buffers will be protected in perpetuity through the use of deed restrictions amounting to approximately 117 acres of riparian preservation.

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List of Acronyms

µS	micro-siemens
Abkf	Cross sectional area
ac	acres
Baker	Michael Baker Jr., Inc.
BEHI	Bank Erosion Hazard Index
BHR	Bank Height Ratio
BWQ	Baseline Water Quality
BMP	Best Management Practices
CC	Compensation Credit
CFR	Code of Federal Regulations
cm	centimeter
CONSOL	CONSOL of Kentucky (the Applicant)
CPUE	Catch Per Unit Effort
CR	Compensation Requirement
CVS-EEP	Carolina Vegetation Survey- Ecosystem Enhancement Program (Lee et al., 2006)
CWA	Clean Water Act
DA	Drainage Area
Dbkf	Bankfull mean depth
ER	Entrenchment Ratio
FCU	Functional Credit Unit
FEIS	Final Environmental Impact Statement
FHWA	Federal Highway Administration
HAV	Habitat Assessment Value
HEC-HMS	Hydrologic Engineering Center – Hydrologic Modeling System (USACE, 2008b)
HEC-RAS	Hydrologic Engineering Center – River Analysis System (USACE, 2008b)
IFAA	Interim Functional Assessment Approach
KCH	King Coal Highway
LF	linear feet
L_C	Length of Compensation
L_I	Length of Impact
LWD	Large Woody Debris
mHBI	Modified Hilsenhoff Biotic Index
mi	mi
NRCS	Natural Resource Conservation Service (of the USDA)
Q	Discharge-streamflow
ROD	Record of Decision
RBP	Rapid Bioassessment Protocol
TR-55	NRCS Technical Release-55 “Urban Hydrology for Snall Watersheds” (USDA NRCS, 2004)
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USM	Virginia Unified Stream Methodology
µS or µmhos	micro-siemens (S = mhos); mhos (now obsolete, although used on lab sheets)
Wbkf	Bankfull width
WVSCI	West Virginia Stream Condition Index

1.0 INTRODUCTION AND BACKGROUND

1.1 Report Overview

This report is organized as follows:

- Section 1.0 describes the proposed project, goals and objectives, methods of providing offset of impacts and complying with the "no net loss" policy for stream mitigation, mitigation credit and debit determination, and selection of mitigation sites.
- Section 2.0 provides watershed-level assessment information on both the proposed impact and mitigation streams, including geology and soils, land use, habitat, and climate.
- Section 3.0 provides reach-level methodologies and assessment results on both the proposed impact and mitigation streams in regards to their five primary functions: hydrologic, hydraulic, geomorphic, biotic, and water quality. Appendix A provides more detailed discussion of methodologies.
- Sections 4.0 through 14.0 are specific to the mitigation areas. These sections cover the selection and application of design criteria. These sections also cover site monitoring, evaluation procedures for the post-implementation period, success standards, contingencies, long-term and adaptive management plans, and financial assurances.

1.2 Project Description and Location

CONSOL of Kentucky Incorporated (CONSOL) is in the process of obtaining all necessary state permits and has applied for all necessary federal permits for its proposed Buffalo Mountain Surface Mine (WVDEP Permit No. S-5018-07), located near the Town of Delbarton, West Virginia in central Mingo County, WV (Figure 1.1). The Buffalo Mountain Surface Mine proposes to extract bituminous coal reserves via a combined method of mining, including area, mountaintop, steep slope, contour, and limited auger/highwall mining, within its proposed 2,308-acres permit area (Figure 1.2). The proposed impact and mitigation stream reaches are within the Pigeon Creek, Miller Creek, and Buffalo Creek watersheds of the Tug Fork River of the Big Sandy River basin, at approximately 34°44'07" latitude and 82°13'28" longitude (Figure 1.2). Approximately 85 percent of the impacts are located in the Pigeon Creek watershed.

The Buffalo Mountain Surface Mine permit includes an approximate original contour (AOC) variance to allow for the construction of the King Coal Highway (KCH) during surface mine reclamation activities. The KCH is an approved federal action with portions of the project under construction in Mercer and Mingo Counties, West Virginia. Following the circulation of the KCH Final Environmental Impact Statement (FEIS), the Federal Highway Administration (FHWA) issued the project's Record of Decision (ROD) on August 24, 2000 and will complete a written re-evaluation of the proposed project as required by FHWA regulations (23 CFR 771).

The surface mine project, in conjunction with the KCH project, will require the permanent placement of excess overburden into valleys or hollows that contain jurisdictional waters of the United States (U.S.); therefore, a Clean Water Act (CWA) Section 404 Permit will be required for the project. In order to implement best management practices (BMPs) and thereby reduce sediment loads, a series of two temporary drainage control structures will be installed downstream of the permanent structures, where feasible; in addition to implementing bottom-up construction techniques of the permanent fill structures to minimize exposure of earth and rock to the environment. In addition, several temporary road crossings will be installed throughout the permit area to maintain efficient operations at the surface mine (Figure 1.3). A description of impacts is provided in Section 1.2.1.

CONSOL has requested that Michael Baker Jr., Inc. (Baker) prepare this Compensatory Mitigation and Stream Restoration Plan ("Mitigation Plan") for the proposed activities in jurisdictional waters at the Buffalo Mountain Surface Mine in accordance with all applicable guidance and regulations for implementing the

CWA, including the *Compensatory Mitigation for Losses of Aquatic Resources; Final Rule* (USEPA & USACE, 2008). The purpose of this Mitigation Plan is to ensure offset of unavoidable permanent and temporary adverse impacts to jurisdictional waters of the U.S. Mitigation is proposed to be located within the Pigeon Creek, Miller Creek, and Buffalo Creek watersheds (Figure 1.4), as detailed in Section 1.2.2.

1.2.1 Summary of Impacts

A stream delineation was performed by Baker (2008) to determine jurisdictional waters of the U.S. located within the permit boundary and the surrounding areas to ensure that all waters of the U.S. were identified. USACE approved the jurisdictional determination on September 18, 2008. The proposed Buffalo Mountain Surface Mine's total impact (permanent and temporary) to jurisdictional stream length will be 51,866 LF (6.618 ac), including 41,651 LF (4.961 ac) of permanent impacts and 10,215 LF (1.657 ac) of temporary impacts. It should be noted that these impacts include both those directly attributable to the mining activities as well as those attributable to the proposed future highway construction within the Buffalo Mountain Surface Mine permit area. This joint approach provides for a more comprehensive mitigation solution for impacts to waters of the U.S. than would separate mitigation plans for the mining activities and the KCH.

A total of nine (9) sub-watersheds of the Tug Fork River were identified within the waters of the U.S. that will be impacted due to the Buffalo Mountain Surface Mine. Total impacted linear footage and acreage are summarized in Table 1.1 for each of the identified watersheds. Figure 1.5 through Figure 1.12 show each subwatershed in the impact area with its corresponding proposed impacts and proposed mitigation plans. Appendix F displays representative photos of each subwatershed in the permit area. Also, Section 2.0 (*Watershed Assessment Results*) provides more general information on the watersheds.

Table 1.1
Impact Summary for the Buffalo Mountain Surface Mine

Sub-Watershed	Permanent Impact				Temporary Impact			
	Intermittent/Perennial		Ephemeral		Intermittent/Perennial		Ephemeral	
	LF	Acres	LF	Acres	LF	Acres	LF	Acres
Ruth Trace Branch (RTB)	5,495	0.583	2,433	0.168	1,064	0.159	--	--
Right Fork of Conley Branch (RFCB)	2,912	0.364	649	0.041	1,450	0.185	--	--
Left Fork of Conley Branch (LFCB)	1,762	0.188	390	0.027	585	0.072	--	--
Right Fork of Hell Creek (RFHC)	6,800	0.0.770	2,385	0.195	2,575	0.353	--	--
Left Fork of Hell Creek (LFHC)	9,889	1.529	899	0.069	2,210	0.486	--	--
Pigeonroost Creek (PRC)	4,275	0.615	245	0.018	1,134	0.255	55	0.001
Unnamed Tributary of Pigeon Creek (UTPC)	883	0.101	447	0.024	607	0.059	40	0.001

Sub-Watershed	Permanent Impact				Temporary Impact			
	Intermittent/Perennial		Ephemeral		Intermittent/Perennial		Ephemeral	
	LF	Acres	LF	Acres	LF	Acres	LF	Acres
Unnamed Tributary of Stonecoal Branch (UTSCB)	100	0.009	--	--	--	--	--	--
Miller Creek (MC)	2,027	0.258	60	0.003	495	0.084	--	--
Total Impacts	**34,143**	**4.417**	**7,508**	**0.544**	**10,120**	**1.654**	**95**	**0.002**
Cumulative Total	**41,651 lf (4.961 ac)**				**10,215 LF (1.657 ac)**			
Grand Total	**51,866 LF (6.618 ac)**							

Of the permanent impacts, approximately 29 percent are in perennial streams, 53 percent are in intermittent streams, and 18 percent are in ephemeral streams. The permit area is located in the southwestern West Virginia coalfields region, which is rich in coal reserves, as well as other natural resources including natural gas and timber. Evidence of past natural resource extraction activity, particularly underground coal mining, is present throughout most of the watersheds. For example, previous mining of the Winifrede, Buffalo, and Coalburg coal seams has left voids in the mountains that serve as underground reservoirs. The groundwater that collects in these voids flows out into the streams via abandoned mine portals, shafts and vents, as well as fissures in the rock strata created from underground blasting activities. As a result of this underground disturbance, many of the streams in the upper reaches of the permit area display perennial characteristics. These areas would be expected to typically exhibit intermittent or ephemeral flow because of their steep advancement up the hillside and small drainage area (Baker, 2008a).

Eighteen percent (18%) of the 29% perennial streams in the permanent impact area are correlated with deep mine portal locations, confirming that the increased flow in these small drainages are a result of deep mine water sources (Table 1.2; Figure 3.3; Baker, 2008a). As a result of the increased flow and change in hydrology, geomorphic and habitat assessments were performed for this project (Section 4.0). These studies found that those perennial streams correlated with the deep mine portals are incised and not in their undisturbed natural condition. Undisturbed natural ephemeral streams have been shown to have limited bedform diversity (i.e. step pools; see Section 3.4.2); therefore with increased flow in these systems the likelihood of incision without grade control would be significantly increased.

Functions typical of natural and undisturbed perennial streams (see Appendix A, Section A.3) are not consistent with the perennial streams identified in the Buffalo Mountain Surface Mine permit area. For example, it was found during stream function assessment activities, that the functions of these streams (e.g., diversity and variability of biotic communities, water storage, depositional processes, substrate and structural architecture, sediment character, in-stream habitat) when compared to low-gradient, “typical” perennial streams are either not present or only minimally present. Sections 3.3 through 3.6 provide details on the functions of the impacted and mitigation streams.

Table 1.2
Summary of Deep Mine Portal & Transistion Point & Stream Stations documented during the Jursidictional Determination (Baker, 2008a)

Stream Identifier	Deep Mine Portal Location	Perennial/Intermittent Point	End of Channel Location
PRC	38+00	24+50	43+40
UT1-LFHC	Above EOC	23+70	38+00
UT1-LFHC	26+00	23+70	38+00
UT10-LFHC	28+00	14+50	29+60
RFHC	59+71	47+71	62+56
RFHC	54+71	47+71	62+56
RFHC	51+71	47+71	62+56
RFHC	47+71	47+71	62+56
UT1-RFHC	34+00	33+00	39+00

1.2.2 Summary of Mitigation

Prior to developing this Mitigation Plan for offsetting unavoidable impacts, CONSOL first sought to avoid and minimize impacts. The alternatives analysis presented in the Section 404 permit application and Environmental Information Document (EID; Baker, 2010) detail these efforts. In summary, the process determined the least environmentally damaging, practicable alternative as required by USACE Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material (40 CFR 230 Subparts A through H). It is this alternative that was selected as the Preferred Alternative for the Buffalo Mountain Surface Mine project and that is the subject of this Mitigation Plan.

Prior to identifying the Preferred Alternative, impacts to waters of the U.S. were avoided through the use of engineering techniques that maximized the valley fill volume per foot of fill length. Additionally, in order to reduce impacts through sedimentation and keep the sedimentation ponds as close to the foot of the fills as possible, an alternative was selected that involves constructing all fills through a bottom-up process. Furthermore, the development of the alternative involved organizing a joint development initative which will reduce cumulative impacts in the region.

For unavoidable impacts, CONSOL will implement a watershed-based approach to compensatory mitigation in the Pigeon Creek and the Miller Creek watersheds, using a combination of on- and off-site mitigation techniques. Headwater drainage networks will be established and preserved. Preservation will include the stream itself and associated riparian buffers. The on-site establishment areas will have a 25-foot riparian buffer on both sides of the stream. The off-site establishment areas, on-site restoration areas, off-site enhancement areas, and off-site preservation areas will have a 50-foot riparian buffer on each side of the stream and the off-site restoration and water quality improvement reaches will have a 10-foot sewer line easement, which will include associated riparian zones on each side of the sewer line. The streams and their riparian buffers will be protected in perpetuity through the use of deed restrictions. All temporarily impacted areas will be restored to equal or better than pre-mining conditions.

Additionally, a combination of restoration, enhancement, establishment, and preservation will take place in one particular subwatershed of Pigeon Creek, the Hell Creek subwatershed. The Hell Creek subwatershed, overlapping and adjacent to the permit area, offers a particularly suitable location for a watershed-based Mitigation Plan because it encompasses some undisturbed headwaters that can be preserved, but also has unfavorable conditions, including fecal pollution, that can be addressed through a suite of other mitigation measures downstream.

Along with physical improvements and protection of streams within the Hell Creek subwatershed, its overall water quality will be improved by providing sewage and wastewater tap-ins for all homes (26) in the Hell Creek subwatershed, construction of a collection line and pump station, and construction of an approximately three-mile long force main to treat sewage at the Town of Delbarton's Wastewater Treatment Plant (Section 13.0). In addition, the Mitigation Plan includes upgrading the treatment plant to be able to handle this added sewage as well as future added sewage. The new three-mile force main will be oversized to offer the future opportunity for residents along its route (currently approximately 122 homes) to also tap into the public sewage treatment system.

Table 1.3 provides summary descriptions of each of the proposed mitigation types. Each type of mitigation is detailed in Sections 4.0 through 8.0 of this document. Incompetent

Table 1.3
Summary of Mitigation Types

Mitigation Type	Kind	Description
On-Site Mitigation		
Restoration (detailed in Section 4.0)	In-Kind	Re-establishment restoration (as defined in 33 CFR 332.2) of the temporarily impacted areas.
Establishment (detailed in Section 5.0)	Out-of-Kind	Establishment of a new drainage network comprised of low gradient stream channels within post-mine drainage control areas.
Off-Site Mitigation		
Establishment (detailed in Section 5.0)	In-Kind	Establishment of high gradient stream channels that extend from the on-site establishment areas to existing jurisdictional waters of the U.S. to establish hydrologic connectivity.
Restoration (detailed in Section 6.0)	In-Kind	Rehabilitiation restoration (as defined in 33 CFR 332.2) of stream channel along residential areas of the Hell Creek subwatershed.
Enhancement (detailed in Section 6.0)	In-Kind	Enhancement of in-stream habitat and riparian vegetation upstream of the residential areas in the Hell Creek subwatershed.
Preservation (detailed in Section 7.0)	In-Kind	Preservation of natural, undisturbed high gradient streams in the Hell Creek subwatershed.
Water Quality Improvement (detailed in Section 8.0)	Out-of-Kind	Provision of public sewage treatment to the residents of the Hell Creek subwatershed by installing sewer lines and a pump station to connect to the Delbarton Wastewater Treatment Plant.

Timing of Mitigation Implementation

Mitigation will be implemented in different phases throughout the mining operation. Preservation of streams in the Hell Creek watershed will begin immediately by filing the necessary deed restriction documents with the county (Section 10.0). The off-site establishment mitigation is expected to be implemented simuateously with the mining operational phases being that the NPDES outlets will be discharging into mitigation areas. Therefore, CONSOL will install grade control structures in the off-site establishment channels where NPDES outlets are actively discharging water from the mine site. This process will occur as the mine progresses over the life time of the mine (approximately 15 years). Also, within one year of impacts to jurisdictional waters of the U.S., the off-site mitigation plan will be initiated in the Hell Creek watershed. On-site mitigation, however, will not occur until after Phase II bond release. Temporal losses have been accounted for the delay in mitigation implementation of these efforts (Section 1.4.4).

1.3 Goals and Objectives

The overall goal of this proposed Mitigation Plan is to offset impacts to jurisdictional waters of the U.S. associated with the Buffalo Mountain Surface Mine. This goal will be met through the following objectives:

1) Complying with all applicable guidance and regulations for implementing the CWA, including the Compensatory Mitigation for Losses of Aquatic Resources; Final Rule (USEPA & USACE, 2008);

2) Restoring geomorphically stable conditions in the temporarily impacted channels, such that the correct stream type is in the appropriate valley type;

3) Establishing headwater drainage ways by designing channels on-site to transport the bankfull flow and create appropriate bedforms, while also providing habitat and riparian corridors;

4) Creating hydrologic connectivity by establishing stream channels from on-site establishment channels to off-site existing jurisdictional waters of the U.S., while preserving an existing and mature riparian zone; and

5) Restoring, enhancing, preserving, and improving water quality in the Hell Creek subwatershed of Pigeon Creek, specifically by:

    a. Reducing the sediment load in sections of the subwatershed through stabilized streambanks and improved riparian areas;

    b. Improving aquatic and terrestrial habitat through creation of riffles and pools (bedform diversity), in-stream cover, woody debris, restored terrestrial habitat, increased extent of natural areas, and improved aesthetics;

    c. Improving landscape pathways for flora and fauna through restored and preserved perennial, intermittent, and ephemeral riparian corridors;

    d. Improving overall water quality in the Hell Creek subwatershed through installed sewer lines and pump station that will transport untreated and poorly treated sewage to the Delbarton Treatment Plant; specifically treating approximately 1.25 million gallons of untreated wastewater per year in Hell Creek.

6) Providing potential for future water quality improvements in the Pigeon Creek watershed by enhancing treatment capacity at the Delbarton Wastewater Treatment Plant and designing a three-mile force main extension that can accommodate future additional hookups from untreated and poorly treated waste streams along Pigeon Creek (WVWRI & CVI, 2008), which will potentially treat 5.76 million additional gallons of wastewater per year in Pigeon Creek.

1.3.1 Offset of Impacts

On June 9, 2008, the *Compensatory Mitigation for Losses of Aquatic Resources; Final Rule* ("Final Rule") became effective (USEPA & USACE, 2008). As codified in 33 CFR 332.1 through 332.8 and 40 CFR 230.91 through 230.98, the Final Rule established revised requirements for mitigation to better ensure the offset of unavoidable adverse impacts associated with USACE permitted actions. To achieve offset, "the amount of required compensatory mitigation must be, to the extent practicable, sufficient to replace lost aquatic resource functions. In cases where appropriate functional or condition assessment methods or other suitable metrics are available, these methods should be used where practicable to determine how much compensatory mitigation is required. If a functional or condition assessment or other suitable metric is not used, a minimum one-to-one acreage or linear foot compensation ratio must be used" (33 CFR 332.3(f)(1)). As detailed below, this Mitigation Plan uses assessment metrics to calculate debits and credits as well as a linear foot compensation ratio to ensure offset of impacts. This Mitigation Plan also uses additional assessment of functions to demonstrate offset.

As detailed in the Final Rule, offset of impacts can be achieved using mitigation banks, in-lieu fee programs, or permittee-responsible mitigation. For the Buffalo Mountain Surface Mine, CONSOL considered each of these mitigation methods. The proposed impacts are not in the service area of an approved mitigation bank; therefore, CONSOL is not pursuing the mitigation bank option.

Payment of fees to the West Virginia Department of Environmental Protection (WVDEP) is recognized as an approved in-lieu fee mitigation program (USACE & WVDEP, 2006). The agreement states that after permittees demonstrate project impacts cannot be avoided, further minimized, nor mitigated on-site, the permittee may achieve mitigation by paying into the in-lieu fee program. However, as summarized in the following sections, CONSOL has demonstrated that mitigation on-site, in combination with off-site mitigation, will be able to offset impacts. Moreover, the proposed on- and off-site mitigation can be conducted using a watershed approach as defined in 33 CFR 332.3(c)(1). Therefore, the in-lieu fee program will not be utilized for this project.

CONSOL has chosen the permittee-responsible mitigation option using the watershed-based approach as their most practicable means of providing compensatory mitigation. CONSOL has strategically selected compensatory mitigation sites within the impacted watersheds.

In order to demonstrate structural and functional offset of impacts, CONSOL used two methodologies for calculating debits and credits and two other methodologies for assessing the impacts and proposed mitigation, which include:

1. Applying the West Virginia Interim Functional Assessment Approach (IFAA) protocol (Section 1.3.2);
2. Applying the Virginia Unified Stream Methodology (USM) protocol (Section 1.3.3);
3. Examining five (5) primary functions at both the impact and mitigation sites to demonstrate offset of the affected aquatic resources (Section 0); and
4. Providing a minimum 1:1 linear footage and acreage replacement ratio, as required by the Huntington USACE District (Section 1.3.5).

As described in Appendix A and below, the West Virginia IFAA protocol is only applicable on intermittent and ephemeral streams greater than four percent gradient. Due to the presence of perennial and low gradient streams throughout the proposed impact and mitigation area, CONSOL chose to calculate offset of impacts through Virginia's USM protocol in lieu of a West Virginia protocol for these stream types; as the USM is applicable on all stream types. Calculations for the West Virginia IFAA protocol are also shown as required by the USACE Huntington District.

1.3.2 West Virginia IFAA

The West Virginia IFAA protocol first involves calculating Functional Credit Units (FCUs) based on stream length and assessment of the following functional categories: hydrology, biogeochemistry, plant community, and habitat (USACE, 2007). Then FCUs for proposed impact reaches (debits) are compared to predict FCUs for proposed mitigation reaches (credits). This protocol was specifically designed for high gradient streams, i.e., ephemeral or intermittent streams with a channel gradient greater than four percent. . Calculation of debits and credits excludes perennial reaches.

Table 1.4 presents the total FCUs for each of the proposed permanent and temporary impacts to high gradient intermittent and ephemeral reaches. Assessment forms for each of the evaluated streams are located in Appendix B of this document.

The West Virginia IFAA protocol was also applied to each of the high gradient intermittent and ephemeral reaches proposed for mitigation. As per direction from the USACE in the Huntington District, the IFAA was additionally applied to the on-site establishment channels which will have less than a four percent grade (phone conversation with Ms. Teresa Spagna, USACE). Mitigation reaches where the IFAA protocol was used included: all of those proposed for establishment (on-site and off-site), a portion of those proposed for on-site restoration, and a portion of those proposed for preservation (off-site). FCUs were calculated for each of these mitigation areas as they are predicted to be functioning at the end of the required ten-year monitoring period. Results for the mitigation reaches are detailed on forms included with Appendix B, and are summarized in Table 1.5.

Results from the IFAA analysis indicate that 120,605 FCUs will be lost because of the project. However, based on the IFAA analysis of the mitigation streams, a gain of 138,529 FCUs is predicted. Therefore, the proposed mitigation will provide a net gain of 17,923 FCUs. With respect to high gradient intermittent and ephemeral reaches, it is anticipated that the mitigation plan will exceed the required offset of functional losses.

Table 1.4
Summary of FCUs at the Proposed High Gradient Intermittent and Ephemeral Impact Areas

Subwatershed	Hydrology Functions	Biogeochemical Functions	Plant Community Functions	Habitat Functions	Total
Proposed Permanent Impacts					
Ruth Trace Branch	5,925	5,932	5,882	5,753	23,492
Conley Branch	4,574	4,583	4,582	4,436	18,175
Right Fork of Hell Creek	5,400	5,328	4,803	5,351	20,882
Left Fork of Hell Creek	5,923	5,933	5,484	5,468	22,808
Pigeonroost Creek	3,900	3,906	3,907	3,754	15,467
Unnamed Tributary of Pigeon Creek	1,293	1,296	1,268	1,227	5,084
Unnamed Tributary of Stonecoal Branch	87	86	77	90	340
Unnamed Tributary of Miller Creek	1,050	1,054	1,048	1,029	4,181
Sub-Total	28,152	28,118	27,050	27,108	110,428
Proposed Temporary Impacts					
Ruth Trace Branch	195	195	195	191	776
Conley Branch	830	832	831	802	3,295
Right Fork of Hell Creek	620	609	528	656	2,414
Pigeonroost Creek	183	192	191	178	1,207
Unnamed Tributary of Pigeon Creek	631	632	620	602	2,485
Sub-Total	2,459	2,459	2,365	2,430	10,177
Total	**30,612**	**30,577**	**29,415**	**29,538**	**120,605**

Table 1.5
Summary of FCUs at the Proposed High Gradient Intermittent and Ephemeral Impact Areas & Mitigation Areas

Impact & Mitigation Areas	Pre-existing FCUs					
	Total Linear Feet	Hydrology Functions	Biogeochemical Functions	Plant Community Functions	Habitat Functions	Total FCUs
Proposed Impact Area						
Mine Through/ Permanent Impacts	29,724	28,152	28,118	27,050	27,108	110,428
Temporary Impact	2,783	2,459	2,459	2,365	2,430	10,177
Total (ft)	**32,507**	**Total FCUs**				**120,605**
Proposed Mitigation Area						
On-Site Restoration	2,783	2,453	2,459	2,232	2,285	9,429
On-Site & Off-Site Establishment	45,423	33,521	26,756	31,020	28,762	120,060
Off-Site Preservation	2,596	2,281	2,279	2,087	2,393	9,040
Total (ft)	**50,802**	**Total FCUs**				**138,529**
Net Gain Linear Feet	**18,295**	**Net Gain FCUs**				**17,923**

* It should be noted that only high gradient mitigation reaches are assessed with the IFAA. As per direction from the USACE in the Huntington District, however, the IFAA was additionally applied to the on-site establishment channels which will have less than a four percent grade.
** It should be noted that this net gain of linear feet includes just the reaches applied to the IFAA protocol. For calculation of the total linear footage debit/credit, see Section 1.3.5.

1.3.3 Virginia Unified Stream Methodology (USM)

Because the IFAA does not generally provide a functional assessment of perennial or low gradient streams, CONSOL has also applied the USM (USACE, 2007a) to assign credits and debits for mitigation. The USM includes a methodology for assessment of the function of headwater streams and provides an integrated framework for determination of impacts and mitigation credit assessment on both high and low gradient streams of all flow regimes (i.e., perennial, intermittent, and ephemeral).

Table 1.6 provides a summary of the USM compensation requirements and credits. Results from the USM analysis show that the total compensation requirement (CR) for impacts to streams equals 57,427 CR, and that the total compensation credits (CC) produced from mitigation activities is predicted to be 37,908, leaving a debit of 19,519 CC. This debit will be compensated for by implementing a water quality improvement plan within the off-site mitigation watershed (Hell Creek). These improvements will account for 34 percent of the mitigation compensation for the Buffalo Mountain Surface Mine project.

Table 1.6
Virginia Unified Stream Methodology (USM) Results

Stream Name	Length of Impact (L_I) (feet)	Compensation Requirement (CR)	% Total
Buffalo Mt. Impact Streams	51,866	57,427	--
Total L_I	**51,866**	**57,427**	--
Stream Name	**Comp. Length (L_c) (feet)**	**Compensation Credit (CC)**	**% Total**
On-Site Establishment	29,079	10,759	18.7%
Off-Site Establishment	16,345	6,048	10.5%
On-Site Restoration	10,215	11,645	20.3%
Off-Site LFHC & RFHC (Rest, Enh, Pres)	14,323	9,456	16.5%
Total	**69,962**	**37,908**	**66.0%**
Water Quality Improvement	--	--	34.0%
Net Remaining	**18,096**	**-19,519**	**100%**

1.3.4 Additional Functional Measurements

In addition to using the debit/credit metrics of the IFAA and USM protocols, CONSOL considered the existing functions provided by the impacted stream reaches and the anticipated functions that will be provided in the mitigation reaches after implementation of this Mitigation Plan. This additional assessment provides another means of ensuring offset because: 1) it was conducted on a different list of functions than that used for the IFAA protocol, and 2) it was based on functions rather than conditions, as with the USM. The additional measurements provide a more qualitative, wholistic assessment of what is being lost and gained than the calculations performed for the debit/credit protocols.

In September 2006, Fischenich (2006) developed a functional framework defining 15 primary functions for the sustenance of stream and riparian ecosystems, while also providing a hierarchy of importance. For the purposes of this Mitigation Plan, CONSOL has used a simplified functional categorization, dividing Fishenich’s 15 functions into five main categories: hydrology, hydraulics, geomorphology, biology, and water quality. Each of the five categories can be measured by standard scientific assessments and engineering models. CONSOL assessed each of the stream function categories at both the impact and proposed mitigation areas for the Buffalo Mountain Surface Mine. Table 1.7 lists the categories along with the measurements, models, and methodologies used in their assessment.

The following sections (Section 1.3.4.1 for locations within the project area and Section 1.3.4.2 for off-site locations) provide a summary of the assessment results and how mitigation will replace the lost functions through functional lift. Figure 1.5 through Figure 1.12 shows each assessment reach evaluated throughout the proposed impact and mitigation areas. Appendix A provides more detailed discussion of stream functions and methodologies, and Chapter 3 provides more detailed results of each functional measurement conducted for this Mitigation Plan.

