PN. ABR-810
88952

IRRIGATION WATER COST RECOVERY IN EGYPT:

DETERMINATION OF WATER COSTS

January 1993

ISPAN # 49

An Applied Study prepared for the USAID Mission to Egypt by the Irrigation Support Project for Asia and the Near East

PREFACE

This study addresses the problem of identifying incremental operation, maintenance, and rehabilitation (OM&R) expenditures needed to raise the performance of the water delivery system in Egypt to an adequate level. Emphasis is placed on developing a procedure for allocating the costs of the system to its various users. Allocation can be the basis of a program to let the government recover all or part of the system costs.

Much effort was focused on defining methodologies and obtaining OM&R costs for two basic scenarios. Scenario 1 is the present system under existing levels of OM&R inputs. Scenario 2 is an improved system with an increased level of OM&R inputs to provide adequate maintenance. Two other scenarios (Scenarios 3 and 4) were identified. These scenarios examine the potential effects of new land reclamation projects (termed new new lands) on the shares of existing system costs borne by present users. Because the new new lands share in the costs of the existing system, costs to present users are reduced. Scenario 3 is Scenario 1 with the new new lands factored into the original scenario, and Scenario 4 is Scenario 2 with the new new lands factored into the original scenario.

The annual costs for Scenario 1 were estimated on the basis of actual costs incurred by various government agencies during the last five years. The proposed Five-Year Water Development Plan was used to estimate the annual OM&R costs for Scenario 2. The report describes the procedures for estimating the annual costs of each scenario and assessing system benefits in the various use sectors. The report also explains the development and application of a cost allocation model to the scenarios, and discusses the results of allocation and sensitivity analyses.

The team owes a large debt of gratitude to officials of the Ministry of Public Works and Water Resources. Help was received from many officials—from district engineers to the chairman of the High Coordinating Committee and all staff in between. Special thanks also are extended to the undersecretaries of the Irrigation and Drainage Directorates who responded in such a timely manner to our questionnaires. Gratitude is also owed to the staff of USAID/Cairo, particularly the Irrigation and Land Development project officers, who generously donated time to assist the team.

This work is a collective effort of the Egyptian team and the American consultants. The team gained greatly by sharing perspectives and insights during its investigations, and believes that the joint effort benefitted the outcome.

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ACRONYMS

ASCRB	Adjusted Separable Costs-Remaining Benefits
EPADP	Egyptian Public Authority for Drainage Projects
FY	Fiscal Year
GOARE	Government of the Arab Republic of Egypt
HAD	High Aswan Dam
ID	Irrigation Department
IMS	Irrigation Management Systems Project
IIP	Irrigation Improvement Program
IS	Irrigation Sector
ISPAN	Irrigation Support Project for Asia and the Near East
LE	Egyptian Pounds
M&I	Municipal and Industrial (Uses)
MED	Mechanical and Electrical Department
MPWWR	Ministry of Public Works Water Resources
O&M	Operations and Maintenance
OM&R	Operation, Maintenance, and Replacement
PEC	Public Excavation Company
PM	Preventive Maintenance Program
SCRB	Separable Cost-Remaining Benefit
SR	Structural Replacement Program
UoF	Use of Facilities
WUAs	Water Users Associations
WRC	Water Research Center
USAID	United States Agency for International Development

إستعاضة تكاليف مياه الرى فى مصر
دراسة ١ : تحديد تكاليف مياه الرى

الملخص التنفيذى

تمهيد

كان الباعث لدراسة تكاليف تشغيل وصيانة وإحلال شبكة الرى فى مصر إعتبارين هامين – الأول يتعلق بالحالة الراهنة للشبكة فكثير من منشآتها جاوزت عمرها الإفتراضى ومن اللازم وضع برنامج لتعزيز صيانتها وتجديدها بغية تحسين كفاءة توصيل المياه وبالتالى زيادة الإنتاج الزراعى . إلا أن ميزانية الدولة ظلت لعدة سنوات لاتكفى لإجراء الصيانة الدورية على المستوى المطلوب وكذا أعمال الإحلال والتجديد فى الشبكة . ويؤكد ذلك تقارير المسئولين فى وزراة الأشغال العامة والموارد المائية والهيئات الدولية المانحة .

