FINAL REPORT

Estimated Regional Economic Impact of Colstrip Site Cleanup and Remediation and Groundwater Treatment Alternatives

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The *POWER Cleanup and Jobs Study: Remediation Alternatives Analysis*, prepared by Kirk Engineering & Natural Resources Inc. (KirK-NRI), presents in detail three site cleanup alternatives (Talen option, Alternative 1 and Alternative 2), and five groundwater treatment options (Talen option, and Alternatives 1 through 4). The direct costs associated with these alternatives are presented in the KirK-NRI report and associated tables and graphs. Additionally, the KirK-NRI report and tables develop estimates of direct employment associated with the cleanup activities over the 50-year time horizon of the project. This employment is presented as FTEs, or full-time equivalent jobs. One FTE represents full-time employment of one person for one year in a specified job.

An important associated impact of any proposed substantial economic activity in a defined economic region (e.g., a county or county group, or a state), is the additional "spin-off" employment and income that the original economic activity creates within the specified economic region.

While KirK-NRI outline the estimates of <u>direct</u> impacts of Colstrip cleanup alternatives to employment, a more comprehensive analysis of the regional economic impact takes these estimates of direct cleanup costs and employment as a starting point in estimating the <u>total</u> effects of that original direct economic activity on the economy. For this analysis, the regional economic impact modeling platform, IMPLAN, was used to estimate total effects on employment and personal income in the local economy from the estimates of direct cleanup spending derived in the KirK-NRI report. IMPLAN is a widely used and relied on regional economic impact model in the US with decades of history and thousands of applications throughout the economy.

When new expenditures are made within a local, state, or regional economy, that spending results in income for employees and business owners. This is referred as a direct impact of the economic activity. In addition to the direct impacts on employment and income however, the businesses involved (whether construction, engineering, technical, etc.) also purchase items and supplies for their businesses within the local economy, thus supporting the employment and income of another group of people. These are called indirect impacts. A third impact is related to the economic activity that occurs when individuals employed either directly in the affected businesses or indirectly spend a portion of their earnings within the defined economic area. This round of spending supports what are called induced impacts on income and employment. The sum of direct, indirect, and induced impacts are the total impacts associated with economic activity (Figure 1).

While many direct impacts of economic activity tied to the Colstrip cleanup alternatives have been described in the KirK-NRI report, estimation of indirect and induced impacts is done with the use of an input-output model. The model uses comprehensive data on the structure and size of a defined economic region for a certain year (2017 in this case) to estimate the indirect and induced effects on the economic region economy (measured in employment and income) associated with a specified level of direct spending within the economic region.

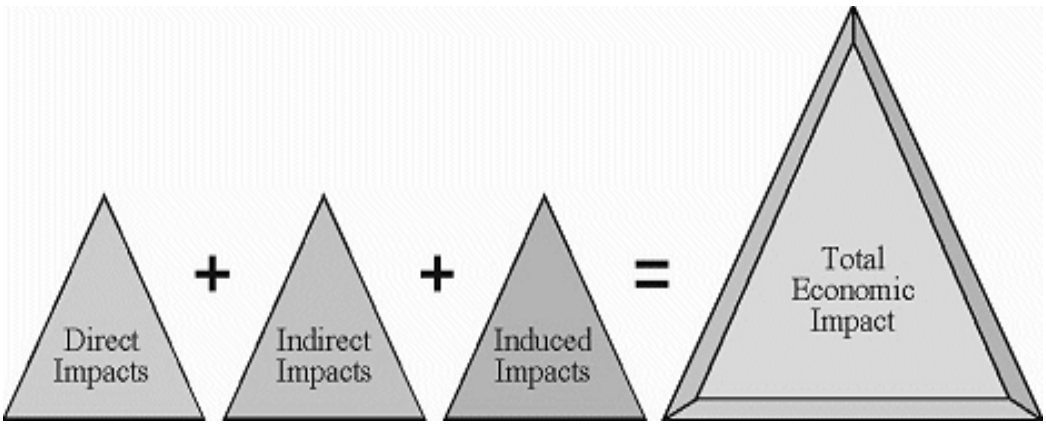

Figure 1. Relationship of Direct, Indirect, and Induced Economic Effects or Impacts.

Regional Economic Impact Analysis using an Input-Output Modeling Framework

There are a number of essential steps involved in conducting any regional economic impact analysis. These steps can be summarized as follows.

