SUB-ARCTIC IMPAK MODEL DOCUMENTATION

Welcome to Sub-Arctic IMPAK! This document provides an overview of the model and describes how to use it to forecast manpower and expenditures needed to carry out oil exploration and development (E&D) operations in Cook Inlet and the Gulf of Alaska. For detailed information on how the model was developed, refer to:

> *Sub-Arctic Economic Impact Model for Petroleum Activities in Alaska (Sub-Arctic IMPAK), Final Technical Report*, December 2003 (OCS Study MMS 2002-060), Technical Report 165). Prepared by Jack Faucett Associates for the U.S. Department of Interior, Minerals Management Service, Alaska OCS Region, Anchorage, Alaska.

This document is accessible through a hyperlink on IMPAK's Documentation screen. It is also available to the public through the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161, Fax: 703-605-6900, www.ntis.gov.

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I. OVERVIEW

The main purpose of the model is to forecast the direct manpower and expenditures needed to conduct oil exploration and development (E&D) operations in Cook Inlet/Shelikof Strait and the Gulf of Alaska. The model can also be adapted to other remote sub-Arctic planning areas. The first round estimates are categorized in such a way that the IMPLAN economic impact model can be used to estimate the secondary economic repercussions associated with these E&D activities.

Sub-Arctic IMPAK is organized around a comprehensive set of activities which characterize oil exploration and development in the sub-arctic areas of Alaska. These activities are shown in Exhibit 1. For each activity, the model houses a cost vector of labor and commodity input requirements on a per unit basis. The commodities are defined according to IMPLAN's 1995 commodity/industry sector scheme. Costs are provided in 1999 dollars.

Beginning with the 2001 IMPLAN data (expected to be available near the end of the 2003), IMPLAN's sectors will be based on the new North American Industry Classification System (NAICs), a new sectoring scheme to be used for all Federal economic statistics. After that time, the Sub-Arctic IMPAK: First-Step model described in this documentation will remain a valid stand alone model. However, some adjustments may be necessary to use it to provide inputs to the IMPAK: Second-Step model files that MMS has developed to estimate employment, personal income, total value added etc.

The user is required to input some general data that describe a particular E&D scenario being evaluated. To make things easy for the user, most of these data can be obtained from MMS' E&D reports. These reports are prepared by MMS staff and describe any given proposed lease sale.

The model translates these user inputs into IMPAK activity levels and then multiplies the results by the cost vectors described above. The product and primary output of the model is a vector of the estimated expenditures by IMPLAN sector. The model produces separate vectors for each year in the forecast horizon. The model can handle up to 50 years in the forecast horizon.

Sub-Arctic IMPAK allows the user to distinguish between three different types of geographic areas where E&D activity takes place. The three areas include Cook Inlet/Shelikof Strait, the Gulf of Alaska and remote regions in sub-Arctic Alaska.

The model also breaks down and assigns the cost estimates to geographic regions where the associated economic impacts accrue. Four regions are utilized: local, Kenai, the rest of Alaska, and the continental United States. The output is organized according to these geographic definitions and is presented on separate worksheet tabs accordingly.

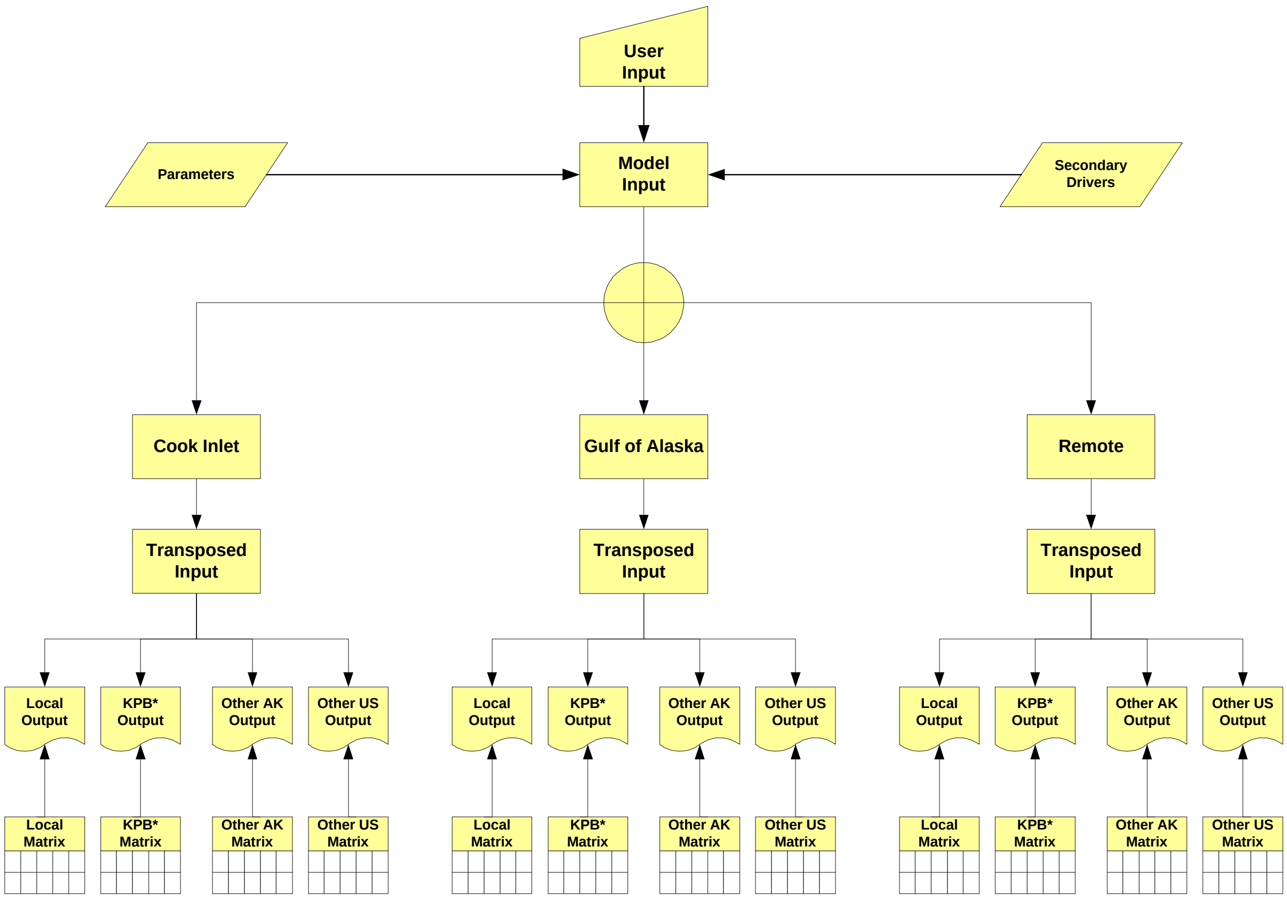
A broad schematic of the model is presented in Exhibit 2.

