Review of ADNR Decision Denying Petition to Designate Lands Unsuitable for Surface Coal Mining

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I have reviewed the Alaska Department of Natural Resources (DNR) decision to deny Chuitna Citizens Coalition and Cook Inletkeeper's petition to designate streambeds and the adjacent riparian area within the Chuitna River watershed as unsuitable for surface coal strip mining. My work specifically addresses the claim by DNR that it is technically feasible to restore salmon bearing streams as part of land reclamation following their complete destruction by strip mining coal at depths of over 300 feet. My opinion is based upon review of materials used by DNR to support how the proposed reclamation techniques are feasible, a review of technical literature relevant to large-scale stream and watershed restoration, and my 25 years of professional experience and practical expertise in applying stream and watershed restoration science to engineering design and construction of salmonid habitats in streams and rivers.

DNR's decision is based upon the technological feasibility of reclamation. DNR concludes that it is technologically feasible to restore salmon-bearing streams with similar ecological values after deep strip mining directly through salmon-bearing streams within the Chuitna River Watershed and PacRim lease areas given:

(1) Past findings regarding the Diamond-Shamrock proposed coal strip mine;

(2) Findings pertaining to the currently proposed Chuitna coal strip mine; and

(3) A series of examples demonstrating stream restoration post-mining (gravel, placer and coal mine examples are provided).

Based upon my review, I conclude that it is not technically feasible to design and reclaim streams and salmon populations after deep strip mining of the streambeds and associated riparian areas in the Chuitna Watershed based upon the following:

1. Strip mining would destroy the watershed's hydrologic and geomorphic functions, including the balance of stream flow and sediment supply that supports stream function and habitats over the long term. As it is infeasible to re-create stable and functional watershed conditions, it is infeasible to restore the pre-project conditions that would support salmon bearing streams.

DNR's conclusion of technical feasibility is not supported by any known or proven stream restoration technologies nor the reclamation examples relied upon. Constructing stream channels on reclaimed overburden alone is not the primary factor upon which to demonstrate success – one must somehow create specific watershed conditions for the stream channel to receive and move sediment, recreate and retain habitat features and a stable morphology after construction (Kondolf, et al, 2006). This has not been demonstrated for the conditions in the Chuitna Watershed by DNR's citations of examples nor with data and information presented. In practice, designing such watershed functions is not possible given the loss of soil and groundwater aquifer structure (Meyers, 2011) and vegetation from strip mining (Palmer, 2011).

DNR's comparison of successful stream restoration examples from other locations is inappropriate for conditions in the Chuitna Watershed primarily because the cited examples all retained pre-project watershed conditions above the mined sites, which left the pre-project hydrology and sediment supply regimes intact.

Strip mining as proposed in the Chuitna River Watershed involves removing the entire existing landscape of hillslopes, streams, ponds, wetlands **and their headwater areas to depths greater than 300 feet**, then reconstructing streams and topography with placed overburden, interburden and topsoil; this action would significantly alter the physical watershed conditions that presently support anadromous streams and wetlands, including topographic characteristics supporting complex surface and groundwater systems, sediment supply and channel forming processes (i.e. sediment transport).

The present watershed characteristics include soil and vegetation cover that dictate the hydrologic characteristics of rainfall/runoff processes and the manner in which sediment is generated and delivered to streams. Runoff under present conditions produces organic matter that underlies stream food webs. The present day streams are valuable because they are in tune with the specific rainfall/runoff and sediment transport processes of a stable watershed. Deep strip mining by its nature removes soil structure and vegetation cover and leaves barren ground for many years. The infiltration capacity of the soils which in turn dictates runoff volumes, is a function of grain size, stratigraphy, vegetation cover and organic material in soils; stripping soil cover and replacing it with barren backfill will not replicate pre-mining hydrologic and vegetative conditions. Without the proper watershed function, streamflow and groundwater regimes will not be the same, therefore surface groundwater interactions that create streamflow and wetlands will be forever lost (Meyers, 2011).

The success of reconstructing and restoring stream channel functions over the long term is highly dependent upon creating a precise balance of sediment and water inflows provided from the upstream watershed areas (Kondolf, et al 2006). Under natural conditions, stream channel width, depth and pattern (the channel path as viewed from above) and the substrate lining the channel are sustained by the hydraulic force of water moving over the land surface and moving sediment; both of these factors are dependent upon the volumes of water and sediment sizes produced by the watershed and delivered to the site (Leopold, et al 1964; Dunne and Leopold, 1978). Key habitat features such as riparian vegetation, spawning gravel in riffles, pools and complex stream banks are all dependent upon the volume and timing of surface flow and sediment loads. Strip mining the streams and their contributing watersheds significantly changes how the watershed converts rainfall into surface runoff, and how, when and if sediment is dislodged by erosion and transported to and within the stream. It is simply not feasible to re-create these characteristics after destroying soil and vegetation cover that were formed and evolved over thousands of years.

