HYDROLOGY AND WATER CHEMISTRY OF SHALLOW AQUIFERS ALONG THE UPPER CLARK FORK, WESTERN MONTANA pdf

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Hydrology and water chemistry of shallow aquifers along the upper Clark Fork, western Montana Water-Resources Investigations Report By: D.A. Nimick.

Journal of Quaternary Science. Geological Survey Scientific Investigations Map Geological Survey Investigations Report â€" Science of the Total Environment, v. Journal of Hydrology, v. Lago Cachet Dos example in Chile. Geological Survey Scientific Investigations Report , 26 p. Geological Survey Scientific Investigations Report , 28 p. Exploration, Environment, Analysis, v. Geochimica Cosmochimica Acta, v. Geological Survey Scientific Investigations Report , 46 p. Environmental Toxicology and Chemistry, v. Environmental Monitoring and Assessment, v. Water, Air, and Soil Pollution, v. Archives of Environmental Contamination and Toxicology, v. Environmental effects of historical mining in the Boulder River watershed, southwestern Montana. Geological Survey Fact Sheet , 2 p. Geological Survey Professional Paper , p. Monitoring surface-water quality in the Tongue River Watershed. Geological Survey Open-File Report , p. Geological Survey Fact Sheet , 4 p. Occurrence and possible causes. Water Resources Research, v. Transactions of the American Fisheries Society, v. Geological Survey Open-File Report , 70 p. Geological Survey Fact Sheet Geological Survey Open-File Report , 71 p. Geological Survey in Montana. Geological Survey Open-File Report , 41 p.

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Hydrology and water chemistry of shallow aquifers along the upper Clark Fork, western Montana.