Exhibit 1: IMPAK Activities and Respective Units

Activity	*Unit*	*Unit Cost*
Seismic Survey	One Month	Cost Per Month
Spill Contingency Operations	Support for 3 Platforms	Annual Operating Cost
Construct Exploration Base	One 3000 Sq. Ft. Facility	Construction Cost
Operate Exploration Base	One 3000 Sq. Ft. Facility	Annual Operating Cost
Install Exploration Platform	One Exploration Platform	Installation Cost
Operate Exploration Platform	One Exploration Platform	Annual Operating Cost
Drill Exploration Well	One Exploration Well	Cost to Drill 1 Well
Construct Production Base	One 7200 Sq. Ft. Facility	Construction Cost
Operate Production Base	One 7200 Sq. Ft. Facility	Annual Operating Cost
Install Production Platform	One Production Platform	Installation Cost
Operate Production Platform	One Production Platform	Annual Operating Cost
Drill Production Well	One Production Well	Cost to Drill 1 Well
Lay Offshore Pipeline	One Mile of Offshore Pipeline	Installation Cost
Lay Onshore Pipeline	One Mile of Onshore Pipeline	Installation Cost
Construct Production Facility	One 50 Million Barrel Facility	Construction Cost
Operate Production Facility	One 50 Million Barrel Facility	Annual Operating Cost
Construct Marine Terminal	One 40,000 Gallon Capacity Terminal	Construction Cost
Operate Marine Terminal	One 40,000 Gallon Capacity Terminal	Annual Operating Cost
Major Platform Maintenance	One Production Platform	Cost to Conduct 1 Maintenance
Well Workover	One Production Well	Cost to Conduct 1 Workover
Helicopter Support	One Hour	Operating Cost Per Hour*
Large Workboat	One Hour	Operating Cost Per Hour*
Small Workboat	One Hour	Operating Cost Per Hour*
Landing Craft	One Hour	Operating Cost Per Hour*
Dive Boat	One Hour	Operating Cost Per Hour*
Camp Support	One Year	Annual Operating Cost
Abandonment	One Production Platform	Cost to Abandon 1 Platform

**Includes annualized capital costs.*

Exhibit 2: Model Flowchart



* Kenai Peninsula Borough

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II. INSTALLATION

The application consists of an Excel spreadsheet file with supporting documentation activated through hyperlinks to PDF files. In order for the hyperlinks to work properly, the documentation and spreadsheet files should be copied to the same directory. The links will not work with shortcuts. The list of files that should be copied include:

Sub-Arctic_IMPAK.xls (MS Excel spreadsheet application)

Sub-Arctic_IMPAK Model Description.pdf (model documentation)

Sub-Arctic IMPAK Final Report.pdf (final report)

To maintain the documentation in a different directory, use Excel's Properties option to set the default address for hyperlinks in the file:

1.) On the File menu, click Properties.
2.) Click the Summary tab.
3.) In the Hyperlink base box, type the path you want to use.

When opening the file, the user may be prompted with a caution and a choice about enabling the macros contained in the file. The application will not work properly if the macros are disabled.

Whether or not the user sees the message will depend upon the security level set for macros in the user's version of Excel (see the Security Level tab in the Security dialog box (Tools menu, Macro submenu). Under all settings, if antivirus software that works with Microsoft Office XP is installed and the file contains macros, the file is scanned for known viruses before it is opened. For information on how to change the security settings and/or verify trusted file sources using digital signatures, see Excel's help files on the topic.

III. USER INTERFACE

IMPAK is a Microsoft Excel workbook consisting of numerous worksheets or pages. Most of these pages are designated by labeled tabs at the bottom of the screen and which the user can select with the mouse. The main screens are described in more detail below.

III.A Documentation Screen

This screen contains hyperlinks to this help file and the final report. These files are in PDF file format so the user must have a version of Adobe's Acrobat Reader in order to view the files.

III.B Model Setup Screen

This screen provides an avenue for altering some of the default settings used in the model.

<u>Calculation</u>

Under this option the user can choose how formulas in the model are updated when the user input data and/or parameters are changed.

- *Automatic* calculation: each time a cell value changes, all other cells linked to it through formulas are immediately updated to reflect the new value. With large spreadsheets, the updating process can be somewhat slow, especially if the user's computer has limited memory and/or a relatively slow processor.
- *Manual* calculation: even though linked cell values change, formulas are not updated until the user presses F9. When the updating process is slow due to limited computer resources, this option allows the user to minimize the amount of time spent waiting for formulas to update.

<u>Study Area</u>

These selections specify where the E&D scenario takes place and the user must choose one. The three choices include Cook Inlet/Shelikof Strait, the Gulf of Alaska and remote regions in sub-Arctic Alaska. The choice determines which matrices, PCE vectors and TPI drivers are used in the model. It should be noted that only one type of scenario can be modeled at one time.

Use of Existing Infrastructure

These options determine whether certain types of existing infrastructure will be used in the scenario or whether new infrastructure will have to be constructed to support the E&D operations. The potential types of existing infrastructure that are addressed include marine terminals, production facilities and shore bases. If an option is not selected, it is assumed that new infrastructure of the respective type will have to be constructed. See Section IV.A for information on how the construction expenditure levels are estimated and when construction activities are assumed to occur.