2. Wholesale strip-mining of watersheds will significantly alter the stream flow and sediment regimes that support stream functions and habitats.

Three fundamental geomorphic processes that support fish and aquatic habitats in streams in the Chuitna watershed would be destroyed with strip mining:

1) **The supply of coarse bedload sediments (gravels, cobbles, etc)**: is crucial for supporting gravel bars, riffles and stream substrate. Clean gravels (and particularly the associated interstitial spaces between streambed gravel) are necessary for spawning and for sustenance of macroinvetebrates that live in gravel substrate and are the primary food source for salmonids (Kondolf, 2000);

2) **The supply of fine sediments (silt, clay and sand) from the overburden**: would likely increase dramatically after reclamation and streams would be subject to contamination; fine sediments fill pools, clog gravel substrate, kill off incubating eggs by decreasing the porosity of substrate and outflow of metabolic waste, reduce macroinvertebrate populations and food production for fish (Roosner and O'Conner, 2004; Kondolf, 2000); and

3) **Post- reclamation stream flow supporting stream function, surface-groundwater interactions:** Changes in topography, vegetation, soil structure and subsurface materials with mining and reclamation destroys

the fundamental processes for stream and wetland ecosystem function (Berhardt and Palmer, 2011)

The examples of successful reclamation and stream restoration cited by DNR did not involve wholesale changes in watershed conditions and flow and sediment processes, and as a result are not appropriate comparisons to the deep strip mining that would take place in the Chuitna watershed, which includes mining directly through and beneath salmon-bearing streams. DNR's cited examples of stream restoration occur in the lower reaches of creeks and rivers where mining did not change the overall reconfiguration of the contributing watersheds.

As an example of what could occur over the entire Chuitna Watershed resulting from DNR's decision, the proposed PacRim Chuitna project proposes strip-mining coal seams 300 to 350 feet below the surface. This would destroy streams by removing them, and their headwaters in order to reach coal underneath. The only currently planned coal strip mine in the Chuitna watershed involves reclamation by large-scale reconstruction of the watershed area creating different yet unknown rainfall/runoff processes and as a result, unknown sediment supply dynamics. Naturally layered aquifers supporting the current groundwater system and upwelling within streams would be replaced with backfill with less favorable hydraulic conditions to form spring-fed streams (Meyers, 2011). Thus, it is simply not possible to support ecologically valuable streams based upon the post-reclamation conditions.

The examples of "successful stream restoration projects" listed below and relied upon by DNR in its decision, did not experience the greater watershed destruction and wholesale hydrologic changes associated with the type of extensive deep strip mining proposed in the Chuitna watershed.

Silver Bow Creek, Butte Montana: restoration of stretches of Creek below watershed area, which was unaffected by mining. Project involved removal of tailings from floodplain.

Pipestone Creek Restoration Project, Illinois: relocation of diverted creeks into pre-existing vegetated riparian corridors. Watershed area above mined area not altered by historic mining – project involved connecting large pits to pre-mining riparian corridors.

Clear Creek Restoration California: restoration occurred in lower reach of clear creek below Whiskytown Dam and mining did not modify reservoir and watershed.

Resurrection Creek, Alaska: reach of creek located below watershed area that was not affected by mining.

Moose Creek Fish Passage Restoration Project: below 45 mi^2 watershed unaffected by mining.

Nome Creek, located in the White Mountains in Interior Alaska: restored reach below unaffected watershed area; project involved re-grading tailings within creek along valley bottom.

The Valdez Creek Mine, located south of the Alaska Range: reclamation and creek restoration occurred downstream of watershed area which was unaffected by mining.

Successful stream restoration design hinges on gaining a precise balance of appropriately sized sediments supplied from the watershed to the creek to achieve channel “dynamic equilibrium.” (Nunnally, 1985). There is no evidence from past stream restoration projects to indicate that it is technologically feasible to rebuild and restore a stream when the stream, including its headwaters and watershed are destroyed. In fact, there is no feasible way to predict post-mining watershed conditions since it is unknown how placed backfill evolve, especially without the stabilizing effects of dense vegetation and precise soil conditions that exist today. Moreover, there are considerable differences between existing conditions and reclaimed watershed condition response to climatic events. Since the future of climate is largely unknown (i.e. the magnitude and sequence of flood events), it is not possible to project watershed and constructed stream channel response and form after reclamation. It is not possible to predict post-reclamation watershed conditions with any degree of certainly as vegetation cover and soil conditions would depend on the future unknown sequence of climatic events that require significant passage of time to develop. The outcome of reclamation would be different if the climatic sequence were a series of dry years than if it were average or wet.