Specific goals are provided as categorized by component project and general goals are categorized with the component project that most directly motivates them, with cross-referencing information about other related projects. For component projects that are awaiting pending funding or funding from planned proposals, the ability to achieve these goals is contingent on successful proposals over the proposed 5-year extension for this MAES project. West Fork of the Gallatin project WFGP The goals of the WFGP are to integrate understanding of the hydrological and ecological controls on whole-stream ecosystem metabolism, which is a useful whole-system indicator of the potential for increases in algal growth to alter the ecosystems of popular fishing streams. From a scientific perspective, the WFGP study site represents a unique combination of rapid urban development in a high-elevation process domain that is more susceptible to the influence of climate change [Barnett et al. This scenario provides a valuable case study for understanding the relative importance of land use change via increased nitrogen loading and climate change via shifts in hydrologic regimes and water temperatures in determining the trajectory of water quality into the future. More generally, our goals are to assess how stream metabolic regimes may provide a useful long-term monitoring signals that are integrative indicators of whole-watershed physical and ecological dynamics in upland mountain headwater process domains [Williamson et al. Our central scientific questions are: What are the relative roles of climate and land use change on aquatic ecosystem function in high elevation watersheds? How do these effects manifest through the specific mechanisms of nutrient loading, temperature change, and alteration of the algal growing season? Gallatin River Watershed project GRWP Our goal for the GRWP research is to apply emerging geochemical methods to improve understanding of hydrologic storage dynamics that are characteristic of this the inter-mountain region and essential to both. This improved understanding will subsequently improve the ability to predict and detect how effects of climate and land use changes influence groundwater and surface water supply quantity and quality. By examining mountain-basin transitions, we seek to address a key gap in our understanding of inputs from the headwaters that drives river biogeochemistry and may influence observations downstream. A longer term goal is to link these Missouri Headwaters chemistries with downstream results, including a time series of Sr isotope data on the middle Missouri Yankton Gauge; Paces unpublished data , and dissolved inorganic and organic carbon loads DIC and DOC loads suggesting land use effects on productivity [Stackpoole et al. How does contact with various weathering materials in soils and groundwater influence the quality of water in longer-term storage, and how can we use the resulting water chemistry and isotope composition of stream baseflow generation to infer the source and age of water resources? Specific to precision agriculture, the goal is to research the appropriate ontologies for the database schema and software engineering that will enable model exploration with more extensive datasets for individual fields. More generally, optimization modeling is not a unique application in scientific workflows, and the goals for development of database schema and software that enable optimization in agriculture generally extends to similar workflows for finding optimum models describing causality in nature. For example, the task of inferring metabolic rates from dissolved oxygen data in streams see WFGP and UCFRP is an optimization modeling process, which can be based on similar abstractions of optimization workflow as the precision agriculture process. While the projects seem disparate on the surface, the OFPEP, WFGP, and UCFRP have a parallel goal for research on the scientific workflow associated with optimization modeling, and complementary work toward this goal will be carried out across these component projects. Our central questions are: How do the principles of structural and functional abstraction from the object-oriented paradigm of software engineering allow for more extensible and integrated scientific databases? How can diverse datatypes be integrated in common workflows designed for a unified metadata organizational structure? Beaver mimicry stream restoration project BMRP Natural storage is frequently referenced as an ecosystem service that will emerge from this beaver mimicry strategies. We currently partner with TNC in building a program using existing and planned BMR activities in the Upper Missouri region as manipulative experiments, working toward a better understanding of the hydrologic consequences of BMR. Our objective is to couple field experiments with simulation modeling to discern the hydrologic mechanisms by which various time scales of natural storage may be created or enhanced. The applied goal is to produce models that may be used predictively in the future for identifying restoration sites which best meet project objectives. How does alteration of surface-subsurface hydrologic exchanges due to beaver mimicry stream restoration influence the potential for seasonal time-scale storage of water in the alluvial system? What are the implications of these changes to stream water temperature regimes and the influence of evapotranspiration on alluvial water budgets? The multiple variables used include simultaneous time series of dissolved oxygen DO , dissolved inorganic carbon DIC , and pH. Recent advances sensor technology for measuring DIC in situ [Lynch et al. However, robust inferential tools for using multivariate data to infer stream metabolic rates are only a recent, and incomplete, development [Holtgrieve et al. More generally, the fundamental tools we develop for estimating stream ecosystem metabolism will also be useful to the metabolism estimates for the WFGP. How does the reconnection of a stream to its floodplain alter the whole-stream metabolic regime of the aquatic ecosystem? How does collection of multiple time series data sets that are jointly influenced by river metabolism e. Project Methods West Fork of the Gallatin project WFGP For both major field seasons for this