Table 1.7
Summary of Identified Functions Assessed for the Buffalo Mountain Surface Mine

Category	Sub-Category	Function	Measurement	Model and/or Reference
1.Hydrology	1. Rainfall / Runoff Relationship	Contributes to channel development and size. Produces a range of discharges from baseflow to flood flows. Includes the channel forming discharge. For perennial and some intermittent streams the bankfull discharge creates the long-term stable channel morphology.	Measures the amount of water received by a channel. Discharge estimates are typically made for bankfull and the 2, 5, 10, 25, 50, and 100 year storm events	IFAA; TR-55; HEC-HMS; Regional Curves
2. Hydraulics	2. Stage-Discharge Relationships	Transport of water at varying stages from baseflow to flood flows. Affects the size and shape of the channel.	Velocity, shear stress, stream power	Mannings equation, HEC-RAS
3. Geomorphology	3a. Sediment Transport	The ability of a stream to move the sediment size and load so that over time the bed does not aggrade or degrade.	Sediment transport competency and capacity	HEC-RAS; Andrews 1984; Rosgen 2006
	3b. Bedform Diversity	Creation of riffles or steps, pools, runs, and glides. Affected by all functions above.	Percent riffle and pool, profile depth variability, grain size distributions	IFAA; RBP; USM; (Rosgen 2006)
	3c. Channel Stability	The ability of a stream to remain stable without incising or aggrading.	Dimension, pattern, and profile; Channel evolution	BHR, ER, W/D, RC/W, MWR, P-P spacing, BEHI; Rosgen 2006
4. Biology	4a. Aquatic Habitats	Supports aquatic life for macroinvertebrates.	Habitat assessment studies, Large woody debris surveys, Macroinvertebrate	IFAA; RBP; WVSCI; USM; Davis et al. 2001
	4b. Terrestrial Habitats	A riparian corridor provides bank stability, wood recruitment for the stream, and habitat for terrestrial animals. It also provides a wildlife corridor.	Habitat assessment studies, Large woody debris surveys, Vegetation surveys	IFAA; RBP; USM; CVS-EEP; Davis et al. 2001; Mills & Stevenson, 1999
5. Water Quality	5a. Basic Chemistry	Basic chemistry, such as pH, dissolved oxygen, and conductivity, along with other metals provide a snap shot of water quality and the ability to support aquatic life.	Physical and chemical water quality analysis	RBP
	5b. Nutrient cycling	The downstream processing of organics and nutrients, including decomposition and retention.	% shredders, Degree of organic pollution, large woody debris surveys	WVSCI; RBP; HBI; Davis et al. 2001

1.3.4.1 Proposed Impact & On-Site Restoration Areas

The following is a summary of important findings for each of the functions in the impact and on-site restoration reaches. Existing functions were assessed at all impacted areas to better understand the functional off-set required at the mitigation sites. Further, assessments of the temporarily impacted areas will provide a baseline to be used for comparison during the monitoring of those areas which will be restored as part of the Mitigation Plan.

Depending on the functional assessment method, either entire streams were evaluated or representative reaches within entire streams were evaluated (Figure 1.5 – Figure 1.12). For instance, habitat and large woody debris assessments were conducted throughout the entire streams, while hydrologic, hydraulic, geomorphic, riparian vegetation, aquatic organism, and water chemistry assessments were conducted only in representative reaches.

Hydrologic and Hydraulic Functions

The proposed impact tributaries in the Buffalo Mountain Surface Mine project area are characterized by first and second order high gradient streams. Because of the gradient and prior disturbance of the impacted streams, specifically the ephemeral channels, existing data indicate that channel forming discharge theory may not be as applicable in these higher gradient channels. Field evidence also suggests that these channels were likely created by human disturbance and are highly unstable. Approximately 29 percent of the proposed permanent stream impacts have flow year round due to deep mine water sources. The additional flow has caused incision down to bedrock in many locations. Hydraulic analysis confirms the magnitude of a given return interval is larger for these smaller drainages.

Geomorphic Functions

The majority of the proposed impact channels are in v-shaped valleys with steep gradients. The lower gradient channels are located in alluvial fan and debris cone valleys. Rosgen stream types are generally A, Aa+, B, Ba, and F, with mostly cobble and gravel beds and bedrock grade control.

Channels are vertically stable because of the colluvium (i.e., large boulders) that has been mass wasted from the hillslopes and the presence of bedrock in the channel bottoms. Most channel reaches were laterally stable with the exception of a few Rosgen A channels, which had erosion rates slightly higher (0.038 – 0.048 tons/ft/yr) than reference data in similar sized watersheds, which show natural erosion rates of 0.030 tons/ft/yr (Baker, project data). Bank erosion is often associated with high stream banks. This may be a result of past channel incision / enlargement resulting from timbering and former residential areas.

Bedform diversity, defined by the presence of a step-pool bed in high gradient channels is minimal within the project area tributaries. The high gradient channels are almost all step/riffle or cascades with minimal pool presence until the gradient becomes shallower. Reference data collected in similar settings show that pool frequency increases with decreasing channel gradient. The data found that on average pools become less frequent in steeper A channel types compared to lower gradient B channel types.

Biotic Functions

Habitat assessments showed a general lack of epifaunal substrate and cover; some excess sediment deposition from past logging and access road disturbances in the subwatersheds; and a general lack of bedform diversity or velocity depth regimes.

Riparian vegetation consists of cove deciduous hardwood trees in the lower reaches and upland hardwoods in the upper reaches with heavy canopy cover. Overall, percent vegetation cover was consistent throughout the watersheds, as the cover was relatively heavy (greater than 90 percent).

As evident by the number of piece counts, piece score per foot, the number of debris dams, and the debris dams score per foot, large woody debris (LWD) is not abundant in these channels. The lack of LWD increases instability of the channel, decreases retention of organic matter and nutrients, and decreases the amount of habitat for aquatic and terrestrial fauna.

Benthic macroinvertebrates analysis found an overall “Fair” to “Very Good” West Virginia Stream Condition Index (WVSCI; Barbour et al., 2000) rating. The percent of shredders (10 percent) was low throughout the proposed impact area when compared to the 25 percent shredders reported in other upper piedmont channels (Marques, 1998). Therefore, it seems likely that decomposition rates and, hence, nutrient cycling may not be as effective in proposed impact streams as in undisturbed natural headwater streams. Overall, the modified Hilsenhoff Biotic Index (mHBI) scores indicated good water quality.

Water Quality Functions

With the exception of some elevated iron and acidic pH levels in the proposed impact areas, water chemistry constituents were within recommended ranges for freshwater organisms. Elevated iron and pH levels did not negatively impact benthic macroinvertebrate communities in the proposed impact areas. Existing conductivity levels collected in the Spring of 2006, showed levels ranged from 44 µS/cm to 171 µS/cm throughout the proposed project area and downstream reaches, while levels of conductivity in the receiving stream, Pigeon Creek, ranged from 269 µS/cm to 536 µS/cm. Existing conductivity levels collected in the Fall of 2006, showed levels ranged from 47 µS/cm to 211 µS/cm throughout the proposed project area and downstream reaches, while levels of conductivity in the receiving stream, Pigeon Creek, ranged from 809 µS/cm to 1,000 µS/cm (Figure 3.3).

1.3.4.2 Proposed Off-Site Mitigation Areas

The following is a summary of important findings for each of the assessed functions in the areas proposed for off-site restoration, enhancement, and preservation (Figure 1.5 – Figure 1.12). (Areas proposed for mitigation through establishment do not currently have stream functions to assess.) Surveys of the off-site restoration and enhancement areas included hydrologic, hydraulic, geomorphic, biotic, and water quality function assessments. Surveys of the preservation areas included only habitat and large woody debris assessments.

Hydrologic and Hydraulic Functions

Overall hydrology has been altered by past land use practices, including mining, timbering, and gas exploration, and associated access roads throughout the Hell Creek subwatershed. By restoring the channels and their adjacent floodplain and riparian zones, overall rainfall/runoff relationships will improve, creating a functional lift in the streams. Hydrologic analysis indicates Hell Creek has a wide range of return intervals (<1.1 to 10), which can lead to channel instability.

In their current condition, the proposed off-site mitigation areas offer opportunity for functional lift with regard to hydrologic and hydraulic functions. The proposed mitigation will reduce channel incision and aggradation so that the channels carry only the bankfull discharge. All other flows will be spread onto an adjacent floodprone area (bankfull bench). This will provide functional lift by re-connecting the stream to the floodprone area.

The proposed off-site restoration and enhancement reaches in the Hell Creek subwatershed are characterized as 2nd and 3rd order low gradient perennial stream segments, while the preservation reaches are 1st and 2nd order, high gradient intermittent and ephemeral streams. This drainage network creates the necessary pathways for hydrologic connectivity and functional input into the Hell Creek stream system.

Geomorphic Functions

Throughout each of the Hell Creek mitigation reaches, channel gradients range from approximately 1.8 to 3.5 percent slope. The subwatershed is located in a v-shaped valley. Rosgen stream types are generally Bc channels dominated by gravel beds. The streams have very poor bedform diversity with large pool-to-pool ratios reaching 34.0 in Reach D (Appendix E) compared to designed ratios of 1.5 to 5.0. Widths of floodprone areas are small, with entrenchment ratios (ER) between 1.1 to 1.6 compared to the design ER of 1.3 to 2.6. Bank height ratios, reaching 3.0, have exceeded the stable range of 1.0 to 1.2 in many locations, showing signs of incision. The current mitigation stream channels have easily erodible bank material and very sparse vegetation, including the invasive species, Japanese knotweed (*Polygonum cuspidatum*), which is causing lateral instability throughout the mitigation reaches.

In their current condition, the proposed off-site mitigation areas offer opportunity for functional lift with regard to geomorphic functions. Sloping back banks, while creating bankfull benches and expanding the floodprone width will maximize riparian vegetation zones to provide efficient functionality. In-stream structures will be installed for grade control and bedform diversity. The invasive species will be eradicated, while the eroded banks will be stabilized to decrease further erosion and thus decrease the production of excess sediment into the stream system. This restoration will improve substrate characterizations, increase dominant particle sizes (D50), and provide in-stream habitat for aquatic organisms. It has been demonstrated that restoration as proposed has been successful in these stream types (Rosgen, 2001; Sylte et al. 2000).

Biotic Functions

Habitat assessments in the restoration and enhancement reaches revealed that in-stream habitat was marginal. Low velocity depth regimes indicated both a lack of bedform diversity in regards to pool and riffle habitats and an excess of sediment deposition. Overall bank stability and vegetative buffers were marginal to sub-optimal. Riparian vegetation consisted of grasses and the invasive Japanese knotweed in the restoration reach and upland hardwoods in the enhancement reaches, with sporatic canopy cover. As evident by the number of piece counts, piece score per foot, the number of debris dams, and the debris dams score per foot, LWD is not very abundant in these channels. The lack of LWD increases instability of the channel, decreases retention of organic matter and nutrients, and results in less available habitat for aquatic and terrestrial fauna. Benthic macroinvertebrate WVSCI scores at the restoration reaches were in the “gray area” (a score between “fair” and “good”; 61 – 68), while the enhancement reaches had “very good” WVSCI scores (Table 3.26). The percent shredders were low in the assessed reaches: between one and eight percent compared to the 25 percent shredders typically found in other upper piedmont channels (Marques, 1998).

In their current condition, the proposed off-site mitigation areas offer opportunity for functional lift with regard to biotic functions. Proposed enhancement and restoration will improve organic retention, in-stream habitat and pool frequency with the addition of wood and rock structures and increased bedform diversity (also a geomorphic functional lift). Open canopy areas will be revegetated, while invasive species will be eradicated and native species will be planted. With the increased habitat diversity anticipated as a result of mitigation measures, benthic macroinvertebrate communities are expected to improve, assuming overall water quality remains within recommended ranges.

Water Quality Functions

With the exception of high fecal coliform levels throughout the off-site restoration reaches in Hell Creek (Appendix H; Table 1.9; Table 1.10), all other water chemistry constituents are within recommended ranges for freshwater organisms. Fecal coliform has shown to have negative effects on benthic macroinvertebrate communities (Moss, et. al; 1993), along with some strains having several harmful effects on humans (Loyalhanna, 2005, EPA, 2009). Fecal coliform is also used as an indication of other harmful pathogens and their presense in streams suggest possible health risks if the water is ingested (EPA, 1997).

In their current condition, the proposed off-site mitigation areas offer opportunity for functional lift with regard to water quality functions. The WVSCI score is expected to improve from the "gray area" ranking as a result of water quality improvement and improved habitat.

1.3.5 Linear Footage & Acreage Offset

In addition to offsetting impacted functions with similar types of functions to the affected resources as preferred in the Final Rule (2008), CONSOL has also demonstrated offset of impacts in terms of linear footage and acreage. As shown in Table 1.8, the proposed mitigation provides an excess of 1:1 linear footage and acreage offset. This offset is achieved through re-creation of impacted streams (on-site restoration) and establishment of streams (both on-site and off-site) in combination with supplemental and temporal loss mitigation (off-site restoration, enhancement, and preservation).

Table 1.8
Buffalo Mountain Surface Mine Linear Footage/Acreage Inventory

Proposed Impacts	Linear Feet	Acres
Permanent Impacts	41,651	4.961
Temporary Impacts	10,215	1.657
DEBIT	**51,866**	**6.618**
Temporal Impacts[1]	15,560	--
TOTAL DEBIT	**67,426**	**6.618**
Proposed Mitigation		
No Net Loss of Linear Feet Mitigation		
On-Site Establishment	29,079	3.826
Off-Site Establishment	16,345	1.973
On-Site Restoration	10,215	1.657
TOTAL	**55,639**	**7.456**
Supplemental & Temporal Loss Mitigation		
Off-Site Enhancement	4,098	1.308
Off-Site Restoration[2]	4,944	2.122
Off-Site Preservation	5,281	1.141
Water Quality Improvement	--	--
TOTAL	**14,323**	**4.570**
TOTAL CREDIT	**69,962**	**12.026**
Excess	**2,536**	**5.408**

[1] An additional 30 percent of the total impact is added to compensate for temporal losses during the operation. 10 percent for every 5 years is provided for the total 15-year mine life.
[2] Water Quality Improvement segment.

1.4 Site Selection

1.4.1 On-Site Mitigation Areas

1.4.1.1 Restoration

The temporarily impacted sections of channel will be restored upon reclamation (Phase II bond release) of the site, approximately 15 years from initiation. These restoration activities will include re-establishment of the channels to be temporarily impacted by surface mine. The location of these on-site restoration activities was determined by the design of the surface mine, which includes temporary ponds below the valley fills and temporary access roads. The proposed Buffalo Mountain Surface Mine will temporarily impact perennial, intermittent, and ephemeral channels within the subwatersheds of Ruth Trace Branch, Conley Branch, Hell Creek, Pigeonroost Creek, Unnamed Tributary of Pigeon Creek, Unnamed Tributary of Stonecoal Branch, and two unnamed tributaries of Miller Creek (Table 1.1). Locations of the proposed on-site restoration are shown in Figure 1.4.

1.4.1.2 Establishment

Establishment of streams on-site will involve creating a new drainage network comprised of low gradient stream channels within post-mine drainage control areas. The identification of the on-site establishment sites was based on the following selection criteria:

- located on the down-dip side of the reclaimed permit area to increase the likelihood of intermittent flow;
- will not require connectivity into jurisdictional waters by means of a groin ditch;
- sufficiently sized to allow appropriate dimensions (i.e., entrenchment ratio, width/depth ratio) for each specific drainage area to be designed as a Rosgen Bc channel; and
- within an area with a high probability for securing protective riparian buffer easements.

1.4.2 Off-Site Mitigation Area

1.4.2.1 Restoration/Enhancement

The location and nature of the off-site restoration and enhancement component of the Mitigation Plan was identified through an iterative process. A brief history of that process to demonstrate that decisions were not arbitrary or capricious is presented below.

The first location option was the Miller Creek watershed. However, after extensive conversations and coordination with the landowners, Miller Creek was dismissed from further consideration. Primarily, this dismissal was based on the inability to obtain preservation easements from property owners.

Streams in the surrounding subwatersheds of Miller Creek, including Peg Fork, Mill Fork, and Parker Fork, were also considered for off-site mitigation. After extensive field reconnaissance and research, the following conditions were found that eliminated these subwatersheds from further consideration:

- many of the streams were functioning so well that they did not offer opportunities to provide significant functional lift;
- on other streams, construction access would be difficult and very costly;
- the probability of securing protective easements was very low; and
- those stream reaches that did offer potential for worthwhile mitigation opportunities were already included in the mitigation plans of other issued permits.

The second set of subwatersheds considered for mitigation were streams located in the headwaters of Laurel Branch, Rockhouse Branch, and Toms Branch watersheds. After extensive field reconnaissance, research, and coordination with landowners it was found that:

- many of these streams were functioning so well that they did not offer opportunities to provide significant functional lift;
- on other streams, construction access would be difficult and very costly; and
- the probability of the securing protective easements was very low.

The third option was developed through extensive discussions among CONSOL and agencies with an interest in this project (e.g., Mingo County Redevelopment Authority, FHWA, WVDOH, Cotiga Land Development Corporation) and conceptually consisted of developing a comprehensive, all-inclusive mitigation (restoration, enhancement, establishment, and preservation) throughout an entire subwatershed of the larger project area, Hell Creek. This comprehensive watershed mitigation plan would, in part, also consist of connecting both the on-site and off-site mitigation efforts together to support a watershed-based approach, a strategy presented by the WV Water Research Institute at the West Virginia University in the Upper Pigeon Creek Watershed Restoration Plan (WVWRI & CVI, 2008). As documented in Section 3.0 of this report and in the Upper Pigeon Creek Watershed Restoration Plan (WVWRI & CVI, 2008), overall habitat is very poor throughout the main stem of Hell Creek having tremendous amounts of excess sediment, channelization constraints, and has very poor bank erosion and bedform diversity. In addition to the physical improvements and preservation to the subwatershed's unimpaired and natural streams, it was decided that water quality improvement (i.e., wastewater treatment) would be a critical component because of the amount of fecal coliform contaminents in the lower portions of the permit area's subwatersheds (Table 1.9) as also documented in the Upper Pigeon Creek Watershed Restoration Plan (WVWRI & CVI, 2008).

The United States Department of Agriculture (USDA) National Research Institute (NRI) Water and Watersheds Program targets bacterial transport and fate in freshwaters, and bacterial water quality as a direct human health concern. Fecal coliform are a group of bacteria found in human and animal intestines and can enter waterbodies through direct discharge of waste and/or runoff from untreated human sewage, animals, and agriculture. Zeckoski (2005) stated that the presence of pathogen bacteria (fecal coliform) is reported to be the most widespread cause of water quality impairment in the United States. The presence of fecal bacteria in a waterbody is a potential heath risk for humans exposed to the water (David, 2008).

After it was decided to develop a comprehensive, watershed-based, off-site mitigation plan, the first step in selecting a watershed was to determine which of the permit area's subwatersheds had the highest fecal coliform pollution. Water quality samples were collected near the mouths of each impacted subwatershed, along with both upstream and downstream on the receiving stream, Pigeon Creek (Figure 1.13). Five samples were taken over the course of one month to determine if fecal coliform levels were within West Virginia Department of Enviromental (WVDEP) water criteria limits. According to Title 47 CSR 2 (WVDEP, 2008), the fecal coliform level shall not exceed 200 colonies/100 mL as a monthly geometric mean based on not less than five samples per month, nor to exceed 100 colonies/100 mL in more than ten percent of all samples taken during a month. Thus, after conducting monthly samples, it was determined that Hell Creek and Conley Branch were outside of the recommended monthly average and single sample fecal coliform limits (Table 1.9 and Table 1.10) and would thus benefit from wastewater treatment. It is important to note that these levels were collected in August, a relatively low flow period. Fecal coliform levels are expected to be higher throughout the year, as fecal coliform levels have been found to increase with an increase in flow (Edwards et al., 1997).

Following extensive coordination with local landowners residing within the Hell Creek and Conley Branch subwatersheds, it was determined that right-of-way entries to access the property for construction and ability to obtain sewer easements could be obtained from landowners within the Hell Creek watershed, but that obtaining of such entries throughout the Conley Creek watershed was not likely. Therefore, the Hell Creek watershed was selected for application of the comprehensive, watershed-based mitigation approach. The Hell Creek subwatershed was also highlighted in the Upper Pigeon Creek Watershed Restoration Plan as a watershed watershed impaired by fecal pollution and would provide "significant benefit" to the Pigeon Creek watershed if a wastewater project were implemented there.

Table 1.9
Monthly Average Fecal Coliform Values per Subwatershed

Sampling Site	Fecal Coliform Levels (colonies/100 mL)
Ruth Trace Branch	174
Conley Branch	***4,571***
Hell Creek	***619***
Unnamed Tributary of Pigeon Creek	176

Monthly Average Water Quality Criteria = 200 colonies/100 mL
Italics/Bold = Exceeds water quality criteria

Table 1.10
Single Sample Fecal Coliform Values per Subwatershed

Fecal Coliform Levels (colonies/100 mL)				
Sampling Date	Ruth Trace Branch	Conley Branch	Hell Creek	Unnamed Tributary of Pigeon Creek
8/14/2008	81	81	340	153
8/18/2008	162	***1,000***	10	72
8/21/2008	63	***19,000***	***2,100***	81
8/26/2008	63	72	10	54
8/29/2008	***500***	***2,700***	***636***	***520***

Notes: Single Fecal Coliform Criteria = 400 colonies/100 mL
Italics/Bold = Exceeds water quality criteria

Approximately 4,944 LF in the Hell Creek subwatershed will be treated for water quality improvement, and subsequently used for restoration. These restoration activities will be rehabilitation versus re-establishment, as defined in 33 CFR 332.2. Upstream of the restoration reaches, overall in-stream habitat and surrounding riparian vegetation is very sparse; therefore, an additional 4,051 LF will be enhanced by installing in-stream aquatic habitat structures and improving existing riparian vegetation zones.

1.4.2.2 Establishment

In order to hydrologically connect the on-site establishement channels to existing jurisdictional waters, off-site establishment channels will be created. Areas identified to establish off-site channels were selected based on of the following selection criteria:

- located in a natural valley setting;
- access in one or more locations to provide grade control to reduce incison and sediment deposition downstream;
- The establishment stream will hydrologically connected to jurisdictional waters of the U.S.; and

- an area within which the probability of securing landowner acceptance of protective riparian buffer easements was high.

1.4.2.3 Preservation

Preservation reaches were located within the Hell Creek subwatershed because the Hell Creek subwatershed was selected as the focus of the overall watershed-based mitigation approach (see discussion in Section 1.4.2.1, *Restoration/Enhancement*). For the selection of specific preservation reaches within the Hell Creek subwatershed, the following criteria were considered:

- same stream type and classification as the impacted channels;
- stable channels in their natural and undisturbed state; and the
- ability to secure protective easements or deed restrictions.

The first two criteria were used to identify potential properties, and then landowners of those properties were identified to determine if there was an ability to secure protective easements or deed restrictions. After the ability to secure such protective measures was confirmed, preservation sites were delineated to confirm stream flow regime, stream type, and total length and acreages.

1.4.2.4 Water Quality

Water quality improvement reaches (Figure 1.7) were located within the Hell Creek subwatershed because the Hell Creek subwatershed was selected as the focus of the overall watershed-based mitigation approach (see discussion in Section 1.4.2.1, *Restoration/Enhancement*). Wastewater engineers and water treatment experts were consulted to assess various treatment options (e.g., wetland clusters, traditional methods; WVWRI & CVI, 2008). Because the mouth of Hell Creek is only approximately three miles from the Delbarton Wastewater Treatment Plant, it was decided that it would be feasible and cost-effective to construct a sewer line, pump station, and three mile force main to the sewage treatment plant. Treatment of sewage by an already established governmental authority will be more cost effective and more efficient at treating water quality, and will provide less maintenance, monitoring and ownership issues than a private alternative for water quality improvements. Also, at this location, CONSOL can provide an added future benefit to the Pigeon Creek watershed. As proposed, the three mile long force main, from the mouth of Hell Creek to the treatment plant will be oversized. This over-sizing will, in the future, provide sewage treatment tap-ins to other residential and businesses located along the route of the force main. By upgrading the sewage treatment plant, many future social and economical opportunities will then be available to the county to assist in implementation of Mingo County's Master Land Use Plan. See Section 8.0 or more detailed information on the water quality improvement portion of the Mitigation Plan.

2.0 WATERSHED ASSESSMENT RESULTS

2.1 Watershed Delineation

2.1.1 Proposed Impact Areas

The Buffalo Mountain Surface Mine permit area lies within the Tug Fork River watershed, which is defined as 8-digit Hydrologic Unit Code (HUC) 05070201 by the United States Department of Agriculture Natural Resources Conservation Service (USDA NRCS) (Figure 1.2). More specifically, the permit area includes portions of the Pigeon Creek, Miller Creek, and Buffalo Creek watersheds, which overlap the 05070201180 (“Pigeon Creek”) and 05070201150 (“Tug Fork River [Direct Drainage]”) 11-digit HUCs. Pigeon Creek is the largest of these tributaries, with a 142-sq mi (90,880-ac) drainage area. Miller Creek has a drainage area of 9.4 sq mi (6,028 ac), and Buffalo Creek has a drainage area of 7.1 sq mi (4,548 ac). Approximately 84 percent of the permit area lies within the Pigeon Creek watershed, with approximately 12 percent within the Miller Creek watershed and approximately four (4) percent within the Buffalo Creek watershed. There are no proposed jurisdictional impacts to waters of the U.S. in the Bufflo Creek watershed. Proposed impacts to jurisdictional waters of the U.S. associated with the Buffalo Mountain Surface Mine only occur, however, within the Pigeon Creek and Miller Creek watersheds (Baker, 2008a).

Table 2.1 lists the sub-watersheds where impacts to jurisdictional waters of the U.S. would occur. Baker (2008) conducted a jurisdictional determination of the proposed impact streams, which was verified by USACE on September 18, 2008. A summary of total length, acreage, and stream flow regime in the proposed project area is included in Chapter 1 (Table 1.1).

Table 2.1
Watershed & Drainage Area Summary of Impact Areas

Watershed Name	Drainage Area (acre/sq mi)
Pigeon Creek Watershed	
Ruth Trace Branch (RTB)	572 / 0.894
Right Fork Conley Branch (RFCB)	471 / 0.736
Left Fork Conley Branch (LFCB)	247 / 0.386
Right Fork of Hell Creek (RFHC)	957 / 1.50
Left Fork Hell Creek (LFHC)	1,268 / 1.981
Unnamed Tributary of Pigeon Creek (UTPC)	218 / 0.341
Pigeonroost Creek (PRC)	805 / 1.26
Unnamed Tributary of Stonecoal Branch (SCB)	315 / 0.492
Miller Creek Watershed	
Miller Creek (MC)	6,028 /9.419

2.1.2 Proposed Mitigation Areas

The Mitigation Plan proposes mitigation activities within each of the nine subwatersheds where impacts to waters of the U.S. are proposed (Table 2.1).

On-site restoration of the temporarily impacted areas will be completed after reclamation in the watersheds described in the previous section ("Proposed Impact Areas"). On-site establishment in the same watersheds will also be completed after reclamation, while the structures will be installed into the proposed off-site establishment channels as mining occurs. Drainage areas and lengths delineated for the on-site restoration and on- and off-site establishment channels are shown on Figure 1.4.

Off-site restoration and enhancement will be completed throughout the Hell Creek subwatershed as mining occurs. Mitigation reaches were delineated and identified based on a significant change in drainage area, which requires different design criteria. Individual mitigation drainage area and length information is located on Figure 1.4.

Six unnamed tributaries within the Hell Creek subwatershed will also be preserved in perpetuity (Section 1.5.2.3). The preservation streams include ephemeral, intermittent, and perennial flow regimes. Drainage areas range from 0.01 sq mi (6.4 ac) to 0.31 sq mi (198 ac). Summary information of the preservation channels is located on Figure 1.4.

2.2 Geology and Soils

2.2.1 Geology

Pigeon Creek, Miller Creek, and Buffalo Creek generally flow in a northwest direction to the Tug Fork River. These watersheds lie within the unglaciated portion of the Appalachian Plateaus physiographic province (USGS, 2009). This province forms the western boundary of the Appalachian Mountains. The sedimentary rock of the plateau was dissected by stream action, forming a region of high relief, with peaks of similar elevations. The region is marked by v-shaped valleys and dendritic drainage patterns.

Specifically, the permit area is within the Mountaintop Mining Region of southern West Virginia, which encompasses portions of Mingo, Logan, Lincoln, Wayne, Boone, Wyoming, Raleigh, Kanawha, Fayette, Clay, Nicholas, Webster, and Braxton Counties (USEPA et al., 2003).

The surface and near sub-surface strata within the permit area belong to the Allegheny Formation, of Middle Pennsylvania Age, and the Kanawha Formation of the Pottsville Group, of Lower Pennsylvania Age (Figure 2.1). Within the permit area for the Buffalo Mountain Surface Mine, the Allegheny Formation is comprised principally of sandstone, with subordinate amounts of shale, siltstone, underclay, and coal. The Kanawha Formation is composed of sandstone, shale, siltstone, and subordinate underclays.

No faults or folds were identified in the driller's logs for WVDEP Permit No. 5018-07. In the vicinity of the proposed operation, strata exhibit a one to two percent dip in the northwesterly direction. This is also the anticipated direction of groundwater movement since the ultimate groundwater flow would be expected to closely parallel regional dip. There were no aquifers identified for the coreholes within the mineral removal area.

Potential aquifers within and adjacent to the permit area are likely alluvial aquifers receiving recharge from the underlying bedrock aquifers through the valley floor fracture system, as well as from infiltration of surface water (WVDEP Permit No. S-5018-07). The Coalburg within the southern portion of the mine permit area has previously been underground mined and is currently discharging water from openings in the upper reaches of the Right Fork of Hell Creek. The mine works and seam in this area is apparently acting as a perched aquifer.

The proposed operations associated with the Buffalo Mountain Surface Mine include a limited amount of auger and/or highwall mining in the Coalburg, Coalburg Rider (Lower Split), Buffalo, and Winifrede seams. The augering and highwall mining is only proposed to occur in the down-dip and on-strike directions (WVDEP Permit No. S-5018-07).

2.2.2 Soils

Soil types and profiles for the proposed impact and mitigation areas were researched using the Natural Resources Conservation Service (NRCS) soil survey data for Mingo County (USDA-NRCS, 2009), along with preliminary on-site evaluations, to determine soil characteristics. A map depicting the boundaries of each soil type in the Buffalo Mountain Surface Mine permit area (impact and on-site mitigation areas) is presented in Figure 2.2. Characterization of each soil type is presented in Table 2.2.