1. Define the regional economic area of interest;
2. Specify the new economic activity being modeled;
3. Map the estimated direct spending/employment associated with the new economic activity into the most appropriate of the 536 predefined IMPLAN economic sectors;
4. Determine the temporal scope of the impact analysis;

5. Construct the spending/employment scenarios appropriate to the analysis
6. Run the I-O model to estimate the direct, indirect, and induced impacts to employment and income in the predefined economic analysis area.

The following discussion describes these steps in the context of estimation of total employment and income impacts of the Colstrip cleanup alternatives.

Define the regional economic area of interest

The most commonly used predefined economic areas utilized in IMPLAN analyses are an individual county, groups of counties, or individual states. Much of the discussion in both Montana politics and the media relating to the shutdown of units at the Colstrip generating facility has appropriately focused on impacts to the town of Colstrip itself. Therefore, as the county most acutely impacted by activities at the Colstrip facility, it is logical to focus on a narrowly defined economic impact zone such as Rosebud County itself, or in combination with one or more neighboring counties. For this analysis the combined economic region of Rosebud and Yellowstone Counties was used.

Yellowstone County (and its largest city, Billings) was included in the analysis area in order to more fully capture the very important connections between trade and labor flows between the two counties. Limiting analysis of impacts of cleanup to only Rosebud county and its very limited population base and economic infrastructure would count a substantial share of direct, indirect, and induced employment and income impacts, but would not capture the totality of economic impact associated with remediation in the area. This is so, because the IMPLAN analysis model looks to the existing structure of the defined economic analysis area to determine what share of the new spending and associated indirect and induced spending will be supported by the diversity of business within that area. Inclusion of the much larger Yellowstone County economy within the analysis area ensures that a much larger share of new spending impacts will be included in the model results.

Specify the new economic activity being modeled

The new economic activities being modeled in the IMPLAN analyses were the estimates of cleanup spending under the three cleanup alternatives: the Talen Plan, Alternative 1 and Alternative 2. Additionally, spending for groundwater treatment under five plans were modeled (the Talen proposal, and Groundwater Alternatives 1 through 4). Each of these alternatives (both for cleanup and groundwater treatment) have specific detailed spending profiles associated with them from the KirK-NRI report and associated cost and jobs tables. IMPLAN spending scenarios for each of these eight alternatives (3-cleanup and 5-groundwater) were constructed and estimated.

Map the estimated direct spending/employment associated with the new economic activity into the most appropriate of the 536 predefined IMPLAN economic sectors

The KirK-NRI report provided quite specific estimates and time profiles for spending categories and activities, including job types and both construction and O&M activities. These detailed classifications were examined and tabulated in order to estimated what share of each alternatives' spending (and associated employment) would be allocated in the model to each specific IMPLAN economic sector. It should be noted that in most every case the spending activity and associated job classifications in the KirK-NRI report were much narrower than specific IMPLAN economic sectors. For example, there is no IMPLAN sector which conveniently is defined as "coal powerplant waste cleanup." Or even, as "groundwater treatment construction and operations." Rather, spending under the Colstrip cleanup alternatives was allocated to such sectors as maintenance and repair of non-residential structures, water, sewage, and other systems, environmental and other technical consulting services, and waste management and remediation services, among others. Care was taken to match the spending and jobs described in the KirK-NRI work to an appropriate IMPLAN category. In many cases, spending supporting a specific job category could appropriately be placed in a number of IMPLAN sectors which all include that specific job activity. In this respect, mapping alternative spending into IMPLAN sectors entailed a certain amount of judgement, and discretion.

Determine the temporal scope of the impact analysis

One somewhat unique aspect of the Colstrip restoration and cleanup alternatives is that the activities and spending associated with them are scheduled to occur over a 50-year time period. This long temporal scope of spending along with substantial uncertainty regarding the timing of key portions of the reclamation activity under the alternatives presents challenges in structuring the IMPLAN impact scenarios. Clearly, given the uncertainty associated with any year-specific spending, analysis on a year-specific level (or even several years) had the potential to significantly overstate or understate the likelihood of the scale and timing of impacts on the economic area.