3. Use of present day reference reaches for stream channel restoration design is inappropriate as watershed conditions would be significantly changed with mining and reclamation.

An example of strip mining reclamation to be used in the Chuitna River watershed using natural stream channel restoration design is found in supporting documents for the PacRim mine (D7 Fish and Wildlife Protection Plan dated July 2007). The PacRim Project proposes using references reaches of pre-project streams to estimate design channel width, depth and pattern. The large-scale watershed changes that would result from mining 300+ feet deep below streams will dramatically change the watershed conditions that created the reference reaches thereby making comparison to post-project conditions moot, i.e. the future watershed sediment water balance will be dramatically degraded compared to present day conditions.

The proposed reclamation would be an experiment in watershed degradation since soils and vegetation cover, topography and subsurface conditions would all be destroyed. Recovery, if it were possible, would take hundreds if not thousands of years in order to build up organic material in soils, create soil stratigraphy, establish mature vegetation cover and allow stable stream channels to form. Since prediction of future watershed conditions over such time scales is not feasible, it is infeasible to design streams whose function is dependent on such factors.

4. Use of the Rosgen Natural Channel Design Method does not fully account for the watershed factors affecting long-term sustenance of healthy streams.

Use of the Rosgen Natural Channel Design method at other locations has resulted in project failures, mostly due to the lack of incorporating site geomorphology (i.e. accurately predicting the volume of stream flow and sediment characteristics) into the project design (Simon, et al 2007; Kondolf, 2006). Predicting future geomorphic conditions to design a stable stream is a great challenge in cases without substantial watershed modification (Brierley and Fryirs, 2008); predicting future conditions where the watershed is completely destroyed then rebuilt is simply not feasible. Stating that the technology exists does not demonstrate in a reliable way as to how the project will function in the future. Geomorphic processes are complex and site specific (Brierley and Fryirs, 2008; Leopold and Maddock, 1954), especially where the watershed area above the project will be significantly altered, as is proposed in the Chuitna coal strip mine project.

There are many well-documented cases of project failures using the Rosgen natural channel design method due to a failure to consider the variability of hydraulic force and sediment supply in large floods and the lack of predicting soil stability and geotechnical factors (Kondolf, 1995; 2006). In many cases, the reconstructed channels simply eroded away. A second factor in many Rosgen designs is the inherent conflict between installing channel bed and bank stabilizing structures (root wads, boulder weirs, vanes, etc.), and allowing for the desired lateral channel meandering and floodplain construction processes. (Kondolf, 2006). Constructed channels have been destroyed in a short period of time simply because a flood larger than the Rosgen natural channel design 1.5 year event occurred.

Use of the Rosgen method for designing stream restoration does not address the larger scope of potential changes associated with the type of mining currently proposed in the Chuitna watershed. As an example, the PacRim project documents (D7 Fish and Wildlife Protection Plan dated July 2007) state that successful restoration of stream channels hinges on having a balance of sediment supply and transport. The type of mining currently proposed in the Chuitna watershed will completely alter this factor, yet there is no supporting evidence of what the post-reclamation watershed will provide in terms of sediment volumes and sizes and the volume and timing of stream flow. It is simply unknown and undemonstrated how sediment balance could be feasibly achieved. Consequently, there is absolutely no basis to support the claim that it is technologically feasible to rebuild the streams and restore the sediment balance.

One must know the sediment inflow rates and the sizes of sediment coming into the restored creek over a large range of floods before it can be known how the reconstructed stream can move, sort and allow sediment deposition to form key stream habitat features such as pools and riffles (Kondolf, et al 2006; Kondolf 1995). All these factors in the present day streams evolved from initial conditions over thousands of years since the end of the last ice age and after multiple phases of climatic change; under reclamation, the ultimate conditions will not be known because it is not possible to predict the future climate, vegetation growth and soil formation. This renders any attempt to predict future reclaimed conditions futile and misleading if attempted.

5. Habitat restoration through stream channel construction does not in itself translate to wildlife population restoration

The proposed restoration methods for the Chuitna coal strip mine do not address larger issues associated with restoring fish and aquatic wildlife populations, especially the linkages between the watershed, stream and ecosystem (Kondolf, et al, 2006). Reconstruction of stream channels only addresses physical habitat, not wildlife population dynamics that ultimately dictate stream ecosystems. Habitat reconstruction does not address larger factors such as food production, cover, substrate, vegetation growth, nutrient supplies from the surrounding watershed and water quality under post-reclamation conditions (Bernhardt and Palmer 2011).

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