project , the experimental designs are generally focused on measuring environmental variables that are hypothesized controls on ecosystem metabolism e. From the dissolved oxygen data, we will be able to infer gross primary production rates with more confidence and ecosystem respiration rates with less confidence. Principle components analysis or other multivariate statistical approaches will be used to assess the relative importance of our primary 3 control variables of interest driving our hypotheses water temperature, hydrologic regime, and nutrient loading have either natural or human-induced variation across the watershed, allowing us to test if the response variables have the variation we would expect across the sites based on those hypotheses. For the second season , the team focused on just two reaches on the same stream above and below the golf course, a major source of nitrogen loading. During the second season, data were collected at a much higher temporal resolution hourly over ca. We are approaching analyses of these data with upstream-downstream comparisons of diel regimes, to test hypotheses regarding how nutrient loading alters variations in controls on metabolism at a sub-daily temporal scale. We are also either completing or planning analyses that span data from both seasons. Also within the first year of the renewed project, Storb will be completing an analysis and submitting a hydrologic manuscript on the topic of comparisons of statistical approaches to detecting trends in the timing of climatic snowmelt drivers inferred from patterns in the hydrograph. Gallatin River Watershed project GRWP Water samples are being collected at sites that are thought to capture the major transitions of sources to baseflow generation. In the upland mountain headwater process domain, most sites are located along Hyalite Canyon. Hypotheses are driven by: Water samples are analyzed in the lab primarily for Ca, Sr, and U concentrations, as well as the isotope ratios for Sr and U. The ratio of Sr to Ca is information about the type of rock being weathered, the ratio of Sr isotopes is information about the age of the rock being weathered, and the ratio of U isotopes is information about the travel time of water after dissolution at the time of weathering. Data are first being analyzed to support hypotheses about the nature of various source waters in contact with various soils and bedrocks across the Gallatin River Watershed. Then, mixing models will be applied to test hypotheses about where storage supporting late summer flows is located along streams and rivers in the watershed. Research on flexible approaches to optimization workflow design are primarily related to metadata ontology for database schemas and software engineering for the tools that use the database. For the initial phase of the project, we have identified workflows generally critical to precision agriculture to be data input, data quality assurance, spatial rectification of data, model selection optimization, application optimization, and application prescription. These workflows represents the primary organization of the constraints on our data model and software design. Beaver mimicry stream restoration project BMRP Our approach is to use a combination of modeling and field data to develop a better understanding of dynamic seasonal storage in a near-stream alluvial aquifer. These models are designed to represent a factorial combination of two factors hypothesized to be important to variation in storage created. The first factor is 3 levels of the hydrologic context in the degree of connection between the water table and the stream, and the second factor is 3 levels of the location of the BMR structure relative to other channel structures. We are constructing nine models with a full factorial combination of these levels, and running these models under simulated snowmelt driven hydrographs. In summary, our methods are designed to identify the "tank" of alluvial storage that fills during high flow conditions under various hydrologic scenarios, and then determine if the size and residence time of that "tank" is sufficient for its draining over the summer to have meaningful influence on late-season flow. We are monitoring stream flow, groundwater levels, and water temperatures at two field sites to augment modeling exercises with field data. We will use temperature data as a tracer, to estimate water fluxes based on their influence on temperature variation. We will also use temperature data to understand the dominant changes in the controls on temperature when BMR structures are installed. We will combine this field data with more complex simulation models constructed as more specific analogs of our study sites. This approach to analysis of residual error from simulations compared to field observations helps provide a more specific direction for the next round of research than an analysis invalid expectations in field data alone. A first step for any novel quantitative inference scheme is to evaluate the potential for parameter sensitivities or parameter interactions that could confound the ability to quantify individual parameters with confidence. The first steps will be sensitivity analyses based on artificial, though reasonable, data. The artificial data will be generated by running the predictive model forward modeling with known parameter values likely to be found at a given study site based on literature values , then random error representing measurement error will be added to the model output for dissolved oxygen and dissolved inorganic carbon. These artificial data will then be run through the inference scheme inverse modeling to compare uncertainty in the inferred parameter values relative to the known parameter values used to generate the artificial data set. The magnitude of the uncertainty from these analyses thus provides a metric of parameter sensitivity or interaction problems, because lower sensitivities or higher parameter interactions will cause wider posterior distributions from Monte Carlo Bayesian estimates. Field data collected early in the project in the coming year will then be used to enhance method development specific to local conditions, allowing us to narrow our uncertainty analysis to the conditions likely to be experienced at our field sites.

