DEPARTMENT OF ENVIRONMENTAL QUALITY
Environmental Assessment

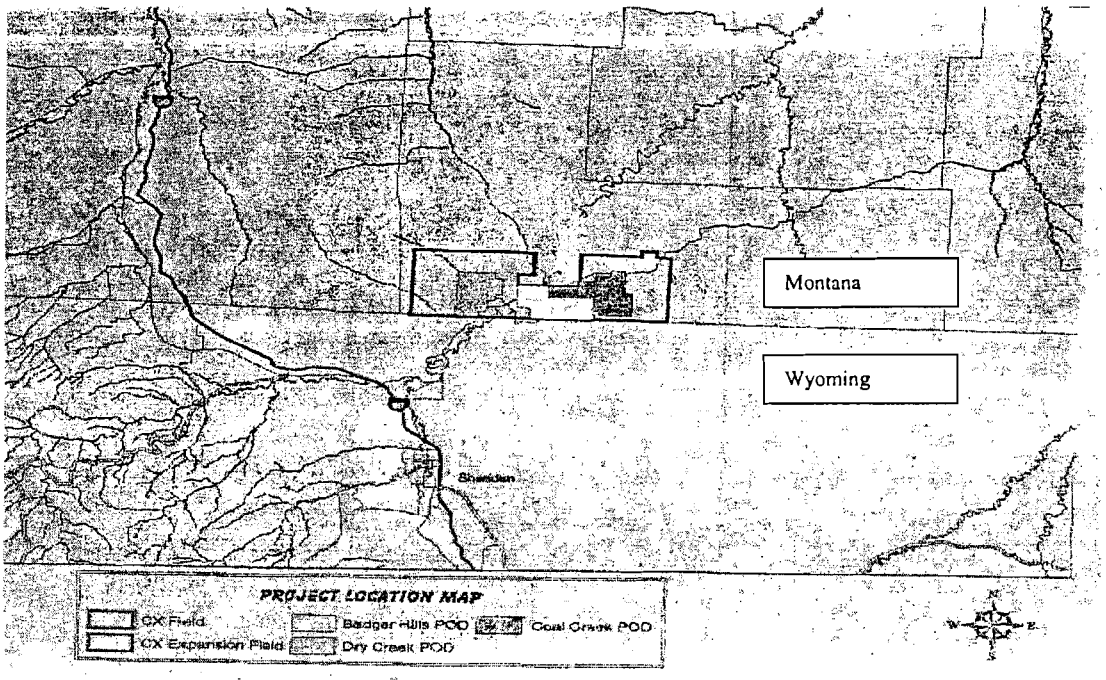
Permitting and Compliance Division
Water Protection Bureau

Name of Project: Fidelity Exploration and Production Company, Tongue River Project

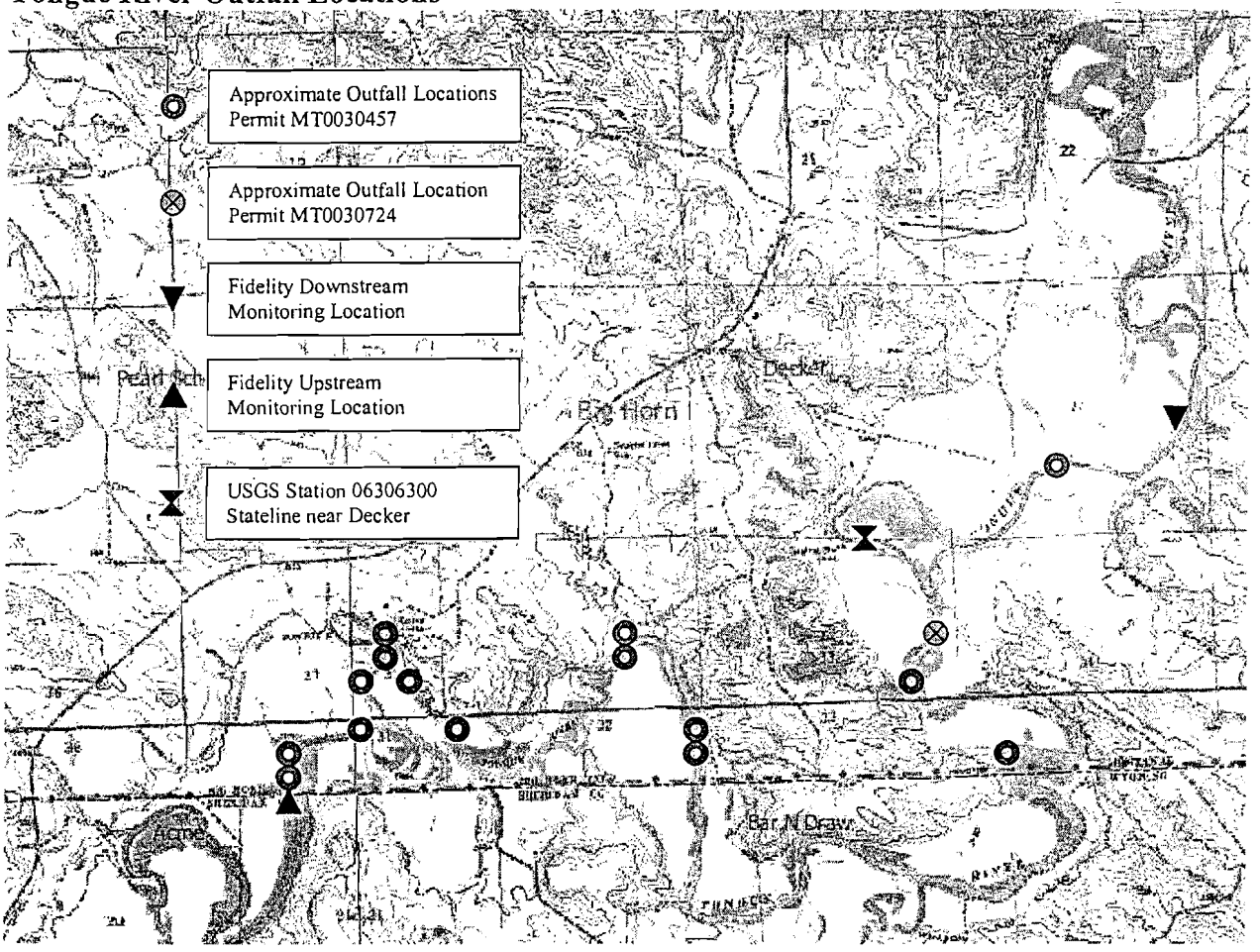
Type of Project: The applicant is engaged in developing and extracting coal bed natural gas (CBNG) from subsurface formations in the Powder River Basin. This process generates excess water, which is considered wastewater and must be disposed of through various methods including direct discharge to state surface waters. The appricant proposes to treat a portion of this produced water prior to discharge; with the remainder of the wastewater to be discharged without treatment. The applicant proposes to discharge both treated and untreated wastewater to state surface waters under the terms and conditions of the Montana Pollutant Discharge Elimination System (MPDES)permit.

Location of Project: The Tongue River Project encompasses all of the following approved Project Plans of Development (PODs): CX Ranch, Badger Hills, Coal Creek, and Dry Creek within the CX Field. The scope of this action entails all or parts of the following townships: T9S R39E, T9S R40E, and T9S R41E. Discharges from the project will enter the Tongue River via 16 existing outfalls spread from river mile 224.1 to 213.5; from the initial crossing of the Montana state line by the Tongue River to approximately two miles upstream from the Otter Road crossing

CX Field Location



Tongue River Outfall Locations



City/Town: Decker **County:** Bighorn

Description of Project: The applicant, Fidelity Exploration and Production Company, a Denver based energy development company, is the operator of the coal bed natural gas CX Field. The CX Field includes the following project plans of development: CX Ranch POD, Badger Hills POD, Coal Creek POD, and the Dry Creek POD. Under approval from the BLM, and the Montana Board of Oil and Gas Conservation (BOGC), the operator has 437 producing wells and 234 wells that have been approved but have yet to be drilled.

437
234
671

Water Management Plans

The applicant has developed water management plans which identify disposal methods for produced water from CBNG extraction. The operator has applied for MPDES permits to discharge produced water from production activities to surface waters. Contained in the MT-FEIS analysis concluded that 20% of the produced water from CBNG production should go to beneficial uses. The operator has identified beneficial uses of produced water for industrial consumption, livestock watering, and managed irrigation.

MPDES Permit MT0030457

The DEQ Water Protection Bureau issued a discharge permit (MT0030457) in June 2001 to Fidelity to discharge produced water to the Tongue River. The initial permit development utilized the requirements for new sources and new dischargers as identified in the Montana Water Quality Act and companion regulations. Regulations in place at that time required the discharge to be nonsignificant under the nondegradation language and the Molloy decision concerning implementation of TMDLs to state waters. The permit was developed and limited flows to the Tongue River in order to meet the nonsignificance requirements on a year around basis.

The permittee proposed a flow based approach, in which discharges could be varied on a daily basis; being dependant on the receiving water flow. The draft permit that the Department developed, allows for a seasonal approach to the flow based rationale. This approach was undertaken because of two factors. Firstly, the uncertainty associated with the dynamic model used to develop the application. Secondly, the uncertainty of developing enforceable permit limitations based on a daily flow determination.

The draft permit stipulates seasonal discharge flows based on the USGS seasonal 7Q10 flow analysis. To determine a net effect of the discharges on the receiving water, all discharges were analyzed together as a point source to the receiving water, not as discrete outfalls throughout the river reach. This conservative approach builds in additional protection to the receiving water. See the Fact Sheet for permit MT0030457 for a discussion concerning permitting decisions and methodology.

Baseline receiving water quality has been developed utilizing data from USGS operations in the Tongue River watershed and MPDES requirements for instream monitoring. Data has been compiled from stations located at Tongue River at Stateline near Decker, Tongue River at Monarch WY, Goose Creek below Sheridan WY, Prairie Dog Creek near Acton WY, and monitoring activities conducted by Fidelity in the Tongue River upstream from their outfalls and Prairie Dog Creek in WY. All data collected from monitoring activities prior to June 2000 was used to create the baseline conditions. In addition, daily flow statistics from all stations were used to develop a flow proportioned, composite ambient quality for the receiving water. The resulting ambient water quality was sorted into seasonal, and, for a majority of cases, monthly ambient quality.

The Tongue River in the areas of the proposed discharges, is listed as impaired for aquatic life support, and cold-water fishery for trout in the 1996 303(d) list. The probable cause is flow alteration. The probable sources are agriculture, flow regulation and/or modification and irrigated crop production. The Tongue River in the location of the proposed discharge has been removed from the 2000, 2002, and 2004, 303(d) lists based on reassessment of the water quality.

Additional analysis has been conducted at the annual 7Q10 flow rate and conditions expected to occur during low flow periods in the cumulative analysis requirement. Based on this analysis, the permit requires reduction in discharge flows if the receiving water instream flow is less than

the annual 7Q10 and the instream electrical conductivity exceeds the instantaneous maximum standard for the receiving water.

MPDES Permit MT0030724
The Department received an application for a new discharge source to manage produced water from the CX Field. The application proposed to treat produced water with an ion exchange process to reduce the total dissolved solids, mainly sodium, to reduce the sodium adsorption ratio (SAR). SAR is a measure that defines the waters ability to be adsorbed into the soils. The application requested a treatment scenario allowing blending, that is based on the receiving water flow rate and water quality. The Department chose to develop seasonal flow- based limits for the reasons stated above. The draft permit allows blending of raw produced water with the treated water with limitations to prevent exceedances of the standards in the receiving water.

The draft permit utilizes nondegradation criteria to establish limitations. Limits have been established for the following parameters: total suspended solids, total nitrogen, sodium adsorption ratio, electrical conductivity, temperature, blending, and flow. Ambient conditions used in the calculations were the same as the baseline receiving water conditions used above. For a detailed accounting of rationale and methodology used during the permit development, review the statement of basis for permit MT0030724.

Beneficial Uses of Produced Water
The operator has filed for and has received conditional use water rights for produced water to be used for beneficial uses. Currently the operator transports produced water via pipeline to both the Spring Creek Mine and the Decker West Mine. The operator has entered into a conservation easement with the Department of Natural Resources and Conservation (DNRC) and Decker Coal Mine. This agreement allows for CBNG production on Decker property, but prevents discharge of produced water to the river from the 31 wells located on their property. This water is pumped back to the Decker mine for internal consumption. Produced water delivered to the mine sites is used for dust suppression and industrial use. Produced water is not discharged from the facilities because it is internally consumed.

Contiguous to the produced water pipelines, the operator has constructed stock tanks. These stock tanks are authorized by the Department to minimize or eliminate the discharge of produced water from livestock watering tanks.

The operator is also exploring the feasibility of conducting managed irrigation practices. By chemically amending the soils, produced water can be used for irrigation. Should the operator decide to utilize this option, a managed irrigation plan and storage facilities would be required to impound produced water during the non-irrigation season.

Agency Action and Applicable Regulations: The proposed action is to issue two MPDES permits to the applicant for discharge of treated and untreated wastewater. The permits specify effluent limitations, waste disposal requirements, and monitoring requirements. The Department

is issuing these permits under the authority of the Montana Water Quality Act 75-5-101 *et seq.* MCA, and the Montana Pollutant Discharge Elimination System rules, ARM 17.30.12 *et seq.* Permit limitations have been developed utilizing the nondegradation provisions of the Water Quality Act at § 75-5-303 MCA, and rules at ARM 17.30.701 *et seq.*

The Department has conducted additional analysis of the project and has issued 18 air quality or operating permits under 75-5-217 and 218 MCA *et seq.* and ARM 17.8.12 *et seq.* The storm water program has issued the following authorizations: MTR100803, MTR100816, MTR100821, MTR100853, and MTR101240 for control of sedimentation from construction activities.

The US Corps of Engineers has issued three Section 404 Clean Water Act permits to the operator: 200190238, 200190111, and 200390095. The Big Horn Conservation District has issued a *Stream Bed and Land Presentation Act* (310 Permit) #2003-4 for the existing outfall structures.

For the purpose of this environmental assessment (EA), the Department will only be analyzing impacts from the proposed project, and the cumulative impacts associated with existing approved PODs. Joint agency EAs have been developed by the BLM, BOGC, and the DEQ for the following PODs: Badger Hills w/amendments February 2004, Dry Creek February 2004, and Coal Creek January 2005. Impacts to the environment and human population will be drawn from these EAs. Cumulative impacts to the receiving water have been analyzed and presented in another section of this EA. In addition, the Final Statewide Oil and Gas, Environmental Impact Statement, January 2003(MT-FEIS) will be used to establish general objectives and mitigation measures within the Powder River Basin in Montana.

Summary of Issues: The Department proposed to issue MPDES permits to limit the discharge of produced water from CBNG development to the Tongue River. Issues of concern include: impacts to air quality, cultural resources, ground and surface water quality and quantity, threatened and endangered wildlife and vascular species, and impacts to the human environment.

Affected Environment & Impacts of the Proposed Project:

> Y = Impacts may occur (explain under Potential Impacts). *Include frequency, duration (long or short term), magnitude, and context for any significant impacts identified. Reference other permit analyses when appropriate (ex: statement of basis). Address significant impacts related to substantive issues and concerns. Identify reasonable feasible mitigation measures (before and after) where significant impacts cannot be avoided and note any irreversible or irretrievable impacts. Include background information on affected environment if necessary to discussion.*
>
> N = Not present or No Impact will likely occur. *Use negative declarations where appropriate (wetlands, T&E, Cultural Resources).*

IMPACTS ON THE PHYSICAL ENVIRONMENT	
RESOURCE	[Y/N] POTENTIAL IMPACTS AND MITIGATION MEASURES
1. GEOLOGY AND SOIL QUALITY, STABILITY AND MOISTURE: Are soils present which are fragile, erosive, susceptible to compaction, or unstable? Are there unusual or unstable geologic features? Are there special reclamation considerations?	[N] Soil survey for the Tongue River Project is based on the *Soil Survey of Big Horn County Area, Montana*, (USDA 1977). Within the project area soils have developed from alluvium and residuum derived from the Tongue River Member of the Tertiary Fort Union Formation and Eocene Wasatch Formation. Lithology consists of siltstone, sandstones, and coal seams within a matrix of shale. Soils identified in the project plans of development, indicate numerous soil types within the project area. Textures range from clay to gravely loam; permeability ranges from 0.06 to 6.0 in/hr; erosion hazard ranges from slight to excessive. Topography of the area is characterized by gently sloping valleys bounded by ridges capped by frequent sandstone and clinker. Elevations range from 3400 to 4400 feet above mean sea level. Topography will not be impacted by construction related activities except within road or pipeline corridors. Road building activities will be limited by concurrent reclamation to minimize any effect. A summary of reclamation practices is available in each POD within the project area (Fidelity, Apr. 2004, Mar. 2004 and Jun. 2003). Mitigation measures have been identified and implemented under the surface reclamation plans within the individual EAs (BLM, Dec. 2004, Feb. 2005, and Feb. 2004). Any additional disturbances will be required to adhere to the terms and conditions contained within the POD and EAs. All mitigation measures are either a result of the impact analysis or adopted from the MT-FEIS, 2003. Soils will not be impacted by the issuance of the MPDES permits unless managed irrigation is utilized as a disposal option.
2. WATER QUALITY, QUANTITY AND DISTRIBUTION: Are important surface or groundwater resources present? Is there potential for violation of ambient water quality standards, drinking water maximum contaminant levels, or degradation of water quality?	[Y]Groundwater The Montana Final Statewide Oil and Gas Environmental Impact Statement and Proposed Amendment of the Powder River and Billings Resource Management Plans (MT-FEIS) Chapter 4- Hydrological Resources, has determined that there will be impacts to the ground water from CBNG production. Ground water impacts associated with the preferred alternative in the MT-FEIS focus on drawdown of the aquifer(s) from the edge of the CBNG field production, and the potential for CBNG produced water (untreated) to infiltrate through the more permeable shallow sub-soils and alter the quality of alluvial ground water. Actual findings after four (4) years of CBNG production from the CX Field, indicate ground water levels have been lowered 20 feet from one to two miles outside the production area. Within the CBNG production area, ground water levels are as much as 150 feet lower than baseline conditions. According to ground water modeling where drawdown is held constant and the discharge rate varied, after 20 years of CBNG production a drawdown of 20 feet was calculated to extend four or more miles outside the producing fields, even considering the physical characteristics of each coal bed may vary widely. Physical characteristics of coal aquifers are site-specific for each field and include hydraulic conductivity, saturated thickness, proximity to the outcrop, and the starting/baseline hydrostatic pressure in the coal bed.