Engineers on this project estimate that the greatest workforce needs would likely fall in the first decade of the work. Therefore, it was decided that a relatively robust division of the spending would be made, combining spending tentatively allocated to the first 10 years of the project into a rough "closure phase" model and the last 40 years into a more "long term remediation and O&M phase." Total and average employment and income impacts associated with these two "phases" were estimated using the IMPLAN model for the two-county analysis area.

Construct the spending/employment scenarios appropriate to the analysis

Based on the composition and timing of the cleanup spending in the alternatives, individual IMPLAN activities were defined which (in combination) would define the total direct spending inputs into the models for particular alternatives and time periods. For example, cleanup

alternative 1 for the 2020-2029 time period would include activities and spending patterns defined for that period associated both with capital (construction) activities, and O&M activities.

Run the I-O model to estimate the direct, indirect, and induced impacts to employment and income in the predefined economic analysis area.

The final step in the IMPLAN modeling was to estimate the IMPLAN models for each of the two time periods, for each of the three cleanup alternatives and each of the five groundwater treatment alternatives, and to examine and discuss the results.

IMPLAN Modeling Results

As noted above, the primary input into the IMPLAN modeling framework is the estimated direct cost of the cleanup/restoration activities under each specified alternative and time period for analysis. Table 1 shows the distribution of costs estimated in the KirK-NRI report for each of the primary cleanup alternatives across the two defined time periods (2020-29 and 2030-69). It is important to note that the alternatives for cleanup do not only differ in the size of the costs associated with them, but also in the composition of the spending associated with those costs. Therefore, although the IMPLAN model is a linear model in terms of estimated effects, impacts on jobs across the alternatives will not be linear to the size of the costs involved because different alternatives (and time periods) allocate those costs to different specific sectors of the economy (depending on the spending patterns outlined in the KirK-NRI spending tables). Overall, the Talen cleanup proposal is estimated to entail significantly less cost than either of the two additional alternatives proposed. The Talen cleanup is estimated to cost less than one-third the total cost of either of the alternatives over the 50-year time period.

Table 1. Estimated Direct cost of Cleanup Alternatives, by time period. (KirK-NRI estimates)

Cleanup Alternative	Time Period	Capital cost (2019 dollars)	O&M COST	Total Cost
Talen Cleanup Proposal	2020-2029	78,375,140	10,667,000	89,042,140
	2030-2069	14,165,940	119,382,000	133,547,940
Alt 1 Cleanup Proposal	2020-2029	319,368,913	19,428,698	338,797,611
	2030-2069	127,665,314	211,863,791	339,529,105
Alt 2 Cleanup Proposal	2020-2029	386,371,882	19,361,435	405,733,317
	2030-2069	176,854,624	201,558,626	378,413,250

Impacts of Colstrip Cleanup/Restoration Spending on Employment

As discussed above, the KirK-NRI analysis developed estimates of specific employment categories and jobs (FTEs) associated with the three cleanup alternatives for each year of the 50-year time profile. Conversations with Peter Haun (KirK-NRI) indicate that the detailing of jobs associated with the costs outlined in the Kirk-NRI report focused on the largest and most easily identified and defined categories of work associated with the anticipated spending. Haun estimated that the KirK-NRI-defined jobs likely captured 70 to 75% of direct on-site employment associated with the spending. Certain less easily defined job categories in terms of both type of employment and scale of employment were not included in the detailed estimates presented.

Table 2 outlines the estimated average number of full-time jobs per year which would be created by the spending outlined in Table 1. Estimates are presented both for the KirK-NRI job totals and employment totals estimated for the two-county analysis area by the IMPLAN model. The closest "apples-to-apples" comparison from the employment estimates in the table is between the KirK-NRI direct jobs estimates and the IMPLAN model direct jobs estimates. The IMPLAN estimates are consistently larger than the KirK-NRI estimates. This is due partially to the KirK-NRI numbers by design only capturing 70-75% of direct on-site employment. Additional variations in estimates are attributable to the fundamental underlying difference between the two methods of estimating direct employment—one model by doing an accounting of obvious classes of labor associated a with specified cleanup work, and the other model (IMPLAN) estimating impacts through inputting total project spending into a model of the local economic analysis area and generating estimated impacts based on the size of the spending impacts and the structure of the economic area. Overall, the KirK-NRI numbers are more appropriate for discussing the number of jobs in specific labor classifications likely to be generated by the cleanup (for example, the number of heavy equipment operator jobs). Conversely, the IMPLAN estimates provide a more holistic and complete estimate of direct jobs likely to be created by a specific level and composition of spending in the local economic analysis area. These estimates could also be viewed as presenting a plausible range of employment impacts to the area.