أما الإعتبار الثانى فإنه نتيجة التغير الجوهرى فى السياسة الإقتصادية للدولة خاصة فى قطاع الزراعة . فالسياسة الجديدة تتيح للفلاحين بيع محاصيلهم بأسعار السوق العالمية وكانت الدولة تقوم بشراء المحاصيل الزراعية الرئيسية بأسعار السوق المحلية وتعيد بيعها فى السوق الحرة بالأسعار العالمية وكان الفرق بين السعرين يمثل عائد الدولة من قطاع الزراعة . وعلى ذلك فإن إتباع السياسة الجديدة يحرم الدولة من هذا العائد وبالتالى لابد من تعويضه من مصادر أخرى لتغطية تكاليف شبكة الرى .

وقد أديا هذان الإعتباران إلى التفكير فى إستعاضة جزء أو كل تكاليف تشغيل وصيانة وتجديد شبكة الرى من القطاعات المستفيدة منها . على أنه من الضروري قبل إنتهاج هذه الوسيلة إجراء دراسةلمعرفة التكاليف الحالية والتكاليف الإضافية اللازمة لتحسين شبكة الرى .

الغرض من الدراسة

تهدف هذه الدراسة إلى تحديد صافى تكاليف تشغيل وصيانة وتجديد شبكة الرى الرئيسية فى مصر (لا تشمل المساقى وما دونها على مستوى الحقل) طبقا لما تتكلفه فى وضعها الحالى وأيضا بعد تحسينها لمستوى كاف . تتناول الدراسة توزيع هذه التكاليف على مستوى شرائح الشبكة بداية من السد العالى على النيل الرئيسى والقناطر المقامة عليه ثم الترع الرئيسيه ومحطات رفع المياه والمصارف حتى ترع التغذية الفرعية فى مديريات الرى المختلفة . وبالإستعانة بنموذج رياضى يمكن معرفة نصيب كل من القطاعات المستفيدة من شبكة الرى حسب الفوائد العائدة منها .

خطة الدراسة

قامت الدراسة على ركيزتين – الأولى شملت تقديرا لتكاليف التشغيل والصيانة بصفة عامة لكل قطاعات المستفيدين من المياه للأغراض المختلفة والثانية تضمنت توزيع هذه التكاليف على مختلف القطاعات وحساب نصيب قطاع الزراعة منها . وقد تم دراسة أربعة حالات "سيناريو" فيما يلي بيان عنها..

سيناريو ١ – يمثل الشبكة الرئيسية فى وضعها الحالى ويعكس الميزانية التى يجرى العمل بها حاليا بأبوابها المختلفة لإدارة وصيانة وتجديد الشبكة طبقا للخطة الخمسية من ٨٦ / ١٩٨٧ حتى ٩٠ / ١٩٩١.

سيناريو ٢ - يتضمن ما يشمله سيناريو ١ مع اضافة تكاليف تحسين الشبكة لمستوى مناسب .

سيناريو ٣ - يضيف إلى سيناريو ١ تكاليف الأعمال الموجودة فى شبكة الرى فى الأراضى الزراعية القديمة لتوصيل المياه إلى الأراضى الزراعية الجديدة .

سيناريو ٤ - يضيف إلى سيناريو ٢ تكاليف الأعمال الموجودة فى شبكة الرى بعد تحسينها لتوصيل المياه إلى الأراضى الزراعية الجديدة .

طريقة تقدير التكاليف

قدرت التكاليف بمعدل سنوى حتى يمكن حسابها لكل فدان أو لكل ألف متر مكعب من المياه . أخذت المعلومات الأساسية لتقدير التكاليف فى سيناريو ١ وسيناريو ٣ من ميزانية وزارة الأشغال العامة والموارد المائية فى الخطةالخمسية ٨٦ / ١٩٨٧ - ٩٠ / ١٩٩١ وتغطى الباب الأولى والثانى والثالث بالنسبة لتكاليف الأجور والصيانة الجارية والإستثمارات الرأسمالية للمنشآت المعمرة وأعتبرت نهاية عام ١٩٩١ الأساس لحساب التكاليف . وأدخلت على السنوات السابقة نسبة التضخم وأخذت المتوسطات لهذه الفترة . كما أستفادت الدراسة من البيانات التى تضمنها الأستبيان الذى أعدته ٢٢ إدراة رى تغطى شبكة التوزيع وقد قسمت التكاليف على مستوى الادارات تفصيلا وأدرجت التقديرات الخاصة بشبكة الرى لكل المناطق الخمسة (مصر العليا - مصر الوسطى - شرق الدلتا - وسط الدلتا - غرب الدلتا) .