IMPACTS ON THE PHYSICAL ENVIRONMENT

With the ground water levels reduced/lowered, there will be a loss of ground water resources. Some springs and supply wells that are sourced from the producing coal beds may experience a reduced water availability. Streams that receive significant portions of their flow from ground water discharge from coal beds that subcrop beneath and recharge the alluvium may decline due to the loss of ground water base flow. In larger surface water bodies this impact may not be measurable. CBM production from the Dietz coal has caused changes in the stage of the Tongue River reservoir due to the drawdown of the Dietz coal beds beneath the reservoir increasing leakage from the reservoir. This particular leakage situation may also be detrimental to CBNG production because water that is not under reduced conditions may migrate into the CBNG field(s), converting methane to carbon dioxide. Gas field development designs will be adjusted to fit specific local aquifer characteristics and stratigraphy (Wheaton and Donato, 2004).

Mitigation agreements are required by the State and the BLM to be offered to the owner of any spring or well adversely impacted by CBNG production. The agreements include water wells or natural springs within one mile of CBNG production, or within the area that the operator reasonably believes may be impacted by CBNG production, whichever is greater, and to extend this area one-half mile beyond any well adversely impacted. These agreements will apply whether the impacts are due to reduced yield, the production of methane (methane migration), or a change in water quality. Ground water levels in overlying and underlying aquifers (sandstones) are expected to show little response to drawdown from CBNG production due to shale dominated stratigraphic sequences. However, the Order [No. 99-99 (Controlled Ground Water Area)] requiring mitigation agreements applies to "all" wells and springs, not just those which derive their water from the developed coal seam(s). Water rights are presently being adjudicated on a watershed basis (BLM, 2004 and 2005).

Impacts to soils and surface water resources may be caused by the inappropriate disposal of CBNG produced water. Required water management practices will address quantity and quality of the water released. Individual CBNG well discharge rates may be influenced by factors such as the time since pumping began, the size of the well field, the position in the field, and the aquifer characteristics of the particular coal. CBNG produced water discharge rates range from 20 gallons per minute (gpm) per producing well at start-up, and may decline to approximately 1 gpm after 10 years of production. Produced CBNG water in Montana is dominated by sodium [according to the sodium adsorption ratio (SAR)] and bicarbonate ions. SARs range from over 30 to 70 (unitless). Calculated dissolved solids (CDS) are greater than 1,000 mg/L to less than 2,000 mg/L (Wheaton and Donato, 2004).

Ground water monitoring by the MBMG and the BLM began in the 1970's in association with coal mining in this area. For CBNG ground water monitoring, nests of monitoring wells will be used to track drawdown of multiple producing coal seams. The USGS is also installing six (6) well clusters along the southern boundary of the Northern Cheyenne Reservation to track drawdown effects from CBNG development east of the CX Ranch and nearby areas. The BLM is

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	also installing ground water monitoring well clusters throughout the Montana portion of the Powder River Basin, including areas adjacent to the Northern Cheyenne and Crow Reservations. Currently, monitoring wells are in place outside the producing field to monitor regional impacts such as the magnitude of drawdown, and the rates and extent of vertical leakage (BLM, 2004 and 2005). [N]Surface Water As stated in the MT-FEIS, surface water quality would be slightly altered, however, downstream uses would not be diminished. Surface water flow would be moderately increased causing some riparian erosion, as well as increased sedimentation. Under the preferred alternative, beneficial reuse would be emphasized. For each POD, a water management plan (WMP) would be required. Contained in the WMP, the applicant would identify options including: injection, treatment, impoundment, direct discharge, or any other operator proposed disposal method. The WMP must address both site-specific conditions and cumulative effects of the proposed management and their effects on soil, water, vegetation, wildlife, stream channel stability and any other resources reasonably expected to be impacted. The WMP must be submitted with the POD and require approval prior to issuance of approvals for Applications for Permit to Drill. Analysis conducted in the MT-FEIS concludes there would be no impact to beneficial uses under the preferred alternative. The operator has submitted WMPs for the Badger Hills, Coal Creek, and Dry Creek PODs. Each POD identifies and analyzes the following areas: Geographic setting, Geology, Existing, Planned and Potential discharges, Water rights, Watershed characteristics, Hydrologic watershed analysis, Groundwater quality, Facility design, Downstream impacts, and Monitoring and mitigation (Fidelity 2003, 2004). WMPs identify direct discharge, treatment and discharge, beneficial uses (industrial water supply and stock watering), impoundments and managed irrigation as discharge options. Cumulative impact analysis contained in the WMPs show that the mixed water quality will not exceed Montana numeric water quality standards in the Tongue River. Environmental Assessments prepared by the BLM, BOGC and the DEQ (BLM Feb. 2004, Dec. 2004 and Feb. 2005) have approved WMP with conditions. Conditions of approval require the operator to conduct additional monitoring and analysis to prevent additional impacts to the surface or groundwater. Should the operator fail to meet MPDES permit limitations, the BLM requires all discharges to cease until the operator has modified the WMP. Once the WMP is modified and approved, the discharges may continue. Cumulative impacts to the Tongue River have been modeled and analyzed. The model accounts for baseline ambient water quality and all discharges to the Tongue River system. Within the river reaches, a mass based model was utilized to predict receiving water quality. In the Tongue River Reservoir, the historic net effect through the reservoir was used to predict future reservoir behavior. Receiving water analysis was conducted at annual 7Q10 flows and at the seasonal 7Q10 flows developed in the MPDES permits. Electrical conductivity (EC) was the only parameter to exceed the 30-day average

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	limitation. Exceedances occurred at the seasonal 7Q10 flow periods in the upper Tongue River near Decker. To prevent exceedances of the daily maximum limit, the permit required daily monitoring during times in which instream flows are less than the seasonal 7Q10. If the instream monitoring demonstrates EC values greater than the daily maximum EC limit, the operator will be required to reduce produced water flows until the resulting instream EC values are reduced to reach a maximum below the daily maximum limitation. Cumulative SAR values in the Tongue River at Birney reached a maximum at 1.98 during the annual 7Q10 flows in April. See Attachment 2, for the complete cumulative impact analysis.
3. AIR QUALITY: Will pollutants or particulate be produced? Is the project influenced by air quality regulations or zones (Class I airshed)?	[N] An Air emissions inventory has been completed by the Department's Air Resources Management Bureau (ARMB) for each POD submitted for approval. The ARMB determined that air quality permits were not required during the exploratory portion of development because the total emission potential was below the 25 tons per year, permit threshold (BLM Dec 2004, Jan. 2005). For fixed source sites (compressor engines or turbines), utilized in the production phase, 18 air quality permits or Title V Operating Permits have been issued. As part of the Badger Hills POD, the ARMB modeled the cumulative impact from CBNG development. Their conclusion was, that the analysis conducted in the MT-FEIS is still representative of the cumulative impacts in the area defined in the MT-FEIS. The cumulative impacts would be in compliance with all of the air quality standards and PSD increments and thresholds for pollutant impact indicators for mandatory federal Class I PSD areas and sensitive lakes (BLM Dec. 2004).
4. VEGETATION COVER, QUANTITY AND QUALITY: Will vegetative communities be significantly impacted? Are any rare plants or cover types present?	[N] Impact to vegetation would be short term and minor. Disturbances from drilling, pipeline corridors, and compaction from equipment would reduce the amount of vegetation available for livestock or wildlife. Disturbances due to road construction and construction of impoundments would eliminate small areas of vegetation but for a longer time. Vegetative productivity would be restored through reclamation and elimination of vehicle traffic (BLM, Jan. 2005, Dec.2004, and Feb. 2004). All reclamation activities are to be conducted as soon as practical. Seeding of reclaimed areas shall use prescribed seed mix. The operator shall follow the noxious weed control plan to control invasive species. The operator is required to reclaim and implement a storm water pollution prevention plan to control erosion and sediment migration from disturbed areas. This requirement is pursuant to the storm water authorizations issued under the storm water general discharge permit for construction activities. No threatened plants or vascular species of concern are known to inhabit the project area.
5. TERRESTRIAL, AVIAN AND AQUATIC LIFE AND HABITATS: Is there substantial use of the area by important wildlife, birds or fish?	[N] It is anticipated that adherence to the established water quality standards will minimize changes to water quality; thus, direct impacts to macroinvertebrates, fish, amphibians and reptiles are also anticipated to be minimal. Indirect impacts to avian species, which subsequently forage on some

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	of these species, are also anticipated to be minimal. The majority of the areas impacted by project development are upland grassland and grassland/shrub habitats adjacent to the riparian habitat associated with the river.
6. UNIQUE, ENDANGERED, FRAGILE OR LIMITED ENVIRONMENTAL RESOURCES: Are any federally listed threatened or endangered species or identified habitat present? Any wetlands? Species of special concern?	[N]A summary of documented wildlife use of the area is attached (Attachment # 1). Bald eagles, a species listed by the USFWS as threatened, occupy the area associated with the Tongue River and the Tongue River Reservoir during migration, winter and the breeding seasons. A pair of bald eagles occupies a nesting territory located within the area to be affected by the proposed project (NE¼, NE¼, Section 33, N9S, R40E). Another active bald eagle nest is approximately four miles south of the Tongue River Reservoir, in Wyoming. Mitigation measures include, no surface occupancy within one half mile of historic (last seven years) or active nest sites or one half mile from any roost site. Active nest sites will be monitored between March 1st and July 15th. In addition, raptor safe structures will be utilized on new and existing facilities. In addition to the bald eagle, 17 species of concern are known to occupy the area of the proposed project. One amphibian, 2 reptile, 1 mammal, 2 avian, and 1 fish species of concern have been documented in the area adjacent to the proposed project. Activities within the areas frequented by these species, as well as other wildlife species, will be largely in areas that have been previously disturbed. Utility corridors are to be placed adjacent to existing county roads or two-track trails. The construction of the outfall structure is the only point impinging on the surface of the Tongue River proper, and disturbance related to this construction will be minimized. Use of the playa in Section 2, T9S, R39E by three species of concern has already been impacted by wastewater discharge. Additional discharge into this playa would further impact these and other wildlife. use of this area as a produced water storage area.
7. HISTORICAL AND ARCHAEOLOGICAL SITES: Are any historical, archaeological or paleontological resources present?	[N] As a condition for BLM approval, the operator must conduct a cultural survey of the areas influenced by development. The operator has contracted a cultural survey provider to conduct assessments within the PODs. As per the BLM requirements they submitted their findings to the BLM for analysis (Fidelity, Jan. 2005, Dec. 2004, and Feb. 2004). The BLM (BLM Jan. 2005, Dec. 2004, and Feb. 2004), has developed mitigation measures for all sites impacted by development. In regards to cultural resources important to native Americans, the BLM directed contractors to pay special attention while conducting the survey to traditional cultural concerns such as springs, homesteads and plant communities. As a condition of approval the operator shall inform the BLM 48 hours prior to construction activities as the Northern Cheyenne Tribe may be contacted. The operator shall allow for a representative from the tribe to be present during construction on federal holdings. Any other cultural or paleontological resources discovered during construction must be reported immediately to the BLM. Construction may not resume until such time that the BLM as inspected and approved disturbances of the site. Given the BLM equirements there will be minimal impacts to cultural resources.
8. AESTHETICS: Is the project on a	[N] Development of CBNG encompasses large tracts of land. Even though

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prominent topographic feature? Will it be visible from populated or scenic areas? Will there be excessive noise or light?	large areas are used in development; relatively small physical areas are occupied. The BOGC sets spacing for oil and gas development to maximize recovery while minimizing surface impact. Well spacing in the CX Field is set at 160-acre intervals. The operator is to use environmentally compatible colors to blend well houses into the landscape. With the use of concurrent reclamation and seeding with native species, visual impacts will be short term. Long term visual impacts will be realized by road and facility placement.
9. DEMANDS ON ENVIRONMENTAL RESOURCES OF LAND, WATER, AIR OR ENERGY: Will the project use resources that are limited in the area? Are there other activities nearby that will affect the project? Will new or upgraded powerline or other energy source be needed)	[N] During the development phase no increases in environment resources will be realized. All activities will be temporary (construction). In the production phase limited electrical demand will be realized. Additional natural gas will become available for transmission to market. No adverse affect will be realized on this category.
10. IMPACTS ON OTHER ENVIRONMENTAL RESOURCES: Are there other activities nearby that will affect the project?	[N] Potential impacts may be realized to coal mining activities in the area. Dewatering of the shallow coals will reduce the amount of water available for internal consumption within the mines. The mine site may have to utilize outside sources, or water rights to obtain adequate volumes. Existing agreements utilizing produced water are in place.

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11. HUMAN HEALTH AND SAFETY: Will this project add to health and safety risks in the area?	[N] No impact is expected in this area. Barring catastrophic events, no additional uses of these resources will be necessary. With development additional transportation facilities will be required; limited risk will be associated with the additional facilities. Because each facility is small and constructed quickly. Engineering controls are required for this type of service, and facilities will be required to meet code.
12. INDUSTRIAL, COMMERCIAL AND AGRICULTURAL ACTIVITIES AND PRODUCTION: Will the project add to or alter these activities?	[Y] Increased development will bring additional industrial sectors into the local area. With increased development, additional resources will become available within the marketplace. With increased development agricultural production may be potentially impacted (decreased carrying capacity). Should the permittee decide to utilize managed irrigation, an incremental increases in production will be realized, in addition to increases in consumable amendments to the soils.
13. QUANTITY AND DISTRIBUTION OF EMPLOYMENT: Will the project create, move or eliminate jobs? If	[Y] Impact to this area will be short term and minor. Additional employment opportunities will be realized during the construction and development phase only. Total manpower requirements in the long term remain constant. Additional workforce in and around the area will not be required.

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so, estimated number.	
14. LOCAL AND STATE TAX BASE AND TAX REVENUES: Will the project create or eliminate tax revenue?	[Y] Development of CBNG resources will increase the revenue to federal, state, and local entities. Leasing of mineral rights will realize initial increases. Production of resources will add additional royalty and production taxes. Additional local activities will increase taxes and consumption in the local areas. By obtaining permits to allow discharges of produced water the operator will continue development, resulting in increased revenue at the federal, state, and local level.
15. DEMAND FOR GOVERNMENT SERVICES: Will substantial traffic be added to existing roads? Will other services (fire protection, police, schools, etc.) be needed?	[N]No impacts are anticipated in these areas. Any increases in traffic will be short term and minor during the construction phase. In the production phase, since no services are available locally, the workforce will be commuting to and from Sheridan WY. Issuing of these permits will allow the operator to continue development of the resources.
16. LOCALLY ADOPTED ENVIRONMENTAL PLANS AND GOALS: Are there State, County, City, USFS, BLM, Tribal, etc. zoning or management plans in effect?	[N] No local ordinances or plans conflict with issuance of these permits. Stipulations contained in the permits require the operator to acquire all the necessary approvals or permits prior to commencing any activities.
17. ACCESS TO AND QUALITY OF RECREATIONAL AND WILDERNESS ACTIVITIES: Are wilderness or recreational areas nearby or accessed through this tract? Is there recreational potential within the tract?	[N] No wilderness areas are near or within the project area. Minor impacts will be realized to recreational potential within the project due to development. Additional access in and around the area will allow for increased recreational opportunities in the area.
18. DENSITY AND DISTRIBUTION OF POPULATION AND HOUSING: Will the project add to the population and require additional housing?	[N] The development of CBNG from this action impacts a limited population base. The workforce associated with CBNG development in the Decker area commute from Sheridan WY. The Town of Sheridan has adequate housing to handle increases in the workforce due to this action.
19. SOCIAL STRUCTURES AND MORES: Is some disruption of native or traditional lifestyles or communities' possible?	[N] No impacts are expected in this area. During the project term no significant increase in population is expected. No transient workforce will integrate into the resident population. No additional social services will be necessary.
20. CULTURAL UNIQUENESS AND DIVERSITY: Will the action cause a shift in some unique quality of the area?	[N] No impacts are anticipated in this area. The workforce employed during construction and development are native to the area, and retain the uniqueness of the culture.
21. OTHER APPROPRIATE SOCIAL AND ECONOMIC CIRCUMSTANCES:	[N] No impacts are anticipated in this area.