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*Hydrology and water chemistry of shallow aquifers along the upper Clark Fork, western Montana [David A. Nimick] on www.enganchecubano.com *FREE* shipping on qualifying offers.*

Please click button to get clarkfork river montana usa book now. This site is like a library, you could find million book here by using search box in the widget. Gary David Blount Language: When the Berkley Pit in Butte, Montana began mining copper it was the beginning of the demise for the Clarkfork River. Years of smelting oar at the nearby town of Anaconda, Montana polluted the flood plains of the upper and lower Clarkfork River Basin with tons of toxic materials. These toxic materials have been distributed throughout the entire Clarkfork River Basin by years of spring run-off. These large deposits of toxic waste originate from the town of Butte, Montana continuing downstream to the Mill Town Dam; three miles east of the city of Missoula, Montana. With all the problems on the Clarkfork River I am amazed that there is still some excellent fishing in certain areas of the river system, however I would advise you not to consume any trout from the Clarkfork River; they are loaded with extremely toxic materials. Beginning in through I worked for the Montana Fish, Wildlife and Parks Department as a Fisheries Technician performing fish population estimates on most of the trout waters in Region 2 in Western Montana. I conducted trout populations on the Clarkfork River from Anaconda downstream to its confluence with the Flathead River near Paradise, Montana. I also conducted trout population estimates on the Clarkfork River Tributaries most notably: The fishable section of the Clarkfork River originates at the outlet of the settling ponds just outside Anaconda, Montana and flows northwesterly to the Idaho State Line. I will try to give a run-down on the trout populations throughout the Clarkfork River Drainage. The Clarkfork River just below the settling ponds is big fish water; these large fish have migrated through the ponds and entered the Clarkfork River system. The Brown Trout population in this area varies from year to year depending on the quantities of heavy metals entering the river system each year from the nearby smelting tailings from Anaconda. Some years the trout population is only 1, trout per mile of stream and in other years it is as high as 6, trout per mile of stream. The Clarkfork River Brown Trout population falls off rapidly just a few miles downstream towards the town of Deer Lodge; to just trout per mile of stream. However, there is a high concentration of Brown Trout at the Deer Lodge sewage treatment plant out-let. These Brown Trout are neon colored due to the high level of nutrients entering into the river from the sewage settling ponds. Gold Creek downstream to Rock Creek the Clarkfork River streambed was altered when the Interstate 90 Freeway was built and the river was channelized and constructed with a constant gradient. The Clarkfork River from Rock Creek downstream to Mill Town Dam and its confluence with the Blackfoot River upstream from the Dam the combined trout population increases tremendously to 1, to 2, trout per mile of stream. The Clarkfork River trout population is poor downstream from Mill Town Dam to its confluence with the Bitterroot River at only to trout per mile of stream. This section of the Clarkfork River runs through the city of Missoula, Montana. Until it was legal to throw garbage off any bridge in Missoula into the Clarkfork River. The Clarkfork River trout population below the Bitterroot River confluence increases slightly to to 1, trout per mile of stream and is maintained at this level downstream to its confluence with the Flathead River. The section of the Clarkfork River below the confluence of the Bitterroot River contains some of the hardest fighting and leaping Rainbow Trout you will find anywhere in Montana. The Rainbow Trout in this section can reach over inches in length and weight over pounds. Also this section contains the Native Bull Trout, which can exceed pounds. Now an update to the Clarkfork River January 1st, ; in the spring of the Mill Town Dam was breached and all migrating trout species now had access to the Blackfoot River, the Upper Clarkfork River and their tributaries. When they breached the Mill Town Dam the trout fishery for miles downstream was devastated by all the toxins that were released and most of the trout species were killed. Handbook of Ecotoxicology, Second Edition focuses on toxic substances and how they affect ecosystems worldwide. It presents methods for quantifying and measuring ecotoxicological effects in the field and in the lab, as well as methods for estimating, predicting, and modeling in ecotoxicology studies. Completely revised and updated with 18 new chapters, this second edition includes contributions from over 75 international experts. Also, a Technical Review Board reviewed all manuscripts for accuracy and currency. This authoritative work is the definitive reference for students, researchers, consultants, and other professionals in the environmental sciences, toxicology, chemistry, biology, and ecology - in academia, industry, and government. Corps of Engineers Language:

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4: Symposium Abstracts - Clark Fork Symposium - University Of Montana

Nimick, D.A., , Hydrology and water chemistry of shallow aquifers along the upper Clark Fork, western Montana. U.S. Geological Survey Water-Resources Investigations Report , 63 p. [Link].

The Flathead Basin is 22, sq. Nutrient loading to Flathead Lake from all major tributaries and atmospheric deposition was measured over a period of 25 years. Pelagic primary production in-lake growth of algae is limited by availability of nitrogen and phosphorus. Nitrogen loading from human sources upstream of Flathead Lake has steadily increased over the last three decades, and daily nitrogen loading weakly correlates with increasing primary production. Our mission is to work cooperatively with farmers, ranchers, and other landowners to develop voluntary agreements that increase stream flows at critical times. Using a grassroots, collaborative approach to restore and protect native fisheries and benefit local communities, the Montana Water Trust seeks to acquire water rights on dewatered tributaries in western Montana, and eventually throughout the state. The Montana Water Trust transfers water rights from interested landowners through a variety of innovative methods, including water right purchases, leases, donations, and water saving projects. We work to maintain mutually beneficial relationships, create healthy streams for the enjoyment of local communities, and maximize the benefits of efficient water management by landowners. The Montana Water Trust uses systematic science-based methodology to ensure protection of our instream water rights and to help demonstrate and monitor the ecological benefits of our acquisitions. Restoring instreams flows is an essential part of watershed restoration. To identify the best sites for reintroduction, over 70 wetlands across the valley were surveyed in fall and subsequently analyzed for habitat suitable for adult survival and nesting. Particular emphasis was placed on the abundance of certain submergent plants which are key food species. Field work was conducted from August to October Each wetland was surveyed by land and by canoe to develop a current baseline dataset of wetland characteristics. Transects were run across areas dominated by submergent vegetation to provide a semi-quantitative estimate of the abundance of these food species. Out of 70 sites surveyed, 22 were determined to have suitable nesting sites, and 9 of these sites were selected as being most suitable for release sites. Hazards near these sites intruding fence lines and power lines will be mitigated in preparation for a July release date. In , the State of Montana filed a natural resource damage lawsuit against the Atlantic Richfield Co. In , the State initiated an annual grant process, administered by the Montana Natural Resource Damage Program, whereby entities can apply for funding for projects that will improve water, fish, and wildlife resources and related public drinking water and recreational services. This poster presentation provides summary information on the projects funded to date. The project goals were 1 to identify and prioritize mainstem reaches of the Little Blackfoot River which suffer from elevated water temperatures and low streamflows, 2 to examine causal as well as mitigating factors, and 3 to identify site- or reach-specific opportunities to solve the documented problems through voluntary measures and landowner participation. Continuous logging temperature recorders were installed in the mainstem Little Blackfoot River at various locations from the confluence with Dog Creek to the mouth, for the summers of and Temperature was measured every half hour from July to October. Streamflows were gaged during the pre-irrigation season, during the irrigation season, and during base flow conditions. The Little Blackfoot River streamflow data were analyzed for influences by natural gaining and losing reaches, tributary inflows, the effects of irrigation withdrawals and "passive storage", and general riparian condition. Critical reaches of concern along the mainstem Little Blackfoot River were identified, as well as potential opportunities for instream leasing. However, residential and commercial development has grown rapidly where the creek approaches I To protect this development, the creek has been confined by a berm, restricting it from much of its former floodplain. Below I the creek does not flow much of the year. The creek generally follows its historic path but has been straightened and channelized. The creek flows near the Mullan Trail subdivision near Mullan Road, where high groundwater from leaking irrigation ditches is thought to contribute to flooding of the subdivision. The creek passes under Mullan Road in a culvert and flows through ranchland on the Clark Fork floodplain to the Clark Fork. Broadway, Mullan Trail and to a lesser extent I are fish passage barriers. HDR has designed a project to address these goals. The purpose of the program is to evaluate and describe the status, spatial patterns, and time trends in water quality and biological health in the Blackfoot watershed, as influenced by the cumulative effects of restoration projects as well as land development activities. The monitoring network consists of six sampling locations in three distinct segments of the mainstem Blackfoot River, and six locations on selected tributaries. Biological monitoring variables include periphyton attached algae community structure parameters as well as standing crops measured as chlorophyll a concentrations , and macroinvertebrate aquatic insect community metrics. The biological monitoring is intended to complement water chemistry monitoring being performed at the same stations by the U. Biological data from summer are presented which demonstrate spatial patterns in water quality and biological integrity throughout the Blackfoot River main stem and in the selected tributaries. Causal factors and impairment sources are discussed. Following several years of monitoring, the biological data will be statistically analyzed for significant time trends. Longer term information from this program will help the Blackfoot Challenge and its cooperators to document water quality and habitat improvements resulting from collaborative watershed restoration efforts, and as a feedback mechanism to fine-tune collaborative management approaches in the greater Blackfoot watershed area. This watershed assessment is a follow-up to a study that found that the primary source of the phosphorus in Gold Creek was one of its tributaries, Griffin Creek. Riparian assessments involved riparian vegetation and streambank stability surveys. The physical assessment documented substrate composition, channel morphology, in-stream temperature fluctuations, and stream discharge. Water quality assessments addressed nutrient and sediment levels and loads at two sites on Griffin Creek and seven other sites throughout the Gold Creek basin. The upper reaches of Griffin Creek were dominated by beaver ponds and showed healthy riparian vegetation and stable channel conditions. The lower three-fourths of Griffin Creek exhibited riparian and channel conditions damaged by grazing, flow manipulation, and beaver dam removal. Griffin Creek continues to be a major source of nutrients to Gold Creek and exhibits nutrient concentrations that exceed water quality standards set for the Upper Clark Fork River. However, Griffin Creek is unlikely to be impaired by nutrients since its fine substrate will not support massive algae growths. Recommendations are made for actions likely to improve the condition of Griffin Creek and reduce its loading to impaired waterbodies downstream. The State is now using field data to develop a Phase II draft restoration design plan that will undergo peer review by a panel of national experts and then issued for public comment. Restoration design must be adjusted to account for a number of limiting factors, with the major one being the contaminated sediment that will be left in place. Other limiting factors that affect restoration design include: Interstate 90 bridges on Blackfoot River, Stimson Lumber infrastructure, bridges downstream of dam, and coordination with remedial actions. The Phase II design process will also thoroughly address technical issues raised in public comments on the conceptual design plan. A two-year watershed project assessed stream and riparian conditions and made recommendations for improvements. Three Mile Creek is a third-order stream with hydrology characterized by mean daily flows of cfs and estimated bank-full flows of 10 cfs in Ambrose Creek, 25 cfs in upper Three Mile Creek, and 50 cfs near the outlet. Geology and soils of the watershed are important aspects of water quality problems. In foothills and valleys, channels were incised with vertical eroding stream banks and unstable channel forms. Gully erosion is an additional source. Summer water temperatures were elevated by discharge of BRID canal water. Priority stream reaches and upland areas were identified. Specific recommendations were developed for improvements, and for monitoring parameters and protocols to verify improvement of creek conditions. The assessment established 8 permanent monitoring reaches. Selection of reasonable indicators of project success will assure that improvement is attainable and measurable. Several pilot stream corridor projects have begun. These areas serve as demonstration sites for other landowners wanting similar work on their properties. Take an imaginary journey using a hand painted floor map and wooden figurines to tell the stories of historical characters whose lives were dependent on water. Curriculum and multimedia materials addressing watershed issues are included. Themes covered are the water cycle, water quality, bull trout, aquatic life and human impacts.