The Matewan-Highsplint-Guyandotte association is the dominant soil unit within the permit area. It is composed of Matewan soils (35 percent), Highsplint soils (30 percent), and Guyandotte soils (20 percent). Each of these soil types is characterized by stony, well-drained soils that are typically found on steep mountain slopes. Udorthents are commonly found within the developed areas of the Pigeon Creek, Buffalo Creek, Hell Creek, Pigeonroost Creek, and Stonecoal Branch floodplains (Figure 2.2).

Other soil units occurring within the valley floors of the watersheds include Craigsville very gravelly sandy loam and Highsplint channery loam (Figure 2.2). Craigsville very gravelly sandy loam soils occur in the floodplains of the lower portion of the watershed, while Highsplint channery loam soils occur within the valley floors of the headwater portions of the watersheds. As the name suggests, the Craigsville soil unit is derived from course sediments, and is well-drained. The Highsplint channery loam soil unit is derived from sandstone, siltstone, and shale sedimentary rock colluvium.

Table 2.2
Project Soil Types and Descriptions

Soil Name	Location	Description
Impacted Reaches and On-site Mitigation Reaches		
Matewan-Highsplint-Guyandotte Association (MHF)	Dominant on valley slopes.	Matewan soils make up 35 percent of this map unit. The proportion of the surface of this component covered by stones and/or boulders ranges from 3 to 15 percent. The parent material consists of sandstone residuum. The runoff class is very high. The depth to a restrictive feature is 20 to 40 inches to bedrock (lithic). This soil is somewhat excessively drained. The slowest soil permeability within a depth of 60 inches is moderately slow. Available water capacity to a depth of 60 inches is very low, and shrink swell potential is low. Annual flooding and ponding is none. The minimum depth to a water table is greater than 6 feet. The assigned Kw erodibility factor is 0.24. It is non-irrigated land capability subclass 7s. This soil is typically not suitable for cultivated crops. This component is not a hydric soil. Highsplint soils make up 30 percent of this map unit. The proportion of the surface of this component covered by stones and/or boulders ranges from 0 to 3 percent. The parent material consists of stony, loamy, colluvium from sandstone, siltstone, and shale sedimentary rocks. The runoff class is high. The depth to a restrictive feature is 48 inches bedrock (lithic). This soil is well drained. The slowest soil permeability within a depth of 60 inches is moderately slow. Available water capacity to a depth of 60 inches is low, and shrink swell potential is low. Annual flooding and ponding is none. The minimum depth to a water table is greater than 6 feet. The assigned Kw erodibility factor is 0.17. It is non-irrigated land capability subclass 6s. This soil is typically not suitable for cultivated crops. This component is not a hydric soil. Guyandotte soils make up 20 percent of the map unit. The proportion of the surface of this component covered by stones and/or boulders ranges from 3 to 15 percent. The parent material consists of colluvium derived from sandstone. The runoff class is very high. The depth to a restrictive feature is greater than 60 inches. This soil is well drained. The slowest soil permeability within a depth of 60 inches is moderate. Available water capacity to a depth of 60 inches is moderate, and shrink swell potential is low. Annual flooding and ponding is none. The minimum depth to a water table is greater than 6 feet. The assigned Kw erodibility factor is 0.10. It is non-irrigated land capability subclass 7s. This soil is typically not suitable for cultivated crops. This component is not a hydric soil.
Highsplint Channery Loam (HgE)	Found on narrow valley floors in headwater reaches; 15 to 35 percent slopes	Highsplint soils make up 80 percent of this map unit. The proportion of the surface of this component covered by stones and/or boulders ranges from 0 to 3 percent. The parent material consists of stony, loamy, colluvium from sandstone, siltstone, and shale sedimentary rocks. The runoff class is high. The depth to a restrictive feature is 48 inches bedrock (lithic). This soil is well drained. The slowest soil permeability within a depth of 60 inches is moderately slow. Available water capacity to a depth of 60 inches is low, and shrink swell potential is low. Annual flooding and ponding is none. The minimum depth to a water table is greater than 6 feet. The assigned Kw erodibility factor is 0.17. It is non-irrigated land capability subclass 6s. This soil is typically not suitable for cultivated crops. This component is not a hydric soil.

Soil Name	Location	Description
Off-Site Mitigation Reaches		
MHF (see above)		
HgE (see above)		
Udorthents-Urban Land Complex (UcB)	Disturbed or developed land on the valley floor or floodplain; 0 to 8 percent slopes.	Not reported (too variable).
Berks-Rock Outcrop Complex (BrG)	Found on steep, greater than 90 percent, slopes	Berks soils make up 45 percent of the map unit. The surface portion of this component that is covered by stones and/or boulders ranges from 3 to 15 percent. The parent material consists of residuum weathered from shale, siltstone and sandstone. The runoff class is very high. The depth to a restrictive feature is 20 to 40 inches to bedrock (paralithic). This soil is well drained. The slowest soil permeability within a depth of 60 inches is moderate. Available water capacity to a depth of 60 inches is very low, and shrink swell potential is low. Annual flooding and ponding is none. The minimum depth to a water table is greater than 6 feet. The assigned Kw erodibility factor is 0.17. It is non-irrigated land capability subclass 7s. This soil is typically not suitable for cultivated crops. This component is not a hydric soil.
Fiveblock and Kaymine Soils (FkF)	Found on strip mine areas; 35 to 80 percent slopes.	Kaymine soils make up 45 percent of this map unit. The proportion of the surface of this component covered by stones and/or boulders ranges from 3 to 15 percent. The parent material consists of loamy-skeletal mine spoil or earthy fill. The runoff class is medium. The depth to a restrictive feature is greater than 60 inches. This soil is well drained. The slowest soil permeability within a depth of 60 inches is moderate. Available water capacity to a depth of 60 inches is moderate, and shrink swell potential is low. Annual flooding and ponding is none. The minimum depth to a water table is greater than 6 feet. The assigned Kw erodibility factor is 0.32. It is non-irrigated land capability subclass 7s. This soil is typically not suitable for cultivated crops. This component is not a hydric soil.

Source: NRCS, 2009

Table 2.3
Project Soil Type Characteristics (NRCS, USDA. Official Soil Series Descriptions)

Series	Max Depth (in)	% Clay (below surface, above 10 in)	Saturated hydraulic conductivity (µm/sec)	Erosion factor (tons/acre/year)	OM on surface / at depth %
MHF	38	7-20	42.0-141.0	2	80-90/ 0-1.0
HgE	65	7-27	42.0-141.0	3	80-90/ 0-1.0
UcB	Not Reported	Not Reported	Not Reported	Not Reported	Not Reported
BrG	38	7-27	42.0-141.0	3	80-90/ 0.1-0.5
FkF	65	5-15	14.0-141.0	5	0.5/ 0-0.1

Source: NRCS, 2009

2.3 Land Use

The Buffalo Mountain Surface Mine permit area is dominated by slopes greater than 20 degrees. Because of the existing topography, the areas proposed for mining activity, as well as much of the mitigation activity is isolated and undeveloped. Past land uses include timbering, gas exploration, underground and surface mining, and wildlife habitat.

The valleys to the east of the mining permit area, including some areas adjacent to off-site mitigation reaches, include residential land uses. The community center of the Town of Delbarton lies half a mile to the southeast, where residential, commercial, and industrial land uses exist. Transportation land uses also surround the permit area to the north, east, and south.

The proposed mining will disrupt existing forestland during the mining phase. Based upon the mining and reclamation plan for the proposed project, the maximum disturbance at any one time during the mine life would be 500 ac. During reclamation, approximately 58 percent of the permit area (1,333 ac) will be returned to forestland, while the remaining areas will be converted to a mixture of Light Industry and Commercial, Public Services, and Residential within the remaining 42 percent of the permit area (approximately 980 ac). A temporary vegetative cover will be established, as contemporaneously as practicable, with backfilling and grading until a permanent cover can be established. Trees will then be planted throughout the areas with Forestland as the post-mining land use, and with limited placement in the areas planned for development; therefore, much of the permit area will still be used by wildlife. A detailed vegetation plan is located in the EID (Baker, 2009).

2.4 Vegetation

Mixed deciduous forest is the dominant land cover type within the proposed impact and mitigation areas, and consists of three strata: canopy, understory, and herbaceous ground cover. The canopy strata consists of mixed-aged stands with occasional large diameter trees (approximately 50 inches dbh), with no old-growth forest remaining. Across the impact and mitigation areas, there are three (3) forest types: oak-hickory, northern hardwoods, and bottomland hardwoods (USDA, NRCS. 2007).

The oak-hickory and northern hardwoods forest types are commonly found on the ridges and valley slopes of each subwatershed in the permit area, and the bottomland hardwoods forest type is typically found on the valley floors. A summary of these forest types is provided in the following paragraphs as described in the Soil Survey of Logan and Mingo Counties, West Virginia (USDA, NRCS. 2007) and field surveys conducted for the jurisdictional report (Michael Baker, Jr., Inc., 2008).

The oak-hickory cover type is found generally along the drier south-east to south-west facing slopes. Dominant tree species include white oak (*Quercus alba*), chestnut oak (*Q. prinus*), scarlet oak (*Q. coccinea*), black oak (*Q. velutina*), hickories (*Carya spp.*), black gum (*Nyssa sylvatica*), and red maple (*Acer rubrum*). Virginia pine (*Pinus virginiana*), pitch pine (*P. rigida*), chestnut oak (*Q. prinus*), and scarlet oak (*Q. coccinea*) may be found along the ridge tops (USDA, NRCS. 2007).

The northern hardwoods cover type is found generally along the moist, partially shaded and well-drained north-west to north-east facing slopes. Dominant tree species consist primarily of tulip poplar (*Liriodendron tulipifera*), red oak (*Q. rubra*), sugar maple (*A. saccharum*), beech (*Fagus grandifolia*), white ash (*Fraxinus americana*), basswood (*Tilia americana*), cucumber (*Magnolia accuminata*), black birch (*Betula lenta*), eastern hemlock (*Tsuga canadensis*), and scattered white oak (USDA, NRCS. 2007).

The bottomland hardwoods cover type is generally found within the stream floodplains and along the stream bank. Sycamore (*Platanus occidentalis*), black walnut (*Juglans nigra*), basswood, and willows (*Salix spp.*) are the dominant tree species. Associated woody plants in bottomlands also include witch-hazel (*Hamamelis virginiana*), spicebush (*Lindera benzion*), hazelnut (*Corylus americana*), pawpaw (*Asimina triloba*), red elm (*Ulmus rubra*) and American elm (*U. americana*) (USDA, NRCS. 2007).

Co-dominant, intermediate, and understory woody plants found in the watershed include flowering dogwood (*Cornus florida*), hawthorns (*Crataegus spp.*), black cherry (*Prunus serotina*), red bud (*Cercis canadensis*), mountain laurel (*Kalmia latifolia*), great rhododendron (*Rhododendron maximus*), mountain magnolia (*M. fraserii*), musclewood (*Carpinus caroliniana*), and ironwood (*Diospyrus virginiana*) (USDA, NRCS. 2007).

Non-woody shrubs and lateral climbing species found in the watershed include greenbrier (*Smilax spp.*), blackberry (*Rubus spp.*), honeysuckle (*Lonicera spp.*), grape vine (*Vitis spp.*), and poison ivy (*Toxicodendron radicans*) (USDA, NRCS. 2007). The herbaceous layer consists of various flowering plants including golden ragwort (*Scencio aureus*), nettles (*Laportea spp.*), violets (*Viola spp.*), goldenrods (*Solidago spp.*), and various woodland grass, sedge, and rush species.

2.5 Climate

The proposed impact and mitigation areas occur in a continental humid temperate climatic type (Friel et al., 1984). The regional climatic characteristics are largely determined by the orogenic effect of the Appalachian Mountains, which creates a rain shadow on the leeward side of the mountains and channels maritime tropical air masses moving up from the south in a northeasterly direction along the mountains where they come into contact with continental polar air masses. The general climate is that of warm, humid summers and moderately cold, mild to severe winters, varying with elevation, with prevailing winds coming from the southwest. Average daily temperatures range from 18 to 86 degrees Fahrenheit. Evaporation rates are generally low, with precipitation being greater than evaporation (surplus), except during the summer and early fall months.

Although fairly well-distributed throughout the year, precipitation amounts are typically greater in late winter and early spring. The wettest months of the year generally are March, April, May, June, and July. In West Virginia, annual precipitation ranges from 38 to 50 inches, with monthly precipitation ranging from 3 to 5 inches during all months, with the exception of July when precipitation generally ranges between 5 to 6 inches. Snowfall averages 30 to 50 inches annually. Precipitation in the project vicinity primarily develops from the movement of warm humid air from the south into West Virginia. Severe thunderstorms often form as these air masses meet land-based frontal systems. Tornadoes are a rarity in the region. The most severe storms generate precipitation over several days, creating moist watershed conditions. Significant flooding then may occur when more intense periods of precipitation fall within a day. The driest months are typically February, August, September, October, November, and December. Both short-term droughts and extended droughts occur periodically in the region. The shorter droughts have the potential to create severe damage as a result of their timing in relation to seasonal water needs.

2.6 Potential Constraints

The proposed mitigation project site was assessed in regards to potential fatal flaws and site constraints. No major constraints or fatal flaws have been identified during project design development.

2.6.1 Property Ownership and Boundary

CONSOL will negotiate site protection requirements of the Mitigation Plan with the on- and off-site landowners (Figure 2.3), Cotiga Development Company (Flourtown Road, Wyndmoor, PA 19118), Consol of Kentucky, Inc (1000 CONSOL Energy Drive, Canonsburg, PA 15317), Margarte Annette Brown et al. (235 RR 3, Delbarton, WV), and Everett Hannah et ux. (1100 E Fourth Ave, Williamson, WV). Negotiations are currently being made with the landowners to ensure protection in perpetuity of a riparian buffer along the on- and off-site mitigation areas through deed restrictions. Discussions with the WV Department of Highways and adjacent landowners along the off-site restoration reaches are currently being held to protect the planted riparian zones along the county road and adjacent land.

2.6.2 Site Access

The impact and mitigation areas can be accessed from U.S. 119 and onto County Road 65. Temporary access roads constructed to gain access to the site, or otherwise required shall be kept to a minimum and only constructed upon approval from CONSOL. Temporary access roads shall be returned to the original or design contour as nearly as possible and revegetated according to Section 5.42 of this report.

2.6.3 Utilities

Several utility companies are located within the Buffalo Mountain Surface Mine project and mitigation areas, including gas, water and sewer lines, power lines, and county roads. They include:

Addington Exploration, LLC	1500 North Big Run Road, Ashland KY, 41102
American Electric Power Company	1300 Buffalo Drive, Williamson, WV 25661
Chesapeake Appalachia, LLC	P.O. Box 6070, Charleston WV, 25304
Cotiga Development Co.	P.O. Box 1956, Williamson, WV 25661
Gilbert Exploration Co. Inc.	P.O. Box 310, Pineville, WV 24874
JML Oil & Gas Company	P.O. Box 1467, Paintsville KY 41240-5467
K & R Operating Co.	P.O. Box 3268, Pikeville, KY40223
J. W. Kinzer	P.O. Box 155, Alle, KY 41601
Mingo County PSD	P.O. Box 408, Chattaroy, WV 25667
New River Energy Corp.	P.O. Box 1951, Charleston, WV 25327
Nytis Exploration Co., LLC	2501 Broadway Street, Catlettsburg, KY 41129
Quality Natural Gas, LLC	1555 Kentucky Route 80, Prestonsburg, KY 41653
RSA Corporation	51 Harper Streets, Detroit, MI 48202

3.0 STREAM CORRIDOR ASSESSMENT RESULTS

3.1 Introduction and Methodology

This section presents the results of functional assessments for each of the streams that will be impacted and for each of the streams that will serve as mitigation sites. Assessments were made of hydrologic, hydraulic, geomorphic, biotic, and water quality functions. The data gathered for the impacted streams document existing conditions to understand their functions in order to provide functional off-set with implementation of the Mitigation Plan. The data gathered for the restoration and enhancement mitigation sites document existing conditions to provide a baseline; after mitigation, conditions at the these sites will be assessed for comparison to the baseline in order to ensure that mitigation has provided functional lift. The off-site reaches that will be preserved as part of the Mitigation Plan were assessed only to the extent necessary to confirm that they met the criteria for preservation (i.e., that they were in an undisturbed state and could be included in a deed restriction).

The following sections detail the identification of representative reaches for assessment (Section 3.2) and the results of the functional assessments of those reaches (Sections 3.3 through 3.6). Appendix A provides detailed methodologies for the functional assessments.

3.2 Reach Identification

Depending on the functional assessment method, either entire streams were evaluated or representative reaches within entire streams were evaluated. Habitat and large woody debris were assessed throughout the entire streams, while hydrologic, hydraulic, geomorphic, riparian vegetation, aquatic organisms, and water chemistry were assessed in representative reaches. Using the Ecological Monitoring and Assessment Program for Surface Waters (Lazorchak, et. al.; 1998) methodology, evaluated reaches were "approximately 40 times the average wetted width at base-flow, but not less than 150 meters (492 feet) long." The following sections identify the reaches used to represent the impact areas (Section 3.2.1) and off-site restoration and enhancement areas (Section 3.2.2) as necessary for certain functional assessments. The discussions in Sections 3.3 through 3.6 indicate when more than just representative reaches were assessed.

3.2.1 Impact Areas

The proposed impacts to jurisdictional waters of the U.S. are located within the Pigeon Creek and Miller Creek watersheds of the Tug Fork River drainage basin. As detailed in Table 1.1, permanent and temporary impacts are proposed within the following nine (9) subwatersheds:

- Ruth Trace Branch
- Right Fork Conley Branch
- Left Fork Conley Branch
- Right Fork Hell Creek
- Left Fork Hell Creek
- Unnamed Tributary of Pigeon Creek
- Pigeonroost Creek
- Unnamed Tributary of Stonecoal Branch
- Unnamed Tributaries of Miller Creek

Forty-nine (49) representative reaches were evaluated in a sub-set of streams throughout the permit area (Figure 1.5 through Figure 1.12). Evaluated reaches throughout the permit area were selected based on a number of criteria to:

- Proportionately sample Rosgen stream types (i.e., Aa+, A, Ba, B, F);
- Proportionately sample flow regimes (i.e., perennial, ephemeral, intermittent);
- Proportionately sample drainage area sizes; and
- Be practicable, in regards to time and accessibility constraints.

Although the Unnamed Tributary of Stonecoal Branch will be impacted by the proposed project, none of the representative reaches are within that subwatered. This is because the impacts to the Unnamed Tributary of Stonecoal Branch (100 LF and less than 0.01 ac) are particularly small as compared to impacts within other subwatersheds (between 1,898 and 12,998 LF and between 0.17 and 2.07 ac). The impact area within the Unnamed Tributary of Stonecoal Branch can be represented by similar channels that will be permanently impacted and are among the representative reaches included in all of the detailed functional assessments.

Table 3.1 summarizes each of the sampled reaches in the permit area. After representative reach data were collected throughout the permit area, conclusions were made about similar stream types, flow regimes, and drainage areas. These conclusions are summarized for each type of functional assessment in Sections 3.3 through 3.6.

Table 3.1
Permit Area Reaches – Classification Summary

Reach	Reach ID	Impact type	Flow Regime	Rosgen Stream Type
Ruth Trace Branch and Associated Tributaries				
Ruth Trace Branch	RTBTP	Temporary	Perennial	F4/1b
Ruth Trace Branch	RTBPP	Permanent	Perennial	B3/1a
Ruth Trace Branch	RTBPI	Permanent	Intermittent	A4
UT15 of Ruth Trace Branch	UT15RTBPE	Permanent	Ephemeral	A4a+
UT1 of UT1 of Ruth Trace Branch	UT1UT1RTBPE	Permanent	Ephemeral	A4
Right Fork Conley Branch and Associated Tributaries				
Right Fork Conley Branch	RFCBTP	Temporary	Perennial	B4/1a
Right Fork Conley Branch	RFCBPP	Permanent	Perennial	A4/1
Right Fork Conley Branch	RFCBPI	Permanent	Intermittent	A4
UT1 of Right Fork Conley Branch	UT1RFCBPP	Permanent	Perennial	A4
UT1 of Right Fork Conley Branch	UT1RFCBPI	Permanent	Intermittent	A4a+
UT2 of Right Fork Conley Branch	UT2RFCBPI	Permanent	Intermittent	A4a+
UT4 of Right Fork Conley Branch	UT4RFCBPE	Permanent	Ephemeral	A4a+

Reach	Reach ID	Impact type	Flow Regime	Rosgen Stream Type
Left Fork Conley Branch				
Left Fork Conley Branch	LFCBTI	Temporary	Intermittent	A4/1a+
Left Fork Conley Branch	LFCBPI	Permanent	Intermittent	A4/1a+
Left Fork Conley Branch	LFCBPE	Permanent	Ephemeral	A4/1a+
Right Fork of Hell Creek and Associated Tributaries				
Right Fork of Hell Creek	RFHCTP1	Temporary	Perennial	B4a
Right Fork of Hell Creek	RFHCTP2	Temporary	Perennial	B4/1a
Right Fork of Hell Creek	RFHCPI	Permanent	Intermittent	B4a
Right Fork of Hell Creek	RFHCPE	Permanent	Ephemeral	A4/3
UT1 of Right Fork Hell Creek	UT1RFHCTP	Temporary	Perennial	A1
UT1 of Right Fork Hell Creek	UT1RFHCPP	Permanent	Perennial	B4a
UT1 of Right Fork Hell Creek	UT1RFHCPI	Permanent	Intermittent	A3
UT1 of Right Fork Hell Creek	UT1RFHCPE	Permanent	Ephemeral	A5a+
UT6 of UT1 of Right Fork Hell Creek	UT6UT1RFHCPE	Permanent	Ephemeral	A4a+
UT8 of UT1 of Right Fork Hell Creek	UT8UT1RFHCPE	Permanent	Ephemeral	A3a+
UT4 of Right Fork Hell Creek	UT4RFHCPI	Permanent	Intermittent	A3
UT10 of Right Fork Hell Creek	UT10RFHCPI	Permanent	Intermittent	A4a+
Left Fork of Hell Creek and Associated Tributaries				
Left Fork Hell Creek	LFHCTP1	Temporary	Perennial	B4
Left Fork Hell Creek	LFHCTP2	Temporary	Perennial	B4
Left Fork Hell Creek	LFHCPP	Permanent	Perennial	B4/1a
Left Fork Hell Creek	LFHCPI	Permanent	Intermittent	A4
UT1 of Left Fork Hell Creek	UT1LFHCTP	Temporary	Perennial	A4/3
UT1 of Left Fork Hell Creek	UT1LFHCPP	Permanent	Perennial	A4/3
UT1 of Left Fork Hell Creek	UT1LFHCPI	Permanent	Intermittent	A4a+
UT2 of UT1 of Left Fork Hell Creek	UT2UT1LFHCPI	Permanent	Intermittent	A4/1a+
UT4 of UT1 of Left Fork Hell Creek	UT4UT1LFHCPE	Permanent	Ephemeral	A4a+
UT10 of Left Fork Hell Creek	UT10LFHCPP	Permanent	Perennial	B3/4a
UT1 of UT10 of Left Fork Hell Creek	UT1UT10LFHCPI	Permanent	Intermittent	A4/1a+
UT1 of UT1 of UT10 of Left Fork Hell Creek	UT1UT1UT10LFHCPI	Permanent	Intermittent	A3a+
Unnamed Tributary of Pigeon Creek and Associated Tributaries				
UT of Pigeon Creek	UTPCTI	Temporary	Intermittent	A3/1a+
UT of Pigeon Creek	UTPCPI	Permanent	Intermittent	A4/1a+
UT of Pigeon Creek	UTPCPE	Permanent	Ephemeral	A3a+

Reach	Reach ID	Impact type	Flow Regime	Rosgen Stream Type
Pigeonroost Creek and Associated Tributaries				
Pigeonroost Creek	PRCTP	Temporary	Perennial	B4/1a
Pigeonroost Creek	PRCPI	Permanent	Intermittent	B3/1a
UT1 of UT1 of Pigeonroost Creek	UT1UT1PRCPE	Permanent	Ephemeral	A3a+
UT5 of Pigeonroost Creek	UT5PRCPI	Permanent	Intermittent	B3/1a
5th Unnamed Tributary of Miller Creek				
UT5 of Miller Creek	UT5MCTP	Temporary	Perennial	B3a
UT5 of Miller Creek	UT5MCPP	Permanent	Perennial	B4a
UT5 of Miller Creek	UT5MCPI	Permanent	Intermittent	A4a+

Note: UT = Unnamed Tributary.
Sources: Baker, 2008a (Jurisdictional Report approved by USACE September 18, 2008); Rosgen, 1994.

3.2.2 Off-Site Restoration and Enhancement Areas

Five reaches, hereafter referred to as Reach A through Reach E, were originally defined throughout the restoration and enhancement reaches, located in the Hell Creek subwatershed (Figure 1.7). An additional reach was defined when Reach B was split into Reach B1 and Reach B2 because of a difference in mitigation type. Reach A extends from the permit area on the main stem of the Right Fork of Hell Creek to a point downstream approximately 1,365 linear feet. Reaches B1 and B2 are also located in the Right Fork of Hell Creek. Reach B1 is an enhancement reach and extends 2,733 linear feet downstream from Reach A; Reach B2 is a restoration reach and extends 867 linear feet further downstream. Reach C is a small reach located between large drainage areas and extends approximately 887 linear feet within the Right Fork of Hell Creek. Reach D extends 1,462 linear feet downstream to the mouth of Hell Creek. Reach E is located on the Left Fork of Hell Creek and extends along the residential area approximately 1,878 linear feet. Table 3.2 summarizes the stream classification of the off-site restoration and enhancement mitigation sites.

For the purposes of the functional assessment, the four restoration reaches, as listed in Table 3.2, are represented by the two longer restoration reaches, Reach D and Reach E. Sections 3.3 through 3.6 present Reach D and Reach E assessment data as representative of the baseline conditions in Hell Creek/Right Fork Hell Creek and Left Fork Hell Creek restoration areas, respectively. Both enhancement reaches (Reach A and Reach B1) were used to gather baseline data for the proposed enhancement mitigation.

Table 3.2
Off-Site Restoration and Enhancement Reaches – Classification Summary

Reach ID	Stream	Mitigation Type	Flow Regime	Rosgen Stream Classification
Reach A*	Right Fork of Hell Creek	Enhancement	Perennial	B3c
Reach B-1*	Right Fork of Hell Creek	Enhancement	Perennial	B3c
Reach B-2	Right Fork of Hell Creek	Restoration	Perennial	B3c**
Reach C	Right Fork of Hell Creek	Restoration	Perennial	B4c**
Reach D*	Hell Creek	Restoration	Perennial	B4c
Reach E*	Left Fork of Hell Creek	Restoration	Perennial	B4c

* = These reaches were chosen as the representative reaches for presentation of detailed functional assessment data in this Mitigation Plan.
** = Based on best professional judgement since no geomorphic assessments were conducted.
Source: Baker, 2008a.

3.3 Hydrologic and Hydraulic Assessment

3.3.1 Impact Areas

3.3.1.1 Watershed Hydrology

Watershed hydrology assessments were used to determine how much runoff is produced from rainfall events. In addition, a discharge is calculated for various return intervals, such as the one-percent chance annual flood, more commonly known as the 100-year event.

Several methodologies are available to estimate the discharge, including hydrologic models, regional regression equations, and flood frequency analyses from stream gage records.

The project is located in the Appalachian Plateau Physiographic Province characterized by mostly noncarbonated sedimentary rocks. The rocks have been eroded by flowing water, forming steep hills and deeply incised valleys.

Regression equations for the region have been developed as detailed in USGS Water-Resources Investigation Reports 00-4080 and 02-4164 (USGS & WVDOT, 2000 and USGS et al., 2002). The project site is located in the Hydrologic South Region, with regression equations as follows for the 2-, 5-, 10-, 25-, 50-, and 100-year events where Q is discharge in cubic feet per second and A is area in square miles:

$$Q_2 = 95.4A^{0.785}$$

$$Q_5 = 153\,A^{0.772}$$

$$Q_{10} = 197\,A^{0.766}$$

$$Q_{25} = 257\,A^{0.759}$$

$$Q_{50} = 305\,A^{0.755}$$

$$Q_{100} = 355\,A^{0.751}$$

equations Table 3.3 through Table 3.9 summarize the peak discharges for each representative reach drainage area.