أخذت تكاليف سيناريو ٢ وسيناريو ٤ من خطة وزارة الأشغال العامة والمواردالمائية المقترحة للسنوات الخمسة القادمة ٩٢ / ١٩٩٣ - ٩٦ / ١٩٩٧ بالإضافة إلى بيانات الدراسات التى قامت بها الوزارة مع هيئة المعونة الأميريكية فى مشروعات تحسين الرى وصيانة الترع والقناطر وقد أدرجت التقديرات لكل من المناطق الخمسة التى تغطى االشبكة .

توزيع التكاليف على القطاعات المستفيدة من شبكة الرى

يتم توزيع تكاليف شبكة الرى الرئيسية على القطاعات المختلفة المستفيدة من مياه الشبكة ومنشآتها وهم : الزراعة - الشرب - الصناعة - الملاحة - الكهرباء - النقل البرى (الجسور) - السياحة النهرية والترفيه - الثروة السمكية - الحماية من الفيضانات وذلك على أساس تحقيق شرطين أساسيين هما الكفاءة الإقتصادية والعدالة فى التوزيع .

وتوجد طريقتان لتوزيع التكاليف على الأغراض المختلفة أحداهما ويطلق عليها "تناسب الإستخدام على أساس السعة " ويتم التوزيع فيها طبقا لمعايير محسوسة مثل كمية إستهلاك المياه وسعة التخزين اللازمة لتحقيق غرض معين . وهذه الطريقة مجحفة بالنسبة للأغراض التى لا تستهلك المياه مثل الكهرباء والملاحة ولذلك لا يتوفر فيها عدالة التوزيع ولذلك لم تستخدم فى هذه الدراسة . أما الطريقة الأخرى التى أستخدمت فإنها تعتمد على المعيار الإقتصادى وهى تعرف باسم "التكاليف المنفصلة - الفوائد المتبقية" وتتوفر فى هذه الطريقة الكفاءة الإقتصادية وعدالة التوزيع وتصنف التكاليف فى مجموعتين . إحداهما التكاليف النوعية التى تخدم غرضا معينا وتضاف بالكامل لهذا الغرض والأخرى التكاليف المشتركة لكل الأغراض وتوزع بينهم أما بنسبة الفوائد التى تعود لكل غرض نتيجة إستخدامه للشبكة أو بنسبة تكاليف المشروع البديل الذى يخدم هذا الغرض بدون إستخدام شبكة الرى - أيهما أقل .

تقدير الفوائد لتوزيع التكاليف

يتطلب توزيع التكاليف المشتركة حسب طريقة " التكاليف المنفصلة – الفوائد المتبقية " ضرورة إيجاد معيار نقدى للزيادة الإقتصادية فى الفوائد(القدرة على السداد) لكل مستفيد من شبكة الرى . وتنص هذه الطريقة على إستخدام الزيادة فى الفوائد وليست الفوائد الكلية . وهناك عدة طرق لحساب زيادة الفوائد. إستخدمت فى هذه الدراسة الزيادة فى الدخل بعد تنفيذ مشروع معين لتقدير الزيادة فى الفوائد الزراعية أما بالنسبة للقطاعات الأخرى كالكهرباء والشرب والصناعة والملاحة فإن الزيادة فى الفوائد تكون نتيجة الزيادة فى تكاليف مشروع بديل يخدم غرضا واحدا وهى الطريقة المعروفة بالتكاليف البديلة .

فروض مهمة

الفروض التالية لها أهمية خاصة فى التوصل إلى نتائج هذه الدراسة .

معدل الفائدة : أختير ١٢٪ وهى النسبة التى يستخدمها البنك الدولى فى تقييم الإستثمارات فى مصر ويعتقد أنه يمثل تقديرا مناسبا .

مستوى الأسعار : قدرت التكاليف على أساس الأسعار فى نهاية عام ١٩٩١ .

التكاليف الغارقة (Sunk Costs) : أعتبرت تكاليف المشروعات طويلة العمر الإفتراضى والتى مضى عليها وقتا طويلا – مثل السد العالى والترع والمصارف – غارقة على أساس أنها سددت ولن تستبدل لقرون طويلة وبالتالى لاتضاف لتكاليف التشغيل والصيانة والتجديد ويعتبر هذا الفرض مناسبا حيث أن هذه الدراسة تتعلق بإستعاضة تكاليف مياه الرى وليس من الإنصاف أن تسترد تكاليف المشروعات التى مضى عليها وقتا طويلا من هذا الجيل من الفلاحين .