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5: Montana Bureau of Mines and Geology [WorldCat Identities]

the upper Clark Fork, western Montana: U.S. Geological Survey Water-Resources Investigations Report , 63 p. Benner, S. Geochemical Processes in a transition zone between surface water and acidic, metal-rich groundwater.

Some of the models had to be modified to match the physics of! Graphs of the water quality parameters show good fit between the measured and predicted concentrations at some stations while substantial deviations are observed at other stations along the course of the stream. CEAM provides analysts and decision-makers operating under various legislative mandates with relevant exposure assessment technology, training and consultation, technical assistance, and demonstration of new or innovative applications. This research brief describes one such demonstration project - analysis of metals contamination of the upper Clark Fork River, Montana. The principal sources of these metals are the waste byproducts of copper mining in the Silver Bow Creek watershed above and around the town of Butte, Montana. Remedial Investigation has been conducted in the Silver Bow Creek region and a set of. Both acid mine drainage and contaminated groundwater seepages enter Silver Bow Creek within the Butte town limits before reaching the Colorado Tailings. The stream flows through Pond 3 hectares of open water into Pond 2 32 hectares and into Pond 1 8 hectares. Sediment deposits rise above the surface of these shallow ponds. Below Pond 2 the creek reaches the confluence with the Mill-Willow Bypass, which drains the waste sites surrounding the Anaconda smelter, the flows from Mill and Willow Creek, and seepage from the Warm Spring Ponds. Waste rocks, ore process tailings, acid mine drainage and smelting wastes are the primary sources of heavy metal loadings to the Silver Bow Creek and Clark Fork River via surface runoff and ground water flow. Settling ponds have limited capacity and during high flows discharges of greater than cfs the flow is by-passed without any treatment. Further, geotechnical studies have revealed that a flow of cfs can result in the failure of diversion and control structures such that a large amount of contaminated sediments are released into the Clark Fork River. Hydrological investigations estimate the year flood to be cfs Ch2M- Hill The Remedial Investigation Final Report indicates that the seepage from under the Warm Springs Ponds can act as a major source of ground water pollution. Toxic elements from tailing deposits are arsenic, cadmium, copper, lead, iron, and zinc. As this brief introduction indicates, the site hydrology, hydrogeology and geochemistry are very complex due to the variety and magnitude of contaminant sources and the multitude of pathways to the surface water and ground water resources. History of Metals in the River Since , when large scale mining and smelting of copper began, the valley and the stream have been used as dumping areas for wastes. Wastes in Butte include tailings from the flotation process that separates copper from the ore and rock that was removed as backfill and overburden from either pit mines or underground mines or was discarded as being too low-grade to be put through a separator. Pollution problems began early along the Silver Bow Creek. The first industrial operations sluiced the wastes directly into the stream. Later, the mine operators constructed settling ponds and streamside tailings piles as part of an attempt to preserve water quality. The wastes in the stream moved down the river, especially during floods which caused erosion and transport of sediment, and were widely distributed over the flood plain and the stream bed. These ponds were originally designed to settle the metals carried by Silver Bow Creek and prevent contamination further downstream. As the two ponds lost capacity due to sediment accumulation, treatment efficiency declined and particles remained suspended in the effluent. To remedy the problem a larger pond was constructed above the first two ponds between and Pond 3 was improved between and to increase the capacity for metal removal. Lime was added to the ponds to precipitate and flocculate the metals. This method of settling the metal colloids and particles from Silver Bow Creek is successful in reducing the metal content of the Clark Fork River during periods of normal flow. During high flows, however, the ponds are bypassed and the flow is directed to the upper Clark Fork River without treatment. Between and the stream itself was channelized to prevent further erosion of the tailings from the banks. The first alteration to the stream course of the Silver Bow Creek was a channelization of the flow between smelting slag blocks placed along the stream channel. This was done to prevent the downstream transport of newly deposited mine and slag tailings on the old banks during periods of bank overflow due to flooding. Biological Impairment Adjacent to Silver Bow Creek and the Clark Fork River are flood plains and low banks that have been covered with waste sediments. In some areas, the sediments have released sufficient metal to either limit plant growth to metal-tolerant species or eliminate plant coverage entirely. These areas are called "slickens," a term that applies to all of the areas that are either dead or have visible biological impairment. The past use of water from the Clark Fork River for irrigation has led to the contamination of grazing lands. The biological habitat of the river and creek has been damaged as well. Silver Bow Creek does not support trout, whereas the Upper Clark Fork River supports a brown trout population that suffers from both chronic and acute toxicity. Mass fish kills occur during floods, and the acute toxic ity of the stream due to elevated metals concentrations is thought to be the cause. During flood flows which can occur during late winter snow melts and during early and late summer heavy rain storms , flow in Silver Bow Creek can bypass the settling ponds and enter untreated into the Upper Clark Fork River. Such events are known to have caused mass fish kills in the Clark Fork River. Objectives of the Study The modeling effort at the Center for Exposure Assessment Modeling CEAM will focus on the prediction of the frequencies of exposure of fish to toxic metals at different concentration levels in the stream by using the metal speciation and water quality models combined with historical data on the site. Investigations to date have focused on the typical flood events. The main objective is to complete a description of metals exposures and anticipated effects on the entire river during historical periods of flooding. Chemical partitioning between water and soil during transport and transport of heavy metals into the stream were analyzed in the following manner. The chemistry of the tailings deposits was used to determine the form of the