Table 3.3
Peak Discharges for Conley Branch and Associated Tributaries

Stream	Drainage Area		Peak Discharge by Return Frequency Interval (cfs)					
	Acres	Sq Mi	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Perennial Streams								
RFCBPP	77	0.12	18	30	39	51	62	72
RFCBTP	83	0.13	19	32	41	55	65	77
UT1RFCBTP	83	0.13	19	32	41	55	65	77
Intermittent Streams								
LFCBPI	51	0.08	13	22	29	38	45	53
LFCBTI	115	0.18	25	41	53	70	84	98
RFCBPI	32	0.05	9	15	20	27	32	37
UT1RFCBPI	38	0.06	11	17	23	30	37	43
UT2RFCBPI	38	0.06	11	17	23	30	37	43
Ephemeral Streams								
UT4RFCBPE	13	0.02	4	8	10	13	16	19

Table 3.4
Peak Discharges for Left Fork of Hell Creek and Associated Tributaries

Stream	Drainage Area		Peak Discharge by Return Frequency Interval (cfs)					
	Acres	Sq Mi	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Perennial Streams								
LFHCPP	154	0.24	31	51	66	87	104	122
LFHCTP1	320	0.50	55	90	116	152	181	211
LFHCTP2	282	0.44	50	81	105	138	164	192
UT1LFHCPP	64	0.10	16	26	34	45	54	63
UT1LFHCTP	147	0.23	30	49	64	84	101	118
UT10LFHCPP	83	0.13	19	32	41	55	65	77
Intermittent Streams								
LFHCPI	58	0.09	14	24	31	41	50	58
UT1LFHCPI	45	0.07	12	20	26	34	41	48
UT1UT1UT10LFHCPI	6	0.01	3	4	6	8	9	11
UT1UT10LFHCPI	13	0.02	4	8	10	13	16	19
UT2UT1LFHCPI	6	0.01	3	4	6	8	9	11

Table 3.5
Peak Discharge for Right Fork of Hell Creek and Associated Tributaries

Stream	Drainage Area		Peak Discharge by Return Frequency Interval (cfs)					
	Acres	Sq Mi	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Perennial Streams								
RFHCTP1	173	0.27	34	56	72	95	114	133
RFHCTP2	250	0.39	46	74	96	126	150	175
UT1RFHCCTP	83	0.13	19	32	41	55	65	77
UT1RFHCPP	58	0.09	14	24	31	41	50	58

Stream	Drainage Area		Peak Discharge by Return Frequency Interval (cfs)					
	Acres	Sq Mi	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Intermittent Streams								
RFHCPI	13	0.02	4	8	10	13	16	19
UT1RFHCPI	13	0.02	4	8	10	13	16	19
UT4RFHCPI	109	0.17	24	39	51	67	80	94
UT10RFHCPI	6	0.01	3	4	6	8	9	11
Ephemeral Streams								
RFHCPE	13	0.02	4	8	10	13	16	19
UT1RFHCPE	13	0.02	4	8	10	13	16	19

Table 3.6
Peak Discharge for Pigeonroost Creek and Associated Tributaries

Stream	Drainage Area		Peak Discharge by Return Frequency Interval (cfs)					
	Acres	Sq Mi	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Perennial Streams								
PRCTP	243	0.38	45	73	94	123	147	172
Intermittent Streams								
PRCPI	154	0.24	31	51	66	87	104	122
UT5PRCPI	64	0.10	16	26	34	45	54	63
Ephemeral Streams								
UT1UT1PRCPE	13	0.02	4	8	10	13	16	19

Table 3.7
Peak Discharge for Ruth Trace Branch and Associated Tributaries

Stream	Drainage Area		Peak Discharge by Return Frequency Interval (cfs)					
	Acres	Sq Mi	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Perennial Streams								
RTBTP	314	0.49	55	88	114	150	178	208
RTBPP	166	0.26	33	54	70	92	110	129
Intermittent Streams								
RTBPI	134	0.21	28	46	60	79	94	110
Ephemeral Streams								
UT15RTBPE	19	0.03	6	10	13	18	22	26
UT1UT17RTBPE	32	0.05	9	15	20	27	32	37

Table 3.8
Peak Discharge for 5th Unnamed Tributary of Miller Creek

Stream	Drainage Area		Peak Discharge by Return Frequency Interval (cfs)					
	Acres	Sq Mi	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Perennial Streams								
UT5MCTP	70	0.11	17	28	36	48	58	68
UT5MCPP	38	0.06	11	17	23	30	37	43
Intermittent Streams								
UT5MCPI	128	0.20	27	44	57	76	91	106

Table 3.9
Peak Discharge for Unnamed Tributary of Pigeon Creek and Associated Tributaries

Stream	Drainage Area		Peak Discharge by Return Frequency Interval (cfs)					
	Acres	Sq Mi	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Intermittent Streams								
UTPCTI	83	0.13	19	32	41	55	65	77
UTPCPI	51	0.08	13	22	29	38	45	53
Ephemeral Streams								
UTPCPE	19	0.03	6	10	13	18	22	26

3.3.1.2 Channel Hydraulics

A single cross section approach was selected for evaluating the channel hydraulics at the impact reaches. A riffle cross section was selected within each representative reach. The selected reach is representative of a stream segment in which field evidence of fluvial processes (e.g., the presence of a cascades, step-pools, or riffle-pool sequences) was observed. Discharge rating (or stage-discharge) and shear stress rating (or stage-shear stress) curves were developed for the selected cross sections using the computer program WinXSPRO; a Channel Cross section Analyzer, Version 3.0, developed by the U.S. Forest Service. WinXSPRO was developed for use in high gradient streams (slope > 0.01) and uses a resistance equation approach.

WinXSPRO supports the use of Manning's equation to estimate mean cross section velocity. It is assumed that flow is uniform within the channel for Manning's equation to be applicable. Uniform flow is met under conditions of constant width, depth, area, velocity, water surface slope, and energy grade. The Manning equation for mean velocity is:

$$V = \frac{1.486}{n} R^{2/3} S^{1/2}$$

where V = average velocity in cross section (feet per second)

n = Manning's roughness coefficient (n-value)

R = hydraulic radius (feet)

S = energy slope (foot/foot)

The Manning's roughness coefficient (n-value) was determined using methods described in the USGS *Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains*. Energy slope is estimated to be the average bed /water slope for low flows over a distance that is at least twenty times the channel width.

Under normal conditions, water that flows within a stream channel is called channelized flow. The channelized flow that creates stable channel morphology and represents the results of a full range of flows is called bankfull discharge. The water surface elevation of the bankfull discharge is known as the bankfull stage. In general, the bankfull discharge and bankfull stage have a recurrence interval between one and two years. Field observed bankfull indicators, where available, were identified and surveyed as part of cross section measurements at stable riffles and pools. For very small and steep streams without clear bankfull indicators, the top of bank was used for the hydraulic analysis rather than trying to estimate (or artificially create) a bankfull stage. It is likely that channel forming discharge theory (e.g. bankfull) doesn't apply to these steep gradient, often ephemeral, channels. For these streams, the "channel full" discharge was calculated rather than the bankfull discharge. This is discussed in more detail below.

Table 3.10 through Table 3.16 summarize the frequency (or recurrence interval) of the discharge that completely filled the channel. The recurrence interval was derived by comparing the calculated discharges from the hydrologic analysis at the cross section location to the stage-discharge relationship developed using WinXSPRO.

Table 3.10
Bankfull/Channel Recurrence Intervals from Stage-Discharge Relationships for Conley Branch

Stream Cross section	*n*-Value	Slope	Bankfull/ Channelfull (ft)	Bankfull Discharge (cfs)	Recurrence Interval (year)	Velocity (ft/s)
Perennial Streams						
RFCBPP	0.058	0.0215	1.06	24.0	2 to 5	3.2
RFCBTP	0.055	0.0409	0.87	20.4	2 to 5	3.61
UT1RFCBTP	0.044	0.5000	0.90	34.1	5 to 10	5.41
Intermittent Streams						
RFCBPI	0.060	0.0379	0.64	14.1	2 to 5	3.12
UT1RFCBPI	0.068	0.0548	0.87	13.5	2 to 5	2.90
UT2RFCBPI	0.060	0.0555	1.09	25.1	2 to 5	3.91
LFCBTI	0.047	0.0124	1.59	44.0	5 to 10	3.57
LFCBPI	0.050	0.1423	1.01	43.0	25 to 50	8.16
Ephemeral Streams						
UT4RFCBPE	0.059	0.1375	0.61	4.9	2.to 5	4.35

Table 3.11
Bankfull/Channel Recurrence Intervals from Stage-Discharge Relationships for Left Fork of Hell Creek

Stream Cross section	*n*-Value	Slope	Bankfull/ Channelfull (ft)	Bankfull Discharge (cfs)	Recurrence Interval (year)	Velocity (ft/s)
Perennial Streams						
LFHCTP1	0.046	0.0429	1.79	100.3	5 to 10	5.93
LFHCTP2	0.047	0.0550	1.83	196.5	> 100	8.36
LFHCPP	0.049	0.0484	1.23	50.7	2 to 5	5.63
UT1LFHCTP	0.042	0.0193	0.97	44.5	2 to 5	3.97
UT1LFHCPP	0.055	0.115	0.74	25.6	2 to 5	5.40
UT10LFHCPP	0.048	0.0342	0.77	14.4	1.4 to 1.5	3.59
Intermittent Streams						
LFHCPI	0.046	0.0635	1.18	43.1	25 to 50	6.03
UT1LFHCPI	0.048	0.2136	1.19	58.1	> 100	11.19
UT2UT1LFHCPI	0.049	0.4784	1.01	39.2	> 100	14.16
UT1UT10LFHCPI	0.059	0.4830	0.23	0.8	< 1.1	4.06
UT1UT1UT10LFHCPI	0.046	0.5039	0.39	14.7	1.8 to 1.9	9.79

Table 3.12
Bankfull/Channel Recurrence Intervals from Stage-Discharge Relationships for Right Fork of Hell Creek

Stream Cross section	*n*-Value	Slope	Bankfull/ Channelfull (ft)	Bankfull Discharge (cfs)	Recurrence Interval (year)	Velocity (ft/s)
Perennial Streams						
RFHCTP1	0.057	0.0467	1.74	60.2	5 to 10	5.34
RFHCTP2	0.053	0.0816	0.76	10.4	< 1.1	3.41
UT1RFHCTP	0.052	0.0131	0.89	15.6	1.5 to 1.6	2.50
UT1RFHCPP	0.046	0.0400	0.30	2.2	< 1.1	2.32
Intermittent Streams						
RFHCPI	0.057	0.0807	0.61	9.4	5 to 10	4.00
UT1RFHCPI	0.066	0.1743	0.89	20.6	> 100	6.32
UT4RFHCPI	0.061	0.0529	1.01	23.7	1.9 to 2.0	3.77
UT10RFHCPI	0.091	0.2659	0.40	7.4	10 to 25	3.63
Ephemeral Streams						
RFHCPE	0.063	0.0322	0.63	3.6	1.5 to 1.6	1.83
UT1RFHCPE	0.064	0.1155	0.59	12.3	10 to 25	4.19

Table 3.13
Bankfull/Channel Recurrence Intervals from Stage-Discharge Relationships for Pigeonroost Creek and Associated Tributaries

Stream Cross section	*n*-Value	Slope	Bankfull/ Channelfull (ft)	Bankfull Discharge (cfs)	Recurrence Interval (year)	Velocity (ft/s)
Perennial Streams						
PRCTP	0.045	0.0301	1.13	31.7	1.3 to 1.4	4.79
Intermittent Streams						
PRCPI	0.060	0.0141	0.17	0.2	< 1.1	0.73
UT5PRCPI	0.046	0.0429	0.92	19.2	2 to 5	4.54
Ephemeral Streams						
UT1UT1PRCPE	0.063	0.1639	0.80	30.4	> 100	6.76

Table 3.14
Bankfull/Channel Recurrence Intervals from Stage-Discharge Relationships for Ruth Trace Branch and Associated Tributaries

Stream Cross section	*n*-Value	Slope	Bankfull/ Channelfull (ft)	Bankfull Discharge (cfs)	Recurrence Interval (year)	Velocity (ft/s)
Perennial Streams						
RTBTP	0.049	0.0838	1.08	80.8	2 to 5	7.27
RTBPP	0.045	0.0225	1.95	100.7	25 to 50	5.77
Intermittent Streams						
RTBPI	0.050	0.0515	1.47	56.4	5 to 10	5.96
Ephemeral Streams						
UT15RTBPE	0.060	0.1803	0.69	8.8	2 to 5	4.91
UT1UT17RTBPE	0.062	0.0524	1.08	15.1	2 to 5	4.17

Table 3.15
Bankfull/Channel Recurrence Intervals from Stage-Discharge Relationships for 5th Unnamed Tributary of Miller Creek

Stream Cross section	*n*-Value	Slope	Bankfull/ Channelfull (ft)	Bankfull Discharge (cfs)	Recurrence Interval (year)	Velocity (ft/s)
Perennial Streams						
UT5MCTP	0.049	0.0332	0.80	11.2	1.3 to 1.4	3.01
UT5MCPP	0.046	0.0289	0.72	16.1	2 to 5	3.67
Intermittent Streams						
UT5MCPI	0.070	0.1737	0.53	1.9	< 1.1	3.49

Table 3.16
Bankfull/Channel Recurrence Intervals from Stage-Discharge Relationships for Unnamed Tributary of Pigeon Creek and Associated Tributaries

Stream Cross section	*n*-Value	Slope	Bankfull/ Channelfull (ft)	BankfullDischarge (cfs)	Recurrence Interval (year)	Velocity (ft/s)
Intermittent Streams						
UTPCTI	0.068	0.0645	0.88	27.3	2 to 5	4.23
UTPCPI	0.047	0.0461	0.81	8.6	1.2 to 1.3	3.29
Ephemeral Streams						
UTPCPE	0.053	0.1799	0.44	10.2	2 to 5	4.62

In general, streams with larger drainage areas resulted in recurrence intervals of less than 1.1 years for bankfull discharge. Conversely, streams with smaller drainage areas generally resulted in bankfull stage and discharge return intervals in the two- to five-year range.

3.3.2 Off-Site Restoration and Enhancement Areas

3.3.2.1 Watershed Hydrology

As detailed in Section 3.3.1.1 for the representative impact reaches, regression equations exist for the project region for calculating discharges for the 2-, 5-, 10-, 25-, 50-, and 100-year events. For the representative restoration and enhancement reaches, discharges for events ranging from the 1.1- to 2-year events have been estimated via interpolation because regression equations are not available for storms less than the two-year event. Table 3.17 shows the discharges calculated for the 1.1-, 1.2-, 1.3-, 1.4-, 1.5-, 1.6- , 1.7-, 1.8-, 1.9-, 2-, 5-, 10-, 25-, 50, and 100-year recurrence intervals.

To simplify the hydrologic analysis, it was assumed that the watershed should be analyzed for the post-mining condition after the surface mine sites have been reclaimed and stabilized. This is reasonable because the proposed stream mitigation is expected to be a permanent feature, whereas the ongoing mining and reclamation operations are temporary conditions. Based on this assumption, the USGS Regional Regression Equations presented the best alternative for evaluating the hydrologic response of these watersheds.

Table 3.17
Discharges for Off-Site Restoration and Enhancement Reaches

Recurrence Interval (yrs)	Discharges (cfs)			
	Enhancement		Restoration	
	Reach A	Reach B-1	Reach D	Reach E
1.1	31	54	128	79
1.2	37	65	155	95
1.3	42	74	174	107
1.4	46	81	190	117
1.5	50	87	204	126
1.6	53	93	217	134
1.7	56	97	227	141
1.8	59	102	238	147
1.9	61	106	247	153
2	63	109	255	158
5	102	175	403	251
10	132	225	514	322
25	172	293	665	418
50	205	348	785	495
100	239	405	910	575

3.3.2.2 Channel Hydraulics

Existing, pre-restoration riffle cross-sections for Right Fork of Hell Creek, Left Fork of Hell Creek and the Main stem of Hell Creek were analyzed using the US Forest Service computer program WinXSPRO, which was developed for steep mountain streams (Table 3.18). This program was chosen for its applicability to gradients steeper than 1% and for streams with rapidly varying cross-sections, although it can be used for slopes less than 1%. Additional information about the design hydraulics is located in Section 7.3.

Table 3.18
Bankfull/Channelfull Recurrence Intervals from Stage-Discharge Relationships for Mitigation Reaches

Reach ID Cross section	*n*-Value	Slope	Bankfull Stage (ft)	Bankfull Discharge (cfs)	Recurrence Interval (year)	Velocity (ft/s)
Reach A	0.073	0.0594	1.04	34.32	1.1 to 1.2	3.04
Reach B-1	0.073	0.0258	1.50	58.33	1.1 to 1.2	2.88
Reach D	0.075	0.0185	1.34	80.58	< 1.1	3.23
Reach E	0.065	0.0038	1.56	103.03	1.2 to 1.3	3.98

3.4 Geomorphic Assessment

The hydrology and hydraulic calculations from Section 3.3 were used along with geomorphic assessments to address the streams' stability (vertical and lateral) and ability to transport sediment. The hydrology and hydraulic processes work with geomorphic processes to create the channel geometry, or form. Longitudinal and cross section surveys were performed in representative impact and mitigation reaches (see Section 3.2) to assess the existing condition of the channels. Bed material samples were collected to characterize the bedform and to perform sediment transport analyses. The following sections summarize the survey results. Surveyed cross sections, profiles, and sediment data are included in Appendix E. A photo log of each of the streams and their representative reaches is included in Appendix F.

3.4.1 Classification

3.4.1.1 Impact Areas

During the stream corridor assessments, a total of seventeen (17) stream types (including streams with additional bedrock influence) were identified at the proposed impact sites (Table 3.1). Rosgen A, B, and F channel types were identified with a range of dominant substrate sizes from sand to bedrock and different channel slopes.

Rosgen A Channels

There were 33 assessed reaches that classified as Rosgen A or Aa+ channels in the proposed impact area (Appendix E). Throughout these subwatersheds, dimension surveys showed entrenchment ratios (ERs) ranged from 1.2 to 4.8 and average width/depth ratios ranged from 6.2 to 13.1, with one channel having a width /depth ratio of 20.0. The channels W/D's and ER's are larger than typical for A channels due to them being incised to bedrock and are now overly wide. The channels now have minimal average depths and excess floodplain areas from incised bank materials. Profile surveys indicated average sinuosity in these subwatersheds ranged from 1.05 to 1.14. Average valley slope ranged from 0.044 to 0.444 (4.4 to 44.4 percent), while the average channel slope ranged from 0.047 to 0.465 (4.7 to 46.5 percent). Median particle size distributions of the channels are located in Appendix E.

Rosgen B Channels

There were 15 assessed reaches that classified as Rosgen B or Ba channels in the proposed impact area (Appendix E). Throughout these subwatersheds, dimension surveys showed ERs ranged from 1.1 to 3.2, and average width/depth ratios ranged from 14.4 to 20.1. As with the A channels, many of the B channels in the project area have incised and are now overly wide with small average depths, resultin in larger than typical ER's. Profile surveys indicated average sinuosity in these subwatersheds ranged from 1.07 to 1.22. Average valley slope ranged from 0.026 to 0.107 (2.6 to

10.7 percent), while the average channel slope ranged from 0.026 to 0.130 (2.6 to 13.0 percent). Median particle size distributions of the channels are located in Appendix E.

Rosgen Fb Channels

There was one assessed reach which classified as a Rosgen Fb channel in the proposed impact area (Appendix E). Throughout this channel, dimension surveys showed ER was 1.1, and average the width/depth ratio was 18.1. The profile survey indicated the sinuosity was1.10. The channel slope was 0.038 (3.8 percent), and the valley slope was 0.041 (4.1 percent). Median particle size distributions of the channels are located in Appendix E.

3.4.1.2 Off-Site Restoration and Enhancement Areas

During the stream corridor assessments, one stream type was identified in the proposed off-site restoration and enhancement areas. Table 3.19 provides a summay of the dimension, pattern, and profile parameters at each of the assessed stream types. More detailed geomorphic assessment data are provided in Appendix E.

Rosgen B Channels

The representative mitigation reaches are classified as Rosgen Bc channels (Table 3.19). Throughout the reaches, design values show ERs range from 1.3 to 2.7, and width/depth ratiois 12. Design values indicate sinuosity to be 1.0. Average valley and channel slopes range from 0.0184 to 0.0348 (1.8 to 3.5 percent). Median particle size distributions of the channels are located in Appendix E.

Table 3.19
Summary of Geomorphological Assessments at the Off-Site Enhancement & Restoration Sites

Stream Segment		Enhancement		Restoration	
		Reach A	Reach B1	Reach D	Reach E
Rosgen Stream Type		B3c	B3c	B4c	B4c
Drainage Area (sq mi)		0.59	1.19	3.5	1.9
Reach Length Surveyed (ft)		514.4	588.8	506.0	493.4
Dimension	Bankfull Width (ft)	11.8	19.2	10.4	16.1
	Bankfull Mean Depth (ft)	0.5	1.3	1.1	1.0
	Width/Depth Ratio	24.5	14.4	9.6	15.7
	Bankfull Area (sq ft)	5.7	25.7	11.2	16.5
	Bankfull Max Depth (ft)	1.04	2.1	1.3	1.6
	Width of Floodprone Area (ft)	18.1	26.1	16.8	18.4
	Entrenchment Ratio	1.5	1.4	1.6	1.1
	Max Pool Depth (ft)	2.1	2.2	2.5	2.0
	Ratio of Max Pool Depth to Bankfull Depth	4.3	1.6	2.4	2.0
	Pool Width (ft)	10.69	16.0	13.1	17.8
	Ratio of Pool Width to Bankfull Width	0.9	0.8	1.3	1.1
	Pool to Pool Spacing (ft)	61.7	28.7	356.6	24.1
	Ratio of Pool to Pool Spacing to Bankfull Width	5.2	1.5	34.4	1.5
	Bank Height Ratio	1.0	1.5	3.0	2.4
Profile	Valley Slope (ft/ft)	0.0280	0.0198	0.030	0.0235
	WS Slope (ft/ft)	NA	NA	NA	NA
	Channel Slope (ft/ft)	0.0291	0.0235	0.021	0.0233
	Pool Slope (ft/ft)	NA	NA	NA	NA
	Ratio of Pool Slope to WS Slope	NA	NA	NA	NA

NA = Not Attainable

3.4.2 Bedform Diversity

3.4.2.1 Impact Areas

Review of the geomorphic characterization study, including the longitudinal profile survey, reveals what appears to be an inverse relationship of stream gradient and bedform diversity; as gradient decreased, bedform diversity increased. For example, in the Rosgen A stream types, bedform diversity in the form of step-pool definition is very poor and sparse, functioning more like a cascade system. The percent of pools was 12 percent versus 88 percent riffles. The Rosgen B type streams had 24 percent pool and 76 percent riffle. In the Rosgen A and Rosgen B stream types, the channels begin to transition from a cascade system to a more defined step-pool system. The Rosgen F stream types were also poor in bedform diversity, having limited pools (21 percent) compared to 79 percent of the reaches being riffles.

3.4.2.2 Off-Site Restoration and Enhancement Areas

Existing conditions data of the geomorphic characterization study, including review of the longitudinal profile survey, indicate bedform diversity and in-stream habitat are balanced, but can be improved upon at the proposed off-site restoration and enhancement areas. Longitudinal data show that within the restoration reaches (Reaches B2, C, D, and E) there was an average of 58 percent riffle and 42 percent pool in the Rosgen B stream type, which is a relatively balanced system. Upon restoration and after sewer line installation, bankfull benches will be installed, where practicable. The riffle and pool ratio will be restored to the previously balanced system by designing in-stream habitat structure in the form of rock and wood.

3.4.3 Vertical Stability

3.4.3.1 Impact Areas

Most of the proposed impact sites were in small watersheds and had steep channel gradients (3.8 to 26 percent). These A and B channels, especially ones with slopes over 10 percent, were characterized as sediment supply reaches. They were degradational in nature, and in most cases had incised to bedrock or large colluvium, resulting in bank height ratios (BHR) ranging from 1.0 to 6.3. ERs were predominantly moderate (1.1 to 2.2), which is common for A and B streams located in v-shaped and colluvial valleys, respectively.

Since most of the empirically based sediment transport competency relationships were not developed for these stream types, only qualitative methods were used to determine vertical stability. However, there were two sites (RTBTP and RTBPP with drainage areas of 0.49 and 0.26 sq mi, respectively), for which, sediment transport competency was assessed by comparing the existing mean depth to the required depth and the existing channel slope to the required slope. The results of this analysis are shown in Table 3.20.

Table 3.20
Sediment Transport Competency Results for the Low Gradient Assessments

Reach ID	Existing Mean Depth (Ft)	Required Depth (Ft)	Existing Slope (ft/ft)	Required Slope (ft/ft)
RTBTP	0.78	0.25	0.041	0.013
RTBPP	1.35	0.26	0.047	0.009

These results show that the existing depth and slope are much larger than the required parameters. The stream has incised and is now an overly wide channel type. These reaches may continue to degrade and bank erosion may increase until stable channel dimensions and slope are achieved and a floodplain area is well established.

Overall, the A, Aa+ and Ba stream types are vertically stable because of the presence of bedrock, colluvium, and small drainage areas. As channel gradient decreases, and stream types transition to B stream types, the risk of incision increases. It is likely that the F channel was like its downstream B channel, but has incised because of channel alterations, resulting in this stream's having a greater risk of instability and not being able to function at its highest potential.

3.4.3.2 Off-Site Restoration and Enhancement Areas

Bed material samples were collected from the representative restoration and enhancement reaches. The boundary shear stress was calculated and the particle size that should be mobile during a bankfull event was predicted using the EPA competency curve (US EPA, 2005). This predicted value was then compared to the D84 of the bed material to assess vertical stability. The results are shown in Table 3.21.

Based on the competency analysis and modeling, the predicted mobile bed material is larger than the existing D84, but smaller than the largest particle (D100), therefore indicating that the stream is not vertically unstable, having additional bed armoring. Other than Reach B-1, which has sufficient armoring capability during bankfull events, competency data indicate that most of the substrate materials in the remaining reaches will be moved during a bankfull event (Table 3.21). Additional signs of incision are demonstrated with the BHRs, which ranged from 1.5 to 3.0 in Reaches B1, D, and E (Table 3.19). A stable BHR, as seen in Reach A, is 1.0 (Table 3.19). Therefore, to prevent further degradation (i.e., incision), additional step-pool structures will be installed and bed material will be used for constructed riffles.

Table 3.21
Sediment Transport Competency Analysis

Reach ID	Shear Stress (lbs/sqft.)	Predicted Grain Diameter (mm) EPA curve	Measured Grain Diameter D84 (mm)	Measured Grain Diameter D100 (mm)
Reach A	1.49	373	270	470
Reach B-1	1.26	317	130	190
Reach D	1.64	409	180	410
Reach E	1.77	441	230	490

3.4.4 Lateral Stability

3.4.4.1 Impact Areas

The potential for streambank erosion was assessed using the Bank Erosion Hazard Index (BEHI) and Near Bank Stress (NBS) analysis (Rosgen, 2001a). Using this methodology, erosion rates were standardized by length of channel in feet (LF) to enable comparison between reaches.

At the temporarily and permanently impacted areas, rates were 0.07 to 0.97 ft^3/LF and 0.02 to 0.84 ft^3/LF, respectively. Erosion rates of 1.00 ft^3/LF or higher are typically indicative of a laterally unstable stream channel (Baker, project data); therefore, the impact reaches were determined to be laterally stable. BEHI-derived erosion estimates by impact type are provided in Table 3.22.

Table 3.22
Erosion Rate Results, Temporary Impact Reaches

Subwatershed	Temporary Impacts			Permanent Impacts		
	ft3/yr	Tons/yr	ft3/LF/yr	ft3/yr	Tons/yr	ft3/LF/yr
Ruth Trace Branch	372	17.9	0.41	74-269	42.6	0.08-0.26
Conley Branch	68-208	28.0	0.08-0.23	63-521	78.8	0.07-0.58
Right Fork Hell Creek	177-705	76.6	0.19-0.78	16-331	56.1	0.02-0.84
Left Fork Hell Creek	127-321	32.5	0.16-0.97	30-426	93.8	0.06-0.47
Unnamed Tributary of Pigeon Creek	236	11.4	0.26	178-236	20.0	0.20-0.26
Pigeonroost Creek	250	12.0	0.28	105-165	20.1	0.16-0.18
Unnamed Tributaries of Miller Creek	64	3.1	0.07	174-226	19.3	0.19-0.25

3.4.4.2 Off-Site Restoration and Enhancement Areas

Using methods described in Section 3.4.4.1 for the representative impact reaches, the representative restoration and enhancement reaches were also assessed and analyzed for lateral stability. Standardized by linear foot of stream, erosion rates were between 0.15 ft^3/LF and 0.43ft^3/LF. Erosion rates of 1.00 ft^3/LF or higher are typically indicative of a laterally unstable stream channel (Baker, project data); therefore, the assessment reaches are considered laterally stable. BEHI-derived erosion estimates by reach are provided in Table 3.23.

Table 3.23
BEHI Results for Off-Site Restoration and Enhancement Reaches

Reach	ft^3/yr	Tons/yr	ft^3/LF/yr
Reach A	155	7.5	0.15
Reach B1	362	17.4	0.32
Reach D	333	16.0	0.43
Reach E	170	8.2	0.19

3.5 Biotic Assessment

Several different biotic assessments were conducted at both the proposed impact and mitigation sites, including assessments of stream habitat, riparian habitat, large woody debris (LWD), and benthic macroinvertebrates. Methodologies for these assessments are detailed in Appendix A. For stream habitat and LWD, entire stream lengths were assessed as opposed to only representative reaches.

3.5.1 Stream Habitat

Stream habitat was assessed throughout the representative stream lengths throughout the impact and mitigation areas using the USEPA's *Rapid Bioassessment Protocols (RBP) for Use in Streams and Wadeable Rivers* (Barbour et al., 1999). The RBP habitat assessment ranks 10 different parameters on a scale of one to twenty with twenty being optimal. The scores of each parameter are totaled to provide a Habitat Assessment Value (HAV). This HAV assessment allows for the rapid assessment of in-stream characteristics, channel morphology, bank stability, and riparian vegetation. Results are summarized below, and Appendix G contains detailed HAV scores for each stream.

3.5.1.1 Impact Areas

On-site scores varied among sites because of disturbances in the subwatershed. In general, HAV scores in the permit area decreased from the perennial to intermittent and from the intermittent to ephemeral streams. In addition to a general lack of in-stream habitat throughout the ephemeral channels, channel flow status and bedfrom diversity (i.e. velocity/depth regimes, frequency of riffles) were lacking (Appendix G). Throughout all the stream flow regimes, there was an overall lack of epifaunal substrate and bedform diversity throughout the proposed permit area. Sedimentation was moderate to heavy throughout much of the proposed permit area as well. In general, bank erosion scores were consistent with the lateral stability analysis results (Section 3.4.4), showing the banks were stable.

In summary, habitat assessments were mostly poor to moderate, with moderate embeddedness and low bedform diversity. Table 3.24 shows the average HAV scores for the impact reaches, broken out by subwatershed and by stream class. Table 3.24 also shows the average HAV results specifically for the streams that will undergo on-site restoration.