- *Use Existing Marine Terminal*: If this box is not selected, the model assumes that a new marine terminal will have to be constructed and estimates the required resources to do so.
- *Use Existing Production Facility*: If this box is not selected, the model assumes that a new production facility will have to be constructed and estimates the required resources to do so.
- *Use Existing Shore Base*: If this box is not selected, the model assumes that a new shore base will have to be constructed and estimates the required resources to do so.

Initialize Forecast Horizon

Here the user specifies the first year in the forecast horizon. Since the Model Setup worksheet does not utilize a blinking cursor a the insertion point, it might be difficult to see that the initial year is already selected. Simply select the cell to the right of Initialize Forecast horizon (Average Water Depth) and enter the first year of the forecast. Subsequent years that are printed on the data entry screen, the output screens, and the manpower graph are determined by this initial year.

Average Water Depth

Average water depth is used to determine whether platforms are situated in deep water or shallow water. The value is compared to the parameter that specifies the criteria for deep water versus shallow water. If the scenario takes place in deep water, installation and operating costs are increased. See Section III.C and IV.A for more details.

III.C Parameters Screen

This screen allows the user to modify the parameters used in model equations to estimate the activity levels for a given scenario. Unlike the variable inputs entered by the user on the Data Entry screen, parameters remain constant throughout the forecasts horizon.

- *Platform Related*: These parameters are used to relate the number of platforms to other activity levels.

Parameter	Description
Number of Platforms Supported by Each Spill Operation	The number of production and exploration platforms is divided by this parameter to estimate the size of the spill contingency operation needed for the scenario.
Number of Exploration Rigs Supported by a 3000 sq. ft. Shore Base	The number of exploration platforms is divided by this parameter to estimate the size of the exploration shore base needed for the scenario.
Number of Production Rigs Supported by a 7200 sq. ft. Shore Base	The number of production platforms is divided by this parameter to estimate the size of the exploration shore base needed for the scenario.

- *Water Depth*: These parameters allow the model to differentiate between different cost factors that apply to deep water versus shallow water scenarios.

Parameter	Description
Water Depth Determining Deep Water from Normal (feet)	This parameter is used to determine whether platforms are situated in deep water or shallow water.
Deep Water Operating Cost Factor	This factor is multiplied by the production platform operating cost vector to account for increased operating costs for platforms situated in deep water.
Deep Water Installation Cost Factor	This factor is multiplied by the production platform installation cost vector to account for the increased costs of installing deep water platforms.

- *Production Facility*: These parameters are used to estimate the size and operating levels of the production facility needed to support production levels in the scenario.

Parameter	Description
Construction Cost Per Annual Volume of Crude Processed (Dollars)	This parameter is multiplied by the maximum barrels of annual oil production to estimate the total resources needed to construct a production facility.
Annual Operating Cost Per Barrel of Oil Treated (Dollars)	This parameter is multiplied by annual oil production to estimate annual operating cost to treat the volume of oil produced in the scenario.

Cost to Build Model Production Facility	This parameter reflects the total construction cost of the facility upon which the production facility construction cost vector is based. It is used to calibrate the estimated construction costs in each scenario.
Annual Cost to Operate Model Production Facility	This parameter reflects the total operating cost of the facility upon which the production facility operating cost vector is based. It is used to calibrate the estimated operating costs in each scenario.

- *Marine Terminal*: These parameters are used to estimate the size and operating levels of the marine terminals needed to support production levels in the scenario.

Parameter	Description
Storage Capacity at Marine Terminal Given Daily Production Volume (Days)	This parameter reflects the average number of days that oil is stored at a marine terminal. The parameter is multiplied by average daily production to estimate the total number of days of storage needed for the scenario. This figure is then used to calculate construction cost of the terminal as well as annual operating cost.
Construction Cost Per Storage Capacity (Dollars Per Day of Storage Capacity)	This parameter reflects the average construction cost per day of storage capacity. It is multiplied by the maximum amount of daily storage capacity needed in the scenario to estimate the total construction cost of the marine terminal.
Annual Operating Cost Per Day of Storage Capacity	This parameter reflects the average annual operating cost per day of storage capacity. It is multiplied by the average daily storage capacity needed each year to estimate the annual operating cost of the marine terminal.
Cost to Build Model Marine Terminal	This parameter reflects the total construction cost of the facility upon which the marine terminal construction cost vector is based. It is used to calibrate the estimated construction costs in each scenario.
Annual Cost to Operate Model Marine Terminal	This parameter reflects the total operating cost of the facility upon which the marine terminal operating cost vector is based. It is used to calibrate the estimated operating costs in each scenario.

- *Boat Support*: These parameters are used to estimate the total hours of boat support required under the given scenario.

Parameter	Description
Adjustment in Miles Added to Straight-line Distance (miles)	A figure added to the distance from base user input to take into account the fact that most trips are not "as the crow flies".
Average Boat Speed (mph)	The average distance per trip is divided by this parameter to estimate the average hours of transit time per trip.
Hours Small Workboat Support Needed to Conduct 1 Month of Seismic Survey	This parameter is multiplied by the months of seismic survey work conducted to estimate the hours of small workboat related support.
Hours Dive Boat Support Needed to Conduct 1 Month of Seismic Survey	This parameter is multiplied by the months of seismic survey work conducted to estimate the hours of dive boat related support.
Number of Large Workboat Trips to Install 1 Exploration Platform	This parameter is multiplied by the number of exploration platforms installed each year to estimate the number of large workboat related support trips.
Number of Small Workboat Trips to Install 1 Exploration Platform	This parameter is multiplied by the number of exploration platforms installed each year to estimate the number of small workboat related support trips.
Number of Large Workboat Trips to Install 1 Production Platform	This parameter is multiplied by the number of production platforms installed each year to estimate the number of large workboat related support trips.
Number of Small Workboat Trips to Install 1 Production Platform	This parameter is multiplied by the number of production platforms installed each year to estimate the number of small workboat related support trips.
Annual Number of Large Workboat Trips to Operate 1 Production Platform	This parameter is multiplied by the number of operating production platforms each year to estimate the number of large workboat related support trips.
Annual Number of Small Workboat Trips to Operate 1 Production Platform	This parameter is multiplied by the number of operating production platforms each year to estimate the number of small workboat related support trips.
Annual Number of Large Workboat Trips to Operate 1 Exploration Platform	This parameter is multiplied by the number of operating exploration platforms each year to estimate the number of large workboat related support trips.
Annual Number of Small Workboat Trips to Operate 1 Exploration Platform	This parameter is multiplied by the number of operating exploration platforms each year to estimate the number of small workboat related support trips.
Number of Large Workboat Trips to Abandon 1 Production Platform	This parameter is multiplied by the number of production platforms abandoned each year to estimate the number of large workboat related support trips.
Number of Small Workboat Trips to Abandon 1 Production Platform	This parameter is multiplied by the number of production platforms abandoned each year to estimate the number of small workboat related support trips.
Number of Large Workboat Trips to Drill 1 Production Well	This parameter is multiplied by the number of production wells drilled each year to estimate the number of large workboat related support trips.