فترة التخطيط : تقدير تكاليف شبكة الرى هى عملية مستمرة لابد أن تراجع كل خطة خمسية إلا أن المشروعات المعمرة يعاد جدولتها حسب عمرها الإفتراضى فى حدود ٣٠ سنة .

الفوائد الإقتصادية الغير مباشرة (الثانوية) : إعتبرت فقط الفوائد المباشرة لإستخدام المياه ولم تؤخذ فى الإعتبار الفوائد الإقتصادية الثانوية مثل فوائد الأعمال التى تخدم قطاع الزراعة وذلك طبقا لما هو متبع فى دراسات الهيئات العالمية من إعتبار الفوائد الثانوية تكاليف لا يترتب عليها فوائد إضافية يمكن إستخدامها لتحسين شبكة الرى .

الأضرار الإقتصادية : لم تدخل فى هذه الدراسة التكاليف الخارجة التى هى فى الحقيقةأضرارا لطرف أخر مثل تلوث المياه نتيجة إستخدام السمادوالمبيدات الحشرية فى الزراعة وأيضا الصرف الصناعى والصرف الصحى فى شبكة الرى . ولو أن هذه التكاليف لها أهمية من الناحية البيئية إلا أنه من الصعب حسابها .

السياسة المناسبة لإستعاضة تكاليف مياه الرى

هناك العديد من المعوقات التى يجب أن تذلل قبل وضع الخطة المناسبة لإستعاضة تكاليف مياه الرى فى مصر منها المعوقات الفنية والإقتصادية والإدارية والسياسية والإجتماعية . وقد تناولت هذه الدراسة هذه المعوقات وتم تحليلها من واقع الخبرة المصرية .

ومن الضرورى أيضا قبل إقرار سياسة لإستعاضة تكاليف مياه الرى تحديد الهدف من ورائها ما إذا كان كوسيلة لزيادة إيراد الدولة لتصبح قادرة على تحمل تكاليف إضافية لتحسين شبكة الرى وفى هذه الحالة

يكون من الأفضل أن تتبع أبسط طريقة فعالة بالنسبة للفلاح والحكومة . أما إذا كان الغرض من إستعاضة التكاليف هو رفع الكفاءة الإقتصادية وعدالة التوزيع فلا بد من الأخذ في الإعتبار عوامل أكثر تعقيدا بحيث تكون إستعاضة التكاليف عنصرا واحدا ضمن خطة شاملة للدولة تشمل حق إستخدام المياه للفلاحين ومقدار ما يتحمله مقابل ذلك هو الحل لتحسين شبكة الرى .

وهناك طريقتان لحساب وحدة التكاليف إحداهما على أساس مساحة الأرض المزروعة مع الأخذ فى الإعتبار التركيب المحصولى وهى طريقة بسيطة وغير مكلفة إداريا لتحصيل هذه القيمة إلا أنها قاصرة عن مجازاة الفلاحين الذين لا يراعون الإستخدام الإقتصادى للمياه سواء فى طريقة الري أو فى إختيار المحصول المناسب . أما الطريقة الثانية فتحصيل قيمة التكاليف على أساس الكمية المستخدمة فعلا من المياه وبالتالى لابد من قياسها . وتتوفر فى هذه الطريقة العدالة حيث أن كل فلاح يقوم بسداد قيمة المياه التى أستخدمها إلا أنه نظرا لصعوبة إجراءات القياس تكون المصاريف الإدارية باهظة .

ويمكن تلافى العيوب الموجودة فى كل من الطريقتين بالجمع بينهما بحيث يحاسب الفلاح ليس فقط على أساس مساحة الأرض المزروعة بل أيضا يحاسب على كمية محدودة من المياه مستمدة من حقه السابق المكتسب وتحصل منه مع ضريبة الأراضى الزراعية . ولو أنه يفضل أن تسدد مباشرة إلى خزينة وزارة الأشغال العامة والموارد المائية للصرف منها على تحسين شبكة الرى وصيانتها وبذلك يلمس الفلاح أن ما يدفعه يعود عليه مباشرة بالنفع .