Table 3.24
Average HAV scores for Impact Sites

HAV Assessment Site	Perennial Channels	Intermittent Channels	Ephemeral Channels	On-Site Restoration Areas
Ruth Trace Branch	102	90	66	119
Conley Branch	114	99	77	124
Right Fork Hell Creek	68	83	66	86
Left Fork Hell Creek	120	102	53	98
Unnamed Tributary of Pigeon Creek	N/A	100	75	103
Pigeonroost Creek	126	116	93	113
Unnamed Tributary of Stonecoal Branch	N/A	124	N/A	N/A
Unnamed Tributaries of Miller Creek	123	117	123	101
Average	**109**	**104**	**79**	**106**

N/A = Not Applicable

3.5.1.2 Off-Site Restoration, Enhancement, and Preservation Areas

Average HAV scores were highest in the preservation reaches. This was anticipated because a selection criterion for preservation reaches was a relatively undisturbed state (Section 1.4.2.2). One preservation reach had some low habitat scores because of an access road running parallel to the stream. The remaining preservation reaches had HAV scores ranging from 75 to 135.

The restoration and enhancement reaches (all perennial) had average HAV scores of 87 and 109, respectively. These reaches had a general lack of habitat types and moderate amounts of sedimentation. During the time of the survey, channel flow status had a low score, while bank stability, vegetative protection, and riparian vegetation zone width parameters also had low scores. In summary, habitat assessments were moderate to poor, having a general lack of aquatic in-stream habitat, substrate, and cover that is ideal for benthic macroinvertebrate and fisheries diversity.

Table 3.25
Average HAV scores for Off-Site Preservation, Restoration, and Enhancement Areas

Flow Regime	Restoration Channels	Enhancement Channels	Preservation Channels
Perennial Channels	87	109	105
Intermittent Channels	N/A	N/A	104
Ephemeral Channels	N/A	N/A	88

N/A = Not Applicable

3.5.2 Riparian Vegetation

Cove hardwoods, also referred to as deciduous woody, perennial trees, are the predominant forest cover type associated with the riparian study areas. Typically, areas along the lower reaches of ephemeral and intermittent streams are wetter and accommodate cove hardwood species, while the upper reaches are drier and eventually transition into the dominant forest cover types of the region, which are upland hardwoods. Upland hardwoods primarily consist of deciduous species of oaks and hickories, with associated species of American beech and red maple, all of which are well adapted to drier sites and are also capable of thriving within the riparian area. Smaller tree species associated with the riparian study areas include witch hazel (*Hamamelis l.)*, musclewood (or ironwood) (*Eusideroxylon teijsm)*, paw paw (*Asimina adans)*, and sourwood (*Oxydendrum dc.)*. Shrubs consist primarily of spicebush (*Lindera benzoin)*.

Herbaceous cover, which includes grasses, sedges, and rushes associated with riparian areas, is typically more abundant close to the stream. Cooler temperatures within the riparian area resulting from shade and moist soil provide habitat for numerous plants, fern, and moss species. Surveyed plants include wild geranium (*Geranium l.)*, poison ivy (*Toxicodendron radicans)*, stinging nettle (*Urtica dioica l.)*, greenbrier (*Smilax l.)*, black berry (*Rubus l.)*, and numerous narrow leaf grasses and broadleaf forbs. Surveyed fern species include Christmas fern (*Polystichum acrostichoides)*, sensitive fern (*Onoclea sensibilis)*, and intermediate fern (*Trichomanes boschianum)*. Appendix G contains all of the vegetation data.

3.5.2.1 Impact Areas

Using three different methodologies (Appendix A), the riparian vegetation throughout the permit area was classified as having xeroriparian habitats, which are mesic to xeric with the average moisture being higher than the surrounding uplands. The dominant class of vegetation consisted of a mix of deciduous and coniferous trees, tall (>1m) shrubs, and a mixture of tall (>30cm) and low-lying (<30cm) herbaceous layer.

With the exception of four reaches, canopy cover ranged between 85 and 89 percent cover throughout the permit area. The other four reaches had greater than 90 percent canopy cover. Overall, the dominant vegetation in the permit area was tree strata; however, either shrubs or a combination of shrubs and herbaceous vegetation with tree strata were also present.

Each assessment tool was evaluated and analyzed to determine if any correlations or conclusions could be drawn from the data collected throughout the permit area and adjacent mitigation areas. For instance, in regards to canopy cover and riparian buffer zone analysis (i.e., the Riparian Vegetation Zone Width habitat parameter), it appears as though with minimal impacts to the riparian buffer zone (i.e., small gas access roads), there is not a negative effect on the overall percentage of canopy cover in the stream; this is the case for the intermittent and ephemeral streams assessed for the project. However, in the perennial streams, which had the largest disturbances to the riparian buffer zone (i.e., larger gas access roads, county roads, residences), canopy cover decreased (Figure 3.2). Riparian buffer disturbances, and hence tree strata, also appeared to correlate with the amount of large woody debris in the streams (Appendix A).

3.5.2.2 Off-Site Restoration and Enhancement Areas

The representative enhancement reaches (A and B1) both had xeroriparian habitats and were dominated by the tree and herbaceous layers, although a portion of Reach B1 had less cover because of an access road. The riparian vegetation in the representative restoration reaches (D and E) was limited by a parallel county road, and both had a sparse shrub layer. Reach D was dominated by the herbaceous layer and had vast areas of bare soil (i.e., dirt road). Reach E was dominated by trees. Reach A had less than 50 percent canopy cover on the left bank and approximately 75 percent cover on the right bank; Reach B1 had over 95 percent canopy cover on both banks; Reach D had less than

20 percent canopy cover on both banks; and Reach E had approximately 70 percent canopy cover on the left bank and greater than 95 percent cover on the right bank.

3.5.3 Large Woody Debris Habitat

Large woody debris (LWD) was assessed throughout all stream lengths. While absent in many environments, LWD is a vital component of riparian ecosystems in the Appalachian Mountains. It slows stream flow, allows organic material to settle out of the suspended load, provides protection and habitat for biota, and shields streambanks. As described in Appendix A, , LWD is defined as organic matter more than three feet in length that is at least four inches in diameter (Davis et al., 2001). This method counts all of the woody debris and debris dams within the bankfull channel. The Piece Score (PS) and Debris Dam Score (DDS) were calculated for each stream and the corresponding LWD Index (LWDI) was also calculated and normalized per foot. A summary of all the LWD assessments for each stream channel is located in Appendix G.

3.5.3.1 Impact Areas

There was an overall lack of LWD in the permit area. The LWDI/foot score ranged from 0.00 to 6.06 with an average of 1.12. Generally, stream classification and flow regime correlated with the LWDI scores, with the highest scores found in intermittent or ephemeral tributaries. Incorporating LWD into the design of the on-site restoration areas will be a primary focus of that portion of the Mitigation Plan.

3.5.3.2 Off-Site Restoration, Enhancement, and Preservation Areas

The average LWDI per foot was the greatest in the preservation reaches (1.49 LWDI/ft), compared to the restoration (0.01 LWDI/ft) and the enhancement reaches (0.04 LWDI/ft). Debris dams were only observed in the preservation reaches.

As revealed in the riparian vegetation assessments (Section 3.5.2), tree strata is lower in the restoration and enhancement reaches with parallel access and county roads. This limits the amount of LWD sources, and is reflected in the LWDI results. It is also likely that historic logging activities in the area have contributed to a reduction in overall LWD sources, even within the subwatersheds of the preservation reaches. However, the proposed preservation reaches are expected to continue to accrue LWD over time if they are protected in perpetuity. As with the on-site restoration reaches, LWD will be a critical component of the restoration and enhancement designs as described in Section 6.0 of this plan. The vegetation plans will also incorporate many woody species plantings to provide future sources of LWD to the stream systems.

3.5.4 Benthic Macroinvertebrates

3.5.4.1 Impact Areas

A total of thirty sampling stations were established within the permit area. The data were collected by Baker (Baker, 2007a) for purposes of the 401 WVDEP permit application. Overall, the representative impact reaches had “good” to “very good” WVSCI scores (Table 3.26). The percent shredders was low throughout the permit area, as the benthic macroinvertebrate population was made of approximately 10 percent shredders, compared to the 25 percent shredders typically found in other upper piedmont channels (Marques, 1998). These data demonstrate that decomposition rates, and hence nutrient cycling, are not as high as in undisturbed natural headwater streams. The data are summarized in Table 3.26 and are located in their entirety in Appendix G.

In summary, overall benthic macroinvertebrate diversity was high (Simpson’s Index, 0.673 to 0.956) throughout the permit area with only three sites having diversity indices lower than 0.800 and most of the species present were intolerant.

3.5.4.2 Off-Site Restoration and Enhancement Areas

A total of five sampling stations were established within the representative off-site restoration and enhancement reaches. The WVSCI scores at the restoration reaches were in the "gray area" (a score between "fair" and "good"; 61 – 68), while the enhancement reaches had "very good" WVSCI scores (Table 3.26). The percent shredders were low in the assessed reaches: between one and eight percent compared to the 25 percent shredders typically found in other upper piedmont channels (Marques, 1998). These data indicate that decomposition rates, and hence nutrient cycling, are low in the enhancement and restoration reaches. In summary, the off-site restoration and enhancement areas had relatively high diversity (Simpson's Index, 0.756 – 0.908); however most of the species present were tolerant. The data are summarized in Table 3.26 and are located in their entirety in Appendix G.

On May 23, 2007, however, additional benthic macroinvertebrate data was collected for the Upper Pigeon Creek Watershed Restoration Plan (WVWRI & CVI, 2008) which showed that Hell Creek had a WVSCI score of 55.2 ("fair") near the mouth (station referred to as Hell Creek Lower; Figure 3.1), which is located in Reach D. There were a total of 8 EPT taxa with a total percentage of only 29.8% EPT in this sample. The percent mayflies at this station were 21.1%. An additional station, Hell Creek Upper (Figure 3.1), was located near the upper section of Reach E in the Left Fork of Hell Creek, showed similar data having a WVSCI score of 58.8 ("fair"), a total of 9 EPT taxa, 41.2% EPT, and 30.3% mayflies.

Table 3.26
Benthic Macroinvertebrate Summary Table

Site Name	Individuals (#)	Taxa (#)	EPT Taxa (#)	% Mayfly	mHBI	WVSCI	Ranking
Proposed Impact Sites							
Ruth Trace Branch	178-180	12-18	10-11	67-78	2.4-2.9	87-91	Very Good
Conley Branch	14-148	9-16	4-12	13-77	1.8-5.0	52-91	Fair to Very Good
Right Fork of Hell Creek	63-144	8-19	6-13	40-68	2.6-3.7	76-93	Good to Very Good
Left Fork of Hell Creek	46-81	13-17	10-12	11-65	2.9-3.8	87-89	Very Good
Unnamed Tributary to Pigeon Creek	54-77	13-15	9-11	44-56	2.3-3.3	73-93	Good to Very Good
Pigeonroost Creek	158-232	18-25	13-15	40-48	3.0-3.4	95-100	Very Good
Unnamed Tributaries to Miller Creek	44-50	13-16	8-10	32-46	2.7-2.8	81-86	Very Good
Proposed Mitigation Sites in Hell Creek Subwatershed							
Reach A	100	13	10	62	3.9	79	Very Good
Reach B1	50	13	9	32	3.8	81	Very Good
Reach D	103	14	9	42	4.3	65	Gray Area[1]
Reach E	61	12	6	41	4.2	66	Gray Area[1]
Upper Pigeon Creek Watershed Restoration Plan							
Hell Creek Lower	N/A	21	8	21	6.1	55	Fair
Hell Creek Upper	N/A	20	9	30	5.9	59	Fair

[1]Gray Area = WVSCI between 61 and 68 between the "fair" and "good rankings (see Appendix A).

3.5.5 Fisheries Resources

3.5.5.1 Impact Areas

A total of five stations were sampled throughout the permit area. One station was located on Pigeonroost Creek, one station was located on Left Fork of Hell Creek, two stations were located on Right Fork of Hell Creek, and one station was located on Ruth Trace Branch (Figure 3.1).

As shown with the Simpson's Diversity Index (Appendix G), overall fish diversity was low within each of the sampled stations. A maximum of two pollution tolerant species were collected at the sampled sites. Total abundance ranged from 30 to 413 individuals per site, and total wet biomass ranged from 18 grams to 1,266 grams. Standing crop varied between 0.27 to 16.88 pounds per acre, while catch per unit effort (CPUE) ranged from 352 to 4,846.

3.5.5.2 Off-Site Restoration and Enhancement Areas

A total of three stations were sampled, including one on Reach B1, one on Reach D, and one on Reach E (Figure 3.1). As shown with the Simpson's Diversity Index (Appendix G), overall fish diversity was moderate within each of the sampled stations. Reaches B1 and E had only two total species, both of which were pollution tolerant (the creek chub and the blacknose dace). Reach D, the furthest downstream fish survey station, also had only two species, but these were pollution intolerant species (the northern hognose sucker and the banded darter). Total abundance ranged from 70 to 144 individuals per site, and total wet biomass ranged from 169 grams to 1,661 grams. Standing crop varied between 2.54 to 19.93 pounds per acre, while CPUE ranged from 924 to 1,901. Most of the fish observed at these stations were saturated with black spot parasites. Some of the fish also had damaged fins.

3.6 Water Quality Assessment

To provide baseline data, water samples were collected during the benthic macroinvertebrate studies in the spring and fall of 2006 (Baker, 2007a, 2007b). Methods and parameters were selected and followed in accordance with those recommended in "Interim Chemical/Biological Monitoring Protocol for Coal Mining Permit Applications" (USEPA, 2000). Assessment results are located in Appendix H. Additional baseline water quality (BWQ) is available in the EID (Baker, 2010), which extends from November 2005 through September 2007.

3.6.1 Impact Areas

The single sampling date data collected during the benthic macroinvertebrate studies showed the water chemistry was good, with the exception of some sites having slightly acidic water. Ruth Trace Branch and Conley Branch watersheds had sites with acidic water, with pH values below the recommended range for freshwater organisms (Appendix G). The remaining subwatersheds had values that were within recommended limits, but were for the most part slightly acidic. The alkalinity or buffering ability of the streams was moderate to low throughout the proposed permit area. Existing conductivity levels collected in the Spring of 2006 throughout the proposed permit area and the downstream reaches (excluding Pigeon Creek) ranged from 44 µS/cm to 171µS/cm (Figure 3.3; Appendix H; Baker 2007a). Conductivity levels in Pigeon Creek in the Spring of 2006 were slightly higher ranging from 269 µS/cm to 536 µS/cm at stations located just above, throughout, and just downstream of permit boundary (Figure 3.3; Appendix H; Baker 2007a). Conley Branch, Right Fork of Hell Creek, and the two unnamed tributaries of Miller Creek within the proposed permit area had areas with iron levels that were greater than the recommended limit for freshwater organisms; Left Fork of Hell Creek had one sampling station with elevated iron levels. Additional fecal coliform analysis collected in August 2008 (Table 1.10) demonstrated that levels were outside of recommended WVDEP criteria. The remaining water constituents were within recommended limits for freshwater organisms.

The BWQ data, collected over several months, provides a better understanding of the water quality in the proposed impact areas. In summary, levels of most of the water chemistry constituents, including iron and pH, were within recommended ranges. Alkalinity levels were low on average at one of the Conley Branch sites, however pH levels were within recommended ranges. On average, conductivity was low, ranging from 52 µS/cm to 240 µS/cm (Baker, 2010), however there appears to be seasonal differences among conductivity levels with peaks in the summer and fall (Table 3.27). It is important to note that the highest conductivity level was in a watershed, Ruth Trace Branch, which has no known previous mining activities and was only impaired by residential homes located in the floodplain areas, indicating residential pollution may have lead to high conductivity levels in this specific subwatershed. Studies have shown that residential pollution is correlated to high specific conductivity levels in downstream waters (Merriam et al., *In Review*; David, 2008; Merriam, 2009; WVWRI & CVI, 2008). It has also been documented that floodplain structure density (i.e. residences) was moderately correlated with conductivity levels in the water (WVWRI & CVI, 2008).

Table 3.27
Specific Conductivity Summary from BWQ data

Subwatershed	Sampling Site	Description	Specific Conductivity (uS/cm; average per season) Fall 2005 - Summer 2006				Average per Year
			Fall (Sep - Nov)	Winter (Dec - Feb)	Spring (Mar - May)	Summer (June-Aug)	
Ruth Trace Branch	**CKRTB**	**mouth**	**297.0**	**NC**	**87.4**	**334.2**	**239.5**
Conley Branch	BWQ CONSOL 1*	ponds	NC	NC	54.3	NC	**54.3**
Conley Branch	BWQ CONSOL 3*	ponds	NC	NC	51.6	NC	**51.6**
Conley Branch	BWQ CONSOL 4	downstream	108.1	62.0	57.9	71.5	**74.9**
Conley Branch	BWQ CONSOL 7	mouth	319.0	91.8	104.5	262.4	**194.4**
Conley Branch	**Average**		**213.5**	**76.9**	**67.1**	**166.9**	**118.3**
Hell Ck	**BWQ CONSOL 14***	**mouth**	**192.5**	**104.7**	**96.2**	**154.3**	**136.9**
RFHC	BWQ CONSOL 11*	ponds	132.1	154.4	129.9	174.2	**147.7**
RFHC	BWQ 27*	ponds	119.4	127.7	227.2	145.5	**154.9**
RFHC	BWQ CONSOL 12*	downstream	191.6	146.2	114.5	182.3	**158.7**
RFHC	**Average**		**147.7**	**142.8**	**157.2**	**167.3**	**153.8**
LFHC	BWQ 30*	ponds	107.5	63.2	76.8	132.3	**94.9**
LFHC	BWQ 29*	ponds	109.1	63.7	99.1	144.8	**104.2**
LFHC	BWQ 31*	mouth	156.4	73.3	81.7	105.4	**104.2**
LFHC	**Average**		**124.4**	**66.7**	**85.9**	**127.5**	**101.1**
Pigeonroost Ck	BWQ 41	downstream	110.8	52.5	56.6	77.4	**74.3**
Pigeonroost Ck	BWQ 40	mouth	255.9	68.6	114.5	200.0	**159.8**
Pigeonroost Ck	**Average**		**183.3**	**60.5**	**85.6**	**138.7**	**117.0**

3.6.2 Off-Site Restoration and Enhancement Areas

Overall, water chemistry was good with the exception of high fecal coliform levels in the off-site restoration reaches (Table 1.9. Table 1.10), which has shown to negatively influence species composition by having more tolerant species present (Moss, et. al, 1993; Loyalhanna, 2005). The alkalinity, or buffering capacity, of the off-site mitigation streams was less than the recommended limits, but the pH of both reaches was close to neutral. All other water chemistry constituents were within recommended limits for freshwater organisms. The Hell Creek Lower and Hell Creek Upper stations sampled in May 2007 (WVWRI & CVI, 2008) showed similar data, having recommened levels of water quality parameters.

Pigeon Creek, the receiving stream to Hell Creek, has high fecal coliform levels, high conductivity levels (Baker 2007a, 2007b; WVDEP 2006; WVWRI & CVI, 2008), and sulfates (WVDEP 2006; WVWRI & CVI, 2008), which may also have a negative effect on the aquatic communities in Hell Creek.

4.0 ON-SITE RESTORATION DESIGN

CONSOL is proposing to restore 10,215 LF (1.657 ac) of temporarily impacted stream channel on the reclaimed mine lands within the Buffalo Mountain Surface Mine permit area. The temporary impact areas include twenty-one drainage control structures and six road crossings. Because mitigation of these channels is not expected to occur for approximately 15 years (see Environmental Information Document for timeline; Baker, 2009), CONSOL proposes to provide an additional 14,323 LF of mitigation off-site to offset temporal loss (Table 1.8; Section 5.0 - 7.0). As described in the following sections, design rationale has been planned for the on-site restoration reaches; however, detailed design criteria and plan views will not be developed until the sites near the construction phase. A conceptual design plan sheet is located in Appendix I.

Natural stream channel design techniques (USDA-NRCS, 2007b; Chapter 11 Rosgen Geomorphic Channel Design) will be implemented to ensure the reconstructed channels obtain the appropriate stream types for their valley settings. All restoration practices will take place during periods of low flow. Both reference channels and those streams in their natural states before disturbances will be used to define existing function for restoration design (Appendix E). These data along with additional reference and regional curve data Appendix A, Figures A-10 and A-11), will allow for the reconstruction of streams to their approximate original state or better.

The primary objectives of the on-site restoration mitigation are to restore the streams' dimension, pattern, and profile to physical conditions that are expected to:

1) Transport the adequate size and amount of sediment,
2) Increase bedform diversity,
3) Create stable bed forms (i.e., decreasing incision and sediment pollutant loading),
4) Increase and improve aquatic habitat,
5) Provide floodplain benefits (i.e., storage and groundwater recharge), and
6) Provide hydrologic connectivity to jurisdictional waters of the U.S.

4.1 Design Rationale – Geomorphology

4.1.1 Design Criteria

4.1.1.1 Overview

Existing conditions data were collected on representative reaches to analyze for both assessment and future design purposes. Representative assessments indicated the areas had minor to major instabilities, presumably from logging, residential, gas, and/or access road disturbances. Therefore, upon restoration and reclamation of these areas, these data will be used to prepare final construction plans of the on-site restoration areas. Nonetheless, preliminary and conceptual design information has been prepared and is summarized below.

Based on existing valley type and corresponding reference data, each of the on-site restoration areas will be designed to the proper Rosgen stream type. The design will include channel dimensions that transport only up to the bankfull discharge. All higher discharges will flow onto the adjacent floodplain area, providing storage for water and sediment. Channel pattern, although minimal, and profile will be designed to increase aquatic habitats and to create a diverse bedform of alternating riffle/steps and pools. Together, channel dimension, pattern, and profile will be designed to create a channel that does not degrade or aggrade over time, while creating a variety of aquatic habitats.

In-stream structures will also be used to enhance the natural channel design. A combination of rock and log cross vanes, step pools, and rootwads will be used to provide grade control, improve bedform diversity, and re-introduce large woody debris. Erosion control matting, live stakes, bareroots, and transplants will be used in combination to stabilize banks and facilitate the establishment of a riparian buffer zone.

4.1.1.2 Dimension

Throughout each of the on-site restoration areas, the bankfull W/D ratio will range from 10 to 12 to help achieve the appropriate depth for sediment transport competency and capacity. Slope (profile, see below) must also be considered for appropriate sediment transport.

The ratio of low bank height to maximum bankfull depth (BHR) will be set to 1.0. Once flood water rises above the bankfull stage, bankfull benches will be constructed to allow the storm flow to spread out on the floodplain and reduce erosion-causing shear stress in the channel. In-stream structures will be used to provide bank protection and maintain pool cross sections throughout the channel.

4.1.1.3 Pattern

The on-site restoration areas will be either Rosgen A or B channels, which typically have low sinuosity (i.e., pattern) and dissipate energy vertically by creating step-pool bed morphology. The stream types have low to moderate sinuosity, therefore no design criteria for meander geometry will be necessary. The pattern for a these channel types is controlled by topography with the stream flowing through the lowest part of the valley. The valley itself is controlled by the underlying geology and adjacent hillslope processes. The design sinuosity for the on-site restoration areas will be between 1.1 and 1.2. This will maintain proper channel slopes.

4.1.1.4 Profile/Bedform

The on-site restoration areas will include the construction of step pool sequences along the stream bed, using a combination of rock and log structures. The slopes for the riffles will typically vary from 1.1 to 1.8 times the design channel slope. Pool slopes will be designed using slope ratios of 0.0 to 0.4 times the design channel slope. The maximum pool depth is 2.0 to 3.5 times the riffle mean depth.

4.2 Design Rationale - Hydrology and Hydraulics

Hydrology and hydraulic modeling for the on-site restoration areas was performed for representative stream segments and is included in Section 3.3 of this plan.

4.3 Design Rationale – Biotic

The biotic functions of a stream system are highly influenced by the structural form of the stream channel itself. Aquatic organisms are suited to specific habitats, and with more habitat diversity there is generally increased diversity in aquatic organisms (i.e., a higher functional level). Natural, stable stream systems develop this diversity over time, through processes such as sediment transport, bed material sorting, organic matter collection, and vegetation growth. When stream systems become impaired, biotic functions are typically impaired as well as a result of excess sedimentation, loss of riparian vegetation, and channel disturbance.

In restored stream systems, newly constructed channels must be built in a way that ensures stability while also providing appropriate and diverse habitat. Stream channels are constructed to provide riffle, pool, and transition areas, with structural components to provide stability and habitat value. As the system matures over time, the restored stream will function more and more as a natural system, with biotic functions approaching those of reference sites.

4.3.1 In-Stream Structures

In-steam structures are used in restoration design to provide channel stability and promote certain habitat types. In-stream structures are necessary because newly constructed channels do not have dense riparian vegetation and roots that provide bank stability, nor do they exhibit a natural distribution of stream bed material that provides armoring and allows stable sediment transport processes. In-stream structures are used to provide stability to the system until these natural processes evolve to provide long-term stability and function to the system (Table 4.1).

The on-site restoration channels will include a variety of different structures including, but not limited to those described below. Specific locations of in-stream structures in each of the mitigation sites are presented on the attached plan sheets (Appendix I).

Table 4.1
Proposed In-Stream Structure Types and Locations

Structure Type	Location
Root Wads	Outer meander bends and other areas of concentrated shear stresses and flow velocities along banks.
Brush Mattresses	Outer meander bends, areas where bank sloping is constrained, and areas susceptible to high velocity flows.
Cross Vanes	Long riffles; tails of pools if used as a step; areas where the channel is overly wide; areas where stream gradient is steep and where grade control is needed.
Single Vanes and J-hooks	Outer meander bends; areas where flow direction changes abruptly; areas where pool habitat for fish species is desirable.
Cover Logs	Used in pools where habitat for fish species is desirable.
Root Wads	Outer meander bends and other areas of concentrated shear stresses and flow velocities along banks.
Angled Log Step Pool	Riffles / steps of smaller streams.
Rock Step Pools	Riffles / steps of smaller streams.

4.3.1.1 Root Wads

Root wads are placed at the toe of the stream bank in the outside of meander bends and other areas of concentrated shear stresses along stream banks for the creation of habitat and for bank protection. Root wads include the root mass or root ball of a tree plus a portion of the trunk. They are used to armor a stream bank by deflecting stream flows away from the bank. In addition to stream bank protection, they provide structural support to the stream bank and habitat for fish and other aquatic animals. Banks underneath rootwads tend to become slightly undercut, forming an area of deep water, shade, and cover for a variety of fish species. Organic debris tends to collect on the root stems that reach out into the channel, providing a food source for numerous macroinvertebrate species. Root wads will be placed throughout the mitigation project (USDA-NRCS, 1992; Chapter 18 Soil Bioengineering; Gray & Sotir, 1996).

4.3.1.2 Brush Mattress

Brush mattresses are placed on bank slopes for stream bank protection. Layers of live, woody cuttings are wired together and staked into the bank. The woody cuttings are then covered by a fine layer of soil. The plant materials quickly sprout and form a dense root mat across the treated area, securing the soil and reducing the potential for erosion. Within one to two years, a dense stand of vegetation can be established that, in addition to bank stability provides shade and a source of organic debris to the stream system. Deep root systems often develop along the waterline of the channel, offering another source of organic matter and a food source to certain macroinvertebrate species, as well as cover and ambush areas for fish species (USDA-NRCS, 1992; Chapter 18 Soil Bioengineering; Gray & Sotir, 1996).

4.3.1.3 Cross Vanes

Cross vanes are used to provide grade control, keep the thalweg in the center of the channel, and protect the stream bank. A cross vane consists of two rock or log vanes joined by a center structure installed perpendicular to the direction of flow. This center structure sets the invert elevation of the stream bed. Cross vanes are typically installed at the tails of riffles or pools or within riffle sections to provide convergence and redirect flows away from streambanks. Cross vanes are also used where stream gradient becomes steeper, such as the downstream end of a small tributary that flows into a large stream (USDA-NRCS, 2007b; Chapter 11 Rosgen Geomorphic Channel Design).

Scour pools form downstream of cross vanes because of the increased flow velocity and gradient. Pool depth will depend on the configuration of the structure, flow velocity, gradient, and the bed material of the stream. For many fish species, the resulting pools form areas of refuge because they provide increased water depth and prime feeding areas (e.g., food items are washed into the pool from the riffle or step directly upstream).

4.3.1.4 Single Vanes and J-Hooks

Vanes are most often located in meander bends just downstream of the point where the stream flow intercepts the bank at acute angles. Vanes may be constructed out of logs or rock boulders. The structures turn water away from the banks and re-direct flow energies toward the center of the channel. In addition to providing stability to streambanks, vanes also promote pool scour and provide structure within the pool habitat. J-hooks are vane structures that have two to three boulders placed in a hook shape at the upstream end of the vane. The boulders are placed with gaps between them to promote flow convergence through the rocks and increased scour of the downstream pool (USDA-NRCS, 2007b; Chapter 11 Rosgen Geomorphic Channel Design).

Because of the increased scour depths and additional structure that is added to the pool, J-hooks are primarily used to enhance pool habitat for fish species. The boulders that cause flow convergence also create current breaks and holding areas along feeding lanes. The boulders also tend to trap leaf packs and small woody debris that are used as a food source for macroinvertebrate species.

4.3.1.5 Cover Logs

A cover log is placed in the outside of a meander bend to provide cover and enhanced habitat in the pool area. The log is buried into the outside bank of the meander bend; the opposite end extends through the deepest part of the pool and may be buried in the inside of the meander bend, in the bottom of the point bar. The placement of the cover log near the bottom of the bank slope on the outside of the bend encourages scour in the pool, provides cover and ambush locations for fish species, and provides additional shade. Cover logs are often used in conjunction with other structures, such as vanes and rootwads, to provide additional structure in the pool.