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22(a). PRIVATE PROPERTY IMPACTS: Are we regulating the use of private property under a regulatory statute adopted pursuant to the police power of the state? (Property management, grants of financial assistance, and the exercise of the power of eminent domain are not within this category.) If not, no further analysis is required.	[N] Issuing the MPDES permits do not regulate the use of private property within the project area.
22(b). PRIVATE PROPERTY IMPACTS: Is the agency proposing to deny the application or condition the approval in a way that restricts the use of the regulated person's private property? If not, no further analysis is required.	[N]
22(c). PRIVATE PROPERTY IMPACTS: If the answer to 21(b) is affirmative, does the agency have legal discretion to impose or not impose the proposed restriction or discretion as to how the restriction will be imposed? If not, no further analysis is required. If so, the agency must determine if there are alternatives that would reduce, minimize or eliminate the restriction on the use of private property, and analyze such alternatives. The agency must disclose the potential costs of identified restrictions.	[N]

23. Description of and Impacts of other Alternatives Considered:

A. No Action: Under the "No Action" alternative, the Department would not issue MPDES permit MT0030724, Permit MT0030457 would remain in effect and allow the discharge of up to 1600 gpm of untreated wastewater. Any other discharges of produced water from CBNG development would need to be impounded away from state waters.

B. Approval with modification: The Department has tentatively decided to issue MPDES permits MT0030457 and MT0030724 to the operator of the CX Field. Under this alternative the permittee will be required to be compliant with all the terms and conditions identified in the permits. Discharges to the Tongue River would result in less impact to soils and wildlife habitat than impounding the wastewater on the surface. Should the operator fail to meet permit limits, the permit may be reopened and modified to provide additional protection to the receiving water. Enforcement actions may impose corrective measures

24. Summary of Magnitude and Significance of Potential Impacts: Issuance of the permits ensures that standards for water quality will be met. Standards are protective of beneficial uses. Therefore impacts are minor and non-significant.

25. Cumulative Effects: Cumulative Impacts have been analyzed as part of this EA. Based on the ambient conditions during the time of the analysis no cumulative impacts have been identified. If the ambient water quality changes appreciable the permits may be reopened or reevaluated during the permit renewal period.

26. Preferred Action Alternative and Rationale: The Department recommends approving the permit issuance with the proposed effluent limitations. This action is preferred because the permit program provides a regulatory mechanism for protecting and improving water quality by applying permit limitations on the point source discharges.

Recommendation for Further Environmental Analysis:

[ ] EIS [ ] More Detailed EA [X] No Further Analysis

26. Public Involvement: This draft EA will be opened for public comment during a 45-day public comment period. It will be posted on the Departments web page at http://www.deq.state.mt.ea.asp or commentors may contact Dianna McKittrick at the Water Protection Bureau at (406) 444-2475. Public Hearings have been scheduled at Lame Deer, MT at 2:00 pm on June 1, 2005, at the Blessed Sacrament Catholic Church, and 6:30 pm at Colstrip MT on May 31, 2005 at the community library. For copies of the Draft EA or to submit comments, write or call the Montana Department of Environmental Quality, Water Protection Bureau, PO Box 200901, Helena MT 59620-0901, (406) 444-3080. Comments will be received for 45-day after the date of the signature below.

The Department maintains a list of persons who have expressed an interest in all environmental water quality related issues. The Department will send a copy of this document to all persons who have submitted their name, address, and telephone number to the Department for the purpose of being included on the water quality interested parties mailing list.

27. Persons and agencies consulted in the preparation of this analysis:

Patricia Potts, DEQ WPB, GWPCS
Chris Yde, DEQ IEMB,
Bruce Waggen, DEQ IEMB

EA Checklist Prepared By:

James Lloyd (Name) — April 22, 2005 (Date)

Approved By:

_____
(Print: name & title)

_____ _____
Signature Date

References:

BLM, 2003. Montana Final Statewide Oil and Gas Environmental Impact Statement and Proposed Amendment of the Powder River and Billings Resource Management Plans (MT-FEIS), US Bureau of Land Management, Miles City Field Office, January 2003.

BLM, 2004. Fidelity Exploration and Production Company, Environmental Assessment MT-020-2004-298 for the Tongue River-Dry Creek Project Plan of Development, Big Horn County, Montana, US Bureau of Land Management, Miles City Field Office, December 2004.

BLM, 2005. Fidelity Exploration and Production Company, Environmental Assessment MT-020-2004-207 for the Tongue River-Coal Creek Project Plan of Development, Big Horn County, Montana, US Bureau of Land Management, Miles City Field Office, January 2005.

BLM, Ground Water Drawdown Impact Analysis for Fidelity Exploration and Production Company Coal Creek Plan of Development.

Fidelity Exploration and Production Company, Plan of Development, Master Surface Use Plan, Tongue River – Badger Hills Project, June 2003.

Fidelity Exploration and Production Company, Plan of Development, Tongue River- Dry Creek Project, March 2004.

Fidelity Exploration and Production Company, Plan of Development, Tongue River- Coal Creek Project April 2004.

Attachment 1

Wildlife

The uplands surrounding this project have been altered by extensive human developments, including farm and ranch operations, surface coal mining, CBM development and their associated roads, wells, pumping stations and power lines. Except for the agricultural areas, the wildlife habitats immediately bordering the Tongue River have not seen the same level of physical development as the upland areas on either side of the Tongue River.

Coal mining companies, private consulting firms and governmental agencies have conducted wildlife monitoring and inventory studies in the area for many years. Much of the information gathered has been used in surface coal mining permitting, land management planning processes, and more recently collected for CBM development and site specific Monitoring and Protection Plans (WMPP). Additional information is available from reports generated by the surface coal mines operated by Decker Coal Company and Spring Creek Coal Company. These mines, located in close proximity to the proposed project, have conducted extensive baseline wildlife surveys and annual monitoring in association with their permitting. These inventories/surveys include Threatened and Endangered species (T/E), including bald eagles and black-footed ferrets, and other high interest species such as raptors, sharp-tailed grouse, sage grouse, black-tailed prairie dogs, and mountain plovers.

The following general summary of wildlife distribution in the area of concern is based largely upon information obtained from annual wildlife monitoring reports submitted to Montana Department of Environmental Quality by Decker Coal Company and Spring Creek Coal Company, as well as from an environmental assessment prepared by the U.S. Bureau of Land Management (BLM, 2000).

Mule deer (*Odocoileus hemionus*) and white-tailed deer (*O. virginianus*) are common, yearlong residents of the area. During winter, populations tend to increase as animals migrate to more suitable habitats. The agricultural fields along the river receive increased use during the winter. Pronghorn (*Antilocapra americana*) are also yearlong residents; however, they tend to utilize the upland shrubland areas and don't tend to concentrate along the river bottoms.

Several species of raptors, including bald eagles (*Haliaeetus leucocphalus*), golden eagles (*Aquila chrysaetos*), osprey (*Pandion haliaetus*), red-tailed hawks (*Buteo jamaicensis*), prairie falcons (*Falco mexicanus*), turkey vultures (*Cathartes aura*) and American kestrels (*Falco sparverius*), nest on a variety of substrates. Bald eagles and osprey forage on fish from both the Tongue River and the Tongue River Reservoir. A variety of waterfowl, including the Canada goose (*Branta Canadensis*), mallard (*Anas platyrhynchos*), northern shoveler (*A. clypeata*), common goldeneye (*Bucephala clangula*), hooded merganser (*Lophodytes cucullatus*) and common merganser (*Mergus merganser*), and shorebirds – including sandpipers, long-billed dowitcher (*Limnodromus scolopaceus*), killdeer (*Charadrius vociferous*), and American avocet (*Recurvirostra americana*) – use the river, reservoir and associated shoreline areas during

migratory and breeding seasons, with several species of waterfowl wintering in the area. The riparian habitats adjacent to the river provide vegetation and structural diversity, which attracts a wide variety of songbirds. Because of the structural diversity and proximity to water these habitats support a wider variety of songbirds than the upland habitats. A great blue heron (*Ardea herodias*) and double-crested cormorant (*Phalacrocorax auritus*) rookery has been long established in the large cottonwoods (*Populus spp.)* at the south end of the Tongue River Reservoir. Several smaller rookeries have also established along the Tongue River; may be in response to the recent raising of the reservoir level. Ringed-necked pheasants (*Phasianus colchicus*), grey partridge (*Perdix perdix*) and turkeys (*Meleagris gallopavo*) inhabit the area adjacent to the river, while sage grouse (*Centrocercus urophasianus*) and sharp-tailed grouse (*Tympanuchus phasianellus*) are found within the upland areas.

A BLM (2005) reptile and amphibian inventory and study encompassed the project area and evaluated existing habitat, historical records, published literature, and consulted with local herpetologists (Maxell et al 2003, Maxell 2004, pers. comm.). Six species of amphibians and thirteen species of reptiles were determined to occur or potentially occur in the vicinity of the project area. These include the tiger salamander (*Ambystoma tigrinum*), plains spadefoot (*Spea bombifrons*), Great Plains toad (*Bufo cognatus*), Woodhouse's toad (*Bufo woodhousii*), boreal chorus frog (*Pseudacris maculate*), northern leopard frog (*Rana pipiens*), spiny softshell (*Apalone spinifera*), snapping turtle (*Chelydra serpentine*), painted turtle (*Chrysemys picta*), greater short horned lizard (*Phrynosoma herandesi*), common sagebrush lizard (*Sceloprus graciosus*), terrestrial gartersnake (*Thamnophis elegans*), common garter snake (*Themnophis sirtalis*), plains gartersnake (*Heterodon nasicus*), Eastern racer (*Coluber constrictor*), milksnake (*Lampropeltis triangulum*), and prairie rattlesnake (*Crotalus viridis*). Of these, three amphibians and six reptiles have special status rankings by either the BLM, U.S. Forest Service (USFS), or MTNHP (Table 1). Currently, the U.S. Fish and Wildlife Service lists no herptile species within Montana as threatened or endangered.

Currently a large playa located in Section 2, T9S, R39E is being used as a waste water discharge storage area. It has been assumed that since this is a small closed basin potential impacts would be minimal. Playas, however, are often important wildlife habitats. During annual wildlife monitoring conducted by Spring Creek Coal Company (summarized in SCCC 2004) it has been documented that at least three species of special concern utilized the playa prior to water discharge inundating at least part of the area. Two active sage grouse leks (one located on the playa and one approximately ¼ mile to the north) have been monitored for a number of years. A black-tailed prairie dog colony was present on the playa prior to inundation. These animals have adjusted somewhat to the disturbance; however, an impact exists. Two active burrowing owl nests were present in the prairie dog colony, with one of the nests active until 2001. Neither nest site has been active since 2001. In addition, a sharp-tailed grouse lek was present on the south side of the playa through the spring of 2001. Replacing the viability of the playa to support a diversity of wildlife species, such as sage grouse, sharp-tailed grouse, black-tailed prairie dogs, and burrowing owls, would alleviate some of the impacts that CBM production has had on wildlife in the area.

Threatened and Endangered Species

The bald eagle, currently listed as a Threatened species by the USFWS, is the only wildlife T/E species to be observed near the project area. Bald eagles are observed throughout the year in the vicinity of the Tongue River. Numerous bald eagles migrate through the area, while others winter along the Tongue River foraging on fish, waterfowl and carrion (mostly winter- or vehicle-killed big game animals wintering in the adjacent uplands). Four active bald eagle nests are located along the Tongue River from Sheridan, Wyoming to the Tongue River Reservoir. The other three are located in Wyoming, upstream of the proposed project. A fifth bald eagle nest/territory is located approximately eight air miles north of the Tongue River Dam. All the nests are located in the riparian habitat associated with the Tongue River. The one active nest – including the foraging area associated with the nest – would be within the area impacted by the construction of water discharge structures and the proposed water discharges (NE¼, NE¼, Section 33, T9S, R40E).

Species of Special Concern [Montana Natural Heritage Program (2004)]

Table 1 summarizes the species of special concern that have been identified by the Montana Natural Heritage Program (MTNHP 2004).

[1]Common Name	[1]Scientific Name	[2]MNHP Rank	[3]USFWS Status	[4]USFS Status	[5]BLM Status
Amphibians					
Plains spadefoot	*Spea bombifrons*	S3			
Great Plains toad[6]	*Bufo cognatus*	S2			
Northern leopard frog	*Rana pipiens*	S3		S	
Reptiles					
Spiny softshell	*Apalone spinifera*	S3			S
Snapping turtle	*Chelydra serpentina*	S3			S
Greater short-horned lizard	*Phrynosoma hernandesi*	S3			
Common sagebrush lizard	*Sceloporus graciosus*	S3			
Western hog-nosed snake	*Heterodon nasicus*	S2			
Milksnake	*Lampropeltis triangulum*	S2			
Mammal					
Black-tailed Prairie Dog	*Cynomys ludovicianus*	S3	C		
Townsend's Big-eared Bat	*Corynorhinus townsendii*	S2		S	S

Birds					
Bald Eagle	*Haliaeetus leucocephalus*	S3B,S3N	T		
Burrowing Owl	*Athene cunicularia*	S2B		S	S
Greater Sage Grouse	*Centrocercus urophasianus*	S3		S	S
Brewer's Sparrow	*Spizella breweri*	S2B			
Black-crowned Night-heron	*Nycticorax nycticorax*	S3B			
American White Pelican	*Pelecanus erythrorhynchos*	S3B			
Fish					
Sauger	*Stizostedion canadense*	S2			

1 Scientific and common names according to MTNHP 2004.
2 Montana Natural Heritage Program state ranking as determined by MTNHP and MFWP biologists: S2 = imperiled – very limited and/or declining numbers, range and/or habitat; S3 = Potentially at risk because of limited and/or declining numbers, range and/or habitat, may be locally abundant. B/N = State rank modifiers indicating the breeding status for a migratory species; B = Breeding, N = Non-breeding.
3 US Fish and Wildlife Service Status: T = Threatened; E = Endangered; C = Candidate (species for which the USFWS has sufficient information on biological status and threats to propose listing as threatened or endangered).
4 USDA, US Forest Service Region 1 Status: (S) = USFS Sensitive Species.
5 USDI, Bureau of Land Management Status: S = BLM Sensitive Species.
6 The (BLM 2005) study documented one Great Plains toad observation; an auditory detection tallied while performing night road-driving surveys on May 19, 2004. The distinct call was heard across the Decker Coal mine exclusion area from a point along Decker Road.

Potential Impacts

It is anticipated that both direct and indirect impacts will occur due to the implementation of the proposed project. Construction activities during the nesting season could cause the bald eagle pair occupying the territory upstream of the Tongue River Reservoir to abandon the territory. The U.S. Fish and Wildlife Service requires a ½ mile buffer around the nest site to be established, limiting new activity during the nesting period (approximately March 1 through July 15 or until the young fledge). Reduction in water quality could also affect the availability and distribution of macroinvertebrates and fish, affecting the availability of food for other species (e.g. common merganser, bald eagle, spiny softshell, snapping turtle). It is anticipated, however, that the water quality standards that are in place will minimize the impacts to these species.

A BLM report states, "No evident relationship between water quality parameters and amphibian and reptile detections is apparent from the data collected. Higher pH and EC values for certain sample sites did not appear to preclude the presence of herptiles. However, the six sites that were chosen as exhibiting particularly high-quality structural or vegetative habitat characteristics, such as shallows and good vegetative cover, exhibited the highest diversity of aquatic species, the widest range of life stages, and the most individuals. Conversely, sites that

were lacking these high quality characteristics produced fewer, and sometimes zero, herptile observations. This suggests that wetland structure and vegetative cover may currently be as strong an indicator of herptile presence and population viability as water quality parameters within the Study Area. However, insufficient water quality and quantity data was collected to assess any effects of water quality on herptiles within the study area" (BLM, 2005).

Macroinvertebrates are an important link in the food chain of river and riparian systems; they provide food sources for fish, reptiles and amphibians living in the Tongue River, Tongue River Reservoir and the associated wetland areas. Environmental changes to water chemistry, water volumes, and temperature can alter macroinvertebrate populations and species makeup, resulting in direct consequences for fish, reptiles and amphibians. A reduction in fish and amphibians results in a reduction in the availability of forage for several bird species (e.g. bald eagle, osprey, common merganser, great blue heron, black-crowned night-heron, and pelicans). Complying with Montana water quality discharge standards should minimize impacts to aquatic life forms. If reductions in aquatic live forms are noted, additional studies and/or monitoring will be needed to determine the extent of the impacts and develop mitigation measures.

Protection

Wildlife protection for this project will follow the guidance documents and requirements outlined in the CBNG Programmatic Wildlife Monitoring and Protection Plan for the Montana Statewide EIS, BLM (2003).

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Maxell, Bryce A. University of Montana. Personal communication. May 6, 2004.

Bryce A. Maxell, J. Kirwin Werner, Paul Hendricks, and Dennis L. Flath. 2004. Amphibians and Reptiles of Montana. Mountain Press Publishing Company, Missoula, Montana.