Number of Large Workboat Trips to Drill 1 Exploration Well	This parameter is multiplied by the number of exploration wells drilled each year to estimate the number of large workboat related support trips.
Number of Large Workboats to Lay 1 Mile of Offshore Pipe.	This parameter is used to estimate the hours of large workboat support needed to lay the offshore pipe in the scenario. It is multiplied by the miles of pipeline, number of days to install 1 mile of pipe, and the average daily hours of support provided.
Number of Dive Boats to Lay 1 Mile of Offshore Pipe.	This parameter is used to estimate the hours of Dive Boat support needed to lay the offshore pipe in the scenario. It is multiplied by the miles of pipeline, number of days to install 1 mile of pipe, and the average daily hours of support provided.
Annual Number of Landing Craft Trips to Construct 1 Marine Terminal	This parameter is used to estimate the hours of landing craft support needed to construct a marine terminal. During years which construction takes place, the parameter is multiplied by the average number of hours required to complete each trip.
Annual Number of Landing Craft Trips to Construct 1 Marine Terminal	This parameter is used to estimate the hours of landing craft support needed to construct a marine terminal. During years which construction takes place, the parameter is multiplied by the average number of hours required to complete each trip.
Annual Number of Landing Craft Trips to Operate 1 Marine Terminal	This parameter is used to estimate the hours of landing craft support needed to operate a marine terminal for one year. During years of operation, the parameter is multiplied by the average number of hours required to complete each trip.
Annual Number of Large Workboat Trips Needed to Support Major Platform Maintenance	During years of oil production, this parameter is multiplied by the number of operating production platforms to estimate the number of large workboat related support trips.
Annual Number of Small Workboat Trips Needed to Support Major Platform Maintenance	During years of oil production, this parameter is multiplied by the number of operating production platforms to estimate the number of small workboat related support trips.
Number of Large Workboat Trips to Support 1 Well Workover	This parameter is multiplied by the number of well workovers each year to estimate the number of large workboat related support trips.

- *Helicopter Support*: These parameters are used to estimate the total number of days of helicopter support required under the given scenario.

Parameter	Description
Number of Helicopter Trips Per Month of Seismic Survey	This parameter is multiplied by the number of months of seismic survey work each year to estimate the number of helicopter-related support trips.
Number of Helicopter Trips to Support a Spill Contingency Operation for 3 Platforms	This parameter is multiplied by the number of spill contingency operations each year to estimate the number of helicopter-related support trips.
Number of Helicopter Trips to Install a Platform in Shallow Water	This parameter is multiplied by the number of platforms installed in shallow water each year to estimate the number of helicopter-related support trips.
Number of Helicopter Trips to Install a Production Platform in Deep Water	This parameter is multiplied by the number of production platforms installed in deep water each year to estimate the number of helicopter-related support trips.
Number of Helicopter Trips to Operate 1 Production Platform	This parameter is multiplied by the number of operating production platforms each year to estimate the number of helicopter-related support trips.
Number of Helicopter Trips to Operate 1 Exploration Platform	This parameter is multiplied by the number of operating exploration platforms each year to estimate the number of helicopter-related support trips.
Number of Helicopter Trips to Abandon 1 Production Island	This parameter is multiplied by the number of production islands abandoned each year to estimate the number of helicopter-related support trips.
Number of Helicopter Trips to Drill 1 Well	This parameter is multiplied by the number of wells drilled each year to estimate the number of helicopter-related support trips.
Number of Helicopter Trips to Lay 1 Mile of Offshore Pipe	This parameter is multiplied by the miles of offshore pipe laid to estimate the number of helicopter related support trips. It was assumed that it would take 6.6 days on average to lay 1 mile of pipe.
Number of Helicopter Trips to Operate 1 Marine Terminal	This parameter is multiplied by the number of operating marine terminals each year to estimate the number of helicopter-related support trips.
Number of Helicopter Trips to Conduct Major Platform Maintenance	This parameter is multiplied by the number of operating production platforms each year to estimate the number of helicopter-related support trips.
Number of Helicopter Trips to Conduct 1 Well Workover	This parameter is multiplied by the number of well workovers each year to estimate the number of helicopter-related support trips.
Average Helicopter Speed (mph)	This parameter is used to convert the total number of helicopter trips into an hourly basis. Distance from base is divided by the parameter and the result is then multiplied by the number of trips.
Average Time to Load/Unload Cargo Personnel (hours)	This parameter is multiplied by 2 (to account for each trip end) and then added to the time it takes to complete each trip.

- *Government Revenue and Taxes*: These parameters are used to estimate government revenues for the local government, the State of Alaska, and the Federal government.