4.3.1.6 Angled Log Step Pool

Angled log step pools consist of a header log and a footer log placed in the bed of the stream channel, perpendicular to stream flow. The logs extend into the stream banks on both sides of the structure to prevent erosion and bypassing of the structure. The header logs are installed flush with the channel bottom upstream of the log. The footer log is placed to the depth of scour expected, to prevent the structure from being undermined. The logs are placed at alternating angles to the bank to diversify the low flow path and allow micro pool habitats to form between steps. This structure provides bedform diversity, maintains the channel profile, and provides pool and cover habitat. Angled log step pools will be used section of the restoration where stream pattern cannot be implemented.

4.3.1.7 Rock Step Pools

A step pool consists of header rocks and footer rocks placed in the bed of the stream channel similar to a cross vane. This center structure sets the invert elevation of the stream bed. This rock structure creates a "step", or abrupt drop in water surface elevation, that serves the same functions as a natural step created from bedrock or boulders that have fallen into the stream. The rock step pool typically forms a very deep pool just downstream, because of the scour energy of the water dropping over the step. Step pools are typically installed with a maximum height of 3 to 6 inches so that fish passage is not impaired. Like log weirs, rock step pools provide bedform diversity, maintain channel profile, and provide pool and cover habitat.

4.3.2 Vegetation

Native riparian and streamside vegetation will be established in the constructed buffer areas. Also, areas of invasive and introduced vegetation, such as Japanese knotweed (*Polygonum cuspidatum*), Kudzu (*Pueraria lobata*) and/or multiflora rose (*Rosa multiflora*), will be managed so that the newly-established native plants within the riparian buffer zones will not be threatened.

4.3.2.1 Stream Buffer Vegetation

Temporary and permanent seeding, live stakes, and bare-root trees will be planted within designated areas of the restoration reaches, including constructed streambanks, access roads, side slopes, and spoil piles. All areas of disturbance will receive temporary seeding to reduce run-off, maintain sheet flow, protect soil surfaces, and promote infiltration into the soil. Temporary seeding conducted during November and April shall be with winter wheat, winter rye, or perennial ryegrass at a rate of 130 pounds per acre. Temporary seeding between April and August shall be with brown top millet at a rate of 40 pounds per acre.

Permanent seed mixtures will be applied to all disturbed areas of the project site with a mixture provided for streambank areas (~10 lbs per acre) and stream riparian buffer areas or floodplain areas (~30 lbs per acre) to provide permanent vegetation groundcover. Table 4.2 lists the species, permanent seed mixtures, and application rates to be used. The permanent seed mixture specified for floodplain areas will be applied to all disturbed areas outside the banks of the restored stream channel and is intended to provide rapid growth of herbaceous ground cover and biological habitat value. The species provided are deep-rooted and have been shown to proliferate along restored stream channels, providing long-term stability. Species selection may change due to availability of species at the time of planting, however, any deviations from plant lists must be preapproved by the proper regulatory agencies.

Table 4.2
Permanent Seed Mixtures for Revegetation

Common Name	Species Name	Frequency	Density (lbs/acre)	Indicator	Strata	Size
Floodplain and Buffer Areas						
Virginia wildrye	*Elymus virginicus*	25%	2	FAC	Grass	Seed
Switchgrass	*Panicum virgatum*	25%	3	FAC+	Grass	Seed
Fox sedge	*Carex vulpinoidea*	25%	3	OBL	Grass	Seed
Redtop	*Agrostis alba*	25%	2	FAC	Grass	Seed

Common Name	Species Name	Frequency	Density (lbs/acre)	Indicator	Strata	Size
Restored Streambanks						
Virginia wildrye	*Elymus virginicus*	30%	12	FAC	Grass	Seed
Switchgrass	*Panicum virgatum*	30%	3	FAC+	Grass	Seed
Soft rush	*Juncus effusus*	20%	2	FACW+	Grass	Seed
Deertongue	*Dichathelium Clandestinum*	20%	12	FACW	Grass	Seed
Alternate Species						
Rice Cutgrass	*Leersia oryzoides*			OBL	Grass	Seed
Wood Reed-Grass	*Cinna arundinacea*			FACW+	Grass	Seed

Live stakes will be installed randomly two to three feet apart using triangular spacing or at a target density of 160 to 250 stakes per 1,000 square feet along the stream banks between the toe of the stream bank and the bankfull elevation. Site variations may require slightly different spacing. The end of the live stake must be soaked in water until installation. The stake will then be installed at a depth so that only 20 percent of the stake is exposed to sunlight, with a minimum of two lateral buds exposed.

In general, bare-root vegetation will be planted randomly eight to ten feet apart using a triangular spacing at a target density of 450 stems per acre. Planting of bare-root trees and live stakes will be conducted during the dormant season (late fall to early spring), with all trees and stakes installed prior to March 31.

Selected species for hardwood live stakes and bare root trees are presented in Table 4.3. Tree species selected for stream restoration areas will be generally weak to tolerant of flooding. Weakly tolerant species are able to survive and grow in areas where the soil is saturated or flooded for relatively short periods of time. Moderately tolerant species are able to survive in soils that are saturated or flooded for several months during the growing season. Flood tolerant species are able to survive on sites in which the soil is saturated or flooded for extended periods during the growing season. Species selection may change due to availability of species at the time of planting, however, any deviations from plant lists must be preapproved by the proper regulatory agencies.

Table 4.3
Bare-Root Trees Species Selected for Revegetation of the On-Site Mitigation Areas

Common Name	Species Name	Minimum Spacing[1]	Frequency (%)	Density	Indicator	Strata	Spacing Type	Size
Stream Banks (Live Stakes)								
Silky dogwood	*Cornus obliqua*	2-3 feet apart	40%	65 to 100 stems per 1,000 SF	FACW	Tree	Random Triangular	2-3 feet long
Silky willow	*Salix sericea*	2-3 feet apart	40%	65 to 100 stems per 1,000 SF	OBL	Tree	Random Triangular	2-3 feet long
Elderberry	*Sambucus canadensis*	2-3 feet apart	20%	33 to 50 stems per 1,000 SF	FACW-	Tree	Random Triangular	2-3 feet long

Common Name	Species Name	Minimum Spacing[1]	Frequency (%)	Density	Indicator	Strata	Spacing Type	Size
Stream Riparian Buffer (Bare Root Trees)								
River birch	*Betula nigra*	8-10 ft apart	30%	140 stems per acre	FACW	Tree	Random Triangular	Seedling
Tulip poplar	*Liriodendron tulipifera*	8-10 ft apart	30%	140 stems per acre	FACU	Tree	Random Triangular	Seedling
American Beech	*Fagus grandifolia*	8-10 ft apart	20%	85 stems per acre	FACW-	Tree	Random Triangular	Seedling
Southern red oak	*Quercus rubra*	8-10 ft apart	20%	85 stems per acre	FACU-	Tree	Random Triangular	Seedling
Alternate Species								
Silky Cornel	*Cornus amomum*				FACW	Tree		
Black Willow	*Salix nigra*				FACW+	Tree		
Ninebark	*Physocarpus opulifolius*				FACW-	Tree		

[1] All species should be evenly distributed within the planting areas

Observations will be made during construction of the site regarding the relative wetness of areas to be planted. Planting zones will be determined based on these observations, and planted species will be matched according to their wetness tolerance and the anticipated wetness of the planting area.

Once trees are transported to the site, they will be planted within two days. Soils across the site will be sufficiently disked and loosened prior to planting. Trees will be planted by manual labor using a dibble bar, mattock, planting bar, or other approved method. Planting holes for the trees will be sufficiently deep to allow the roots to spread out and down without "J-rooting." Soil will be loosely compacted around trees once they have been planted to avoid drying out.

4.3.2.2 Invasive Species Removal

To reduce the immediate threat and minimize the long-term potential of degradation, no identified invasive or introduced species will be planted in the mitigation sites. For instance, invasive or introduced species, such as but not limited to annual rye grass, timothy, weeping lovegrass, reed canary grass, white clover, orchard grass, foxtail millet, autumn olive, kudzu, European black alder, and red clover will not be used. Only plant materials native and indigenous to the region shall be used. Vegetation monitoring will begin the first full growing season after initial planting and continue for a minimum of ten years. Any natural invasion of invasive or introduced species detected during the monitoring period shall be removed and/or controlled using either manual, chemical, or mechanical control efforts to ensure that they are not present during the final monitoring season.

4.4 Design Rationale – Water Quality

Design considerations for the improvement of water quality in the mitigation reaches focus on increased aeration, shading, and the addition of organic matter (see Appendix A for further discussion). These functional lifts are the result of natural channel design which addresses stream dimension, pattern, and profile, placement of rock and wood in-stream structures, and planting of riparian vegetation. In addition to providing functional lifts, the design will make alterations that reduce sediment from both upland and in-stream sources and enhance stream bank stability.

Water quality monitoring of impaired streams and the quantification of improvements through restoration requires substantial amounts of data collected over many years, both before and after restoration. Therefore, developing design criteria to address site-specific water quality monitoring is not practical. Instead, a thorough review of the literature was used as a guide to create a natural channel design that will ultimately improve water quality (Appendix A).

5.0 ON-SITE & OFF-SITE ESTABLISHMENT DESIGN

CONSOL is proposing to establish 29,079 (3.826 ac) of stream on-site and 16,345 LF (1.973 ac) of stream off-site (Table 5.1). The on-site establishment channels will flow hydrologically either into the off-site establishment channels, which will connect to existing jurisdictional waters of the U.S., or directly into jurisdictional waters of the U.S. Off-site establishment will take place within the Pigeon Creek, Miller Creek, and Buffalo Creek watersheds adjacent to the permit area. Sections 1.4.1.2 and 1.4.2.2 described the criteria used to select the locations for on-site and off-site establishment, respectively, and Figure 1.4 shows the establishment channels.

Because the construction of the on-site establishment channels will occur during different stages of the mining operation, CONSOL will provide excess mitigation credits off-site by implementing restoration, enhancement, preservation, and water quality improvements within the Hell Creek subwatershed (detailed in Sections 6.0, 7.0, and 8.0, respectively). This mitigation in the Hell Creek subwatershed is expected to occur within one year after the first impacts to jurisdictional waters of the U.S. have occurred.

The size of the bankfull channels will be determined by using regional curves and applying natural stream channel design techniques (USDA-NRCS, 2007b). Establishment of streams on-site will involve creating a new drainage network comprised of low gradient stream channels within post-mine drainage control areas. The size of the established on-site channels will be of a different Rosgen stream classification than the existing channels because the post-mine slopes will be lower; the size of the established off-site channels will be of the same Rosgen stream classifications as streams that will have been mined-through. The on-site establishment areas will have a 25-foot riparian buffer on both sides of the stream, while the off-site establishment areas will have a 50-foot riparian buffer on each side of the stream. The stream and its associated riparian buffer will be protected in prepetutiy through the use of a deed restriction.

The primary objectives of the establishment mitigation are to construct streams that,

1) Have stable dimension, pattern, and profiles with access to a floodprone area,
2) Are hydrologically connected to jurisdictional waters of the U.S.,
3) Will provide structure and function to offset loss of these parameters, and will
4) Result in "no net loss" of stream length.

5.1 Design Rationale - Geomorphology

5.1.1 Design Approach

The design approach for the on-site establishment channels includes utilizing the 100-year channel, already constructed for drainage control on-site during the mining operation. The 100-year channel serves as the floodprone area (secondary channel) for the on-site establishment channel. Upon reclamation and during Stage II of construction, a primary bankfull channel with an average width between 5.8 feet and 6.0 feet, depending on the drainage area (Table 5.1), will be excavated or shaped into the base of the constructed 100-year channel. The primary water source for this channel will be groundwater flow along the impermeable pavement layer in the channel and surface runoff from the upland areas. Seepage through the reclaimed high wall and overburden is anticipated to provide additional potential groundwater sources filtering through the backfill and flowing along the pavement of the mining area. As such, it is anticipated that the on-site establishment channels will likely exhibit at least intermittent flow. After construction, each of the on-site establishment channels will have a riparian buffer on each stream side to provide sufficient buffering capacity from surface run-off of any proposed post-mine land use activities (Ebihara et al., 2009; Andrews et al, 1984; Barrett et al., 1993). Conceptual plan sheets, design specifications, and details for the design of one on-site establishment channels, it's hydrologically connected off-site establishment channel and its corresponding on-site restoration area downstream are included in Appendix I.

The design approach for the off-site establishment channels is enhancement-based, by providing in-stream habitat and grade control at select access locations. These channels will naturally incise down existing valley settings during the mining operation from approved NPDES outlets (see Section 12.0). In order to reduce excessive incision to bedrock, grade control structures including rock step pool structures will be installed soon after the mining operation begins. The channel should be excavated to have a bankfull width between 5.1feet and 5.5 feet, depending on the drainage area (Table 5.1), before installing structures. On each of the off-site establishment channels, a 50-foot riparian buffer will be protected, providing further buffering capacity from surface run-off (Figure 1.5-Figure 1.12) and protecting the stream from human incursions.

5.1.2 Classification

The Rosgen Bc on-site establishment channels are designed to have properly sized bankfull widths and depths, and, hence, bankfull cross sectional areas specific to each channel's drainage area in order to convey bankfull discharges. The width/depth ratio in these constructed channels will be 12. The ratio of low bank height to maximum bankfull depth (BHR) will be set to 1.0. Typical cross sections are shown on in Appendix I.

The Rosgen A and Aa+ off-site establishment channels are designed to have properly sized bankfull widths and depths, and, hence, bankfull cross sectional areas specific to each channel's drainage area in order to convey bankfull discharges. The width/depth ratio in these constructed structure locations will be 10. As with the on-site establishment mitigation, the ratio of low bank height to maximum BHR will be set to 1.0 to ensure that flows exceeding the bankfull discharge will access the floodplain area, minimizing shear stress in the channel and resulting in lower risk of channel instability.

5.1.3 Dimension

A stable bankfull cross section will be constructed based upon regional curves developed from reference reach data that were collected from similar settings in the general vicinity of the permit area (Appendix A, Figures A-10 and A-11). On average, the bankfull width of the on-site establishment channels will be 5.7 feet with an average bankfull depth of 0.5 ft and a maximum bankfull depth of 0.6 feet, resulting in an average cross sectional area of 2.7 ft^2 (Figure 5.1). The designed W/D ratio on-site is 12 ft/ft with an ER between 1.5 and 2.3 ft/ft. The maximum depth of the pools on-site is designed to be 1.7 feet with pool widths between 6.2 feet and 8.8 feet (Appendix I). In all of the designed channels, it has been determined that there is sufficient area to meet the minimum floodplain criteria (Appendix I). In five of the ditches, however, the maximum floodplain length is not available. Therefore, if it is decided that a more concervative design needs constructed to maximize the floodplain area, the berm of the existing sediment ditch can be dug out to maximize the area (Figure 5.2 - Figure 5.6). It is recommended that this strategy be used as an adaptive management plan (Section 13.0) after monitoring to determine if sufficient flows are available for the need to maximize the floodplain area.

On average, the bankfull width of the off-site establishment channels will be smaller due to the smaller W/D ratio (5.3 feet) with an average bankfull depth of 0.5 ft and a maximum bankfull depth of 0.7 feet, resulting in an average cross sectional area of 2.8 ft^2. Table 5.1 shows the actual design dimensions of the on- and off-site establishment channels. The designed W/D ratio off-site is 10 ft/ft with an ER of 1.4 ft/ft. The maximum depth of the pools on-site is designed to be 1.8 feet with pool widths between 5.7 feet and 6.1 feet (Appendix I).

Table 5.1
Summary of the Proposed On- and Off-Site Establishment Channels

On-Site Establishment					
Sediment Ditch #	**Length (ft)**	**DA (mi^2)**	**Wbkf (ft)**	**Abkf (ft^2)**	**Dbkf (ft)**
55	870	0.006	5.7	2.7	0.5
1a	1,535	0.015	5.8	2.8	0.5
1	730	0.007	5.7	2.7	0.5
6b	895	0.008	5.7	2.7	0.5
6	552	0.026	5.9	2.9	0.5
5a	879	0.009	5.7	2.7	0.5
5	562	0.018	5.8	2.8	0.5
20	971	0.010	5.7	2.7	0.5
20a	904	0.010	5.7	2.7	0.5
21	892	0.010	5.7	2.7	0.5
23	1,002	0.009	5.7	2.7	0.5
28	1,301	0.011	5.7	2.7	0.5
34	857	0.007	5.7	2.7	0.5
34a	1,447	0.021	5.8	2.9	0.5
70	752	0.008	5.7	2.7	0.5
67	1,223	0.028	5.9	2.9	0.5
67a	1,235	0.008	5.7	2.7	0.5
66	787	0.005	5.6	2.6	0.5
66a	883	0.013	5.7	2.7	0.5
63a	905	0.005	5.6	2.6	0.5
90	1,015	0.006	5.7	2.7	0.5
90a	884	0.011	5.7	2.7	0.5
80	1,342	0.016	5.8	2.8	0.5
80a	532	0.005	5.6	2.6	0.5
85	1,334	0.011	5.7	2.7	0.5
110a	1,042	0.013	5.7	2.7	0.5
110	1,172	0.015	5.8	2.8	0.5
108a	758	0.011	5.7	2.7	0.5
108	1,043	0.014	5.8	2.8	0.5
100	774	0.023	5.9	2.9	0.5
TOTAL	**29,079**	--	--	--	--

Off-Site Establishment					
Establishment Channel #	Length (ft)	DA (mi^2)	Wbkf (ft)	Abkf (ft^2)	Dbkf (ft)
55	883	0.010	5.2	2.7	0.5
1a	517	0.015	5.3	2.8	0.5
1	362	0.008	5.2	2.7	0.5
6b	588	0.008	5.2	2.7	0.5
5a	542	0.010	5.2	2.7	0.5
5	735	0.019	5.3	2.8	0.5
20	387	0.015	5.3	2.8	0.5
20a	502	0.013	5.2	2.7	0.5
21	480	0.014	5.2	2.8	0.5
23	866	0.015	5.3	2.8	0.5
28	474	0.014	5.3	2.8	0.5
34	557	0.013	5.2	2.7	0.5
70	667	0.012	5.2	2.7	0.5
67	728	0.035	5.5	3.0	0.6
67a	563	0.011	5.2	2.7	0.5
66	582	0.006	5.2	2.7	0.5
66a	817	0.014	5.3	2.8	0.5
63a	846	0.005	5.1	2.6	0.5
90	1006	0.017	5.3	2.8	0.5
90a	797	0.018	5.3	2.8	0.5
80	631	0.018	5.3	2.8	0.5
85	183	0.011	5.2	2.7	0.5
110a	600	0.014	5.2	2.8	0.5
110	930	0.019	5.3	2.8	0.5
108a	776	0.012	5.2	2.7	0.5
100	325	0.023	5.4	2.9	0.5
TOTAL	**16,345**	--	--	--	--

[Note: See List of Acronyms after the Table of Contents for acronym definitions.

5.1.4 Pattern

Both the on- and off-site establishment channels are designed to function as step-pool systems having low to moderate sinuosity. The on-site channels will be designed as low-gradient, Rosgen Bc stream types with a sinuosity of 1.1 (+/- 0.1). In the high gradient, off-site establishment channels, a cascade system will be designed, similar to what is observed in natural headwater Rosgen Aa+ stream types with a 1.0 sinuosity.

5.1.5 Profile/Bedform

On-and off-site establishment channels will include the construction of step-pool sequences along the stream bed. The off-site establishment streams will predominately have rock structures because of the high gradients; however, the on-site establishment channel will have a combination or rock and/or log structures, along with rootwad structures. The in-stream structures will be installed to provide grade control in the constructed channels.

The reference reaches utilized in developing the regional curves indicated that this ratio range will be appropriate. Pool slopes were designed using slope ratios averaging 0.1 times the design channel slope. Therefore the pool slopes were 0.001 ft/ft for both mitigation channels. The pool to pool spacing will range from 1.5 to 3.0 (off-site) and 1.5 to 5.0 (on-site) times the designed bankfull width. Riffle slope on-site will be approximately 0.013 ft/ft with an average channel slope of 0.011 ft/ft. Profiles of the stream channels will be developed after collecting baseline data of the proposed channels, which will take place after the final bond release.

5.2 Design Rationale - Hydrology and Hydraulics

Hydrologic considerations in designing the on-site establishment channels included predicted post-mining site hydrology, the size of the regraded drainage areas, the overall topography of the lowest seam being mined, potential for the development of a post-mining drainage network, and location with regard to natural stream networks.

The on-site drainage control structures built during the mining operation are sized to carry a 100-year storm flow. These channels will serve as the floodplain (secondary channel) for the primary bankfull channel, designed at the 1.5 year discharge (Q, Appendix I). The bankfull channel will be excavated in the previously constructed sediment ditch such that it intercepts groundwater flowing along the mine pavement beneath the channel. The primary water sources the bankfull channel will be groundwater flow along the mine pavement discharging into the channel, because the site selected is located down-dip of the proposed mineral removal area (in general direction of groundwater flow), and surface water runoff from upland areas.

Hydrologic connectivity for the on-site establishment channel will be produced by establishing off-site step pool, high gradient channels that connect with existing jurisdictional waters of the U.S. Like the on-site channels, hydrologic considerations were used by examining the size of the drainage area and using reference data to provide channel dimensions where in-stream structures are to be installed. These streams are expected to function hydrologically and hydraulically like the high gradient streams that are proposed to be impacted, as discussed in Section 4.2 above.

5.2.1 Sediment Transport

Based on the channel dimensions that were calculated from the reference data, the critical shear stress was calculated. The Critical Sheer Stress Curve developed by the USEPA (WARSSS, 2006) was then used to determine the maximum particle size that the on-site establishment channel would be capable of moving at bankfull depth. Thus, the designed channel dimensions and slope will be appropriate if the d84 particles of the bed material used in the channel is equal to approximately 68 mm. If the d84 particles is smaller than 68 mm then there will be potential for degradation and bed scour. If the d84 paricles are larger than 68 mm then there will be potential for aggradation. Appendix I shows a list of required d84 sizes to be used in the on-site establishment channels.

Therefore, the driving factor for this design will actually be the size of the new bed material. During construction, it will be essential to ensure that the accurate d84 of the new bad material, is used, thus it is recommenedt that a 100 LF section of channel is first constructed, then a pebble count is conducted to be sure the accurate bed material is being used. Based on the sediment analysis and required d84 particle size, the critical design depth may be changed if the channel material is smaller than necessary. Thus, it is crucial that the designer be on-site during construction to make these determinations to increase success of the established channels and maintain efficient sediment transport through the reaches.

5.3 Design Rationale – Biotic

5.3.1 In-Stream Structures

In-steam structures are used in design to provide channel stability and promote certain habitat types. In-stream structures are necessary because newly constructed channels do not have dense riparian vegetation and roots that provide bank stability, nor do they exhibit a natural distribution of stream bed material that provides armoring and allows stable sediment transport processes. In-stream structures are used to provide stability to the system until these natural processes evolve to provide long-term stability and function to the system. A variety of in-stream structures are proposed for the establishment reaches. Types and locations of in-stream structures will follow the same design principles as the mitigation streams presented in Section 4.3.1.

5.3.2 Vegetation

Native riparian and streamside vegetation will be established in the constructed buffer areas. Also, areas of invasive and introduced vegetation, such as autumn olive (*Elaeagnus umbellate*) and multiflora rose (*Rosa multiflora*), will be managed so they do not threaten the newly-established native plants within the riparian buffer zones, which are to be protected by deed restriction. Riparian vegetation plantings will follow the same design principles as the mitigation streams presented in Section 4.3.2.

5.4 Design Rationale – Water Quality

Overall water quality is expected to be within standards prescribed for freshwater organisms. CONSOL has designed their permit boundary to minimize disturbances as documented in the Environmental Information Document (EID; Baker, 2010) by designing valley fills in the most upstream portions of the subwatersheds. By doing so, CONSOL is maximizing possible dilution effects in the subwatershed by not impacting several headwater tributaries in the subwatersheds and maximizing unmined drainages to protect downstream resources (Figure 3.3; Pond 2009, Pond et al.2008, WVWRI & CVI, 2008). Among the proposed impact watersheds, there is between 47% and 70% unmined drainage which has available headwater tributaries to provide refugia for maintenance of regional diversity and sources of recolonication, which is recommended and suggested by Pond et al. (2008) and Lowe et al. (2006) (Figure 3.3). Additionally, establishment of off-site mitigation channels will also provide additional refugia for aquatic organisms, while also providing additional dilution to the watersheds by suppling good water quality to the downstream watersheds.

In regards to dilution in this physiographic region, CONSOL has collected water quality data in an adjacent watershed with similar mining practices, showing that not only is dilution contributing to better water quality, but overall water quality, particularily specific conductivity, is not reaching “high” levels (greater than 500 µS/cm; Figure 5.7; Pond, 2008) after activity. In the summer of 2009, when conductivity levels should be near or at their peaks (Andrews et al., 1984), several subwatersheds in the Miller Creek and Road Branch watersheds were sampled for basic water quality data showing that only “mid” (500 – 1000 µS/cm; Pond, 2008) and “low” (less than 500 µS/cm; Pond, 2008) conductivity levels were present throughout the watersheds. Consequently, those watersheads that did have “mid” conductivity levels, showed dilution effects downstream, by having lower conductivitiy levels (Figure 5.7). Thus, CONSOL would expect that water quality throughout the Buffalo Mountain permit would show similar responses in water quality being it is located in the same physiographic region with similar geology. Other best management practices (BMP’s) will also be used during the different mining phases to protect water quality (Baker, 2010; Section 1.2).

During the mining operation, several baseline water quality (BWQ) points will be monitored to ensure that NPDES effluent limits are met before water enters the off-site establishment channels and/or existing jurisdictional waters of the U.S. The NPDES limits were set based on the existing Total Maximum Daily

Load (TMDL) study conducted on Tug Fork (USEPA, 2002), which showed Pigeon Creek to be listed for iron and manganese. Data collected from other independent parties (WVWRI & CVI, 2008) also demonstrates that Pigeon Creek has both specific conductivity and fecal coliform levels out of recommended ranges. Therefore, the stringent NPDES limits set for the permit is to protect Pigeon Creek from assimilating additional pollutants.

Additionally, baseline water quality chemistry will also be monitored during the mitigation phases to ensure parameters remain within recommended limits (Section 12.0). If any parameters are out of range from freshwater organisms, the adaptive management plan will be implemented (Section 13.0). To further protect water quality in the establishment channels, a minimum of 50 feet to either side of the streams will be planted and preserved to provide a vegetated riparian buffer for increase infiltration, while also providing a valuable organic material source. As described above, vegetated riparian buffers have been shown to greatly influence and protect overall water quality.

6.0 OFF-SITE RESTORATION & ENHANCEMENT DESIGN

CONSOL is proposing to restore 4,944 LF (2.122 ac) of stream channel off-site, and to enhance 4,098 LF (1.308 ac) of stream channel off-site, all within the Hell Creek subwatershed which is adjacent to the permit area (Figure 1.7). Restoration will occur following installation of the proposed sewer line, which will be buried approximately one to two feet below the streambed (see Section 8.0, *Off-Site Water Quality Improvement*). Enhancement will occur immediately upstream from the restoration reaches, and extend upstream to the on-site restoration of the drainage control structures (Figure 1.7).

Restoration will return the channels to a Rosgen Bc classification and will include installation of structures to provide grade control and aquatic habitat while protecting the stream banks. Riparian buffers will be planted on expanded floodplain areas; their width will be maximized to the extent possible between the stream bank and the parallel county road. Enhancement will provide greater in-stream habitat and wider riparian buffer zones for aquatic and terrestrial communities in these reaches.

Conversations with the WV Division of Highways and adjacent landowners have been initiated to protect riparian zones and restoration and avoide any disturbance along the county road. The enhancement reaches will be preserved in perpetuity with deed restrictions encompassing a 50-foot riparian buffer on both stream sides.

The primary objectives of the off-site restoration and enhancement mitigation are to:

1) Reduce sediment load through stabilized streambanks and improved riparian areas,
2) Improve aquatic habitat through added substrate, in-stream cover, and woody debris,
3) Increase extent of natural areas between the county road and stream,
4) Improve water quality reducing fecal coliform levels throughout Hell Creek, and
5) Improve aesthetics.

6.1 Potential for Restoration & Enhancement

The restoration and enhancement approach considers the potential of each reach, with the overall goal of improving impaired functions. The discussion below describes how the mitigation design will improve geomorphology, hydrology and hydraulics, biotic conditions, and water quality in the restored reaches. Often, a design aspect can provide a functional lift for more than one function, e.g., in-stream structures provide improved aquatic habitat, but also have a positive effect on geomorphology by providing bed and/or bank stability. In such cases, the discussion for the particular design aspect appears under the heading of the function that it has the greatest effect upon.

6.1.1 Restoration Reaches

Existing data (Section 4.0) collected in the restoration reach indicated some extensive bank erosion due to a parallel county road and lack of riparian vegetation. The channel has been historically channelized, resulting in a channel that is a wider than necessary. Consequently, the channel is now unable to transport the sediment load and the stream is aggrading. Vegetation surveys also showed that these reaches are saturated with the invasive species Japanese knotweed, which has been shown to overtake stream banks after disturbances because of its very high growth rate. The species also has a very weak and short root structure, which limites overall bank stability and protection (www.agf.gov.bc.ca/cropprot/jknotweed.htm).

These sections of the subwatershed, however, will be temporarily disturbed to install the sewer line for water quality improvement (Section 8.0). Upon installation of the sewer line, new bankfull benches will be constructed along the lengths of the restoration to provide floodplain storage and additional riparian zone widths. Restoring proper pattern, profile, and dimension, while moving the channel away from the county road with benches, will help to stabilize the channel bed and banks, improve sediment transport function, increase floodplain functions, and improve bedform diversity and aquatic habitats. The riparian plantings will also focus on planting fast growing species in an attempt to -prevent the Japanse knotweed from invading the restoration site.

6.1.2 Enhancement Reaches

After analysis of existing condition data (Section 3.0), it was found that the most limiting functions in these areas of the Hell Creek subwatershed are bedform diversity and riparian vegetation. Additionally, bank erosion prediction scores indicate there are areas of high erosionthat are contributing excess sediment to the channel. Therefore, installing a variety of in-stream rock and log structures throughout the enhancement reaches, while also stabilizing banks and planting riparian vegetation in deficient areas, will improve overall functions in the enhancement locations. These measures will contribute to the overall functional lift in the subwatershed.