Montana Natural Heritage Program (MTNHP). 2004. MTNHP Animal Field Guide. December 16, 2004. URL: http://nhp.nris.state.mt.us/animalguide/

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USDI. Bureau of Land Management (BLM). 2000. Environmental Assessment and Powder River Resource Area, Resource Management Plan for Spring Creek Coal Company's Federal Coal Lease by Application MTM 88405 and Stat of Montana Coal Lease Applications C-1099-XX, C1100-XX, and C-1101-XX. EA No. MT-020-99-20. Miles City Field Office and Montana Department of Natural Resources and Conservation.
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USDI. Bureau of Land Management (BLM). 2003. Final Oil and Gas Environmental Impact Statement and Proposed Amendment of the Powder River and Billings Resource Management Plans. URL: www.mt.blm.gov/mcfo/cbm/eis/index.html

USDI. Bureau of Land Management (BLM). 2004. Environmental Assessment MT-020-2004-0134 on Fidelity Exploration and Production Company. Tongue River Badger Hills Project Plan of Development. URL: www.mt.blm.gov/mcfo/cbng/badgerhills/index.html

USDI. Bureau of Land Management (BLM). 2005. Amphibian and Reptile Baseline Survey: CX Field Study Area Bighorn County, Montana. February 2005.

Walker, Brett. 2004. University of Montana. Personal communication. November 29, 2004. As cited in: **U.S. Department of the Interior, Bureau of Land Management (BLM). 2005**. Amphibian and Reptile Baseline Survey: CX Field Study Area Bighorn County, Montana. February 2005.

Attachment 2

Fidelity Tongue River Project
Cumulative Impact Analysis
MPDES permits MT0030457 and MT0030724.

Pursuant to the Montana Environmental Policy Act (MEPA), cumulative impacts must be assessed to determine overall impacts brought about by any state action. For the cumulative impact analysis for issuing MPDES permits MT0030457 and MT0030724 the following spreadsheets calculate the impacts to the receiving water, the Tongue River.

To determine the impact to the Tongue River baseline water quality was determined. Using water quality data from pre-development monitoring, data from the following locations were compiled.

Tongue River at Stateline near Decker,
Tongue River at Monarch WY,
Goose Creek below Sheridan WY,
Prairie Dog Creek near Acton WY, and monitoring activities conducted by Fidelity in the Tongue River upstream from their outfalls, and
Prairie Dog Creek in WY.

To generate a comprehensive data set, data analysis from the tributary monitoring was flow proportional and weighted to generate composite analysis. Composite analysis was averaged with instream data by the following combinations. Data obtained at the Stateline station was all pre-June 2001 to reflect pre-development conditions.

- Stateline near Decker
- Tongue river at Monarch + Goose Creek + Prairie Dog Creek (All USGS stations) flow weighted and proportioned
- Fidelity Tongue River upstream monitoring + Fidelity Prairie Dog Creek Monitoring, flow weighted and proportioned

Datum generated using this method was sorted by month and analyzed to find the mean and median valued for each period. Where sufficient data points were available monthly water quality was obtained for most conventional parameters, were as for metals seasonal or even annual average water quality was obtained.

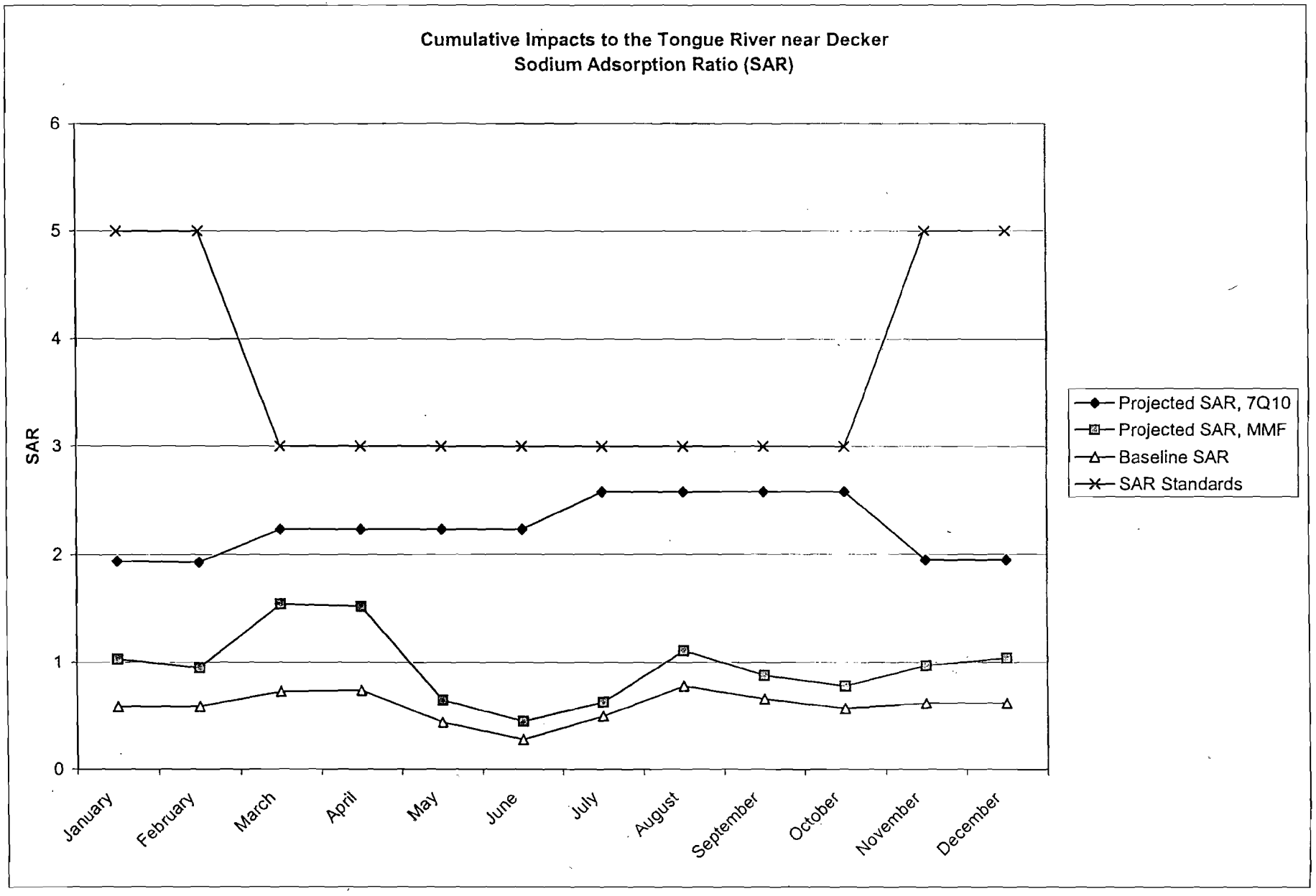
Additional analysis from the data set allowed for specific parameter concentrations to be compared to actual instream flows. From this data set regression models were developed to define concentrations of individual parameters at a specific instream flow rate. Regression coefficients, (R^2) ranged from 0.991 for sodium, 0.848 for magnesium and 0.798 for calcium. These regression models were used to define instream concentrations for these parameters at the seasonal 7Q10 flows. One item that requires clarification, the seasonal 7Q10 loads were calculated on a monthly basis and carried forward. In actually low flow conditions rarely exceed a seven-day period. This conservatism allows for evaluation of extended low flow periods that may not reflect actual instream conditions.

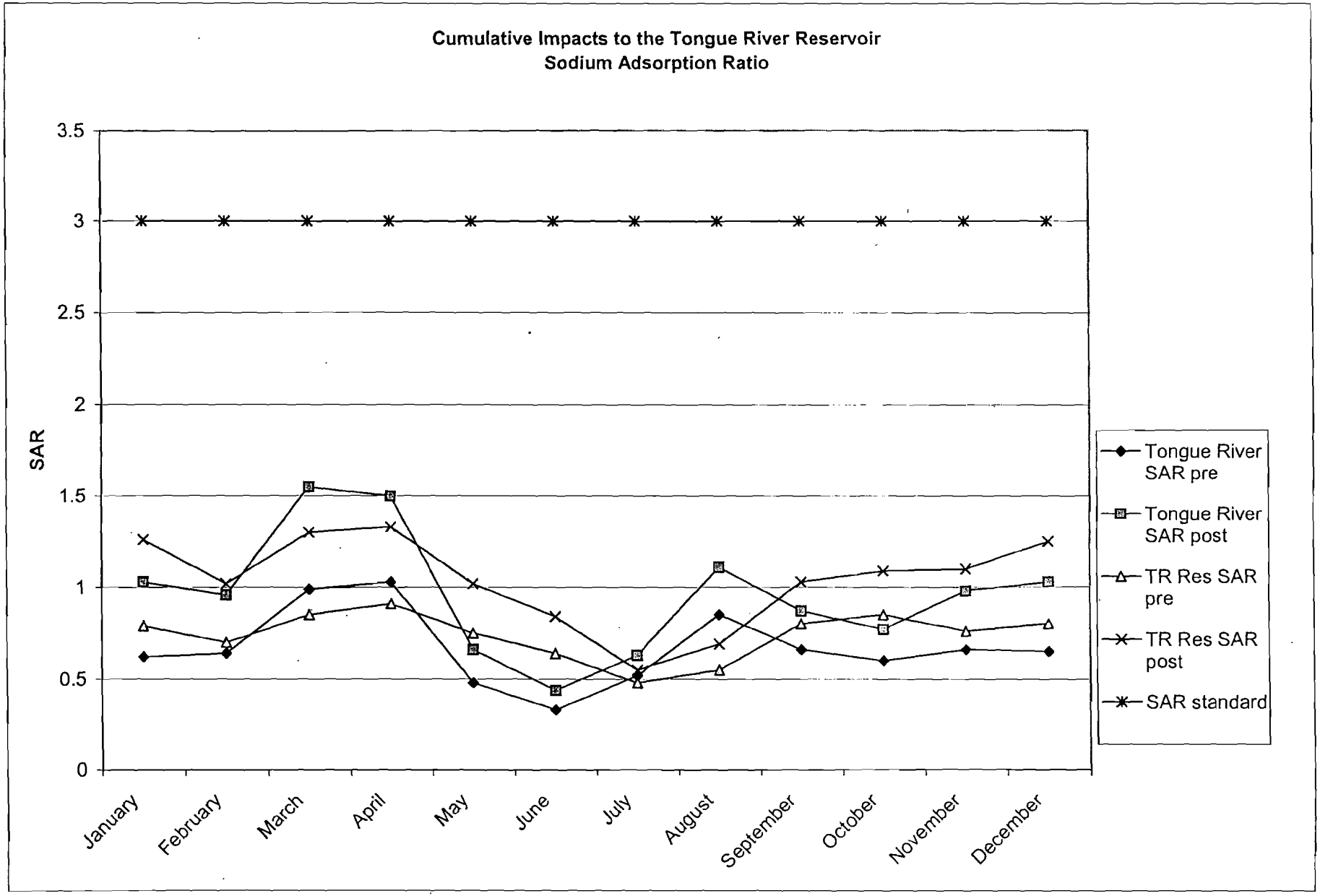
Tongue River at Decker
Cumulative impacts for this reach of the river used the following assumptions. To aid in the analysis of the net impact to the receiving water, all discharges to the receiving water for permit MT0030457 was modeled as a single point source. This method is more conservative and will be more protective to the receiving water. The receiving water ambient condition was calculated to reflect conditions of the Tongue River once the influenced of Prairie Dog Creek is fully mixed and the river finally crosses into Montana. The discharge to the receiving water from the Fidelity Treatment plant utilized full production through the plant, or 1700 gpm. To determine total dissolved solids, electrical conductivity was factored by 0.635. This allowed a mass balance method to determine loads to the receiving water.

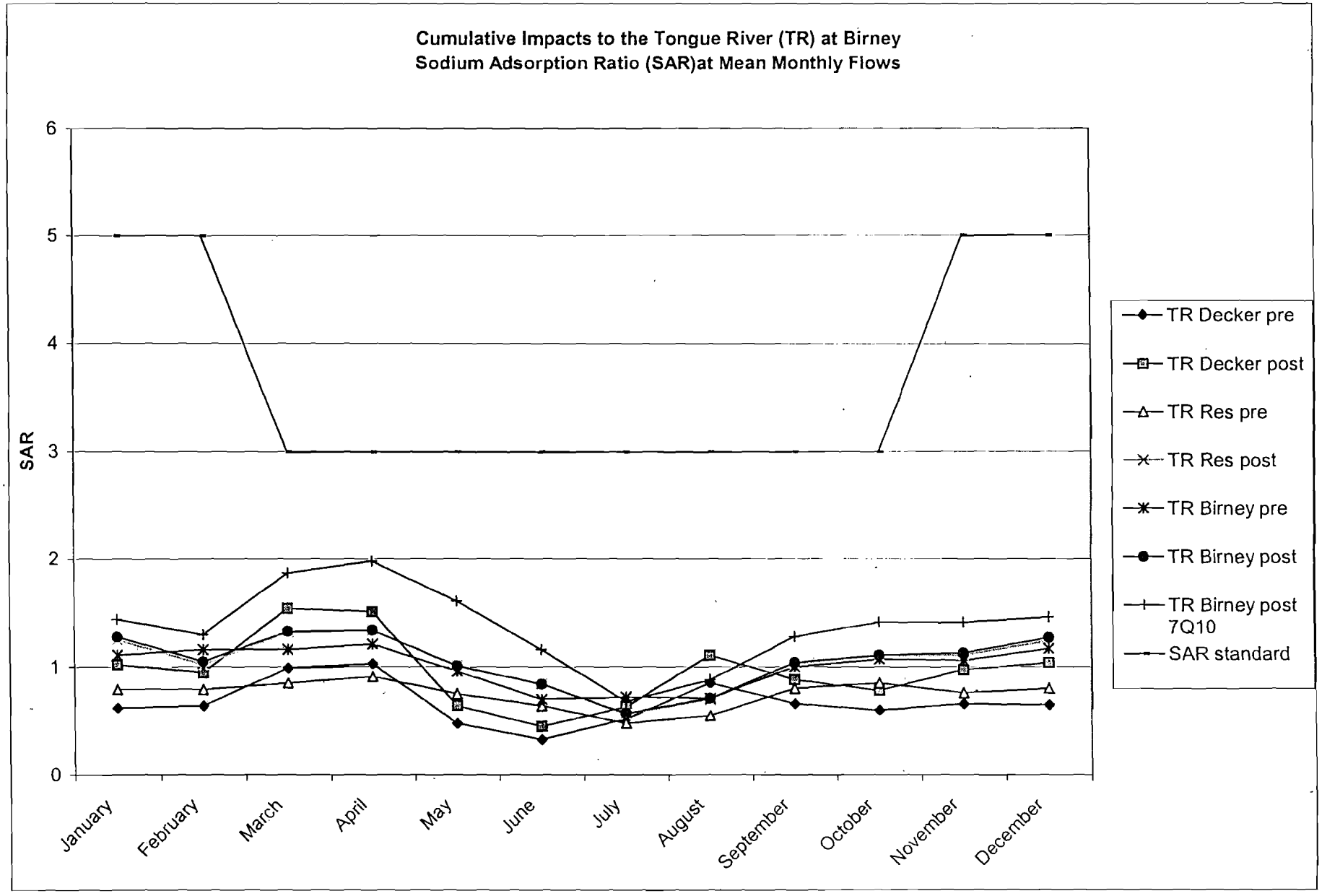
Cumulative impacts were evaluated once the total loads,i.e. ambient loads and inputs to the receiving water were calculated. Total instream loads were compared to the water quality standards and nondegradation criteria to determine impacts. As a result of 7Q10 analysis, instream electrical conductivity exceeded the 30-day average water quality standard. A permit condition was inserted to reduce or eliminate direct discharge flows to the receiving water if the instream flows are less than the annual 7Q10 and the instream EC values exceed the daily maximum water quality standard.