metals; the flow behavior of rain on the banks as well as overland flow determined the principal transport mechanisms. Surface water transport is simulated by WASP4. Geology and Geochemistry The Super fund site has been divided into geographic subsites for the purpose of exposure assessment modeling, with each subsite having its own geology, hydrology, and geochemistry. A substantial body of scientific literature already exists on the chemical processes that create acid mine drainage from mine wastes. What is known about the mine and process wastes is summarized below. The sidestream tailings deposits are sandlike fine particles of metal sulfides. The primary sulf ide minerals in the waste rock, overburden, and processed ore include iron pyrite FeS_2, iron sulfide , chalcopyrite $FeCuS_2$, iron-copper sulfide , realgar AsS, arsenic sulfide , chalcocite Cu_2S, copper sulfide , and galena PbS, lead sulfide. These minerals are geologically embedded in monzonite porphyry primarily feldspar. The ores are blasted, then mined, crushed, and leached during the initial processing steps. Smelting is an oxidative roasting process that leaves slag as process waste. Mechanical reduction in size of the ore particles increases the availability of surface area for oxidation of the sulfide minerals. The source of the copper in assumed to be a sulfide- bearing waste tailings particle that is corroded by exposure to water and oxygen. MINTEQA2 is applied with the assumption that oxidized heavy metal is always present metal availability is not rate- limited. Oxygen Transport Eh is controlled by the availability of oxygen. The sulfides react with oxygen and water to form metal ions and sulfuric acid. The process of oxidation is dependent on a supply of reactants water, sulfides, oxygen and on water as a transport medium for reactants and products. The process of oxidation must be limited by transport of product or reactants; otherwise rock sulfides would not exist in native form. Oxygen is transported from the surface of the tailings where oxygen in the water phase is in equilibrium with the atmosphere. Transport of oxygen to the metal sulfide particle core depends on the rate of diffusion through metal oxide and metal sulfate layers on a particle surface. The rate of metal oxidation and sulfate formation is assumed to be equivalent to the oxygen transport rate through the soil pores that is, the oxygen transport rate is assumed to be the rate-limiting step. The rate of oxygen transport into the oxidized layer and through the sulfide particle fissures to unreacted metal sulfides is greater than or equal to the transport away of some oxidation products FeO or CuO. This was concluded from the observed buildup of metal oxides on particles in the unsaturated zone oxidized soil stratum. As corrosion of the sulfide proceeds, the pH of the particle surface drops and the copper at the particle surface and within particle fractures and crevices becomes more soluble. Oxidation products are transported away by diffusion out of the particle fissures into the soil pore water and subsequent advection. Figure 3 Copper diffuses into the groundwater and enters other transport pathways. The oxidizing particles are the major source for copper entering subsequent transport pathways such as runoff, erosion, and leaching. Consequently, during dry periods, there is an increase in the source term for mobile and soluble metal outside the particles. During wet periods, pH at the particle surface is lowered sufficiently to reduce transport outside the particle and reduce the source term. This can serve as an explanation why the magnitude of the source term varies seasonally. In the groundwater away from the sulfide particle, pH drops, oxygen concentration increases, and the copper precipitates to form a metal oxide or carbonate colloid in suspension in the unsaturated zone. The groundwater around the sulfide particles has a lower hydrogen ion concentration than the water film around the sulfide particles, and the Oxidation of a Sulfide Metal Oxide Precipitate VD lowpH H2O higher pH reduces copper solubility relative to the water film. The higher pH will result in precipitates being formed in the groundwater, and these precipitates represent the bulk of the copper transported by leaching and runoff. An example of this will be shown later: Copper will be carried in colloidal form into the rain runoff and into saturated groundwater. Dependence of Geochemistry on Soil In the absence of a model that will define the geochemical conditions for a vertical soil core 1-D , the first step in the analysis of the waste site is to develop a general modeling framework. The soil core can be described as a mixture of tailings and alluvium cm deep, with a water table that can vary from a depth of 0 cm adjacent to the stream bank to a depth of cm at the edge of the tailings furthest away from the surface water Figure Ench soil stratum below tli-"? The soil core model corresponds to both measurements of depth vs. Oxygen diffusion to lower strata is limited by consumption in upper soil strata, particularly for tailings that are compacted and fine-grained, and have a small void fraction. In such situations, the limited amount of diffusing oxygen can be totally consumed in the upper soil strata. Figure 5 The conditions in the soil and tailings mixture are represented by two geochemical parameters: Eh electrochemical potential and pH hydrogen ion abundance. In some cases the tailings have been mixed by alluvial or mechanical processes with the common associated bedrock of the Butte valley. This native bedrock has large portions of calcium carbonate that can neutralize acid produced by oxidation and corrosion of the sulfide particles. The top cm of soil-tailings layer has excess oxygen available, and the Eh consequently is at an oxidizing potential of approximately 0. Because of the rapid rate of hydrogen ion production, the pH in this layer is about 4. The mixing layers have an electrochemical potential of 0. Oxidation can also occur by copper sulfate oxidizing iron sulfide to form copper sulfide and iron sulfate. Even in the presence of hydrogen ions from this layer and the oxidation layer above, the pH is higher, because of lower reaction rates and the neutralizing effect of the carbonates and the unoxidized sulfides. In this idealized description of native soil and tailings, the bottom stratum is assumed to be a reduced layer, where there is a negligible concentration of oxygen. This layer is represented as having a reducing Eh of The saturated zone has little oxygen because of oxygen consumption by reaction in the upper layers and because diffusive transport through water is slow. Oxidative conversion of sulfides in the saturation zone, therefore, is assumed to be small relative to the source term for copper in the oxidized stratum. The saturated zone is rauch better mixed than the unsaturated zone because of the continuous water phase.