6.2 Design Rationale – Geomorphology

Specific design parameters were developed using a combination of reference reach data, evaluation of past projects, analytical models, and best professional judgment. A description of the design rationale is provided in this section for each of the project reaches. See the Project Plan Sheets (Appendix J) for detailed design information on the restoration and enhancement reaches.

6.2.1 Design Criteria

An undisturbed reference reach for dimension, pattern, and profile could not be found in close proximity to the project site. Therefore, stable riffle cross sections in nearby watersheds with drainage areas below one square mile were used to develop dimension design criteria (Appendix A). Bankfull cross sectional area and width were measured and plotted as a function of the drainage area (regional curves, Appendix A, Figures A-10 and A-11). The developed regional curves were used to determine the dimension, especially the bankfull cross sectional area, for each of the mitigation stream reaches (Appendix A).

An evaluation of past projects was used to create a set of design criteria for colluvial channels (B stream types). The results from this evaluation are shown in Table 6.1. These results represent an evaluation of a reference reach database published by the North Carolina Department of Transportation along with the evaluation of over twenty projects, including six projects that have been monitored for over five years and have experienced two hurricanes (Baker, 2008b).

Table 6.1
Design Criteria for B Stream Types

Parameter	Design Ratios	
	Minimum	Maximum
Stream Type (Rosgen)	B4	
Width to Depth Ratio, W/D (ft/ft)	12.0	18.0
Riffle Max Depth Ratio, Dmax/Dbkf	1.1	1.4
Bank Height Ratio, Dtob/Dmax (ft/ft)	1.0	1.2
Meander Length Ratio, Lm/Wbkf	N/A	N/A
Rc Ratio, Rc/Wbkf	N/A	N/A
Meander Width Ratio, Wblt/Wbkf	N/A	N/A
Sinuosity, K	1.1	1.2
Valley Slope, Sval (ft/ft)	0.020	0.04*

Parameter	Design Ratios	
	Minimum	Maximum
Riffle Slope Ratio, Srif/Schan	1.2	2.5
Run Slope Ratio, Srun/Srif	N/A	N/A
Glide Slope Ratio, Sglide/Schan	0.3	0.5
Pool Slope Ratio, Spool/Schan	0.0	0.4
Pool Max Depth Ratio, Dmaxpool/Dbkf	2.0	3.5
Pool Width Ratio, Wpool/Wbkf	1.1	1.5
Pool-Pool Spacing Ratio, Lps/Wbkf	1.5	5.0

N/A = Not Applicable; * For slopes greater than four percent, the Pool-Pool Spacing will be decreased

6.2.1.1 Overview

Based on the existing condition survey and the reference riffle cross sectional data, the restoration and enhancement reaches are Rosgen B4c stream types. Selected design criteria are listed inTable 6.2. The design includes channel dimensions that only transport up to the bankfull discharge. All higher discharges will flow onto the adjacent floodplain area, providing storage for water and sediment. Channel profile is designed to increase aquatic habitats and to create a diverse bedform of alternating riffle/steps and pools. Together, channel dimension and profile are designed to create a channel that doesn't degrade or aggrade over time, while creating a variety of aquatic habitats.

In-stream structures will also be used to enhance the natural channel design. A combination of rock and log cross vanes, step pools, and rootwads will be used to provide grade control, improve bedform diversity, and re-introduce large woody debris. Erosion control matting, live stakes, bareroots, and transplants will be used to further stabilize banks and facilitate a riparian buffer zone, where necessary.

6.2.1.2 Dimension

Typical riffle and pool cross sections are shown on the plan sheets in Appendix J. A bankfull W/D ratio of 12 was selected so that a proper riffle slopes could be created along the riffle banks and to help achieve the appropriate depth for sediment transport competency and capacity.

The ratio of low bank height to maximum bankfull depth (BHR) will be set to 1.0. In areas along the main stem channel where bank height might exceed bankfull stage because of localized topography or a low stream bed elevation, minimal grading will be used to transition bankfull stage to the floodplain. Once flood water rises above the bankfull stage, bankfull benches allow the storm flow to spread out on the floodplain and reduce erosion-causing shear stress in the channel. In-stream structures will be used to provide bank protection and maintain pool cross sections throughout the channel, where necessary. Typical cross sections are shown on the plan sheets (Appendix J).

6.2.1.3 Pattern

With only some minor adjustments due to dimension enhancement, the existing pattern in the restoration reaches will remain the same as the existing conditions. Due to some constrictions with the valley side and a paralleling road, the channel will have a low sinuosity for the B channel type. Plan views of the main channel are shown on the attached plan sheets (Appendix J) to demonstrate areas where pattern was "smoothed" out to reduce sinuosity in that particular location. The sinuosity is 1.00 (+/- 0.1), thereby maximizing channel slope in those locations.

6.2.1.4 Profile/Bedform

The mitigation will include the construction of step pool sequences along the stream bed, using a combination of rock and log structures. The slopes for the riffles will vary from 1.1 to 1.8 times the proposed channel slope. Pool slopes were designed using slope ratios of 0.0 to 0.4 times the design channel slope. The maximum pool depth (2.0 to 3.5 times the riffle mean depth) will be constructed from the head of one structure to the head of the next downstream structure along the profile.

Table 6.2
Summary of Design Criteria for the Hell Creek Subwatershed

Parameter	Design Values Hell Creek Reach A		Design Values Hell Creek Reach B		Design Values Hell Creek Reach C		Design Values Hell Creek Reach D		Design Values Hell Creek Reach E	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
Drainage Area, DA (sq mi)	0.60		1.25		1.53		3.47		1.88	
Reach Length (ft)	1,365		3,600[1]		737		1,462		1,878	
Stream Type (Rosgen)	B4		B4		B4		B4		B4	
Bankfull Discharge, Qbkf (cfs)	51	51	90	90	106	106	203	203	125	125
Bankfull Riffle XSEC Area, Abkf (sq ft)	10.7	10.7	19.3	19.3	22.6	22.6	43.6	43.6	26.7	26.7
Bankfull Mean Velocity, Vbkf (ft/s)	4.8	4.8	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
Bankfull Riffle Width, Wbkf (ft)	11.3	11.3	15.2	15.2	16.5	16.5	22.9	22.9	17.9	17.9
Bankfull Riffle Mean Depth, Dbkf (ft)	0.9	0.9	1.3	1.3	1.4	1.4	1.9	1.9	1.5	1.5
Width to Depth Ratio, W/D (ft/ft)	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
Width Floodprone Area, Wfpa (ft)	16	30	20	40	24	42	30	60	26	48
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	1.4	2.6	1.3	2.6	1.5	2.6	1.3	2.6	1.5	2.7
Riffle Max Depth @ bkf, Dmax (ft)	1.0	1.0	1.4	1.4	1.5	1.5	2.1	2.1	1.6	1.6
Riffle Max Depth Ratio, Dmax/Dbkf	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Max Depth @ tob, Dmaxtob (ft)	1.0	1.0	1.4	1.4	1.5	1.5	2.1	2.1	1.6	1.6
Bank Height Ratio, Dtob/Dmax (ft/ft)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Sinuosity, K	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Valley Slope, Sval (ft/ft)	0.0348	0.0348	0.0283	0.0283	0.0184	0.0184	0.0227	0.0227	0.0248	0.0248
Channel Slope, Schan (ft/ft)	0.0348	0.0348	0.0283	0.0283	0.0184	0.0184	0.0227	0.0227	0.0248	0.0248
Slope Riffle, Srif (ft/ft)	0.0383	0.0626	0.0311	0.0509	0.0202	0.0331	0.0250	0.0409	0.0273	0.0446
Riffle Slope Ratio, Srif/Schan	1.1	1.8	1.1	1.8	1.1	1.8	1.1	1.8	1.1	1.8
Slope Pool, Spool (ft/ft)	0.0000	0.0139	0.0000	0.0113	0.0000	0.0074	0.0000	0.0091	0.0000	0.0099
Pool Slope Ratio, Spool/Schan	0.00	0.40	0.00	0.40	0.00	0.40	0.00	0.40	0.00	0.40
Pool Max Depth, Dmaxpool (ft)	1.9	3.3	2.5	4.4	2.7	4.8	3.8	6.7	3.0	5.2
Pool Max Depth Ratio, Dmaxpool/Dbkf	2.0	3.5	2.0	3.5	2.0	3.5	2.0	3.5	2.0	3.5
Pool Width, Wpool (ft)	12.5	17.0	16.7	22.8	18.1	24.7	25.2	34.3	19.7	26.8
Pool Width Ratio, Wpool/Wbkf	1.10	1.50	1.10	1.50	1.10	1.50	1.10	1.50	1.10	1.50
Pool Width/Depth Ratio	6.60	5.14	6.60	5.14	6.60	5.14	6.60	5.14	6.60	5.14
Pool Area, Apool, (ft/ft)	13.91	21.40	25.09	38.60	24.86	27.12	47.96	52.32	34.71	53.40
Pool Area Ratio, Apool/Abkf	1.30	2.00	1.30	2.00	1.10	1.20	1.10	1.20	1.30	2.00
Riffle Length, Lriffle (ft)	11.3	34.0	15.2	45.7	16.5	49.4	22.9	68.6	17.9	53.7
Riffle Length Ratio, Lriffle/Wbkf (ft)	1.0	3.0	1.0	3.0	1.0	3.0	1.0	3.0	1.0	3.0
Pool-Pool Spacing, Lps (ft)	17.0	56.7	22.8	76.1	24.7	82.3	34.3	114.4	26.8	89.5
Pool-Pool Spacing Ratio, Lps/Wbkf	1.50	5.00	1.50	5.00	1.50	5.00	1.50	5.00	1.50	5.00
d16 (mm)	17.0		17.0		17.0		17.0		17.0	
d35 (mm)	29.0		29.0		29.0		29.0		29.0	
d50 (mm)	46.0		46.0		46.0		46.0		46.0	
d84 (mm)	110.0		110.0		110.0		110.0		110.0	
d95 (mm)	160.0		160.0		160.0		160.0		160.0	

[1]Reach B is comprised of two sections: Reach B1 the upstream portion of the reach with a length of 2,733 ft. and Reach B2 the downstream portion with a length of 867 ft.

6.3 Design Rationale – Hydrologic & Hydraulics

Sediment transport competency was assessed for the proposed typical cross sections in the Hell Creek subwatershed. As explained in section 3.3.2, sediment transport competency is a stream's ability to mobilize particles of a particular size and sediment transport capacity is a stream's ability to move a certain volume of particles over a specific duration of time. When designing natural channels to carry the bankfull discharge, the particle size used for analysis is the largest particle collected from a sub-pavement sample (material that is immediately beneath the bed veneer) or the largest particle from a point bar (Rosgen, 2001b). Results from the sediment transport competency analysis are shown below in Table 6.3.

6.3.1 Modeling

A proposed conditions (design) model was developed in WinXSPRO to represent the restoration channel geometries of typical riffle cross sections. WinXSPRO was chosen for the relatively steep gradients that are characteristic of the design and to be consistent with the existing channel hydraulic design for ease of comparison. The design parameters specified in Table 6.2 were used to create a typical cross section that was used for hydraulic analysis. A stage discharge curve was developed from that typical cross section and the discharge that filled the channel (bankfull discharge) was determined. It was found that these discharges were between the 1.3- to 1.6-year return interval, with the discharge and corresponding recurrence interval increasing with the riffle bed slope. The typical cross section was analyzed using the range of bed slopes specified in Table 6.2. These results are consistent with other bankfull recurrence intervals for similar streams in other parts of West Virginia and with the results of the geomorphic analysis performed for the existing streams.

6.3.2 Sediment Transport Competency

The ability of a stream to transport the available bed material is important for creating a stable channel that displays stable bed forms, such as, riffles, pools, runs, and glides. These bed features are an integral aspect of the overall stream function and help to support aquatic life, such as benthic macroinvertebrates and fish. In addition, balanced sediment transport will allow the stream to reach a dynamic equilibrium in which major aggradation or degradation does not occur (e.g., the stream has the competency and capacity to transport available sediment without causing erosion).

Based on the competency analysis and modeling, the predicted mobile bed material is larger than the existing D84, but smaller than the largest particle (D100), therefore indicating that the stream is not vertically unstable, having additional bed armoring. Other than Reach B-1, which has sufficient armoring capability during bankfull events, competency data indicate that most of the substrate materials in the remaining reaches will be moved during a bankfull event (Table 6.3).

Table 6.3
Sediment Transport Competency Analysis

Reach ID	Shear Stress (lbs/sqft.)	Predicted Grain Diameter (mm) EPA curve	Measured Grain Diameter D84 (mm)	Measured Grain Diameter D100 (mm)
Reach A	1.49	373	270	470
Reach B-1	1.26	317	130	190
Reach D	1.64	409	180	410
Reach E	1.77	441	230	490

6.4 Design Rationale – Biotic

6.4.1 In-Stream Structures

As discussed in detail above (Section 4.3), in-steam structures are used to provide channel stability and promote certain habitat types. In-stream structures are necessary because newly constructed channels do not have dense riparian vegetation and roots that provide bank stability, nor do they exhibit a natural distribution of stream bed material that provides armoring and allows stable sediment transport processes. In-stream structures are used to provide stability to the system until these natural processes evolve to provide long-term stability and function to the system. A variety of in-stream structures are proposed for the establishment reaches. Types and locations of in-stream structures will follow the same design principles as the mitigation streams presented in Section 4.3.1.

6.4.2 Vegetation

Native riparian and streamside vegetation will be established in the constructed buffer areas. Also, areas of invasive and introduced vegetation, such as Japanese knotweed, will be managed so as not to threaten the newly-established native plants within the riparian buffer zones. It will be important during the construction phases of the restoration reaches to ensure that the invasive species are not re-located beyond the construction limits via equipment. Chemical eradication techniques may be necessary in the restoration reaches to completely eradicate the invasive species before replanting the reatoration reaches. Riparian vegetation plantings will follow the same design principles as the mitigation streams presented in Section 4.3.2.

6.5 Design Rationale – Water Quality

Water quality is expected to greatly improve in the restoration reaches because of the measures to treat fecal coliform pollution outlined in Section 8.0. Overall water quality is expected to be within the standards prescribed for freshwater organisms (Appendix H). Baseline water quality chemistry will be monitored during the mitigation phases to ensure parameters remain within recommended limits (Section 11.0). To further protect water quality in the restoration and enhancement channels, riparian zone widths will be maximized to the extent practicable considering existing limitations, including existing paved county and local dirt and gravel roads and driveways. As described above (Section 5.4), vegetated riparian buffers have been shown to greatly influence and protect overall water quality.

7.0 OFF-SITE PRESERVATION

In addition to the restoration, enhancement, and water quality efforts in the Hell Creek subwatershed, stable channels in their natural and undisturbed state will be preserved in perpetuity with a deed restriction within 120-days of permit receipt, further supporting the headwater drainage network and watershed restoration approach in the selected subwatershed. The preservation of undisturbed channels is crucial in the watershed approach to preserve existing high quality functions that are important to downstream reaches (Sedell et al, 1989; Pond et al. 2008; WVWRI & CVI, 2008). The preservation streams will be of the same stream type and classification as impacted channels, providing off-site, in-kind mitigation. The Mitigation Plan currently includes preservation of 5,281 LF (1.141 ac) of stream channel in the Hell Creek subwatershed (Table 7.1). The preservation channels are located upstream of reaches proposed for restoration, enhancement, and water quality improvements with this Mitigation Plan.

Table 7.1
Summary of Preservation Streams

Preservation Stream	Acres	Length (ft)	Drainage Area (sq mi)
UT1 of RFHC	0.105	1,285	0.31
UT2 of RFHC	0.379	2,170	0.13
UT5 of RFHC	0.031	465	0.01
UT6 of RFHC	0.576	635	0.06
LUT1 of RFHC	0.030	437	0.04
LUT2 of RFHC	0.020	289	0.01
Totals	**1.141**	**5,281**	**--**

The primary objectives of the off-site preservation mitigation are to:

1) Maintain undisturbed headwater drainage areas of the Hell Creek subwatershed,
2) Preserve pathways for flora and fauna in the Hell Creek subwatershed, and
3) Reduce chances for future disturbances that could affect the downstream channels proposed for restoration, enhancement, and water quality improvements.

In addition to the preservation of stream channel, which contributes to the offset of linear footage and acreage loss due to the proposed surface mine, the Mitigation Plan includes preservation of riparian buffers on either side of most mitigation stream channels. Each of the on-site restoration, on- and off-site establishment, off-site enhancement, and off-site preservation reaches will have riparian buffers preserved in perpetuity through deed restrictions on both sides of the steams. The area of riparian buffer that will be protected from future development with this Mitigation Plan totals approximately 117 acres (Table 7.2).

Table 7.2
Summary of Preservation Acreage

Mitigation Type	Riparian Buffer Area		
	Length (LF)	Area (sq ft)	Acres
Off-Site Establishment	16,345	1,634,500.0	37.5
On-Site Establishment (sed ditches)	29,079	1,453,950.0	33.4
Off-Site Enhancement (HC)	4,098	409,800.0	9.4
On-Site Restoration (ponds)	10,215	1,021,500.0	23.5
Off-site Restoration (HC)	4,944	49,440.0	1.1
Off-Site Preservation	5,281	528,100.0	12.1
Totals	**69,962**	**5,097,290.0**	**117.0**

8.0 OFF-SITE WATER QUALITY IMPROVEMENT

8.1 Potential for Improvement

Because of the amount of wastewater contaminents (e.g., laundry products, household cleaners, human wast etc.) in the lower portions of the Hell Creek subwatershed (Table 1.9 and Table 1.10), many improvements proposed with this Mitigation Plan would be limited in their ability to improve biotic communities unless the Mitigation Plan also included water quality improvements. Pond (2009) would agree, stating that the first obvious step in rehabilitating streams should be to control water quality assocated with discharge from mining and residential landuses. Merriman (2009) also suggests that systems impacted by residential development would benefit the most from restoring both water chemistry and physical habitat toward natural conditions, further stating that restoration should be on a watershed scale to be successful. CONSOL's Mitigation Plan is consistent with the current literature, focusing on a watershed scale mitigation approach, which includes both physical habitat and water quality improvements.

The downstream portion of Hell Creek, located between its confluence with Pigeon Creek and a point upstream just past the residential area of Left Fork of Hell Creek, along with the downstream 1,063 feet of Right Fork of Hell Creek will be the areas targeted for water quality improvement. These channels will be temporarily impacted in order to install a sewer line for water quality treatment, and then restored at a 1:1 linear foot replacement ratio. The restoration design is addressed in Section 6.0 (*Off-Site Restoration and Enhancement*).

The primary objectives of the off-site water quality improvement mitigation are to improve water quality, specifically fecal colifrom levels, in the Hell Creek subwatershed by installing sewer lines and a pump station to transport untreated and poorly treated sewage to the Delbarton Wastewater Treament Plant. In addition, through installation of the force main extension and providing the funding necessary to augment capacity at the Delbarton Wastewater Treatment Plant, this Mitigation Plan will provide the potential for future water quality improvements in the Pigeon Creek watershed. Additional homes and businesses along the three miles of the force main extension can be connected to the system in the future, thereby reducing fecal coliform and other pollution inputs (i.e. total phosphates, nitrates/nitraites, specific conductivity) to Pigeon Creek. Studies have shown that high fecal coliform levels are correlated with high specific conductivity levels (Christensen et al., 2002; Davis, 2008), therefore it is expected that this water quality improvement plan has the potential to help reduced specific conductivity levels in the associated watersheds.

8.2 Conceptual Design

Based on research conducted by the Canaan Valley Institute in conjunction with the WV Water Research Institute at the Watershed Technical Assistance Center at West Virginia University (WVWRI & CVI, 2008), installing a wetland cluster to passively treat wastewater in the subwatershed was considered. After discussion with engineers, inspectors, and regulators, this option appeared to be very expensive because of construction, maintenance, and long-term monitoring while not as efficient at improving water quality as other researched options. The cost of building the wetland cluster system was estimated at approximately $1.4 million dollars and did not include the cost of the gravity line needed to serve the 26 homes up Hell Creek, which would add considerable more cost to the project. In addition, this approach would require a wastewater treatment plant operator to monitor the plant on a daily basis.

Further consultation continued to identify an alternate method of wastewater treatment in Hell Creek. Because the mouth of Hell Creek is approximately three miles from the Town of Delbarton Wastewater Treatment Plant, it was determined that a gravity sewer line and associated pump station could be installed to pump the sewage approximately 13,000 LF from Hell Creek to the existing plant located on CR 65, thereby providing a more active method of treatment Figure 8.1and Figure 8.2). The 26 homes in the Hell Creek subwatershed would constitute only a six percent increase in the plant's influent. This method of wastewater treatment will be more cost effective, yield cleaner effluent, thus improving stream water quality, and will provide less maintenance and monitoring.

The installation of the gravity sewer line is proposed to be located along one side of the restoration sites described in Section 6.0 and shown in Figure 1.7. The line will be installed under designed bankfull benches and or the streambed to allow for maximum pool depths throughout the reach. As part of the conceptual design, manhole structures shall be constructed along the stream bank, but not in the bankfull channel. The manholes will be coated on the inside with an epoxy based paint to keep them from allowing any wastewater from migrating out of the system. Furthermore, the manholes will have a tongue and groove configuration at each joint with rubber gaskets. The proposed eight- inch gravity sewer line will be buried at least two feet below the existing stream bed elevation with gravel bedding.

In summary the existing Hell Creek subwatershed has some of the highest fecal coliform measurements in the area (Table 1.10), resulting in water that is unfit for human recreation. The proposed restoration and water quality improvement project will maximize functional lift in this system with no additional cost to the Hell Creek community treating approximately 1.2 million gallons of wastewater a year with the potential to treat an additional 5.8 million gallons of wastewater a year once residents along Pigeon Creek are tied to the system. The proposed project has the formal and/or informal support of the residents along Hell Creek, The Pigeon Creek Watershed Group, WVDEP, and The Town of Delbarton among others.

9.0 PERFORMANCE STANDARDS AND PROJECT SUCCESS

Channel stability, stream functions, benthic macroinvertebrates, water quality, and vegetation survival will be monitored along each mitigation reach, with the exception of biotic monitoring in the ephemeral reaches, for a minimum of ten years following the completion of construction. Table 9.1 provides a list of each component that will be measured during monitoring along with the standard to determine success and the action or adaptive management (also see Section 13.0) to be taken if the standard is not met.

It should be noted that biotic standards are contingent upon water quality parameters' remaining within recommended ranges for freshwater organisms (Appendix G; Table G-1). If water quality parameters become out of range for freshwater organisms, the contingency and adaptive management plans (Sections 11.0 and 13.0) will need to be discussed and considered in order to meet biotic performance standards.

Table 9.1
Success Criteria and Monitoring Actions

Mitigation Component	Success Standard	Failure →	Action
Photographs Longitudinal photos Lateral photos	No substantial aggradation, degradation, or bank erosion; no evidence of structure failures (i.e., piping, fallen rock) that are determined to threaten overall stability or project success.	Substantial differences between as-built photographs and montiring photographs.	Remedial actions will need to be planned and approved on a case-by-case and site-specific basis (e.g., install additional structure, repair structure, reslope bank).
Geomorphic Cross sections Longitudinal profiles Pebble counts Stream Classification Stream Type	Minimal evidence of instability (down-cutting, deposition, bank erosion, increase in sediments); stream classification (i.e., ephemeral, intermittent, perennial) and stream type (Rosgen stream type) as predicted.	Substantial evidence of instability (BHR greater than 1.2 or less than 0.8, BEHI = 20 or greater); monitoring data outside range of design ratios (i.e. W/D ratio will not increase by more than 1.2 from design criteria, ER will be less than 1.3) (Appendix I & J).	Remedial actions will need to be planned and approved on a case-by-case and site-specific basis (e.g., install additional structure, repair structure, reslope bank).
Hydrology Crest Gages	Document cumulative bankfull events. At least 3 cumulative events recorded by year 10.	No bankfull events recorded. Should have at least one bankfull event by year 2.	Data (i.e. geomorphology, USGS hydrological data) need to be re-evaluated. Remedial actision will need planned if bankfull events should have occurred.
Habitat EPA's RBP HAV	Improve total HAV scores from baseline conditions.	Decrease total HAV scores from baseline conditions.	Remedial actions will need to be planned and approved on a case-by-case and site-specific basis (e.g., install additional structures, repair structures, revegetate).

Mitigation Component	Success Standard	Failure →	Action
Vegetation CVS-EEP Protocol for Recording Vegetation Canopy Cover: Densiometer Species Identification USEPA RBP HAV: Bank Vegetation Protection & Riparian Zone Width Parameters	450 stems per acre at end of year three and throughout monitoring period, 70% woody tree stems with no more than 25% soft mast producers; no invasive species; increase canopy cover from as-built conditions; HAV parameters are at least sub-optimal (with the exception of road paralleling areas).	Less than prescribed amount of trees per acre; Invasive species present; canopy cover not increasing from as-built conditions; HAV parameters below sub-optimal (with the exception of road paralleling areas).	Areas of less trees per acre will be re-planted with live stakes and bare rooted trees to achieve desired densities; invasive species will be manually or chemically removed.
Biotic USEPA RBP (benthics, fish)	A 5% increase in total WVSCI (benthic only) and species richness and biomass scores (fish only) at the end of year 10 from baseline conditions.	Lower metrics and values than baseline conditions.	Area shall be further investigated for other potential problems that may impact biotic assessments (e.g., water chemistry).
Water Quality Fecal Coliform	A decrease from baseline conditions in fecal coliform levels at the water quality improvement reaches.	Increase or no change in fecal coliform levels from baseline conditions at water quality improvement reaches.	Remedial measures shall be taken to evaluate the conditions of the system for need of repair.

Note: See List of Acronyms after the Table of Contents for acronym definitions.

9.1 Photo Reference Sites

Photographs will be used to evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, and effectiveness of erosion control measures. Lateral photos should not indicate excessive erosion or continuing degradation of the banks. A series of photos over time should indicate successive maturation of riparian vegetation. Photographic documentation will be used to inform the other monitoring efforts.

9.2 Geomorphic & Hydrology Success Criteria

Geomorphic monitoring will include tracking and assessment of flow events, stream dimension (cross sections), pattern (longitudinal survey), profile (profile survey), and bed material. The related success criteria are described below for each monitored parameter.

9.2.1 Bankfull Events

For the intermittent and perennial reaches, two bankfull flow events must be documented within the ten-year monitoring period. The purpose of monitoring bankfull events is to determine if out-of-bank flows and an active floodplain have been restored as required by the mitigation plan.

Monitoring of bankfull events is not applicable for the ephemeral reaches because the channel's return interval may be much longer than the 1.5-year return interval typically associated with bankfull flow in intermittent and perennial channels.

9.2.2 Cross sections

There should be little change in as-built cross sections. If changes do take place, they will be evaluated to determine if they represent a movement toward a more unstable condition (e.g., down-cutting or widening) or a movement toward increased stability (e.g., settling, vegetative changes, deposition along the banks, or decrease in width/depth ratio). Cross sections will be classified using the Rosgen Stream Classification System. All monitored cross sections should fall within the quantitative design criteria for channels of the designed stream type; otherwise, remedial actions may be necessary (Table 9.1).

9.2.3 Longitudinal Profile

The longitudinal profiles should show that the bedform features are remaining stable, i.e., they are not aggrading or degrading. The pools should remain deep, with flat water surface slopes, and the riffles should remain steeper and shallower than the pools. Bedforms should be consistent with those observed for channels of the designed stream type; otherwise, remedial actions may be necessary (Table 9.1).

9.2.4 BEHI/BHR

Bank erosion hazard index (BEHI) scores will be collected throughout each of the mitigation reaches to determine if the channels are laterally stable. In additional the Bank Height Ratios (BHR's) will be monitoring from the riffle cross sections to determine if the streams are vertically stable. Success will be achieved by demonstrating a stable BEHI (less than 20) score and a low BHR (1.0-1.1) at the end of the ten year monitoring period.

9.2.5 Bed Material Analyses

Pebble count data will be plotted on a semi-log graph and compared with data from previous years. Data should indicate a relative coarsening of the substrate riffles (or maintenance of a coarse bed in riffles); otherwise, remedial actions may be necessary (Table 9.1).

9.3 Habitat Success Criteria

Specific and measurable success criteria for habitat will include comparison of the average HAV collected prior to initiation of mitigation and those collected after mitigation. The final success criteria will be achieved by demonstrating an increase in HAV scores from existing condition values at the end of the ten-year monitoring period (Table 9.1). If scores are not met, remedial actions may be necessary (Table 9.1).

9.4 Vegetation Success Criteria

The interim measure of vegetative success for the site will be the survival of at at least 450 stems (tree and shrub stems) at the end of the ten year monitoring period. The native plantings shall consist of a minimum of 70 percent woody tree stems and no more than 25 percent these trees should be soft mast producers. Woody stems shall be irregularly placed along the corridor, and low growing shrubs will be planted between trees. All trees and shrubs will be native to the area and will be selected based upon their hydrologic and edaphic tolerances, wildlife food and cover. At least eight herbaceous species, three shrub species, and four tree species will be planted along each of the riparian buffer zones (Table 4.3).

While measuring species density is the current accepted methodology for evaluating vegetation success on restoration projects, species density alone may be inadequate for assessing plant community health. For this reason, the vegetation monitoring plan will incorporate the evaluation of additional plant community indices to assess overall vegetative success as specified in Section 12.4.

Throughout the monitoring period, canopy cover will be measured with a densiometer. There should be an increase of canopy cover noticed from the as-built conditions.

Habitat parameters, including the bank vegetation protection and riparian zone with scores, will also be assessed. These specific parameters should demonstrate an increase in score from the as-built conditions. In situations where there are permanent paralleling roads, the riparian zone width score may not reach sub-optimal levels.