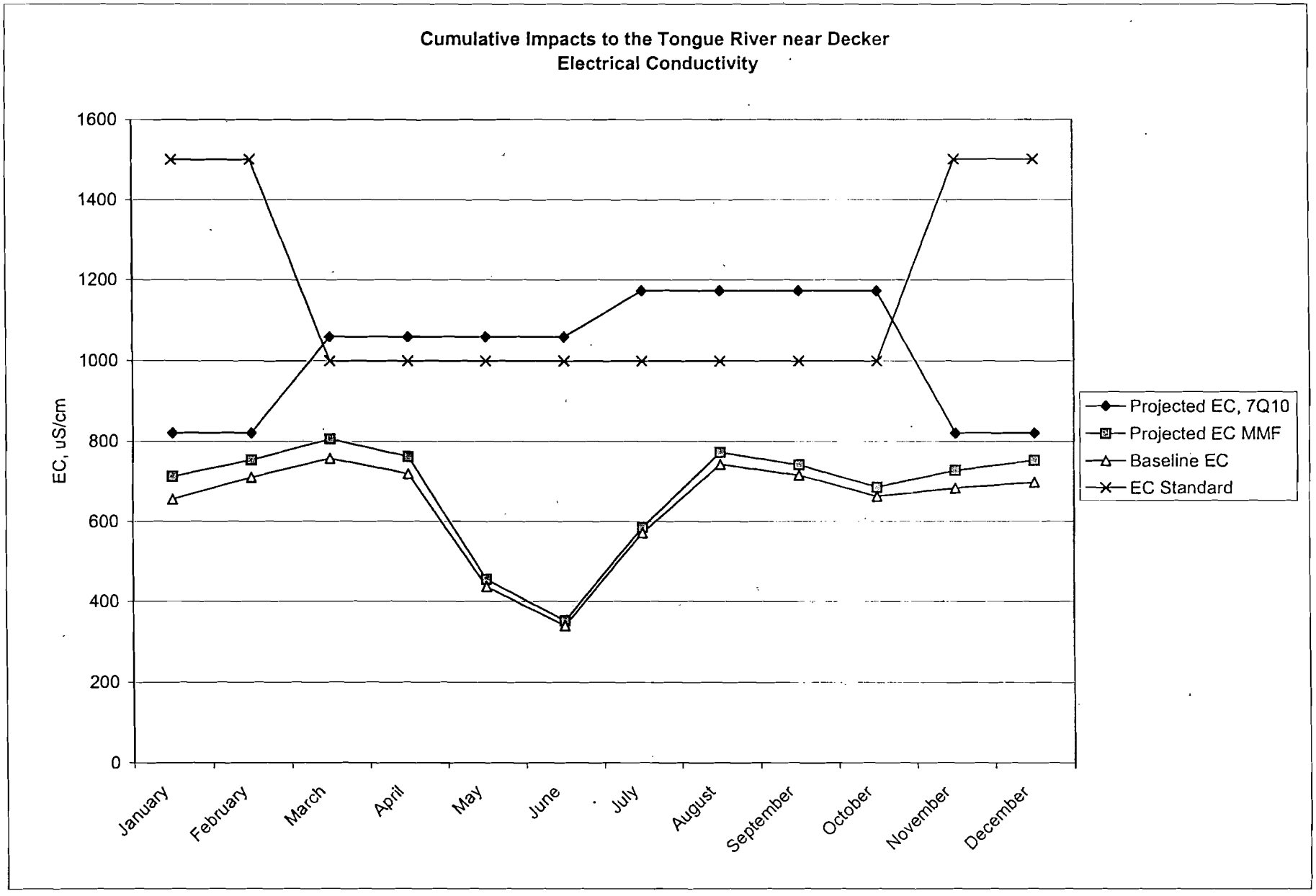
Tongue River Reservoir
Modeling of the reservoir utilized the net change through the water body instead of modeling the specific interaction within the water body. Using historic data depicting inputs and discharges from the reservoir, the behavior of the reservoir was determined. Assuming the reservoir will behave in the same fashion, the net change can be calculated with the additional loads. Based on this model, EC was exceeded the 7Q10 monthly analysis periods, February and December. These exceedances will be eliminated with the permit conditions stated above. SAR values did not exceed the specific water quality standards for the water body.

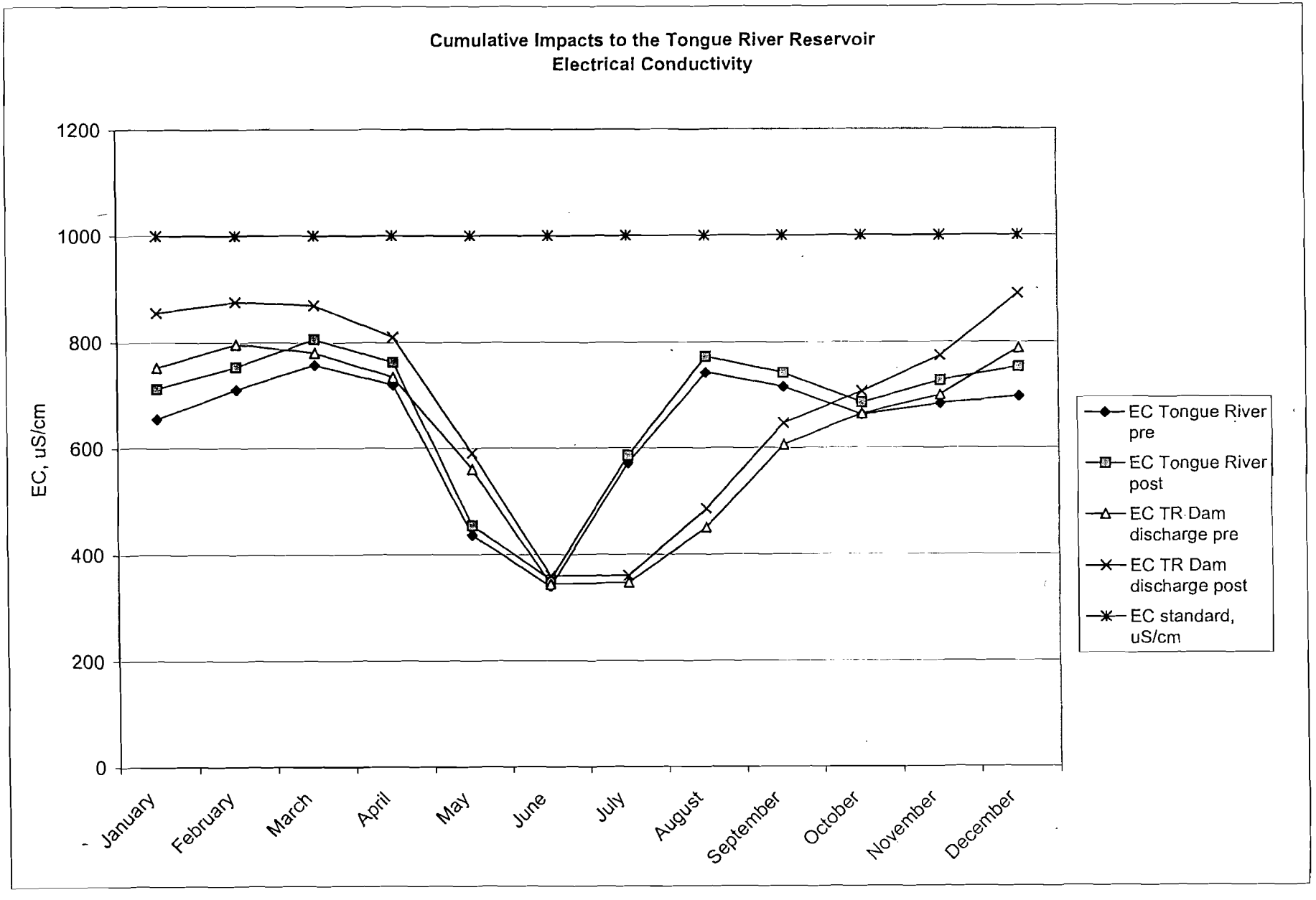
Tongue River at Birney
Cumulative impacts to the Tongue River at Birney were also evaluated. Discharges from the Tongue River Dam were used as a baseline. Loads were carried down stream with additional inputs for other permitted facilities. Loads were calculated using the mass balance equation. SAR values were recalculated from individual parameters to determine resulting water quality. SAR values from the recalculation reach a maximum of 1.98 during April at this point. Influences from the 7Q10 flows upriver are still evident at Birney during March. In March the 7Q10 EC value is calculated to be 1013 us/cm. This value exceeds the 30-day average water quality standard of 1000 uS/cm.

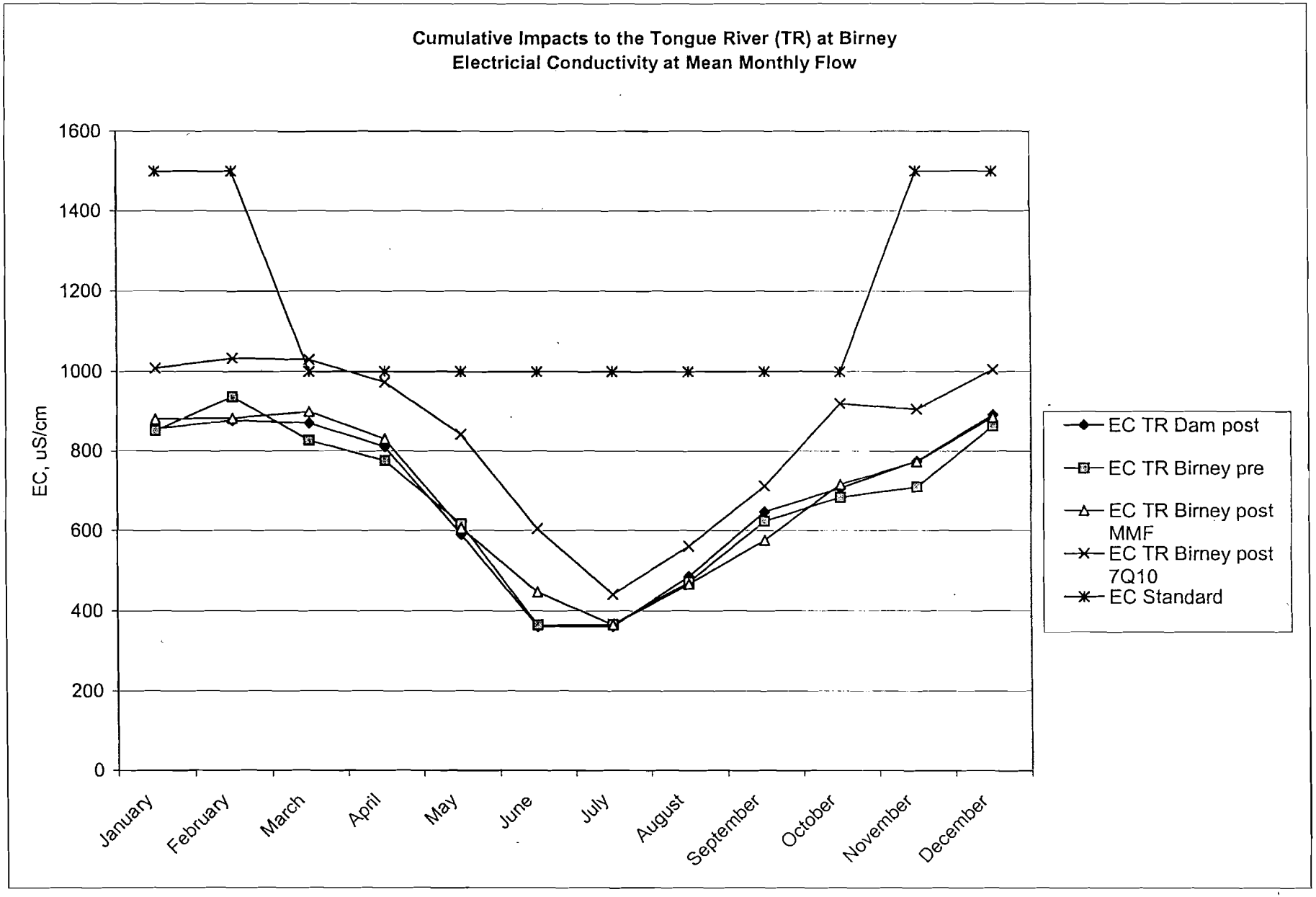

Cumulative Impacts to the Tongue River near Decker
Sodium Adsorption Ratio (SAR)
SAR
6
5
4
3
2
1
0
January
February
March
April
May
June
July
August
September
October
November
December
Projected SAR, 7Q10
Projected SAR, MMF
Baseline SAR
SAR Standards

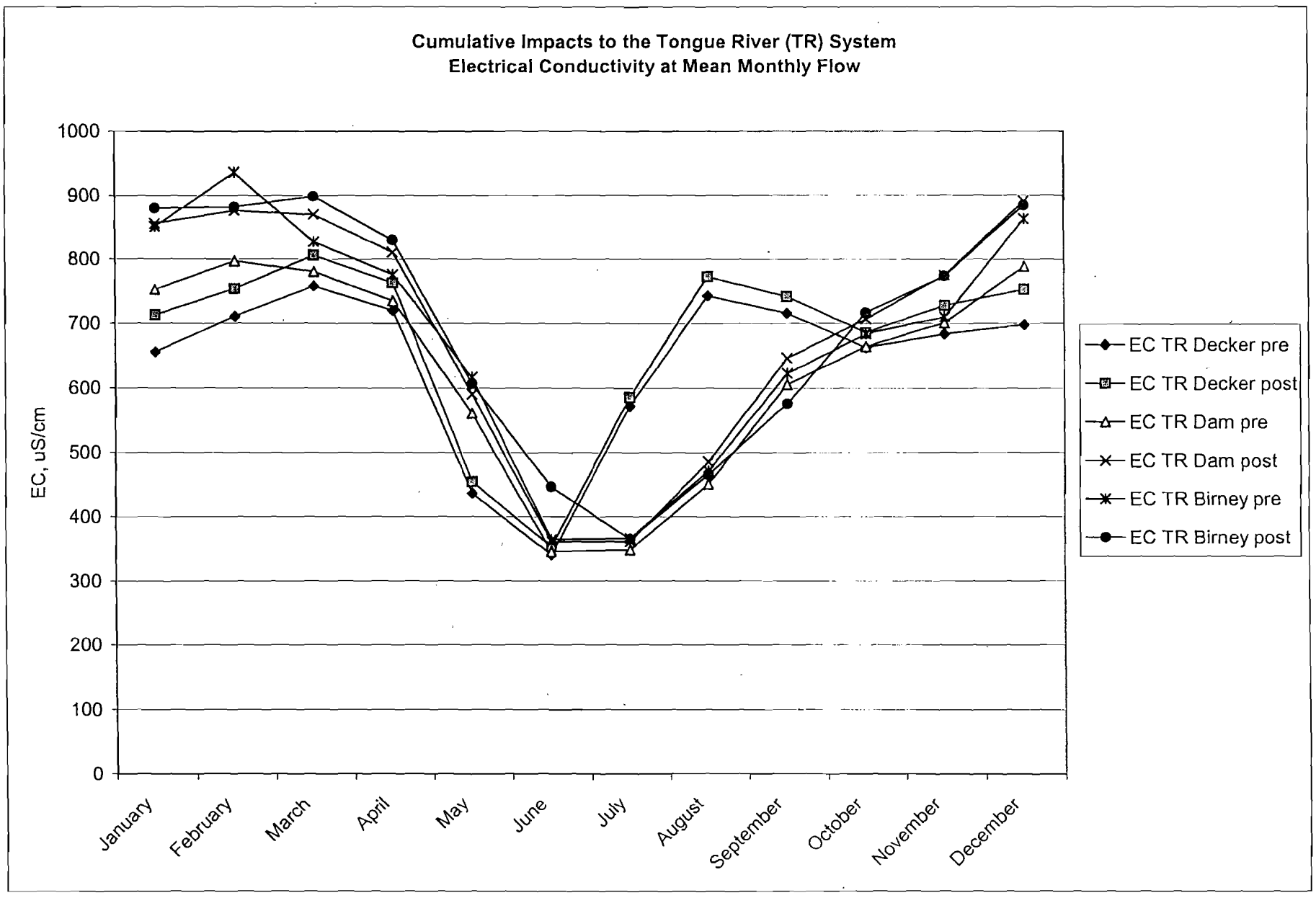

Cumulative Impacts to the Tongue River Reservoir
Sodium Adsorption Ratio
SAR
3.5
3
2.5
2
1.5
1
0.5
0
January
February
March
April
May
June
July
August
September
October
November
December
Tongue River SAR pre
Tongue River SAR post
TR Res SAR pre
TR Res SAR post
SAR standard


Cumulative Impacts to the Tongue River (TR) at Birney
Sodium Adsorption Ratio (SAR)at Mean Monthly Flows
SAR
6
5
4
3
2
1
0
January
February
March
April
May
June
July
August
September
October
November
December
TR Decker pre
TR Decker post
TR Res pre
TR Res post
TR Birney pre
TR Birney post
TR Birney post 7Q10
SAR standard


Cumulative Impacts to the Tongue River near Decker
Electrical Conductivity
EC, uS/cm
1600
1400
1200
1000
800
600
400
200
0
January
February
March
April
May
June
July
August
September
October
November
December
Projected EC, 7Q10
Projected EC MMF
Baseline EC
EC Standard


Cumulative Impacts to the Tongue River Reservoir
Electrical Conductivity
EC, uS/cm
1200
1000
800
600
400
200
0
January
February
March
April
May
June
July
August
September
October
November
December
EC Tongue River pre
EC Tongue River post
EC TR Dam discharge pre
EC TR Dam discharge post
EC standard, uS/cm


Cumulative Impacts to the Tongue River (TR) at Birney
Electricial Conductivity at Mean Monthly Flow
EC, uS/cm
1600
1400
1200
1000
800
600
400
200
0
January
February
March
April
May
June
July
August
September
October
November
December
EC TR Dam post
EC TR Birney pre
EC TR Birney post MMF
EC TR Birney post 7Q10
EC Standard


Cumulative Impacts to the Tongue River (TR) System
Electrical Conductivity at Mean Monthly Flow
EC, uS/cm
1000
900
800
700
600
500
400
300
200
100
0
January
February
March
April
May
June
July
August
September
October
November
December
EC TR Decker pre
EC TR Decker post
EC TR Dam pre
EC TR Dam post
EC TR Birney pre
EC TR Birney post