Parameter	Description
Royalty Paid for Oil Production	This parameter is multiplied by the value of oil production to estimate royalty revenues to the Federal government.
Fee Paid to Lease Land During E&D	This parameter is multiplied by leased acreage to estimate acreage rental payments to the Federal government.
Percent of 8(g) Revenues Returned to Alaska	This parameter is multiplied by total 8(g) revenues to estimate the amounts that contribute to Federal government revenues and state government revenues.
Percent of 8(g) Revenues Allocated to General Fund	This parameter is used to estimate the amount of the state's 8(g) revenues that are allocated to the state's general fund.
Percent of 8(g) Revenues Allocated to Permanent Fund	This parameter is used to estimate the amount of the state's 8(g) revenues that are allocated to the Alaska Permanent Fund.
Percent of AK Tax and 8(g) Revenues Distributed to each local government	This parameter is used to estimate the amount of state government revenues that are distributed to the local government.
Percent of Permanent Fund Balance Distributed to the Populace	This parameter is used to estimate Permanent Fund dividends that can be attributed to the oil industry activity in the given scenario.
Percent of Permanent Fund Dividend Allocated to the local residents	This parameter is used to distribute Permanent Fund dividends between local residents and Other Alaska residents.
Percent of local Permanent Fund Dividend Spent Locally	This parameter is used to determine where local residents spend their Permanent Fund dividends. The amounts are added to PCE estimates in the various regions.
Local Tax Revenues as a Percent of Total Income	This parameter is multiplied by the amount of personal income generated to estimate the amount of local government revenues generated from taxes.
State Tax Revenues as a Percent of Total Income	This parameter is multiplied by the amount of personal income generated to estimate the amount of state government revenues generated from taxes.
Federal Tax Revenues as a Percent of Total Income	This parameter is multiplied by the amount of personal income generated to estimate the amount of federal government revenues generated from taxes.

- *Miscellaneous*: These parameters are used to produce a variety of estimates used in the model.

Parameter	Description
Total Camp Expenditures for 1 Camp Operation	This parameter is used to determine the level of camp support operations required in the given scenario.
Gasoline Price (1999 Dollars Per Gallon)	This parameter is used to estimate fuel purchases and is multiplied by the gallons of fuel consumed in each activity. The parameter reflects the price of gasoline at the factor gate and does not include transportation or retail margins.
Number of Days to Lay 1 Mile of Offshore Pipe	This parameter converts mileage of pipe into days of activity. This is necessary in order to estimate the level of boat activity (calculated on a daily basis) needed to support the offshore pipe laying operation.
PCE as a Percent of Disposable Income	This parameter is used to determine the amount of Permanent Fund income that is spent on consumption and allocated to PCE.
Personal Savings as a Percent of Total Income	This parameter is multiplied by the amount of personal income generated to estimate personal savings.

III.D Data Entry

The Data Entry screen presents the user with a table organized by year and E&D activity. Shown below in Exhibit 3, most of these activities can be obtained from MMS's E&D Scenario/Schedule. The one exception is "Distance from Base" which specifies the average straight-line distance between the shore base used and the platforms. This variable is used to calculate transit time for boat and helicopter operations.

Note that the activities in Exhibit 3 are somewhat different than the ones presented above in Exhibit 1. Through a number of formulas, the data entered by the user are converted into quantities that correspond to the activities defined in the Exhibit 1.

To develop an accurate analysis, the user should enter as much information as possible. The temporal profile of the data that is entered should also reflect the actual timeline that MMS expects to see for a given scenario: for example, aggregating the inputs and entering them into a single year may lead to anomalous results since many of the formulas have temporal components.

Since the matrices, PCE vectors and TPI vectors were developed in 1999 dollar values, data entry variables that are in dollar value units need to be stripped of inflation and computed in constant 1999 dollars.

Once the data has been entered, the user should be able to review the results almost immediately simply by clicking on the appropriate tab. If calculation is set to "manual", you will need to first press F9 so that the formulas are updated; otherwise the results will not correspond to the most recent data inputs.

The password to unprotect the sheet is “MMS”. If the user wishes to view the right hand columns that show the calculation, right click on the desired columns and choose unhide from the list.

Exhibit 3: E&D Data Entry Requirements and Respective Units

Variable	***Unit***
Distance from Base	(Feet)
Seismic Survey	(Months)
Exploration Wells	(Number)
Delineation Wells	(Number)
Exploration Platforms	(Number)
Production Wells	(Number)
Production Platforms	(Number)
New Offshore Pipeline	(Miles)
New Onshore Pipeline	(Miles)
Total Oil Production	(Million Barrels)
8(g) Oil Production	(Million Barrels)
Oil Price	(1999 Constant Dollars per Barrel)
Total Gas Production	(Billion Cubic Feet)
8(g) Gas Production	(Billion Cubic Feet)
Gas Price	(1999 Constant Dollars Per Thousand Cubic Feet)
Total Lease Acreage	(Thousand Acres)
8(g) Lease Acreage	(Thousand Acres)
Total Bonus Bid	(Millions of 1999 Constant Dollars)
8(g) Bonus Bid	(Millions of 1999 Constant Dollars)

III.E Output Screens

Output for a scenario is provided in tabular form on four different screens. The LocalOutput screen presents industry expenditures (by IMPLAN sector) and direct manpower that take place within and are provided by the local economy. Included are expenditures and employment by the local government, personal consumption expenditures (PCE) that take place within the local economy, and total personal income (TPI) that is generated for local residents.

The KenaiOutput screen presents industry expenditures (by IMPLAN sector), personal consumption expenditures (PCE), and total personal income (TPI) that is generated or takes place within the Kenai Peninsula Borough (KPB). When the Study Area is Cook Inlet / Shelikof Strait, please note that the local borough is KPB; for this reason, industry purchases, PCE and TPI values are set to zero on the LocalOutput screen when the Study Area is Cook Inlet / Shelikof Strait.

The AKOutput screen presents industry expenditures (by IMPLAN sector), personal consumption expenditures (PCE), and total personal income (TPI) that is generated or takes place within Alaska areas other than the local borough and KPB.

The USOutput screen presents industry expenditures (by IMPLAN sector), personal consumption expenditures (PCE), and total personal income that is generated or takes place in the continental US.

Please note that personal consumption expenditures reflect household purchases of commodities and services in an area and should be used to estimate the induced impacts in a region. The figures are derived from estimates of disposable income (total income minus taxes and savings) and take into account differences between where income is earned and where it is spent.