Table 2. Comparison of Estimated Direct and Total Employment Impacts of Colstrip Cleanup Alternatives.

	TALEN CLEANUP PLAN		CLEANUP ALTERNATIVE 1		CLEANUP ALTERNATIVE 2	
	2020-29[a]	2030-69	2020-29	2030-69	2020-29	2030-69
KIRK-NRI ESTIMATES						
DIRECT JOBS	30.3	25.7	80.5	43.9	94.2	41.4
IMPLAN MODEL						
DIRECT JOBS	48.6	24.1	155.3	52.8	182.0	54.7
INDIRECT JOBS	12.4	3.6	51.5	10.5	64.8	11.8
INDUCED JOBS	21.5	9.6	81.1	23.1	93.3	24.0
TOTAL JOBS	82.5	37.3	287.9	86.5	340.1	90.5

[a] Estimates are average full-time equivalent jobs available per year over the time frame specified.

In addition to direct employment impacts, the IMPLAN model also estimates indirect and induced impacts on local area employment by the cleanup spending. Depending on the cleanup alternative and time frame analyzed, the overall employment multipliers for spending under the alternatives range from 1.52 to 1.87. That is, total jobs created (including both indirect and induced jobs from the initial spending) are between 152% and 187% greater than estimated direct jobs created, depending on the time period and cleanup alternative. This multiplier range is generally consistent with employment multipliers associated with similarly sized economic regions.

Impacts of Colstrip Cleanup/Restoration Spending on Labor Income

A second primary data output from the IMPLAN modeling framework is estimates of the level of personal income in the local economic region that will result from a given level of direct spending in the economy. Table 3 shows average annual direct, indirect, induced and total personal income which the IMPLAN model for Rosebud and Yellowstone Counties estimated would be generated by the levels of direct cleanup spending shown in Table 1. The income estimates in the table are presented in millions of 2019 dollars. Overall, personal income levels are expected to range from 50% to 66% of the average annual total cost of the cleanup/restoration alternatives.

Table 3. Estimated Personal Income in the Rosebud-Yellowstone County economy resulting from spending on Colstrip Cleanup Alternatives. (millions of 2019 dollars)

	TALEN PLAN		CLEANUP ALTERNATIVE 1		CLEANUP ALTERNATIVE 2	
	2020-29	**2030-69**	**2020-29**	**2030-69**	**2020-29**	**2030-69**
Average Total Annual Cost	8.9	3.3	33.9	8.5	40.6	9.5
IMPLAN LABOR INCOME ESTIMATE OF LABOR INCOME						
DIRECT EFFECTS	3.11	1.47	11.41	3.45	13.01	3.53
INDIRECT EFFECTS	0.69	0.22	2.89	0.63	3.53	0.68
INDUCED EFFECTS	0.96	0.43	3.63	1.03	4.19	1.07
TOTAL EFFECTS	4.76	2.12	17.94	5.12	20.74	5.28

Impacts of Groundwater treatment and Monitoring Spending on Employment

The second primary activity associated with cleanup activities at the Colstrip facility involves long term groundwater treatment as well as monitoring of groundwater. As in the case with primary site cleanup/restoration, estimates of the methods and costs associated with groundwater treatment and overall site monitoring were developed by KirK-NRI. The year-by-year cost profile for the Talen groundwater treatment alternative as well as for the four other groundwater alternatives are detailed in the KirK-NRI report and associated tables and graphs. In addition to annual treatment and monitoring costs, the five different alternatives presented each have

different capital infrastructure (and associated construction costs) associated with the treatment activities. For example, the Talen groundwater plan includes a $26 million clean water treatment system and brine concentrator system along with another $8 million brine disposal area. The other four alternatives for groundwater treatment each have some combination of solar multiple systems and clean water treatment systems. These four alternatives have capital costs associated with the solar and CWTS components ranging from $25 to $52 million. Table 4 shows the costs estimated by KirK-NRI for the five groundwater treatment alternatives. While the five groundwater alternatives each had different treatment and capital costs associated with them, monitoring costs were estimated to be the same across the five groundwater alternatives. These monitoring costs were estimated to total $6.2 million for the period from 2020-2029 and $17.65 million for the period from 2030-2069. These monitoring costs are in addition to the direct treatment and capital costs shown in Table 4. It must also be noted that Alternatives 1 through 4 all include substantial costs associated with purchase of electricity for the operation of the solar modules. This cost for electricity is not included in the Table 4 costs, or in the direct costs input into the IMPLAN models. The reason for this exclusion is that the power is purchased from a market that would not increase production or employment in the local economic analysis area.