Cumulative Impacts Analysis Summary
Upper Tongue River at Decker

	January		February		March		April		May		June	
Total Flow, cfs	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
	85	186	85	238	134	319	134	371	134	1156	134	1656
Total TDS, lbs/day	228286	454969	242734	615214	398838	878575	383492	967252	269484	1799370	230081	2000210
Calculated TDS, mg/l	496	453	527	479	554	512	533	484	375	289	320	224
Calculated EC post developement, uS/cm	781	713	830	754	873	806	839	763	590	455	504	353
Actual EC pre-development, uS/cm	656		711		758		720		437		340	
Total Na, lbs/day	35,937	42,192	35,740	50,814	55,591	87,303	55,546	96,382	55,546	122,703	55,546	119,394
Calculated Na, mg/l	78	42	78	40	77	51	77	48	77	20	77	13
Total Ca, lbs/day	27222	65341	27222	86691	41255	75105	41255	82578	41255	242175	41255	329027
Calculated Ca, mg/l	59	65	59	67	57	44	57	41	57	39	57	37
Total Mg, lbs/day	17,645	37,646	17,645	50,228	14,751	40,095	14,751	43,013	14,751	120,311	14,751	157,821
Calculated Mg, mg/l	38	37	38	39	21	23	21	22	21	19	21	18
Calculated SAR post development	1.94	1.03	1.93	0.95	2.23	1.54	2.23	1.52	2.23	0.65	2.23	0.45
Actual SAR pre-development		0.59		0.59		0.73		0.74		0.44		0.28

	July		August		September		October		November		December	
Total Flow, cfs	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
	43	468	43	183	43	221	43	260	85	233	85	188
Total TDS, lbs/day	108029	939813	129153	485305	125818	562150	119223	611398	235524	581789	239244	485267
Calculated TDS, mg/l	462	372	552	491	538	471	510	436	512	462	520	478
Calculated EC post developement, uS/cm	727	586	869	773	847	742	803	686	806	728	819	753
Actual EC pre-development, uS/cm	572		743		716		663		684		698	
Total Na, lbs/day	23,865	61,175	23,865	43,516	23,865	42,293	23,865	44,087	35,937	50,973	35,937	44,087
Calculated Na, mg/l	102	24	102	44	102	35	102	31	78	41	78	43
Total Ca, lbs/day	12749	144956	12749	59387	12749	74117	12749	85999	27099	84564	27099	67869
Calculated Ca, mg/l	54	57	54	60	54	62	54	61	59	67	59	67
Total Mg, lbs/day	9,115	84,486	9,115	34,973	9,115	44,375	9,115	51,348	17,645	49,193	17,645	39,508
Calculated Mg, mg/l	39	33	39	35	39	37	39	37	38	39	38	39
Calculated SAR post development	2.58	0.63	2.58	1.11	2.58	0.88	2.58	0.78	1.95	0.97	1.95	1.04
Actual SAR pre-development		0.50		0.78		0.66		0.57		0.62		0.62

Cumulative Impact Analysis
Electrical Conductivity in the Upper Tongue River

	January		February		March		April		May		June	
	EC	wt%	EC	wt%	EC	wt%	EC	wt%	EC	wt%	EC	wt%
TR @ Monarch, WY	427	0.50	523	0.49	520	0.43	550	0.45	308	0.58	205	0.63
Goose Crk, WY	736	0.39	833	0.37	805	0.32	730	0.38	501	0.34	256	0.35
Fidelity Stateline, MT	535	0.90	522	0.86	557	0.75	562	0.83	465	0.92	457	0.98
Prairie Dog Crk, WY	1476	0.10	1666	0.14	1214	0.25	1340	0.17	1377	0.08	1520	0.02
USGS Decker, MT	690	1.00	654	1.00	767	1.00	712	1.00	315	1.00	292	1.00
	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
Mean EC, uS/cm	701	656	701	711	968	758	968	720	968	437	968	340
Calculated TDS, mg/l	445	416	446	452	615	481	615	457	615	278	615	216
Flow, cfs	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
USGS Decker, MT	76	177	76	229	118	303	118	355	118	1,140	118	1,640
TDS allocated load, lbs/day	182,345	397,257	182,345	557,502	390,949	785,731	390,949	874,408	390,949	1,706,526	390,949	1,907,366
	TDS, mg/l	Flow, cfs	TDS, mg/l	Flow, cfs	TDS, mg/l	Flow, cfs	TDS, mg/l	Flow, cfs	TDS, mg/l	Flow, cfs	TDS, mg/l	Flow, cfs
Fidelity Direct Discharge	1,266	5.6	1,266	5.6	1,266	4.5	1,266	11.7	1,266	11.7	1,266	11.7
Allocated load, lbs/day	38,213		38,213		30,707		79,838		79,838		79,838	
Fidelity Treatment Plant	952	3.8	952	3.8	635	3.8	635	3.8	635	3.8	635	3.8
Allocated load, lbs/day	19,499		19,499		13,006		13,006		13,006		13,006	
Total Flow, cfs	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
	85	186	85	238	126	311	134	371	134	1,156	134	1,656
Total TDS, lbs/day	240,057	454,969	240,057	615,214	434,662	829,444	483,793	967,252	483,793	1,799,370	483,793	2,000,210
Calculated TDS, mg/l	522	453	522	479	638	494	672	484	672	289	672	224
Calculated EC, uS/cm	821	713	821	754	1,006	778	1,059	763	1,059	455	1,059	353

	July		August		September		October		November		December	
	EC	wt%	EC	wt%	EC	wt%	EC	wt%	EC	wt%	EC	wt%
TR @ Monarch, WY	340	0.63	436	0.51	466	0.42	471	0.46	465	0.46	480	0.44
Goose Crk, WY	778	0.32	836	0.34	728	0.39	697	0.40	780	0.41	650	0.43
Fidelity Stateline, MT	506	0.95	676	0.85	676	0.81	577	0.85	586	0.87	582	0.87
Prairie Dog Crk, WY	2036	0.05	1592	0.15	1330	0.19	1187	0.15	1470	0.13	1583	0.13
USGS Decker, MT	568	1.00	671	1.00	616	1.00	646	1.00	625	1.00	685	1.00
	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
Mean EC, uS/cm	1110	572	1110	743	1110	716	1110	663	701	684	701	698
Calculated TDS, mg/l	705	363	705	472	705	455	705	421	445	434	445	443
USGS Decker, MT	36	461	36	176	36	214	36	253	76	224	76	179
TDS allocated load, lbs/day	136,769	902,241	136,769	447,734	136,769	524,579	136,769	573,826	182,345	524,078	182,345	427,555
	TDS, mg/l	Flow, cfs	TDS, mg/l	Flow, cfs	TDS, mg/l	Flow, cfs	TDS, mg/l	Flow, cfs	TDS, mg/l	Flow, cfs	TDS, mg/l	Flow, cfs
Fidelity Direct Discharge	1,266	0.0	1,266	3.6	1,266	3.6	1,266	3.6	1,266	5.6	1,266	5.6
Allocated load, lbs/day	0		24,565		24,565		24,565		38,213		38,213	
Fidelity Treatment Plant	635	3.8	635	3.8	635	3.8	635	3.8	952	3.8	952	3.8
Allocated load, lbs/day	13,006		13,006		13,006		13,006		19,499		19,499	
Total Flow, cfs	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
	40	465	43	183	43	221	43	260	85	233	85	188
Total TDS, lbs/day	149,775	915,247	174,341	485,305	174,341	562,150	174,341	611,398	240,057	581,789	240,057	485,267
Calculated TDS, mg/l	698	365	745	491	745	471	745	436	522	462	522	478
Calculated EC, uS/cm	1,099	575	1,174	773	1,174	742	1,174	686	821	728	821	753

Cumulative Impact Analysis
Sodium Concentration in the Upper Tongue River

	January		February		March		April		May		June	
	Na	wt%	Na	wt%	Na	wt%	Na	wt%	Na	wt%	Na	wt%
TR @ Monarch, WY	14	0.50	17	0.49	24	0.43	26	0.45	12	0.58	5	0.63
Goose Crk, WY	28.4	0.39	28	0.37	32	0.32	27	0.38	19	0.34	7	0.35
Fidelity Stateline, MT	19	0.90	20	0.86	19	0.75	25	0.83	13	0.92	10	0.98
Prairie Dog Crk, WY	63	0.10	71	0.14	64	0.25	70	0.17	71	0.08	75	0.02
USGS Decker, MT	31	1.00	26	1.00	33	1.00	33	1.00	7	1.00	11	1.00
Mean Na, mg/l	45.48	26	45	27	35.97	33	35.9	33	35.9	15	35.9	10
Flow, cfs	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
USGS Decker, MT	76	177	76	229	118	303	118	355	118	1,140	118	1,640
Na allocated load, lbs/day	18,630	24,886	18,434	33,508	22,878	54,590	22,833	63,669	22,833	89,990	22,833	86,681
	Na, mg/l	Flow, cfs	Na, mg/l	Flow, cfs	Na, mg/l	Flow, cfs	Na, mg/l	Flow, cfs	Na, mg/l	Flow, cfs	Na, mg/l	Flow, cfs
Fidelity Direct Discharge	496	5.6	496	5.6	496	11.7	496	11.7	496	11.7	496	11.7
Allocated load, lbs/day	14,971		14,971		31,279		31,279		31,279		31,279	
Fidelity Treatment Plant	114	3.8	114	3.8	70	3.8	70	3.8	70	3.8	70	3.8
Allocated load, lbs/day	2,335		2,335		1,434		1,434		1,434		1,434	
Total Flow, cfs	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
	85	186	85	238	134	319	134	371	134	1,156	134	1,656
Total Na, lbs/day	35,937	42,192	35,740	50,814	55,591	87,303	55,546	96,382	55,546	122,703	55,546	119,394
Calculated Na, mg/l	78	42	78	40	77	51	77	48	77	20	77	13

	July		August		September		October		November		December	
	Na	wt%	Na	wt%	Na	wt%	Na	wt%	Na	wt%	Na	wt%
TR @ Monarch, WY	9	0.63	18	0.51	17	0.42	17	0.46	16	0.46	19	0.44
Goose Crk, WY	33	0.32	32	0.34	31	0.39	29	0.40	27	0.41	29	0.43
Fidelity Stateline, MT	20	0.95	32	0.85	32	0.81	20	0.85	22	0.87	19	0.87
Prairie Dog Crk, WY	101	0.05	71	0.15	39	0.19	44	0.15	58	0.13	66	0.13
USGS Decker, MT	15	1.00	34	1.00	22	1.00	24	1.00	31	1.00	29	1.00
Mean Na, mg/l	66	20	66	34	66	27	66	24	45.48	28	45.48	28
Calculated TDS, mg/l	13		22		17		15		18		18	
Flow, cfs	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
USGS Decker, MT	36	461	36	176	36	214	36	253	76	224	76	179
Na allocated load, lbs/day	12,807	50,117	12,807	32,458	12,807	31,235	12,807	33,029	18,630	33,666	18,630	26,781
	Na, mg/l	Flow, cfs	Na, mg/l	Flow, cfs	Na, mg/l	Flow, cfs	Na, mg/l	Flow, cfs	Na, mg/l	Flow, cfs	Na, mg/l	Flow, cfs
Fidelity Direct Discharge	496	3.6	496	3.6	496	3.6	496	3.6	496	5.6	496	5.6
Allocated load, lbs/day	9,624		9,624		9,624		9,624		14,971		14,971	
Fidelity Treatment Plant	70	3.8	70	3.8	70	3.8	70	3.8	114	3.8	114	3.8
Allocated load, lbs/day	1,434		1,434		1,434		1,434		2,335		2,335	
Total Flow, cfs	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
	43	468	43	183	43	221	43	260	85	233	85	188
Total Na, lbs/day	23,865	61,175	23,865	43,516	23,865	42,293	23,865	44,087	35,937	50,973	35,937	44,087
Calculated Na, mg/l	102	24	102	44	102	35	102	31	78	41	78	43

Cumulative Impact Analysis

Calcium Concentration in the Upper Tongue River

	January		February		March		April		May		June	
	Ca	wt%	Ca	wt%	Ca	wt%	Ca	wt%	Ca	wt%	Ca	wt%
TR @ Monarch, WY	55	0.50	55	0.49	45	0.43	45	0.45	45	0.58	45	0.63
Goose Crk, WY	67	0.39	67	0.37	50	0.32	50	0.38	50	0.34	50	0.35
Fidelity Stateline, MT		0.90		0.86		0.75		0.83		0.92		0.98
Prairie Dog Crk, WY	145	0.10	145	0.14	117	0.25	117	0.17	117	0.08	117	0.02
USGS Decker, MT	67	1.00	67	1.00	26	1.00	26	1.00	26	1.00	26	1.00
Mean Ca, mg/l	64	68	64	70	63	45	63	43	63	39	63	37
Flow, cfs	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
USGS Decker, MT	76	177	76	229	118	303	118	355	118	1,140	118	1,640
Ca allocated load, lbs/day	26,340	64,459	26,340	85,809	40,133	73,983	40,133	81,456	40,133	241,053	40,133	327,905
	Ca, mg/l	Flow, cfs	Ca, mg/l	Flow, cfs	Ca, mg/l	Flow, cfs	Ca, mg/l	Flow, cfs	Ca, mg/l	Flow, cfs	Ca, mg/l	Flow, cfs
Fidelity Direct Discharge	5	5.6	5	5.6	5	11.7	5	11.7	5	11.7	5	11.7
Allocated load, lbs/day	145		145		303		303		303		303	
Fidelity Treatment Plant	36	3.8	36	3.8	40	3.8	40	3.8	40	3.8	40	3.8
Allocated load, lbs/day	737		737		819		819		819		819	
Total Flow, cfs	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
	85	186	85	238	134	319	134	371	134	1,156	134	1,656
Total Ca, lbs/day	27,222	65,341	27,222	86,691	41,255	75,105	41,255	82,578	41,255	242,175	41,255	329,027
Calculated Ca, mg/l	59	65	59	67	57	44	57	41	57	39	57	37

	July		August		September		October		November		December	
	Ca	wt%	Ca	wt%	Ca	wt%	Ca	wt%	Ca	wt%	Ca	wt%
TR @ Monarch, WY	49	0.63	49	0.51	49	0.42	49	0.46	55	0.46	55	0.44
Goose Crk, WY	66	0.32	66	0.34	66	0.39	66	0.40	67	0.41	67	0.43
Fidelity Stateline, MT		0.95		0.85		0.81		0.85		0.87		0.87
Prairie Dog Crk, WY	119	0.05	119	0.15	119	0.19	119	0.15	145	0.13	145	0.13
USGS Decker, MT	58	1.00	58	1.00	58	1.00	58	1.00	67	1.00	67	1.00
Mean Ca, mg/l	61	58	61	62	61	63	61	62	64	69	64	69
Calculated TDS, mg/l	37		39		40		40		44		44	
Flow, cfs	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
USGS Decker, MT	36	461	36	176	36	214	36	253	76	224	76	179
Ca allocated load, lbs/day	11,836	144,043	11,836	58,474	11,836	73,204	11,836	85,086	26,217	83,682	26,217	66,987
	Ca, mg/l	Flow, cfs	Ca, mg/l	Flow, cfs	Ca, mg/l	Flow, cfs	Ca, mg/l	Flow, cfs	Ca, mg/l	Flow, cfs	Ca, mg/l	Flow, cfs
Fidelity Direct Discharge	5	3.6	5	3.6	5	3.6	5	3.6	5	5.6	5	5.6
Allocated load, lbs/day	93		93		93		93		145		145	
Fidelity Treatment Plant	40	3.8	40	3.8	40	3.8	40	3.8	36	3.8	36	3.8
Allocated load, lbs/day	819		819		819		819		737		737	
Total Flow, cfs	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
	43	468	43	183	43	221	43	260	85	233	85	188
Total Ca, lbs/day	12,749	144,956	12,749	59,387	12,749	74,117	12,749	85,999	27,099	84,564	27,099	67,869
Calculated Ca, mg/l	54	57	54	60	54	62	54	61	59	67	59	67

Cumulative Impact Analysis
Magnesium Concentration in the Upper Tongue River

	January		February		March		April		May		June	
	Mg	wt%	Mg	wt%	Mg	wt%	Mg	wt%	Mg	wt%	Mg	wt%
TR @ Monarch, WY	24	0.50	24	0.49	20	0.43	20	0.45	20	0.58	20	0.63
Goose Crk, WY	43	0.39	43	0.37	30	0.32	30	0.38	30	0.34	30	0.35
Fidelity Stateline, MT		0.90		0.86		0.75		0.83		0.92		0.98
Prairie Dog Crk, WY	90	0.10	90	0.14	79	0.25	79	0.17	79	0.08	79	0.02
USGS Decker, MT	41	1.00	41	1.00	11	1.00	11	1.00	11	1.00	11	1.00
Mean Mg, mg/l	42.9	39	42.9	41	23	24	23	22	23	20	23	18
Flow, cfs	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
USGS Decker, MT	76	177	76	229	118	303	118	355	118	1,140	118	1,640
Mg allocated load, lbs/day	17,574	37,574	17,574	50,156	14,628	39,972	14,628	42,890	14,628	120,188	14,628	157,698
	Mg, mg/l	Flow, cfs	Mg, mg/l	Flow, cfs	Mg, mg/l	Flow, cfs	Mg, mg/l	Flow, cfs	Mg, mg/l	Flow, cfs	Mg, mg/l	Flow, cfs
Fidelity Direct Discharge	2	5.6	2	5.6	2	11.7	2	11.7	2	11.7	2	11.7
Allocated load, lbs/day	48		48		101		101		101		101	
Fidelity Treatment Plant	1	3.8	1	3.8	1	3.8	1	3.8	1	3.8	1	3.8
Allocated load, lbs/day	23		23		22		22		22		22	
Total Flow, cfs	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
	85	186	85	238	134	319	134	371	134	1,156	134	1,656
Total Mg, lbs/day	17,645	37,646	17,645	50,228	14,751	40,095	14,751	43,013	14,751	120,311	14,751	157,821
Calculated Mg, mg/l	38	37	38	39	21	23	21	22	21	19	21	18