III.F Manpower Graph

The Manpower Graph screen graphically depicts the amount of manpower (days) needed to conduct the scenario under consideration. The data used to populate the graph are taken from the LocalOutput screen and refer to labor directly involved in oil exploration, development and production activities. Management and overhead personnel who are not directly involved in the activities are not included in the totals. The figures also do not include local government employment that is stimulated by the E&D activity; these data, however, are provided at the bottom of the LocalOutput screen.

IV. MODEL PROCESSING ENGINE

IV.A Conversion of Data Entry Input into IMPAK Activity Levels

Since the activities listed in the E&D reports are not identical to those used in IMPAK, the model has to convert the E&D data into the corresponding IMPAK activity levels. The result of this translation takes place on the Input Worksheet. The conversion is a function of model equations, the model parameters contained in the Parameters Worksheet, and the secondary activity drivers contained in the Secondary Drivers Worksheet. Details of the process are provided below.

Activity 1: Geological Survey

Currently, there are no E&D data that can be used to estimate this activity level and the user will have to enter the total number of months of geo-surveys required for all activities in the E&D scenario.

Activity 2: Spill Contingency Response

The number of spill contingency response operations required is based on the number of platforms in operation. The number of platforms needing spill containment support is equal to the number of production platforms established since the inception date. To be consistent with the expenditure vector, this figure is calibrated by dividing it by the average number of platforms supported by a spill containment operation. This parameter is currently set at five platforms per spill response operations, but can be changed by the analyst.

Activity 3: Construct Exploration Shore Base

This activity may not be required if existing underutilized exploration shore bases exist, such as in the Cook Inlet area. The analyst selects whether to use existing shore bases.

If existing exploration shore bases are not utilized the number needed is based on the number of exploration platforms in operation. The number of exploration platforms requiring shore base support is equal to the number of exploration platforms established since the inception date. To be consistent with the expenditure vector, this figure is calibrated by dividing it by the average number of exploration platforms supported by an exploration shore base operation. This parameter is currently set at three exploration platforms per exploration shore base, but can be changed by the analyst.

Activity 4: Operate Exploration Shore Base

The number of exploration shore bases required to be operating is based on the number of exploration platforms in operation. The number of exploration platforms requiring shore base support is equal to the number of exploration platforms listed in the E&D report for that current year. Therefore, to estimate the required number of exploration shore bases, the model divides the number of exploration platforms by the average number of exploration platforms supported by an exploration shore base operation, a parameter which is specified on the Parameters worksheet. The parameter is currently set at three exploration platforms per shore base, but can be changed by the analyst.

Activity 5: Install Exploration Platform

The number of exploration platforms installed is equal to the number of exploration platforms listed in the E&D report for that current year. All explorations platforms are assumed to be installed in shallow water.

Activity 6: Operate Exploration Platform

The number of exploration platforms operated is equal to the number of exploration platforms listed in the E&D report for that current year. All explorations platforms are assumed to operate in shallow water.

Activity 7: Drill Exploration Well

The number of exploration wells drilled is equal to the number of exploration and delineation wells listed in the E&D report for that current year. All exploration wells are assumed to be drilled from platforms situated in shallow water.

Activity 8: Construct Production Shore Base

This activity may not be required if existing underutilized production shore bases exist, such as in the Cook Inlet area. On the parameter worksheet, the analyst selects whether to use existing shore bases.

The number of production shore bases that need to be constructed is based on the number of production platforms in operation. The number of production platforms requiring shore base support is equal to the number of production platforms established since the inception date. Therefore, to estimate the required number of production shore bases, the model divides the number of production platforms by the average number of production platforms supported by a production shore base operation, a parameter which is specified on the Parameters worksheet. The parameter is currently set at three production platforms per production shore base, but can be changed by the analyst.

Production shore bases are built the year before the production rigs are installed.

Activity 9: Operate Production Shore Base

The number of production shore bases required to be operating is based on the number of production platforms in operation. The number of production platforms requiring shore base support is equal to the number of production platforms established since the inception date. To be consistent with the expenditure vector, this figure is calibrated by dividing it by the average number of production platforms supported by a production shore base operation. This parameter is currently set at three production platforms per production shore base, but can be changed by the analyst.

Activity 10: Install Production Platform

The number of production platforms installed is equal to the number of production platforms listed in the E&D report for that current year. The vector is calculated for a shallow water platform and is scaled by a factor of two for deep-water platforms. The analyst can change this factor on the Parameters worksheet. In addition, please note that boat support and helicopter support are automatically increased to reflect the higher installation costs in deep water.

Activity 11: Operate Production Platform

The number of production platforms in operation is equal to the sum of production platforms listed in the E&D report since the inception date. The vector is calculated for a shallow water platform and is scaled by a factor of two for deep-water platforms. The analyst can change this factor on the Parameters worksheet. In addition, please note that boat support and helicopter support are automatically increased to reflect the higher operating costs in deep water.

Activity 12: Drill Production Well

The number of production wells drilled is equal to the number of production wells listed in the E&D report for that current year. The vector is calculated for a well drilled from a shallow water platform. By altering a factor on the Parameters worksheet, the analyst can scale the costs for wells drilled from deep water platforms. The default value of the scalar was set to "1", implying no cost differential between shallow and deep water wells. Given the prevalence of non-vertical well drilling techniques, water depth in the Alaskan OCS is often only a small percentage of the total well depth (or length). High fixed costs for well set-up also mean that the difference between shallow and deep water depths will translate into relatively smaller cost increases. If the analyst does choose to increase the well drilling cost in deep water, please note that boat support and helicopter support will automatically increase to reflect the higher drilling costs in deep water.

Activity 13: Lay Offshore Pipeline

The number of pipeline miles is equal to offshore pipeline miles, specified in the E&D report, for that current year. Please note that although different approaches are used to lay pipe in shallow water versus deep water, the per-unit installation costs are the same. Therefore, no adjustment is made for installing pipeline in deep water.

Activity 14: Lay Onshore Pipeline

The number of pipeline miles is equal to onshore pipeline miles, specified in the E&D report, for that current year.