Table 4. Costs associated with Groundwater Treatment, by Alternative and time period. (excludes costs for electricity)

	Time Period	Capital Costs	Capital Costs	Operations Cost
Talen Plan	2020-2029	26,040,000 Install CWTS and BCC	8,000,000 Construct BCC Disposal Site	45,243,000
	2030-2069	-	-	80,777,000
Alternative 1	2020-2029	52,000,000 Install Solar Multiple Systems	-	10,617,329
	2030-2069	-	-	19,636,218
Alternative 2	2020-2029	15,660,000 Install Solar Multiple Systems	15,103,000 Install CWTS	40,120,811
	2030-2069	-	-	56,390,866
Alternative 3	2020-2029	25,133,137 Install Solar Multiple Systems	-	5,308,661
	2030-2069	4,933,333 Install Solar Multiple Systems	-	9,818,108
Alternative 4	2020-2029	7,540,000 Install Solar Multiple Systems	15,103,000 Install CWTS	38,528,212
	2030-2069	2,146,000 Install Solar Multiple Systems	-	53,445,432

Table 5 details a comparison of estimated average annual jobs created under the five different groundwater treatment and monitoring alternatives. As was the case for the three primary cleanup and restoration alternatives, the estimated jobs using the IMPLAN model are greater

than those estimated by the engineers (KirK-NRI). This is consistent with several primary differences in the ways these estimates are generated. The KirK-NRI estimates do not include estimated job creation (direct, indirect, or induced) associated with capital expenditures under the alternatives. In order to identify how these substantial capital costs would impact the local economy, estimates were made based on communication with the KirK-NRI report authors as to the percentage of the capital costs under each alternative which would be associated with on-site construction activities (which would impact local area employment) vs. the percentage that would be spent out of the local area to purchase equipment not manufactured or sold in the local economic area (which would not impact local employment). Only those capital costs associated with items such as site prep and installation of the equipment were included as expenditures in the local economy in the IMPLAN models.

In addition to the inclusion of some capital costs, the IMPLAN model also provided a comprehensive accounting of job creation throughout the economic analysis area. There were two different analysis methods of jobs and income impacts used in the IMPLAN models depending on the cost data presented in the KirK-NRI tables. For the Talen alternative as well as for Alternatives 2 and 4, total costs associated with treatment and monitoring and capital were used as inputs to the IMPLAN models. In the case of Alternatives 2 and 3, however, the KirK-NRI tables presented cost estimates for primarily labor (in addition to costs of electricity which was not included in the model). These labor cost estimates were entered into the IMPLAN model as changes in personal income in the economic area rather than as increases in the production in a specific industry sector. In these cases, the employment impacts estimated by the IMPLAN model were added to the direct employment (job FTEs) estimated by KirK-NRI to arrive at total estimated impacts on local area employment.

Table 5. Comparison of Estimated Employment associated with Alternatives for Groundwater Treatment and Monitoring. (average number of full-time jobs per year)

Impact Estimate	**Talen Groundwater**		**Alternative 1 Groundwater**		**Alternative 2 Groundwater**		**Alternative 3 Groundwater**		**Alternative 4 Groundwater**	
	2020-2029	**2030-2069**	**2020-2029**	**2030-2069**	**2020-2029**	**2030-2069**	**2020-2029**	**2030-2069**	**2020-2029**	**2030-2069**
KirK-NRI Groundwater Treatment and Monitoring Estimates (average annual jobs)										
Treatment	14.2	6.4	10.8	5.0	14.8	5.5	5.4	2.5	13.2	4.7
Monitoring	5.0	3.7	5.0	3.7	5.0	3.7	5.0	3.7	5.0	3.7
Total Jobs	19.2	10.0	15.8	8.6	19.8	9.1	10.4	6.1	18.2	8.4
IMPLAN Model Estimates (annual average jobs)										
Direct Effect	43.0	15.4	28.8	7.9	36.2	11.7	18.9	6.4	35.0	12.1
Indirect Effect	11.8	4.1	3.5	1.0	9.8	3.1	2.8	1.0	9.3	3.1
Induced Effect	21.1	7.6	16.1	4.2	17.7	5.8	10.2	3.4	17.0	6.0
Total Effect	75.9	27.1	32.7	9.4	63.7	20.6	24.4	8.9	61.3	21.2