	July		August		September		October		November		December	
	Mg	wt%	Mg	wt%	Mg	wt%	Mg	wt%	Mg	wt%	Mg	wt%
TR @ Monarch, WY	23	0.63	23	0.51	23	0.42	23	0.46	24	0.46	24	0.44
Goose Crk, WY	46	0.32	46	0.34	46	0.39	46	0.40	43	0.41	43	0.43
Fidelity Stateline, MT		0.95		0.85		0.81		0.85		0.87		0.87
Prairie Dog Crk, WY	75	0.05	75	0.15	75	0.19	75	0.15	90	0.13	90	0.13
USGS Decker, MT	35	1.00	35	1.00	35	1.00	35	1.00	41	1.00	41	1.00
Mean Mg, mg/l	46.7	34	46.7	37	46.7	38	46.7	38	42.9	41	42.9	41
Calculated TDS, mg/l	22		23		24		24		26		26	
Flow, cfs	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
USGS Decker, MT	36	461	36	176	36	214	36	253	76	224	76	179
Mg allocated load, lbs/day	9,062	84,433	9,062	34,919	9,062	44,322	9,062	51,294	17,574	49,121	17,574	39,437
	Mg, mg/l	Flow, cfs	Mg, mg/l	Flow, cfs	Mg, mg/l	Flow, cfs	Mg, mg/l	Flow, cfs	Mg, mg/l	Flow, cfs	Mg, mg/l	Flow, cfs
Fidelity Direct Discharge	2	3.6	2	3.6	2	3.6	2	3.6	2	5.6	2	5.6
Allocated load, lbs/day	31		31		31		31		48		48	
Fidelity Treatment Plant	1	3.8	1	3.8	1	3.8	1	3.8	1	3.8	1	3.8
Allocated load, lbs/day	22		22		22		22		23		23	
Total Flow, cfs	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
	43	468	43	183	43	221	43	260	85	233	85	188
Total Mg, lbs/day	9,115	84,486	9,115	34,973	9,115	44,375	9,115	51,348	17,645	49,193	17,645	39,508
Calculated Mg, mg/l	39	33	39	35	39	37	39	37	38	39	38	39

Cumulative Impact Analysis
Sodium Adsorption Ratio in the Tongue River Reservoir

		Jan		Feb		March		April		May		June	
		7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
	River												
Pre	Mean Na, mg/l	26		27		33		33		15		10	
	Mean Ca, mg/l	68		70		45		43		39		37	
	Mean Mg, mg/l	39		41		24		22		20		18	
Post	Calculated Na, mg/l	78	42	78	40	77	51	77	48	77	20	77	13
	Calculated Ca, mg/l	59	65	59	67	57	44	57	41	57	39	57	37
	Calculated Mg, mg/l	39	37	38	39	21	23	21	22	21	19	21	18
Pre	SAR	0.62		0.64		0.99		1.03		0.48		0.33	
Post	SAR	1.93	1.03	1.94	0.96	2.21	1.55	2.21	1.50	2.21	0.66	2.21	0.44
	Reservoir												
Pre	Dam Discharge Na, mg/l	35		31		37		38		28		19	
	Dam Discharge Ca, mg/l	73		73		69		61		52		35	
	Dam Discharge Mg, mg/l	45		45		44		43		32		19	
Post	Cal Na mg/l	61	56	55	45	81	57	83	56	60	38	34	25
	Cal Ca mg/l	75	74	75	74	71	70	63	62	53	52	36	35
	Cal Mg mg/l	45	45	45	45	44	44	43	43	32	32	19	19
Pre	SAR	0.79		0.70		0.85		0.91		0.75		0.64	
Post	SAR	1.37	1.26	1.24	1.02	1.85	1.31	1.97	1.33	1.60	1.02	1.14	0.84

		July		August		September		October		November		December	
		7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
	River												
Pre	Mean Na, mg/l	20		34		27		24		28		28	
	Mean Ca, mg/l	58		62		63		62		69		69	
	Mean Mg, mg/l	34		37		38		38		41		41	
Post	Calculated Na, mg/l	102	24	102	44	102	35	102	31	78	41	78	43
	Calculated Ca, mg/l	54	57	54	60	54	62	54	61	59	67	59	67
	Calculated Mg, mg/l	39	33	39	35	39	37	39	37	38	39	38	39
Pre	SAR	0.52		0.85		0.66		0.60		0.66		0.65	
Post	SAR	2.58	0.62	2.58	1.11	2.58	0.87	2.58	0.77	1.94	0.98	1.94	1.03
	Reservoir												
Pre	Dam Discharge Na, mg/l	14		20		30		35		31		35	
	Dam Discharge Ca, mg/l	35		43		49		60		60		71	
	Dam Discharge Mg, mg/l	18		34		35		41		40		45	
Post	Cal Na mg/l	19	16	31	25	48	39	57	45	55	45	62	55
	Cal Ca mg/l	37	35	46	44	52	50	64	61	62	61	73	72
	Cal Mg mg/l	18	18	34	34	35	35	41	41	40	40	45	45
Pre	SAR	0.48		0.55		0.80		0.85		0.76		0.80	
Post	SAR	0.64	0.55	0.84	0.69	1.26	1.03	1.36	1.09	1.33	1.10	1.40	1.25

Cumulative Impacts Analysis
Electrical Conductivity in the Tongue River Reservoir

	Jan		Feb		March		April		May		June	
	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
Tongue River Inputs												
TDS pre, lbs/day	182,345	397,257	182,345	557,502	390,949	785,731	390,949	874,408	390,949	1,706,526	390,949	1,907,366
Total TDS post, lbs/day	240057	454969	240057	615214	483793	878575	483793	967252	483793	1799370	483793	2000210
Reservoir Inputs												
Decker Coal West TDS mg/l	2,400	1.23	2,065	1.1	2,378	1.1	2,098	1.02	1,852	1.2	1,696	8.8
Allocated load, lbs/day	15,911		12,132		13,971		11,534		11,979		80,719	
Decker Coal East	2,178	0.8	2,126	0.8	2,300	1.0	2,230	1.06	1,940	1.3	1,962	1.0
Allocated load, lbs/day	9,392		8,938		11,901		12,741		13,384		10,469	
TDS Load to reservoir (pre)	207,648	422,560	203,415	578,573	416,821	811,603	415,224	898,683	416,312	1,731,890	482,137	1,998,554
TDS Load to reservoir (post)	265,360	480,272	261,127	636,284	509,665	904,447	508,068	991,527	509,156	1,824,733	574,981	2,091,398
Historic Dam Discharge												
Dam Discharge EC	753		797		781		735		561		345	
Dam Discharge TDS	478		506		496		467		356		219	
Mean Monthly Outflow cfs	70	173	70	180	70	224	70	362	157	903	183	1430
TDS, load #/day (pre)	180408	445865	190950	491013	187116	598772	176095	910664	301457	1733856	216089	1688564
Cal TDS load (post)	230549	506760	245125	539991	228795	667269	215470	1004746	368686	1826806	257701	1767007
Cal TDS mg/l	611	543	650	557	606	553	571	515	436	375	261	229
Cal EC uS/cm	962	856	1023	876	955	870	899	811	686	591	411	361

	July		August		September		October		November		December	
	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
Tongue River Inputs												
TDS pre, lbs/day	136,769	902,241	136,769	447,734	136,769	524,579	136,769	573,826	182,345	524,078	182,345	427,555
Total TDS post, lbs/day	174341	939813	174341	485305	174341	562150	174341	611398	240057	581789	240057	485267
Reservoir Inputs												
Decker Coal West TDS mg/l	1,808	7.8	2,076	2.8	2,033	1.9	1,911	1.3	2,264	0.9	2,316	0.9
Allocated load, lbs/day	75,622		31,555		21,149		13,287		11,349		10,736	
Decker Coal East	2,161	0.9	2,108	0.9	2,132	0.8	2,082	0.8	2,186	0.7	2,176	0.9
Allocated load, lbs/day	9,901		9,999		9,308		8,416		8,483		10,204	
TDS Load to reservoir (pre)	222,292	987,764	178,323	489,287	167,226	555,035	158,473	595,530	202,177	543,910	203,285	448,495
TDS Load to reservoir (post)	259,863	1,025,336	215,894	526,859	204,797	592,607	196,044	633,102	259,889	601,622	260,996	506,206
Historic Dam Discharge												
Dam Discharge EC	348		451		606		665		701		789	
Dam Discharge TDS	221		286		385		422		445		501	
Mean Monthly Outflow cfs	169	571	103	361	107	308	71	274	70	254	70	188
TDS, load #/day (pre)	201293	680108	158992	557245	221931	638831	161600	623641	167949	609417	189033	507689
Cal TDS load (post)	235315	705977	192491	600035	271794	682075	199913	662986	215891	674079	242699	573017
Cal TDS mg/l	258	229	347	308	471	411	522	449	572	492	643	565
Cal EC uS/cm	407	361	546	486	742	647	823	707	901	775	1013	891

Cumulative Impacts Analysis
Sodium Concentration in the Tongue River Reservoir

	Jan		Feb		March		April		May		June	
	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
Tongue River Inputs												
Na allocated load, lbs/day	18,630	24,886	18,434	33,508	22,878	54,590	22,833	63,669	22,833	89,990	22,833	86,681
Total Na, lbs/day	35937	42192	35740	50814	55591	87303	55546	96382	55546	122703	55546	119394
Reservoir Inputs												
Decker Coal West Na mg/l	334	1.23	334	1.1	334	1.1	334	1.02	334	1.2	334	8.8
Allocated load, lbs/day	2,214		1,962		1,962		1,836		2,160		15,896	
Decker Coal East, Na, mg/l	567	0.8	567	0.8	567	1.0	567	1.06	567	1.3	567	1.0
Allocated load, lbs/day	2,445		2,384		2,934		3,239		3,912		3,026	
Na Load to reservoir (pre)	23,290	29,545	22,780	37,854	27,774	59,487	27,909	68,745	28,905	96,062	41,755	105,603
Na Load to reservoir (post)	40,596	46,852	40,086	55,160	60,487	92,199	60,622	101,458	61,618	128,775	74,468	138,316
Dam Discharge												
Dam Discharge Na, mg/l	35		31		37		38		28		19	
Mean Monthly Outflow cfs	70	173	70	180	70	224	70	362	157	903	183	1430
Na, load #/day (pre)	13206	32636	11696	30076	13960	44672	14337	74145	23694	136281	18741	146446
Cal Na load (post)	23018	51753	20582	43827	30403	69239	31143	109428	50510	182690	33424	191811
Cal Na mg/l	61	56	55	45	81	57	83	56	60	38	34	25

	July		August		September		October		November		December	
	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
Tongue River Inputs												
Na allocated load, lbs/day	12,807	50,117	12,807	32,458	12,807	31,235	12,807	33,029	18,630	33,666	18,630	26,781
Total Na, lbs/day	23865	61175	23865	43516	23865	42293	23865	44087	35937	50973	35937	44087
Reservoir Inputs												
Decker Coal West Na mg/l	334	7.8	334	2.8	334	1.9	334	1.3	334	0.9	334	0.9
Allocated load, lbs/day	13,970		5,077		3,475		2,322		1,674		1,548	
Decker Coal East, Na, mg/l	567	0.9	567	0.9	567	0.8	567	0.8	567	0.7	567	0.9
Allocated load, lbs/day	2,598		2,689		2,475		2,292		2,200		2,659	
Na Load to reservoir (pre)	29,374	66,684	20,573	40,224	18,757	37,185	17,421	37,643	22,505	37,541	22,837	30,988
Na Load to reservoir (post)	40,432	77,742	31,631	51,282	29,815	48,243	28,479	48,702	39,811	54,847	40,144	48,294
Dam Discharge												
Dam Discharge Na, mg/l	14		20		30		35		31		35	
Mean Monthly Outflow cfs	169	571	103	361	107	308	71	274	70	254	70	188
Na, load #/day (pre)	12753	43088	11103	38916	17302	49804	13394	51690	11696	42441	13206	35466
Cal Na load (post)	17554	50233	17072	49614	27502	64614	21896	66875	20691	62006	23213	55273
Cal Na mg/l	19	16	31	25	48	39	57	45	55	45	62	55

Cumulative Impacts Analysis
Calcium Concentration in the Tongue River Reservoir

	Jan		Feb		March		April		May		June	
	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
Tongue River Inputs												
Ca allocated load, lbs/day	26,340	64,459	26,340	85,809	40,133	73,983	40,133	81,456	40,133	241,053	40,133	327,905
Total Ca, lbs/day	27222	65341	27222	86691	41255	75105	41255	82578	41255	242175	41255	329027
Reservoir Inputs												
Decker Coal West Ca mg/l	168	1.23	168	1.1	193	1.1	193	1.02	193	1.2	193	8.8
Allocated load, lbs/day	1,114		987		1,134		1,061		1,248		9,186	
Decker Coal East, Ca, mg/l	87	0.8	87	0.8	67	1.0	67	1.06	67	1.3	67	1.0
Allocated load, lbs/day	375		366		347		383		462		358	
Ca Load to reservoir (pre)	27,829	65,948	27,693	87,162	41,613	75,463	41,577	82,899	41,843	242,763	49,676	337,448
Ca Load to reservoir (post)	28,711	66,830	28,575	88,044	42,735	76,585	42,699	84,021	42,965	243,885	50,798	338,570
Dam Discharge												
Dam Discharge Ca, mg/l	73		73		69		61		52		35	
Mean Monthly Outflow cfs	70	173	70	180	70	224	70	362	157	903	183	1430
Ca, load #/day (pre)	27543	68070	27543	70825	26034	83308	23015	119022	44004	253093	34523	269770
Cal Ca load (post)	28416	68981	28420	71541	26736	84546	23636	120633	45184	254263	35303	270666
Cal Ca mg/l	75	74	75	74	71	70	63	62	53	52	36	35

	July		August		September		October		November		December	
	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
Tongue River Inputs												
Ca allocated load, lbs/day	11,836	144,043	11,836	58,474	11,836	73,204	11,836	85,086	26,217	83,682	26,217	66,987
Total Ca, lbs/day	12749	144956	12749	59387	12749	74117	12749	85999	27099	84564	27099	67869
Reservoir Inputs												
Decker Coal West Ca mg/l	200	7.8	200	2.8	200	1.9	200	1.3	168	0.9	168	0.9
Allocated load, lbs/day	8,365		3,040		2,081		1,391		842		779	
Decker Coal East, Ca, mg/l	72	0.9	72	0.9	72	0.8	72	0.8	87	0.7	87	0.9
Allocated load, lbs/day	330		342		314		291		338		408	
Ca Load to reservoir (pre)	20,532	152,738	15,218	61,856	14,231	75,599	13,518	86,768	27,397	84,862	27,404	68,173
Ca Load to reservoir (post)	21,444	153,651	16,130	62,768	15,144	76,512	14,431	87,680	28,279	85,744	28,286	69,056
Dam Discharge												
Dam Discharge Ca, mg/l	35		43		49		60		60		71	
Mean Monthly Outflow cfs	169	571	103	361	107	308	71	274	70	254	70	188
Ca, load #/day (pre)	31882	107719	23872	83669	28260	81346	22961	88612	22638	82144	26788	71946
Cal Ca load (post)	33299	108363	25304	84903	30072	82328	24511	89543	23367	82998	27651	72877
Cal Ca mg/l	37	35	46	44	52	50	64	61	62	61	73	72

Cumulative Impacts Analysis
Magnesium Concentration in the Tongue River Reservoir

	Jan		Feb		March		April		May		June	
	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
Tongue River Inputs												
Mg (pre), lbs/day	17,574	37,574	17,574	50,156	14,628	39,972	14,628	42,890	14,628	120,188	14,628	157,698
Total Mg (post), lbs/day	17645	37646	17645	50228	14751	40095	14751	43013	14751	120311	14751	157821
Reservoir Inputs												
Decker Coal West Mg mg/l	60	1.23	60	1.1	60	1.1	60	1.02	60	1.2	60	8.8
Allocated load, lbs/day	398		353		353		330		388		2,856	
Decker Coal East, Mg, mg/l	23	0.8	23	0.8	23	1.0	23	1.06	23	1.3	23	1.0
Allocated load, lbs/day	99		97		119		131		159		123	
Mg Load to reservoir (pre)	18,071	38,071	18,023	50,605	15,100	40,443	15,090	43,351	15,175	120,735	17,607	160,677
Mg Load to reservoir (post)	18,142	38,143	18,094	50,677	15,223	40,566	15,213	43,474	15,298	120,858	17,730	160,800
Dam Discharge												
Dam Discharge Mg, mg/l	45		45		44		43		32		19	
Mean Monthly Outflow cfs	70	173	70	180	70	224	70	362	157	903	183	1430
Mg, load #/day (pre)	16979	41961	16979	43659	16601	53124	16224	83901	27079	155749	18741	146446
Cal Mg load (post)	17046	42040	17046	43721	16736	53285	16356	84139	27299	155908	18872	146558
Cal Mg mg/l	45	45	45	45	44	44	43	43	32	32	19	19