9.5 Biotic Success Criteria

9.5.1 Benthic Macroinvertebrates

Specific and measurable success criteria for benthic macroinvertebrates will include comparison of the RBP metrics, associated diversity indices, and WVSCI values at the restored stations and un-restored stations. Assuming all water quality parameters remain within recommended ranges for freshwater organisms (Appendix G; Table G-1), the final success criteria will be the achievement of at least a five percent increase in the WVSCI and Simpson's Diversity Index from the existing conditions at the end of the ten year monitoring period. If success criteria are not met, remedial actions may be necessary (Table 9.1). Existing condition data at these sites will be collected in the subsequent sampling season after submittal of this report and submitted as supplemental data. The data will also be compared to the un-restored reaches within the ten-year monitoring period. It is expected that with the physical and chemical improvements, there will be an increase in the WVSCI and diversity indices at the mitigation sites.

9.5.2 Fish

Specific and measurable success criteria for fisheries resources will include comparison of the associated diversity indices and metrics at the restored stations and un-restored stations. Assuming all water quality parameters remain within recommended ranges for freshwater organisms (Appendix G; Table G-1) the final success criteria will be the achievement of at least a five percent increase in biomass and species richness from the existing conditions at the end of the ten-year monitoring period. If success criteria are not met, remedial actions may be necessary (Table 9.1). Existing condition data at these sites will be collected in the subsequent sampling season after submittal of this report and submitted as supplemental data. The data will also be compared to the un-restored reaches within the ten-year monitoring period. It is expected that with the physical and chemical improvements, there will be an increase in species richness and biomass at the mitigation sites (Roni et al, 2006, Baker 2008c).

9.6 Water Quality Success Criteria

Fecal coliform levels (colonies/100 mL) will be measured in the Hell Creek watershed to demonstrate success in water quality by the installation of a sewer line. Levels of fecal coliform (colonies/100 mL) will be measured at a minimum one a week though the month of August each monitoring year to compare results to those collected during baseline conditions. Success will be determined by demonstrating a decrease in monthly average fecal coliform (colonies/100 mL) levels from baseline conditions.

10.0 SITE PROTECTION

The Mitigation Plan was prepared in accordance with the December 24, 2002, USACE Regulatory Guidance Letter (RGL 02-2) and the new Wetlands Compensatory Mitigation Rule (USEPA&USACE, 2008). CONSOL has complied with the guidelines of RGL 02-2, providing more than a 1:1 linear foot replacement. In addition, CONSOL has provided both on-site and off-site mitigation to provide functional lift to streams in the Hell Creek watershed.

With the exception of the restoration reaches along Hell Creek that have residences along the stream, the current land owners at the proposed mitigation sites include Cotiga Development Company (Flourtown Road, Wyndmoor, PA 19118) and CONSOL of Kentucky Inc. (1000 CONSOL Energy Drive, Canonsburg, Pennsylvania 15317; Figure 2.3). Once negotiations with the current landowners are finalized, CONSOL will coordinate accordingly with the USACE and the Mingo County clerk to file any required easement documents or materials with the county within 120-days of permit approval.

Proposed deed restrictive easements with the landowners are still in negotiation, however they are to include the stream itself and associated riparian buffer. The on-site establishment areas are proposed to have 25-foot riparian buffer on both sides of the stream. The off-site establishment areas, on-site restoration areas, off-site enhancement areas, and off-site preservation areas will have a 50-foot riparian buffer on each side of the stream and the off-site restoration and water quality improvement reaches will have a 10-foot sewer line easement, which will include associated riparian zones on each side of the sewer line. The streams and their riparian buffers will be protected in perpetuity through the use of deed restrictions.

11.0 CONTINGENCY PLAN

This mitigation plan has been developed and presented such that a high level of success is anticipated. A post-mitigation monitoring period is discussed in Section 12.0 of this plan. In the unlikely event that successful mitigation of jurisdictional waters can not be achieved, CONSOL proposes the following contingencies.

11.1 Revised Mitigation and/or Site Selection

If any of the proposed mitigation activities are found to be unsuccessful, the company will submit to the USACE a revised mitigation plan based on technologies and current knowledge at that time. This revised mitigation plan may include a different method of mitigation or a proposal to restore other jurisdictional waters in the surrounding area(s).

11.2 Submittal of In-Lieu Fees

In the event that the company is unable to restore, establish, or preserve jurisdictional waters during the phases of their operations as proposed in this Mitigation Plan to the satisfaction of the USACE, the company may elect to pay in-lieu fees commensurate with the amount and quality of the existing jurisdictional waters that were lost.

11.3 Mitigation Banking

The company may elect in the future to purchase mitigation credits through an approved stream mitigation bank, if one is available in the same 8-digit HUC watershed. CONSOL may also utilize excess mitigation credits obtained from their other nearby projects, once they are deemed successful by the USACE.

11.4 Preservation

As a contingency for a failed mitigation plan, the company may elect to set aside, by conservation easement, deed restriction, or other protective measure, aquatic habitats that are threatened by future land disturbances. The amount and types of aquatic resources to be protected shall be approved by the USACE.

11.5 Performance Bonds

CONSOL will post a performance bond payable to the WVDEP's Stream Restoration Fund in the amount of Seven Hundred Twenty-one Thousand Five Hundred Sixty Dollars ($721,560.00) to assure compensation for the impacts of waters of the State. Upon completion of the compensation project, the WVDEP will release the performance bond provided CONSOL will obtain a certification from a registered engineer that all compensation project work has been completed in accordance to the plans and specificiations and the state certification conditions. The 401 Water Quality Certification for WVDEP Permit No. S-5018-07/WVNPDES Permit No. WV1029690 and associated Mitigation and Compensation Agreement provide more information on the performance bond(s) and state requirements.

12.0 MONITORING AND LONG-TERM MANAGEMENT

Monitoring will be conducted in order to 1) document project successes, and 2) identify failures for which a contingency plan (Section 11.0) or an adaptive management plan (Section 13.0) must be implemented. Channel stability, stream functions, benthic macroinvertebrates, water quality, and vegetation survival will be monitored along each mitigation reach, with the exception of biotic monitoring in the ephemeral reaches, for a minimum of ten years following the completion of construction. Table 9.1 in Section 9.0 provides a list of each component that will be measured during monitoring along with the standard to determine success and the action to be taken if the standard is not met. Biotic standards are contingent upon water quality parameters' remaining within recommended ranges for freshwater organisms (Appendix G; Table G-1). If water quality parameters become out of range for freshwater organisms, the contingency and adaptive management plans (Sections 11.0 and 13.0) will need to be discussed and considered in order to meet biotic performance standards.

The following sections detail each category of monitoring to be conducted: photographing reference sites (Section 12.1); geomorphic monitoring (Section 12.2); habitat monitoring (Section 12.3); vegetation monitoring (Section 12.4); and biotic and water quality monitoring (Section 12.5). Reporting methods, maintenance issues, and monitoring release are addressed in Sections 12.6, 12.7, and 12.8, respectively. Conceptual maps of monitoring plans are located in the figures section of this report: Figure 12.1 for on-site restoration, Figure 12.2 for on- and off-site establishment, Figure 12.3 for off-site restoration, Figure 12.4 for off-site enhancement, and Figure 12.5 for water quality.

12.1 Photo Reference Sites

Photographs will be used to document restoration success. Reference stations will be photographed before construction and annually for a minimum of ten years following construction, or until mitigation is deemed successful. Reference station photos will be taken once a year. Photographs will be taken from a height of approximately five to six feet. Permanent markers will be established (every 500 – 1,000 LF in the restoration and establishment reaches; at every structure thoughout the enhancement reaches) to ensure that the same locations (and view directions) on the site are documented in each monitoring period.

Lateral reference station photo transects will be taken at each permanent cross section. Photographs will be taken of both banks at each cross section. The water line will be located in the lower edge of the frame, and as much of the bank as possible will be included in each photo. Photographers will make an effort to consistently maintain the same area in each photo over time. Photographic documentation will be used to inform the other monitoring efforts.

12.2 Geomorphic Monitoring

Geomorphic monitoring of restored, established, and enhanced stream reaches will be conducted to evaluate the effectiveness of the mitigation practices for a minimum of ten years or until mitigation is deemed successful. Monitored stream components include bankfull flow events (crest gages, photographs), stream dimension (cross sections), profile (plan view survey, longitudinal profile survey), lateral and vertical stability (BEHI, BHR), and bed material (pebble counts). The methods to be used are described below for each parameter.

12.2.1 Bankfull Events

The occurrence of bankfull events within the monitoring period will be documented by the use of water crest gages and photographs. A water crest gage will be installed at the downstream end of each mitigation reach to record the maximum stream water level. Crest gages will be installed near bankfull elevation. Photographs will be used in addition to the water crest gage to document any occurrence of debris lines (i.e., wrack lines) and sediment deposition on the floodplain during monitoring site visits.

12.2.2 Cross sections

Pairs of permanent cross sections will be identified and their locations and dimensions permanently marked. One cross section will be located at a riffle reach and the other at a pool. These cross section pairs will be established every 1,000 LF throughout the on- and off-site stream restoration streams and throughoutthe on-site establishment streams.. Cross section pairs will be selected at random structures throughout the off-site establishment and off-site enhancement streams. Each cross section will be marked on both banks with permanent pins for monitoring consistency and to facilitate easy comparison of year-to-year data. The annual cross section survey will include points measured at all breaks in slope, including top of bank, bankfull, inner berm, edge of water, and thalweg, if the features are present. Riffle cross sections will be classified using the Rosgen Stream Classification System (Rosgen 1996).

12.2.3 Longitudinal Profile

Representative longitudinal profiles extending 20 to 30 times the bankfull width will be completed throughout each of the mitigation reaches in two-year intervals, beginning in the first year following construction completion. Measurements will include thalweg, water surface, inner berm, bankfull, and top of low bank. Each of these measurements will be taken at the head of each feature (e.g., riffle, run, pool, and glide) and at the maximum pool depth. The survey will be tied to a permanent benchmark. Bedforms observed should be consistent with those typically observed for channels of the design stream type.

12.2.4 BEHI/BHR

Bank erosion hazard index (BEHI) scores will be collected throughout each of the mitigation reaches to determine if the channels are laterally stable. In additional the Bank Height Ratios (BHR's) will be monitoring from the riffle cross sections to determine if the streams are vertically stable. Success will be achieved by demonstrating a stable BEHI (less than 20) score and a low BHR (1.0 - 1.1) at the end of the ten year monitoring period.

12.2.5 Bed Material Analyses

Pebble counts will be conducted at the locations of the permanent cross section pairs. One-hundred counts will be taken at each cross section pair, using a zig-zag pattern back and forth across the stream within 20 feet upstream and downstream of the cross section pair. Pebble counts will be conducted at the first year after construction and at two-year intervals thereafter, at the time the longitudinal profile surveys are performed.

12.3 Habitat Monitoring

Habitat monitoring will follow USEPA's *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition* (Barbour et al. 1999). The method allows for a visual-based habitat assessment. The assessment focuses on the following habitat features: in-stream habitat, channel morphology, bank structural features, and riparian vegetation. A total of ten parameters are rated as optimal, suboptimal, marginal, or poor based on criteria. As prescribed, 100 meters of stream length or 40 times the stream's wetted width will be evaluated in each reach. As detailed in Section 3.0, habitat has already been assessed at the mitigation sites. Habitat assessments will be conducted annually throughout each of the mitigation reaches.

12.4 Vegetation Monitoring

Successful restoration of the vegetation on a stream mitigation site is dependent upon hydrologic restoration, active planting of preferred canopy species, and volunteer regeneration of the native plant community. In order to determine if the criteria have been met, vegetation monitoring quadrats will be permanently installed across the restoration sites. The number of quadrats required will be based on the species/area curve method, as described in monitoring guidance documents (Starr et al., 2001). The size of individual quadrats is 100 square meters for woody tree species and one square meter for herbaceous vegetation. Data will include diameter, density, and coverage quantities. Individual seedlings will be marked such that they can be found in successive monitoring years. Mortality will be determined from the difference between the previous year's living, planted seedlings and the current year's living, planted seedlings.

At the end of the first growing season, species composition, density, and survival will be evaluated. For each subsequent year, until the final success criteria are met, the restored site will be evaluated between July and November.

12.5 Biotic & Water Quality Monitoring

Monitoring of biotic elements, including benthic macroinvertebrates, will facilitate the evaluation of the effectiveness of the mitigation measures to provide habitat for aquatic fauna. The collected data will also document any changes in the biotic populations over time, provide identification of problems with the physical or biological development of the mitigation reaches, and assist with documenting maintenance needs.

As detailed in Section 3.0, biotic assessments have already been conducted at the mitigation sites. After construction, biotic monitoring will be conducted annually during the recommended sampling season (benthics: April 1 thru October 15; fish: April 1 thru June 15), beginning the first year following construction (USEPA, 2000). A detailed methodology for each of the monitored biotics is provided in Appendix A of this report.

12.5.1 Benthic Macroinvertebrates

In order to determine if the success criteria are achieved, benthic macroinvertebrate monitoring will follow USEPA's Rapid Bioassessment Protocol (RBP) (Barbour et al., 1999). As detailed in Appendix A of this report, a multi-habitat sampling approach will be used. Benthic macroinvertebrate stations will be sampled throughout each of the intermittent and perennial mitigation reaches, while additional benthic macroinvertebrate stations will be collected just upstream of those mitigation reaches or at a nearby stream. Along with the data collected prior to construction, these data will be used to compare benthic macroinvertebrate metrics in the mitigation reaches to those of the upstream or nearby reach. By collecting biotic data at these locations each sampling year, both sites are assumed to be exposed to the same environmental influences (e.g., flooding, drought, water quality).

Data analysis will include calculation of USEPA's RBP metrics, along with the WVSCI values. Diversity indices, including Simpson's Index (Simpson 1949), will be evaluated at each of the sampling stations.

12.5.2 Fish

Like the benthic macroinvertebrates, fish sampling will follow USEPA's RBP (Barbour et al. 1999). Similar sampling stations will be selected for fish as were for benthic macroinvertebrates, however will only be located in perennial mitigation reaches. Sampling reaches will be determined using the proportional-distance approach, however having a maximum of a 500 meter sampling reach or maximum of 3 hours electroshocking time (Klemm et al. 1993). Along with a minimum of one sampling reach in each perennial mitigation reach, a station will be sampled upstream of the restored/enhanced area or at a nearby steram. Along with the data collected prior to construction, the monitoriong data will be used to compare fisheries resource data in the mitigation reaches to those of the impaired or un-restored reaches. By collecting biotic data at these locations each sampling year, both sites are assumed to be exposed to the same environmental influences (e.g., flooding, drought, water quality). Along with the diversity indices described in the benthic macroinvertebrate section, species richness, abundance, total biomass, and tolerance classifications will be identified at each sampling reach.

12.5.3 Water Quality

Preliminary engineering in regards to valley fill construction and mining operating procedures has been conducted to reduce water quality impairments, as part of the selection of the least environmentally damaging practicable alternative detailed in the Section 404 CWA permit application in accordance with 40 CFR 230 Subparts A through H. For instance, the valley fill construction will involve bottom-up construction techniques, which will reduce the amount of time unconsolidated rock strata is exposed to air or water, the valley fill lifts will be compacted at a steady rate, and the valley fill lifts will be reclaimed and vegetated as they are constructed (personal conversations with WVDEP). Additionally, in several of the subwatersheds (i.e., Right Fork of Hell Creek, Left Fork of Hell Creek, Right Fork of Conley Branch, Left Fork of Conley Branch, Miller Creek, and Pigeonroost Creek), CONSOL has proposed a series of two drainage control structures to be installed to assist in water quality treatment and necessary retainage of solids or metals during the mining operation before drainage enters jurisdictional waters of the U.S. These proactive operational measures will play a significant role in preventing water quality impairments during the mining operational phases.

During the mining operation, several BWQ stations will be monitored to comply with NPDES effluent limits to ensure that water quality is not being impacted in the subsequent sub-watersheds (Figure 12.5). The BWQ data will be reviewed as part of the monitoring efforts for the mitigation plan to ensure that water quality is not impaired at the proposed mitigation sites. If water quality impairment is observed, the adaptive management plan will be implemented (Section 13.0).

In addition to the required BWQ monitoring efforts, additional water quality will be monitored during the biotic sampling, as recommended in the USEPA guidance (2000). At each station, water chemistry parameters will be analyzed in the field and laboratory. Laboratory parameters will include pH, specific conductance, total and dissolved iron, total and dissolved manganese, total and dissolved aluminum, total magnesium, total suspended and total dissolved solids, carbonate, bicarbonate, and total alkalinity, acidity, selenium, calcium, potassium, chloride, sodium, and total sulfate. Additional parameters at the Hell Creek off-site restoration areas include fecal coliform, total phosphates, and nitrates/nitrites (Figure 12.3). Field parameters will include flow, pH, conductivity, dissolved oxygen, and temperature.

12.6 Reporting Methods

12.6.1 As-Built Report

An as-built survey documenting post-construction conditions will be conducted within 60 days of the completion of planting on the mitigation sites and the corresponding report will be submitted to the USACE with the year one monitoring report. One hard copy of the report will be submitted to the USACE, plus an additional electronic copy on CD and in PDF format. The as-built reports will include:

- A map showing all monitoring locations (i.e., biotic sampling locations, vegetation plots, BEHI locations, photograph locations, etc.);
- As-built topographic maps showing location of monitoring stations, vegetation sampling plots, permanent photo points, and location of transects;
- The final planting scheme and planting list;
- Revised credit/debit matrix comparing the as-built conditions versus the proposed matrix in this plan and a summary of any noticeable changes.

12.6.2 Annual Monitoring Report

The annual monitoring reports will include all information required by the USACE; Regulatory Guidance Letter (RGL No. 08-03) dated October 10, 2008 (USACE, 2008). The monitoring program will be implemented to document system development and progress toward achieving the success criteria referenced in the previous sections. Stream morphology, hydrology, and vegetation, will be assessed to determine the success of the mitigation. The monitoring program each year will be initiated after the first full growing season following initial planting and continue for a minimum of five years, or until the final success criteria are achieved (Section 9.0). Monitoring reports will be prepared each year of monitoring and submitted to the USACE by December 31 each year. One hard copy of the report will be submitted to the USACE, plus an additional electronic copy on CD and in PDF format. The monitoring reports will include:

- A detailed narrative summarizing the condition of the mitigation site and all regular maintenance activities;
- Topographic maps showing location of monitoring stations, vegetation sampling plots, permanent photo points, and location of transects;
- Total linear feet of mitigation, revised IFAA's, revised USM credits, and revised debit/credit tables;
- Photographs showing views of the mitigation site taken from fixed-point stations;
- Hydrologic information;
- Vegetative data including species identified and any maintenance activities with invasive species;
- Identification of any invasion by undesirable plant species, including quantification of the extent of invasion of undesirable plants by either stem counts, percent cover, or area, whichever is appropriate;
- Biotic data;
- A description of any damage done by animals or vandalism;
- Wildlife observations; and
- Reference hydrology and stream data.

12.7 Maintenance Issues

Maintenance issues and recommended remediation measures will be detailed and documented in the as-built and monitoring reports. Maintenance requirements vary from site to site and are generally driven by the following conditions:

- Projects without established, woody floodplain vegetation are more susceptible to erosion from floods than those with a mature, hardwood forest.
- Projects with sandy, non-cohesive soils are more prone to short-term bank erosion than cohesive soils or soils with high gravel and cobble content.
- Alluvial valley channels with wide floodplains are less vulnerable than confined channels.
- Wet weather during construction can make accurate channel and floodplain excavations difficult.
- Extreme and/or frequent flooding can cause floodplain and channel erosion.
- Extreme hot, cold, wet, or dry weather during and after construction can limit vegetation growth, particularly temporary and permanent seed.

- The presence and aggressiveness of invasive species can affect the extent to which a native buffer can be established.

Regardless of any maintenance issues discovered during the monitoring, the project will be maintained accordingly.

12.8 Release from Monitoring

Once the project has been monitored for a minimum of ten years and has met the annual success criteria, CONSOL shall request, in writing, release from monitoring. The request shall include a minimum of the following items:

1) Final Monitoring Report, including an evaluation of project success and final success criteria metrics;
2) Final credits based on project success;
3) Jurisdictional determinations for any created waters of the U.S.; and
4) Any other items deemed necessary.

The USACE shall conduct a final site visit and notify CONSOL in writing whether release from monitoring is deemed appropriate or what additional information, corrective measures, or additional monitoring are necessary for the USACE to approve monitoring release.

13.0 ADAPTIVE MANAGEMENT

13.1 General Plan

With the application of adaptive management, this mitigation plan is intended to survive well beyond the visible planning horizon, remaining viable and vital to any future planning efforts throughout the watershed.

Based on the monitoring results, if it is determined that an adaptive management plan needs or actions as described in Table 9.1 to be implemented, the adaptive management steps will include (Salafsky et al. 2002):

- Defining a clear objective;
- Developing a plan to achieve the objective;
- Developing success criteria for the objective;
- Developing a revised monitoring plan to evaluate success;
- Using monitoring data to re-evaluate the plan and refine strategies in-case of a failure in the plan;
- Communicate results to clients and regulatory agencies.

The concept of adaptive management acknowledges the dynamic nature of natural systems and the changing state of knowledge and developing management strategies. Adaptive management involves not only acknowledging new information and making objective judgments regarding whether to change strategies to better achieve management objectives, but also learning from past efforts, using monitoring data, and re-evaluating current methods and practices. Methods and strategies that are currently used should always be refined once new and better information is available (Wilhere, 2002). If new information indicates an alternative strategy is effective, the plan should provide the flexibility and allow the latitude to pursue it. It is very difficult to predict what adjustments might be necessary in the future.

Additions or changes to this mitigation plan will occur only with the approval of the regulatory agencies, aside from specific structure locations or minor modifications during construction, of which will be documented and professionally certified in the final as-built surveys. In order to keep the plan document current and relevant, the following items will be reviewed on a regular basis:

- Changes to resource permitting requirements,
- Monitoring data from on-going programs,
- Other newly reported data coming to CONSOL's attention, and
- Reassessment of specific goals and whether or not they have been met.

13.2 Specific Plans

13.2.1 On-Site

During the implementation of the on-site establishment, adaptive management may be necessary during construction. For example, as-built surveys and certification along with maintenance records of the establishment streams will serve as a baseline to compare with structural monitoring after Phase II bond release and aid in adaptive construction practices. Monitoring data will validate if on-site adaptive management efforts need to be implemented based on effective monitoring strategies incorporated during the construction phases.

Areas of Concern with respect to on-site establishment include:

- Available floodplain - In all of the designed channels, it has been determined that there is sufficient area to meet the minimum floodplain criteria (Appendix I). In five of the ditches, however, the maximum floodplain length is not available. Therefore, if it is decided that a more concervative design needs constructed to maximize the floodplain area, the berm of the existing sediment ditch can be dug out to maximize the area (Figure 5.2 - Figure 5.6). If, after monitoring, it is determined that there is a need to maximize the floodplain in these specific ditches to determine if sufficient flows are available, there is a design plan to do so (Figure 5.2 - Figure 5.6).

- Bedrock encountered during construction – If bedrock is encountered, the establishment channel may need to be built on-top of the existing base width, rather than digging a bankfull channel down into the existing base width. If this is necessary, additional excavation may be necessary for a sufficient floodplain (see Figure 13.1).
- Flow Regime – It is expected that the establishment streams will maintain intermittent flow because of the groundwater table and surrounding topography. However, because the flow is affected by the regrade topography and construction staging, the streams will need to be assessed post-construction to determine the proper flow regime for final classification determination.
- Water Quality – It is expected that overall water quality will remain within recommended ranges for freshwater organisms and within the NPDES requirements, however, if any parameters become out of range, an alternate mitigation site may need to be proposed and approved by regulatory agencies to ensure that poor water quality is not entering jurisdictional waters of the U.S. Adaptive management would involve immediately blocking any contaminated water from entering existing jurisdictional waters and implementing a water treatment plan, if necessary.
- Vegetation Establishment – It is expected that grasses, trees, and shrubs will grow on the topsoil substitute utilized during reclamation of the mineral removal areas. If plantings are not growing as expected, soil amendments and mulch additions may be required to enhance the soils for better vegetation establishment.

During the implementation of the on-site restoration, if new, relevant information is developed concerning the impacted watershed, it will be incorporated into the Mitigation Plan. From permit approval to implementation, any new monitoring data, scientific findings, and management practices learned from the best available science will be utilized for re-evaluation before implementation to increase chances of success.

Areas of Concern with respect to on-site restoration include:

- Bedrock encountered during construction – If bedrock is encountered, the restoration design shall be re-evaluated to determine if channel alignment can be adjusted to avoid the bedrock or if new in-stream structures need to be incorporated. Typically, when bedrock is encountered and channel alignment is maintained, footer rocks are not necessary in the structures. Because the bedrock surface cannot be scoured, function would shift to creating a backwater pool instead of a larger downstream scour pool.
- Maintenance Access – If maintenance access is to be incorporated into the restoration design, it shall be outside of the prescribed riparian zone width, if practicable. If maintenance access must be within the protected riparian zone, the area shall be returned to its pre-disturbance state after the monitoring event.

13.2.2 Off-Site

As with the on-site mitigation plans, any new information about the off-site mitigation watershed will be researched and incorporated into the proposed mitigation plan. From permit approval to implementation any new monitoring data, scientific findings, and management practices learned from the best available science will also be utilized for re-evaluation before implementation to increase chances of success.

The watershed will be completely re-evaluated to determine if any impacts to the proposed preservation reaches have occurred since permit approval to validate these streams continue to be worthy of preservation.

With respect to off-site establishment, areas of concern include:

- Flow Regime – As described above, it is expected that the on-site establishment streams will maintain intermittent flow because of the groundwater table and surrounding topography; therefore, it is expected that the off-site establishment streams will also have intermittent flow. However, because the flow is affected by the regrade topography and construction staging, the streams will need to be assessed post-construction to determine the proper flow regime for final flow regime classification determination.
- Water Quality – It is expected that overall water quality will remain within recommended ranges for freshwater organisms, however, if any parameters become out of range, an alternate mitigation site may need to be proposed and approved by regulatory agencies to ensure that poor water quality is not entering jurisdictional waters of the U.S. Adaptive management would involve immediately blocking any contaminated water from entering existing jurisdictional waters and implementing a water treatment plan, if necessary.
- Slippage – Because of the steep nature of the off-site establishment streams, there may be slippage of larger boulders and material. If slippage is noticed during the construction or monitoring process, these areas will be revisited and adjusted to secure the materials and associated sediments to reduce erosion and possible incision.
- Maintenance Access – Off-site establishment channels were selected based on availability of access roads on sections of the stream. If it is determined that access to any of the sites is infeasible, a new mitigation site may need to be proposed and approved by regulatory agencies.

With respect to restoration and enhancement, areas of concern include:

- Bedrock encountered during construction – If bedrock is encountered, the restoration design shall be re-evaluated to determine if channel alignment can be adjusted to avoid the bedrock or if new in-stream structures need to be incorporated. Typically, when bedrock is encountered and channel alignment is maintained, footer rocks are not necessary in the structures. Because the bedrock surface cannot be scoured, function would shift to creating a backwater pool instead to a larger downstream scour pool.
- Maintenance Access – If maintenance access is to be incorporated into the restoration design, it shall be outside of the prescribed riparian zone width (25-feet on each stream bank), as practicable. If maintenance access must be within the riparian zone width, the area shall be reclaimed after monitoring and success determination.

14.0 FINANCIAL ASSURANCES

CONSOL of Kentucky Inc., a subsidiary of CONSOL Energy, Inc., is a high-Btu bituminous coal and coal bed methane company. CONSOL Energy, Inc. is a member of the Standard & Poor's 500 Equity Index and has annual revenues of $3.7 billion. It has 20 bituminous coal mining complexes in six states and reports proven and probable coal reserves of 4.5 billion tons. In addition, the company is a majority shareholder in one of the largest U.S. producers of coalbed methane gas, CNX Gas Corporation.

CONSOL Energy, Inc. was named one of America's most admired companies in 2005 by Fortune magazine. It received the U.S. Department of the Interior's Office of Surface Mining National Award for Excellence in Surface Mining for the company's innovative reclamation practices in 2002, 2003 and 2004. Also in 2003, the company was listed in Information Week magazine's "Information Week 500" list for its information technology operations. In 2002, the company received a U.S. Environmental Protection Agency Climate Protection Award.

CONSOL is financially secure with regards to its ability to complete all required jurisdictional waters mitigation activities, including all necessary post-mitigation maintenance and monitoring. Reclamation liability bonds posted with the WVDEP for this project total $11,565,000. Additionally, CONSOL will post a performance bond of $761,480 for mitigation as financial assurance that the proposed mitigation will be completed and monitored for achievement of success standards.

15.0 DISCLAIMER

This project was assembled at the client's request by Michael Baker Jr., Inc., using data and information provided by CONSOL of Kentucky Inc. The scope of this study was mutually devised by Michael Baker Jr., Inc. and the client, and it is limited to the specific project, location, and time period described herein.

Michael Baker Jr., Inc. assumes no responsibility for information provided or developed by others or for documenting conditions detectable with methods or techniques not specified in the work scope. Michael Baker Jr., Inc. has reviewed the information provided by others and found it to be credible for the purpose of this report.

This report is intended for the use of the designated client within a reasonable period of time from its issuance. Michael Baker Jr., Inc. also has not independently verified information furnished by other parties included in this report and therefore cannot warrant the accuracy, completeness, legality, reliability, or efficacy of such information. However, Michael Baker Jr., Inc. has deemed this information to be credible at the time of issuance of this report, and therefore its use is considered to be judicious. Conclusions derived from this report are subject to revision if unverified data are demonstrated after issuance of this report to be incomplete or inaccurate, there are modifications to the data, or there emerges significant new data. Unauthorized or unintended use of this report or the information contained herein shall indemnify Michael Baker Jr., Inc. from any and all injury, damage, and liability arising from such use. This disclaimer applies to both partial and aggregate uses of this report.

16.0 REFERENCE

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