Impacts of Groundwater treatment and Monitoring Spending on Personal Income

Table 6 shows a comparison of impacts to total labor income anticipated under the five groundwater treatment and monitoring alternatives. The differences between the KirK-NRI and the IMPLAN model estimates are likely due to the previously mentioned differences in the underlying structure of these estimates. Additionally, the Talen, Alternative 2 and Alternative 4 estimates from KirK-NRI employ a generalized 30% estimate of total costs that are attributable to labor. The overall groundwater monitoring estimates assume that 60% of monitoring costs are attributable to labor. The resulting estimates of total labor income are directly sensitive to these assumptions.

Table 6. Estimated Personal Income in the Rosebud-Yellowstone County economy resulting from spending on Colstrip Groundwater Treatment and Monitoring Activities. (Millions of 2019 dollars)

Impact Estimate	Talen Groundwater		Alternative 1 Groundwater		Alternative 2 Groundwater		Alternative 3 Groundwater		Alternative 4 Groundwater	
	2020-29	2030-69	2020-29	2030-69	2020-29	2030-69	2020-29	2030-69	2020-29	2030-69
KirK-NRI Estimates										
Average Total Annual Cost	8.5	2.5	6.9	0.9	7.7	1.9	3.7	0.8	6.7	1.8
IMPLAN Model Estimates (Labor Income)										
Direct Effect	4.8	0.7	3.2	0.5	3.6	0.6	2.0	0.5	3.6	0.6
Indirect Effect	1.0	0.2	0.2	0.1	0.8	0.2	0.2	0.1	0.8	0.1
Induced Effect	1.4	0.2	0.8	0.2	1.2	0.2	0.6	0.2	1.2	0.2
Total Effect	7.2	1.1	2.4	0.5	5.6	0.9	2.0	0.5	5.6	0.9

Limitations of Analysis

The IMPLAN regional economic impact model provides a very useful and robust framework within which to answer questions such as "if a business (or business activity) increases its production by a certain amount in a pre-defined economic area, what will the impacts on employment and income be to all business throughout that area?" In order to achieve this type of estimation, the IMPLAN model makes a number of potentially limiting assumptions. Key among these is regarding the temporal structure of the IMPLAN data and resulting model estimates.

- IMPLAN is a static model. That is, the model provides a snapshot of changes at a point in time, and does not further consider changes to the local economy resulting from the original industrial change that is being modelled. Data for the economic analysis area is purchased for a specific year. In the case of this analysis, the Rosebud and Yellowstone Counties data was from the most recently available year—2017. The estimates modelled in this analysis are based on 2017 economic data in the region, but span 50 years. To the extent the economic region might continue to grow and diversify over that period (particularly Yellowstone County) the indirect and induced impacts in the model for the 2017 data would likely be somewhat understated.

A second clear limitation of the estimates presented relates to the large degree of uncertainty as to the final composition of the clean-up and groundwater remedies and the ultimate timing of those activities. The estimates presented do not consider the differential impacts of timing across years and the associated "time value of monies" either spent in the clean-up or earned by workers.

Summary

The primary purpose of this regional economic impact analysis is to provide a complementary estimate of the likely impacts on jobs and income in the two-county (Rosebud and Yellowstone) economic area of the estimated clean-up expenditures associated with the Colstrip units over a long (50-year) period. Estimates are presented for two periods: the first 10 years of clean-up (2020-2029) and the final 40 years of clean-up (2030-2069). Employment and income impacts are presented as average annual impacts for each alternative.

The employment impacts developed by KirK-NRI and under the IMPLAN model should be viewed as complementary, rather than competing. The two methods begin from different assumptions and measure overlapping, but different total employment impacts. The engineering estimates provide the best snapshot of impacts of alternative spending associated with clean-up on specific classes of labor. What TYPES of jobs and skills will be required to conduct the primary restoration work? Conversely, the IMPLAN model results present a more comprehensive picture of impacts to employment and income in the two-county region associated with the levels and composition of spending anticipated under the clean-up alternatives.