Activity 15: Construct Onshore Production Facility

This activity may not be required if existing underutilized production shore bases exist, such as in the Cook Inlet area. The analyst selects whether to use existing production facilities. Production facilities are built in the two years before production begins. Their size is based on the maximum yearly oil production.

Activity 16: Operate Production Facility

The vector for the cost of operating the production facility is developed on a per barrel basis. The number of barrels produced in each year, as specified in the E&D report, is then multiplied by the per barrel costs.

Activity 17: Construct Marine Terminal

This activity may not be required if existing underutilized marine terminals exist, such as in the Cook Inlet area. The analyst selects whether to use existing terminal facilities. Terminal facilities are built in the two years before production begins. Their size is based on the maximum yearly oil production.

Activity 18: Operate Marine Terminal

The vector for the cost of operating the terminal facility is developed on a per barrel basis. The number of barrels produced in each year, as specified in the E&D report, is then multiplied by the per barrel costs.

Activity 19: Major Platform Maintenance

The number of platform maintenance operations is based on the assumption that each production platform listed in the E&D report will need maintenance every year. It is assumed that all platforms continue operation until oil production ceases.

Activity 20: Well Workover

The number of well workovers is based on the assumption that each production well listed in the E&D report will need maintenance every six years. It is assumed that all wells continue operation until oil production ceases.

Activity 21: Helicopter Support

Helicopter support costs are based on an hourly rate, since this is the most accurate data available. The model, therefore, calculates the hours of support required. For each activity requiring helicopter support, the product of the number of helicopter trips per activity unit and the number of activity units is calculated. These results are then summed and converted into total trips of helicopter support. Helicopter trips are then converted into hours of operation. Hours are based on a formula that assumes a half-hour combined for take-off and landing and an average travel speed of 100 mph. Distance is an input that is specified by the analyst. In deep water scenarios, please note that helicopter support is indirectly elevated through cost increases for platform installation, platform operation, and well drilling.

Activities 22 - 25: Boat Support:

Boat support costs are hourly and are based on a daily rate and a ten-hour day, since daily rates are the most accurate data available. The model, therefore, calculates the hours of support required. For each activity requiring boat support, the product of the number of boat trips (by type of boat) per activity unit and the number of activity units is calculated. These results are then summed and converted into total trips of boat support by type of boat. Boat trips are then converted into hours of operation. Hours are based on a formula that assumes an average travel speed. Distance is an input that is specified by the analyst and augmented by a circuitry factor. In deep water scenarios, please note that boat support is indirectly elevated through cost increases for platform installation, platform operation, and well drilling.

Activity 26: Camp Support

Expenditures for food and lodging were estimated for every activity except general personnel transportation. These expenditures, presented on the Secondary Drivers worksheet, are normalized by the total cost of running a camp, multiplied by the corresponding activity levels, and then summed. When the sum is multiplied by the camp support input vector, the result will be the same as if the food and lodging expenditures had been allocated to input sectors based upon each commodity's share of the total cost of a camp operation.

Government

The model uses various government revenue functions to stimulate three government expenditure vectors: local government, the Alaska State government, and the US Federal government. In all three cases, government expenditures in the current period are assumed to be equal to revenues generated in the previous year.

The revenue function for a specific jurisdiction can be modeled by trying to imitate each revenue instrument or by using proxies. For many revenue sources, the former approach would be extremely time-consuming to implement, fraught with the potential of compounding errors in estimation, and difficult to adapt for changing fiscal regimes. In addition, the means by which State and local governments obtain revenues will vary over time and, certainly, from jurisdiction to jurisdiction. IMPAK instead uses a combination of the two approaches to estimate revenues resulting from new OCS activities. It directly estimates State (and local shares of) revenues from the Federal Government but uses proxies to estimate tax revenues.

State and Local Government

State and local government expenditures are a function of two primary revenue sources: (1) state and local tax revenues and (2) state revenues obtained from 8(g) funds.

Estimates of tax revenues by jurisdiction are based on ratios of total tax revenues to total personal income developed from data in the *Statistical Abstract of the United States*. To produce the revenue estimates, the ratios are multiplied by the amount of total personal income generated from the E&D activities in an IMPAK scenario. Total Personal Income is used as a proxy for the general level of economic activity, reflecting changes in infrastructure investment, production, property assessments, and government tax revenues. By using the relationship between Total Personal Income and government tax revenues, IMPAK can be adapted to changing fiscal regimes or for use with other local government entities, such as individual villages. However, given the small size of these jurisdictions, and the difficulty of obtaining good data, the user should be careful to seek independent confirmation of the revenue estimates.

Neither the State of Alaska nor local government has a broad-based income tax or a general sales tax, so state and local tax revenues are collected through property taxes, indirect business taxes (IBT), licenses (hunting, motor vehicle, etc.), and selective sales taxes (alcohol, insurance, motor fuel, and utility). The average ratio between total state tax revenues and total personal income in Alaska was calculated to be 1.6% between 1995 and 1997. The average ratio between total local tax revenues and total personal income in the state was calculated to be 5.17% over the same period. This average local tax ratio was applied to all Alaska residents. It should be noted that both the state and local tax parameters can be changed on the Parameters screen.

OCS oil activities provide income for Alaska residents through worker earnings and increases in the annual Permanent Fund dividends. Estimates of local earnings are obtained by summing, across activities, the product of earnings per unit and number of units. To estimate PF dividends, the model maintains a running PF balance based upon annual disbursements and additions generated by the level of E&D activities specified in the scenario. It should be emphasized that IMPAK's PF account only deals with funds related to the scenario under consideration; its balance and dividends, therefore, do not correspond to the actual values associated with the fund itself. Total dividends to Alaska residents are calculated by multiplying the dividend rate (a parameter) by the balance in the previous year. Parameters are then used to assign a portion of the total dividends to residents of the local community, the Kenai Peninsula Borough, and Other Alaska residents.