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6: Cottonwood Creek - Clark Fork Symposium - University Of Montana

Hydrology and Water Chemistry of Shallow Aquifers Along the Upper Clark Fork, Western Montana: (Prepared in cooperation with the Montana Bureau of Mines and Geology) Helena, Montana, U.S. Geological Survey Water Resources Investigation Report , 62 pp.

Material other than sediment on channel bottom Stalinization Dewatering Amount of fish cover Time constraints restricted our riparian assessments to the parts of Cottonwood Creek and Reese Anderson Creek that included NRCS conservation and restoration projects. Both assessment methods divide the riparian area into polygons homogenous sub-units then assess each separately. Our study area was divided into a total of 15 polygons, 11 on Cottonwood Creek and 4 on Reese Anderson Creek. Upstream and downstream boundaries of each polygon were recorded using a Magellan GPS unit. This was done so that the locations can be found in the future. In addition, these points were downloaded into the program Map Site 2. The points were then transferred to ArcView GIS, and maps were created showing the location of the polygons. Photographs were taken looking upstream and downstream at the boundaries between each polygon Stream cross sections were measured at about the middle of each polygon, and locations recorded using the Magellan GPS unit. Measurements taken at these locations include bank full width and depth and base flow width and depth. Depth was measured once every meter along the stream cross section. The measurements were taken to calculate a width to depth ratio along the stream. However, these measurements were only taken on Cottonwood Creek and the one polygon assessed on Baggs Creek. Reese Anderson Creek has a restricted flow because of a dam in its upper reaches and was just a trickle at the time of measurement. Stream discharge was measured using a standard Price Pygmy Meter at four locations along Cottonwood Creek. Measurements were taken at three locations on October 20th. After discussing the first set of measurements, we decided to add a sample point farther upstream on November 3rd and drop one of the previously sampled locations. Discharge measurements were taken to determine whether the creek was gaining or losing water. In the national forest, the creek has three branches, south, middle and north branches. These two creeks join Cottonwood Creek in the ranch land east of Deer Lodge. In total, the watershed drains about Natural history â€” climate, soils, hydrology, vegetation The Cottonwood Creek watershed is in a semiarid environment. The average annual precipitation is 12 to 14 inches, half of which falls during the months of May, June, and July Nimick et al. The watershed includes mountains terrain dropping to a valley underlain by Tertiary and Quaternary sedimentary deposits. The groundwater in the valley is shallow, has a high flow rate and a high infiltration rate. Transmissivity of alluvium in the watershed is feet squared per day and in bedrock feet squared per day. The median well depth in the area is 37 feet, with few wells deeper than 70 feet. Most soils in this area are loam types. Much of the soil is alluvium and is more than 60 inches deep, resulting in thick deposits. The range of water capacity for the soils in the riparian area is 5. Today, the general vegetative makeup of the watershed includes mature Populus trichocarpa black cottonwood stands and Populus tremuloides quacking aspen groves in the lower watershed riparian areas. Second growth Pinus contorta lodgepole pine forests exist in the upper watershed, and upland vegetation in the lower watershed is comprised of herbaceous vegetation used for grazing. By , mining was a major activity in the Deer Lodge Valley with some mines located in the upper Cottonwood Creek watershed. The most recent mining activity in the watershed was the Emery Mine which ended mining in However, the mine operation did not have any water rights. Today, the main uses in the watershed include logging, ranching, crop and pasture, recreation, and urban areas. The map in Appendix E shows the general landuse in the watershed. Rosgen classification Using the Rosgen classification system, Cottonwood Creek is classified as a B3 stream. B refers to the stream type and 3 refers to the makeup of the streambed material. B type streams are moderately entrenched, have a moderate slope and are riffle dominated with infrequently spaced pools. Rosgen describes the substrate category 3 as being predominantly cobbles with lesser amounts of boulders, gravel and sand. All these characteristics are evident in Cottonwood Creek.

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Other characteristics of a B3 stream include a sinuosity of greater than 1. Cottonwood Creek from Baggs Creek to Interstate 90 has a sinuosity of 1. A4 streams are described as steep, deeply entrenched and confined, and the channel is incised in coarse depositional materials. Cattle use and water restriction has caused Reese Anderson Creek to have a silty creek bed. Stream Discharge In this study, discharge measurements were taken to evaluate stream flow losses and gains along the channel. Table 1 shows the results of the discharge measurements. Polygon C-2 is at the upstream end of the riparian assessment area and polygon C is located at the downstream end of the riparian assessment area, right before the stream flows under the highway. The sample location in C is located in one of the water gaps that will be removed in the summer of After the first set of samples, we did not take second measurement at C because the location being heavily impacted by cattle activity. This sample site is located just downstream of the confluence of the south fork of the creek â€” the last fork to join the main stem. See map in Appendix C for measurement locations. Computed discharge measurements Date.

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