	July		August		September		October		November		December	
	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
Tongue River Inputs												
Mg (pre), lbs/day	9,062	84,433	9,062	34,919	9,062	44,322	9,062	51,294	17,574	49,121	17,574	39,437
Total Mg (post), lbs/day	9115	84486	9115	34973	9115	44375	9115	51348	17645	49193	17645	39508
Reservoir Inputs												
Decker Coal West Mg mg/l	60	7.8	60	2.8	60	1.9	60	1.3	60	0.9	60	0.9
Allocated load, lbs/day	2,510		912		624		417		301		278	
Decker Coal East, Mg, mg/l	23	0.9	23	0.9	23	0.8	23	0.8	23	0.7	23	0.9
Allocated load, lbs/day	105		109		100		93		89		108	
Mg Load to reservoir (pre)	11,677	87,048	10,083	35,941	9,786	45,046	9,572	51,805	17,964	49,511	17,960	39,823
Mg Load to reservoir (post)	11,730	87,101	10,136	35,994	9,839	45,099	9,625	51,858	18,035	49,583	18,031	39,894
Dam Discharge												
Dam Discharge Mg, mg/l	18		34		35		41		40		45	
Mean Monthly Outflow cfs	169	571	103	361	107	308	71	274	70	254	70	188
Mg, load #/day (pre)	16396	55398	18876	66157	20186	58104	15690	60551	15092	54762	16979	45599
Cal Mg load (post)	16471	55432	18975	66255	20295	58173	15777	60613	15152	54842	17046	45681
Cal Mg mg/l	18	18	34	34	35	35	41	41	40	40	45	45

Cumulative Impact Analysis
Sodium Adsorption Ratio in the Tongue River at Birney

		Jan		Feb		March		April		May		June	
		7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
	River												
Pre	Mean [Na], mg/l		26		27		33		33		15		10
	Mean [Ca], mg/l		68		70		45		43		39		37
	Mean [Mg], mg/l		39		41		24		22		20		18
Post	Calculated [Na], mg/l	78	42	78	40	77	51	77	48	77	20	77	13
	Calculated [Ca], mg/l	59	65	59	67	57	44	57	41	57	39	57	37
	Calculated [Mg], mg/l	39	37	38	39	21	23	21	22	21	19	21	18
Pre	SAR	0.62		0.64		0.99		1.03		0.48		0.33	
Post	SAR	1.93	1.02	1.94	0.95	2.21	1.54	2.21	1.51	2.21	0.64	2.21	0.45
	Reservior												
Pre	Dam Discharge [Na], mg/l		35		35		37		38		28		19
	Dam Discharge [Ca], mg/l		73		73		69		61		52		35
	Dam Discharge [Mg], mg/l		45		45		44		43		32		19
Post	Cal [Na] mg/l	61	56	55	45	81	57	83	56	60	38	34	25
	Cal [Ca] mg/l	75	74	75	74	71	70	63	62	53	52	36	35
	Cal [Mg] mg/l	45	45	45	45	44	44	43	43	32	32	19	19
Pre	SAR	0.79		0.79		0.85		0.91		0.75		0.64	
Post	SAR	1.37	1.25	1.22	1.02	1.85	1.32	1.96	1.34	1.59	1.01	1.13	0.84
	Lower river at Birney												
Pre	[Na] TR at Birney		46		50		47		49		33		19
	[Ca] TR at Birney		49		53		47		47		34		21
	[Mg] TR at Birney		49		53		47		47		34		21
Post	Calculated [Na], mg/l	63	57	57	46	81	58	83	56	60	38	35	25
	Calculated [Ca], mg/l	74	74	74	73	70	70	62	62	53	52	36	35
	Calculated [Mg], mg/l	44	44	44	44	43	44	42	43	32	32	19	19
Pre	SAR	1.11		1.16		1.16		1.21		0.96		0.70	
Post	SAR	1.44	1.28	1.30	1.05	1.87	1.33	1.98	1.34	1.61	1.01	1.16	0.84

		July		August		September		October		November		December	
		7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
	River												
Pre	Mean [Na], mg/l		20		34		27		24		28		28
	Mean [Ca], mg/l		58		62		63		62		69		69
	Mean [Mg], mg/l		34		37		38		38		41		41
Post	Calculated [Na], mg/l	102	24	102	44	102	35	102	31	78	41	78	43
	Calculated [Ca], mg/l	54	57	54	60	54	62	54	61	59	67	59	67
	Calculated [Mg], mg/l	39	33	39	35	39	37	39	37	38	39	38	39
Pre	SAR	0.52		0.85		0.66		0.60		0.66		0.65	
Post	SAR	2.58	0.63	2.58	1.11	2.58	0.88	2.58	0.78	1.94	0.97	1.94	1.04
	Reservior												
Pre	Dam Discharge [Na], mg/l		14		20		30		35		31		35
	Dam Discharge [Ca], mg/l		35		43		49		60		60		71
	Dam Discharge [Mg], mg/l		18		34		35		41		40		45
Post	Cal [Na] mg/l	19	16	31	25	48	39	57	45	55	45	62	55
	Cal [Ca] mg/l	37	35	46	44	52	50	64	61	62	61	73	72
	Cal [Mg] mg/l	18	18	34	34	35	35	41	41	40	40	45	45
Pre	SAR	0.48		0.55		0.80		0.85		0.76		0.80	
Post	SAR	0.65	0.56	0.84	0.70	1.25	1.03	1.37	1.10	1.33	1.11	1.39	1.24
	Lower river at Birney												
Pre	[Na] TR at Birney		19		21		36		42		42		49
	[Ca] TR at Birney		20		25		37		44		45		50
	[Mg] TR at Birney		20		25		37		44		45		50
Post	Calculated [Na], mg/l	20	17	32	26	49	39	58	46	57	46	64	56
	Calculated [Ca], mg/l	37	35	46	44	52	50	63	60	61	60	72	72
	Calculated [Mg], mg/l	18	18	33	34	34	35	40	41	39	40	44	45
Pre	SAR	0.72		0.71		1.00		1.07		1.06		1.17	
Post	SAR	0.68	0.57	0.88	0.71	1.28	1.04	1.41	1.11	1.41	1.13	1.46	1.27

Cumulative Impact Analysis
Electrical Conductivity in the Tongue River at Birney

Dam Discharge	January EC		February EC		March EC		April EC		May EC		June EC	
Flow, cfs	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
Mean Monthly Outflow cfs	70	173	70	180	70	224	70	362	157	903	183	1,430
Cal TDS mg/l	611	543	650	557	606	553	571	515	436	375	261	229
Cal TDS load (post)	237594	515509	243501	537959	247130	688628	232974	1026618	450991	1872394	375273	2181870
	TDS, mg/l	Flow, cfs	TDS, mg/l	Flow, cfs	TDS, mg/l	Flow, cfs	TDS, mg/l	Flow, cfs	TDS, mg/l	Flow, cfs	TDS, mg/l	Flow, cfs
PRG LLC, Treatment Plant	952	2.5	952	2.5	635	2.5	635	2.5	635	2.5	635	2.5
Allocated load, lbs/day	12,828		12,828		8,557		8,557		8,557		8,557	
Total Flow, cfs	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
	73	176	73	183	73	227	73	365	160	906	186	1,433
Total TDS, lbs/day	250,423	528,337	256,329	550,787	255,686	697,185	241,531	1,035,175	459,548	1,880,951	383,830	2,190,427
Calculated TDS, mg/l	641	559	656	560	654	571	618	527	535	385	384	284
Calculated EC, uS/cm	1,009	880	1,033	882	1,030	899	973	830	842	607	605	447
Historical												
Tongue River flow at Birney	91	179	90	197	78	226	73.8	275	144	654	225	1120
EC TR at Birney	851		936		827		776		617		365	

Dam Discharge	July EC		August EC		September EC		October EC		November EC		December EC	
Flow, cfs	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
Mean Monthly Outflow cfs	169	571	103	361	107	308	71	274	70	254	70	188
Cal TDS mg/l	258	229	347	308	471	411	522	449	572	492	643	565
Cal TDS load (post)	250497	708006	193916	570765	258426	603287	222665	669965	216062	671194	241067	568660
	TDS, mg/l	Flow, cfs	TDS, mg/l	Flow, cfs	TDS, mg/l	Flow, cfs	TDS, mg/l	Flow, cfs	TDS, mg/l	Flow, cfs	TDS, mg/l	Flow, cfs
PRG LLC, Treatment Plant	635	2.5	635	2.5	635	2.5	635	2.5	635	2.5	635	2.5
Allocated load, lbs/day	8,557		8,557		8,557		8,557		8,557		8,557	
Total Flow, cfs	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
	172	574	106	364	110	311	74	277	73	257	73	191
Total TDS, lbs/day	259,054	716,562	202,473	579,322	266,983	611,844	231,221	678,522	224,618	679,751	249,624	577,216
Calculated TDS, mg/l	280	232	356	296	452	366	584	455	575	492	639	562
Calculated EC, uS/cm	441	365	561	466	712	576	919	717	905	774	1,006	885
Historical												
Tongue River flow at Birney	234	556	159	399	133	320	85	246	73.8	219	73.8	179
EC TR at Birney	366		472		623		684		710		863	

Cumulative Impact Analysis
Sodium Concentration in the Tongue River at Birney

	January		February		March		April		May		June	
Dam Discharge	Na		Na		Na		Na		Na		Na	
Flow, cfs	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
Mean Monthly Outflow cfs	70	173	70	180	70	224	70	362	157	903	183	1,430
Cal Na mg/l	61	56	55	45	81	57	83	56	60	38	34	25
Cal Na load (post)	23,018	51,753	20,582	43,827	30,403	69,239	31,143	109,428	50,510	182,690	33,424	191,811
	Na, mg/l	Flow, cfs	Na, mg/l	Flow, cfs	Na, mg/l	Flow, cfs	Na, mg/l	Flow, cfs	Na, mg/l	Flow, cfs	Na, mg/l	Flow, cfs
PRG LLC, Treatment Plant	131	2.5	131	2.5	87	2.5	87	2.5	87	2.5	87	2.5
Allocated load, lbs/day	1,765		1,765		1,172		1,172		1,172		1,172	
	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
Total Flow, cfs	73	176	73	183	73	227	73	365	160	906	186	1,433
Total Na, lbs/day	24,784	53,518	22,347	45,592	31,575	70,411	32,315	110,600	51,682	183,862	34,596	192,984
Calculated Na, mg/l	63	57	57	46	81	58	83	56	60	38	35	25
Historic												
Tongue River flow at Birney	91	179	90	197	78	226	73.8	275	144	654	225	1120
Na TR at Birney	46		50		47		49		33		19	

	July		August		September		October		November		December	
Dam Discharge	Na		Na		Na		Na	wt%	Na	wt%	Na	wt%
Flow, cfs	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
Mean Monthly Outflow cfs	169	571	103	361	107	308	71	274	70	254	70	188
Cal Na mg/l	19	16	31	25	48	39	57	45	55	45	62	55
Cal Na load (post)	17,554	50,233	17,072	49,614	27,502	64,614	21,896	66,875	20,691	62,006	23,213	55,273
	Na, mg/l	Flow, cfs	Na, mg/l	Flow, cfs	Na, mg/l	Flow, cfs	Na, mg/l	Flow, cfs	Na, mg/l	Flow, cfs	Na, mg/l	Flow, cfs
PRG LLC, Treatment Plant	87	2.5	87	2.5	87	2.5	87	2.5	131	2.5	131	2.5
Allocated load, lbs/day	1,172		1,172		1,172		1,172		1,765		1,765	
	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
Total Flow, cfs	172	574	106	364	110	311	74	277	73	257	73	191
Total Na, lbs/day	18,726	51,405	18,244	50,787	28,675	65,786	23,068	68,047	22,456	63,771	24,978	57,038
Calculated Na, mg/l	20	17	32	26	49	39	58	46	57	46	64	56
Historic												
Tongue River flow at Birney	234	556	159	399	133	320	85	246	73.8	219	73.8	179
Na TR at Birney	19		21		36		42		42		49	

Cumulative Impact Analysis
Calcium Concentration in the Tongue River at Birney

Dam Discharge	January Ca		February Ca		March Ca		April Ca		May Ca		June Ca	
Flow, cfs	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
Mean Monthly Outflow cfs	70	173	70	180	70	224	70	362	157	903	183	1,430
Cal Ca mg/l	75	74	75	74	71	70	63	62	53	52	36	35
Cal Ca load (post)	28,416	68,981	28,420	71,541	26,736	84,546	23,636	120,633	45,184	254,263	35,303	270,666
	Ca, mg/l	Flow, cfs	Ca, mg/l	Flow, cfs	Ca, mg/l	Flow, cfs	Ca, mg/l	Flow, cfs	Ca, mg/l	Flow, cfs	Ca, mg/l	Flow, cfs
PRG LLC, Treatment Plant	46	2.5	46	2.5	46	2.5	46	2.5	46	2.5	46	2.5
Allocated load, lbs/day	620		620		620		620		620		620	
	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
Total Flow, cfs	73	176	73	183	73	227	73	365	160	906	186	1,433
Total Ca, lbs/day	29,036	69,601	29,040	72,161	27,355	85,166	24,256	121,253	45,804	254,882	35,923	271,286
Calculated [Ca], mg/l	74	74	74	73	70	70	62	62	53	52	36	35
Historic												
Tongue River flow at Birney	91	179	90	197	78	226	73.8	275	144	654	225	1120
[Ca] TR at Birney	49		53		47		47		34		21	

Dam Discharge	July Ca		August Ca		September Ca		October Ca		November Ca		December Ca	
Flow, cfs	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
Mean Monthly Outflow cfs	169	571	103	361	107	308	71	274	70	254	70	188
Cal Ca mg/l	37	35	46	44	52	50	64	61	62	61	73	72
Cal Ca load (post)	33,299	108,363	25,304	84,903	30,072	82,328	24,511	89,543	23,367	82,998	27,651	72,877
	Ca, mg/l	Flow, cfs	Ca, mg/l	Flow, cfs	Ca, mg/l	Flow, cfs	Ca, mg/l	Flow, cfs	Ca, mg/l	Flow, cfs	Ca, mg/l	Flow, cfs
PRG LLC, Treatment Plant	46	2.5	46	2.5	46	2.5	46	2.5	46	2.5	46	2.5
Allocated load, lbs/day	620		620		620		620		620		620	
	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
Total Flow, cfs	172	574	106	364	110	311	74	277	73	257	73	191
Total Ca, lbs/day	33,919	108,982	25,923	85,523	30,691	82,948	25,131	90,163	23,987	83,617	28,271	73,497
Calculated [Ca], mg/l	37	35	46	44	52	50	63	60	61	60	72	72
Historic												
Tongue River flow at Birney	234	556	159	399	133	320	85	246	73.8	219	73.8	179
[Ca] TR at Birney	20		25		37		44		45		50	

Cumulative Impact Analysis
Magnesium Concentration in the Tongue River

Dam Discharge	January Ca		February Ca		March Ca		April Ca		May Ca		June Ca	
Flow, cfs	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
Mean Monthly Outflow cfs	70	173	70	180	70	224	70	362	157	903	183	1,430
Cal Mg mg/l	45	45	45	45	44	44	43	43	32	32	19	19
Cal Mg load (post)	17,046	42,040	17,046	43,721	16,736	53,285	16,356	84,139	27,299	155,908	18,872	146,558
	Mg, mg/l	Flow, cfs	Mg, mg/l	Flow, cfs	Mg, mg/l	Flow, cfs	Mg, mg/l	Flow, cfs	Mg, mg/l	Flow, cfs	Mg, mg/l	Flow, cfs
PRG LLC, Treatment Plant	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5
Allocated load, lbs/day	13		13		13		13		13		13	
	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
Total Flow, cfs	73	176	73	183	73	227	73	365	160	906	186	1,433
Total Mg, lbs/day	17,059	42,054	17,059	43,734	16,750	53,299	16,370	84,152	27,312	155,922	18,885	146,572
Calculated [Mg], mg/l	44	44	44	44	43	44	42	43	32	32	19	19

Historic												
Tongue River flow at Birney	91	179	90	197	78	226	73.8	275	144	654	225	1120
[Mg] TR at Birney	49		53		47		47		34		21	

Dam Discharge	July Ca		August Ca		September Ca		October Ca		November Ca		December Ca	
Flow, cfs	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
Mean Monthly Outflow cfs	169	571	103	361	107	308	71	274	70	254	70	188
Cal Mg mg/l	18	18	34	34	35	35	41	41	40	40	45	45
Cal Mg load (post)	16,471	55,432	18,975	66,255	20,295	58,173	15,777	60,613	15,152	54,842	17,046	45,681
	Mg, mg/l	Flow, cfs	Mg, mg/l	Flow, cfs	Mg, mg/l	Flow, cfs	Mg, mg/l	Flow, cfs	Mg, mg/l	Flow, cfs	Mg, mg/l	Flow, cfs
PRG LLC, Treatment Plant	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5	1	2.5
Allocated load, lbs/day	13		13		13		13		13		13	
	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF	7Q10	MMF
Total Flow, cfs	172	574	106	364	110	311	74	277	73	257	73	191
Total Mg, lbs/day	16,485	55,446	18,989	66,268	20,309	58,186	15,791	60,627	15,166	54,855	17,060	45,695
Calculated [Mg], mg/l	18	18	33	34	34	35	40	41	39	40	44	45

Historic												
Tongue River flow at Birney	234	556	159	399	133	320	85	246	73.8	219	73.8	179
[Mg] TR at Birney	20		25		37		44		45		50	