As noted above, revenues are also derived from 8(g) funds. Under section 8(g) of the OCS Lands Act, as amended, the Federal Government must pay to the State 27 percent of all revenues (bids to obtain leases, annual lease rental payments, and royalties on production) for leases within 3 miles of State waters. In IMPAK, 8(g) revenues are directly estimated based upon projected 8(g) bids, leases and oil production. Estimated royalties are the product of the royalty rate (a parameter,) 8(g) oil production, and price per barrel; production and price are both user inputs. Lease revenues are the product of 8(g) lease acreage (a user input) and the acreage rental rate (a parameter). Bonus bids are input by the user. Twenty-seven percent of the total 8(g) revenue is then allocated to Alaska, where it is divided equally between the State budget and the Alaska Permanent Fund. Through the Parameters Worksheet, the user can change the default for any of the relevant rates: the Federal royalty rate, the 8(g) payment rate, the percentage of 8(g) revenues going into the Permanent Fund, etc.

Local governments receive none of these payments directly. However, a small portion of State funds is distributed to these governments as intergovernmental revenues. The proportion of the state revenues going to local governments can be changed on the Parameters Worksheet.

Federal Government

Federal government expenditures are a function of two primary revenue sources: (1) federal tax revenues generated from earnings, and (2) federal revenues obtained from royalties, lease revenues, and bonus bids. Government expenditures in the current period are assumed to be equal to revenues generated in the previous year.

Tax revenues are estimated by applying a federal tax rate to earnings that can be attributed to E&D activities (including government) in the scenario. Earnings are obtained by summing, across activities, the product of earnings per unit and number of units. These results are provided on the USOutput screen. The federal tax rate, a parameter, was estimated to be 11.7%. This was calculated as the average ratio between 1996 federal individual income tax returns of Alaska residents and personal income in the state in 1996 (The data were obtained from the Statistical Abstract of the United States.). Tax revenues were estimated for all US residents involved in the scenario. These include production workers directly involved in the E&D activities as well as overhead support personnel such as oil company employees serving engineering or administrative functions.

Other Federal revenues were estimated from total royalties, lease rental revenues, and bonus (auction) bids, less the portion of these amounts paid to Alaska under section 8(g) of the OCS Lands Act (see above). Royalties are the product of the royalty rate (a parameter,) total oil production, and price per barrel; production and price are both user inputs. Lease revenues are the product of total lease acreage (a user input) and the acreage rental rate (a parameter). Bonus bids are input by the user.

IV.B SecondaryDrivers Worksheet

This worksheet is not displayed but is used in the model to estimate the amount of camp support needed for a given scenario. Camp support is the only secondary activity in the Sub-Arctic model and it is a function of the amount of activity generated by all of the other primary activities. The amount of camp support generated by one unit of each primary activity is maintained on this page as a vector of secondary activity. For each year in the forecast horizon, the secondary activity vector is multiplied by the primary activity levels and the resulting products are then summed to estimate total camp support. Before the multiplication occurs, note that the secondary activity levels are first calibrated by the level of camp support (i.e., the size of the camp) that was used to develop the camp support expenditure vectors. The calibration is necessary to scale the activity and associated expenditures according to the size of the operation.

To view the page, select the following from Excel's menu system: Format | Sheet | Unhide | SecondaryDrivers.

IV.C TransposeInput Worksheet

This worksheet is not displayed but is used as an intermediary step to facilitate the multiplication of the matrices and arrays in the model. To view the page, select the following from Excel's menu system: Format | Sheet | Unhide | TransposeInput.

IV.D I-O Matrices

These screens are not displayed but allow the user to view the input-output vectors and coefficients associated with each IMPAK activity and geographic region. Please note that only four out of the twelve matrices will be used for any model run, depending upon whether the scenario is in Cook Inlet / Shelikof Strait, in the Gulf of Alaska, or in another remote sub-Arctic region. The matrices show the commodities (IMPLAN sector) and associated values purchased by each activity. Values are in constant 1999 dollars and reflect the amounts needed to produce one unit of each respective activity. Included in the matrices are expenditures for labor (referred to as total personal income (TPI)), personal consumption expenditures generated from TPI, and man-power estimates.

Each column in a given matrix is multiplied by the corresponding activity level generated from the scenario data to produce an estimate of purchases by activity, commodity and year. For each year, these results are then summed across activities, resulting in an estimate of total purchases by year and commodity.

To view a matrix, select the following from Excel's menu system: Format | Sheet | Unhide | Name of WorkSheet. The worksheet names are self-explanatory and correspond to the respective matrices on the sheets.

IV.E Generation of Model Output

The model inputs are first transposed into a matrix compatible with the regional input-output matrices. An Excel array function (transpose) is used to accomplish the task. The transposed input is then multiplied by each region's input-output matrix to yield the total direct impacts by region and IMPLAN sector. Again, an Excel array function is used to accomplish the matrix multiplication (mmult). Note that each year in the forecast horizon requires a separate formula.

It should be noted that annual Permanent Fund (PF) disbursements arising from E&D activities in the scenario are converted and added to PCE at this time. As noted above, the dividends are estimated for both the NSB and "Other Alaska" residents. The disbursements are adjusted for savings and taxes and then allocated to local spending areas. For example, after the tax and savings adjustment, PF disbursements to NSB residents are then divided between the North Slope Borough and Other Alaska. The adjustment for taxes is based upon the tax rate parameters found on the Government Parameters worksheet. The PCERate parameter is used to adjust for savings and specify the percentage of disposable income assigned to personal consumption expenditures (PCE). The parameter is currently set at 95% with the remaining 5% going to savings. A location parameter (NSBPFExpenditurePercent) is used to divide the PCE into the areas where it is spent. The parameter is currently set at 10%, meaning that NSB residents spend 10% of their PF dividend, after adjustments for taxes and savings, in the NSB; the remainder is assumed to be spent in "Other Alaska". Estimated PF expenditures in "Other Alaska" are based upon the dividends to all Alaska residents. PF expenditures by "Other Alaska" residents are assumed to take place entirely in "Other Alaska". Added to these expenditures are purchases by NSB residents. As implied above, it is assumed that 90% of NSB PF expenditures are made in "Other Alaska".