ملخص النتائج

تم فى هذه الدراسة تقدير تكاليف تشغيل وصيانة وإحلال شبكة الرى فى مصر لكل من الحالات الأربعة (سيناريو) التى سبق تعريفها. يبين الجدول ١ والجدول ٢ موجزا لهذه التقديرات. يجدر بالإشارة أن الطريقة التي استخدمت في هذه الدراسة لمعرفة نصيب كل من القطاعات المستفيدة من شبكة الرى سواء من التكاليف المنفصلة أو التكاليف النوعية إستلزمت توزيع هذه التكاليف حسب الفائدة التى تعود على كل قطاع من جراء إستخدامه لشبكة الرى. ولما كانت الزيادة فى تكاليف تشغيل وصيانة وإحلال الشبكة تخدم فى المقام الأول قطاع الزراعة فإن غالبية هذه التكاليف تقع على عاتق هذا القطاع.

تقدير التكاليف الإجمالية للشبكة وتوزيعها على القطاعات المستفيدة

يبين السطر الأخير فى جدول ١ إجمالى التكاليف المشتركة لكل سيناريو. ففى سيناريو ١ وسيناريو ٢ اللذين يمثلن التكاليف الإجمالية السنوية للشبكة حسب الميزانية الحالية تبلغ القيمة الكلية ٥٥٥ مليون جنيه نصيب قطاع الزراعة منها ٨٣٪ فى سيناريو ١ يليه قطاع السياحة النهرية والترفيه بنسبة حوالي ٨٪ ونسبة ٩٪ الباقية توزع على القطاعات الستة الأخرى التى تستخدم شبكة الرى. أما فى سيناريو ٣ الذى أخذ فى الإعتبار التكاليف الإضافية لتوصيل المياه للأراضى الجديدة يقل نصيب قطاع الزراعة فى الأراضي الحالية وأيضاً نصيب القطاعات الأخرى ويعود ذلك إلى أن قطاع التوسع الزراعى يتحمل جزء من هذه التكاليف.

فى سيناريو ٢ وسيناريو ٤ اللذين يعكسين التكاليف الإضافية لتحسين الشبكة لمستوى كاف فإن التكاليف الإجمالية تزيد بنسبة ٤٣٪ لتبلغ حوالى ٧٩٢ مليون جنيه وبالتالى فإن نصيب قطاع الزراعة من هذه التكاليف يزيد عما هو فى سيناريو١ . وتختلف نسب ما تتحمله القطاعات الأخرى عنها فى حالة السيناريو

جدول ١: توزيع التكاليف الكلية السنوية لتشغيل وصيانة وإحلال شبكة الرى على المستفيدين لكل سيناريو

سيناريو	١		٢		٣		٤	
المستفيد:	التكاليف (مليون جنيه)	النسبة المئوية	التكاليف (مليون جنيه)	النسبة المئوية	التكاليف (مليون جنيه)	النسبة المئوية	التكاليف (مليون جنيه)	النسبة المئوية
الزراعة الحالية	٤٦١,٣	٨٣,١	٦٢٤,٠	٧٨,٨	٤٤٤,٨	٨٠,١	٥٩٥,٢	٧٥,٢
الزراعة الجديدة	٠,٠	٠,٠	٠,٠	٠,٠	٣٧,٩	٦,٨	٦٨,٦	٨,٧
مياه الشرب	١,٢	٠,٢	١,٣	٠,٢	١,١	٠,٢	١,٢	٠,٢
الملاحة	٢٧,٠	٤,٩	٣٦,٦	٤,٦	٢١,٣	٣,٨	٢٨,٨	٣,٦
الكهرباء	٩,٩	١,٨	٢٨,٨	٣,٦	٧,٨	١,٤	٢٢,٥	٢,٨
النقل البرى (الجسور)	٨,٧	١,٦	١١,٣	١,٤	٦,٥	١,٢	٨,٣	١,١
السياحة النهرية والترفيه	٤١,٩	٧,٦	٨١,٤	١٠,٣	٣١,٧	٥,٧	٦٠,٦	٧,٧
الثروة السمكية	١,٢	٠,٢	٢,٠	٠,٢	٠,٩	٠,٢	١,٥	٠,٢
الحماية من الفيضان	٣,٨	٠,٧	٦,٤	٠,٨	٣,٠	٠,٥	٥,٠	٠,٦
إجمـــــالى	٥٥٥,٠	١٠٠,٠	٧٩١,٧	١٠٠,٠	٥٥٥,٠	١٠٠,٠	٧٩١,٧	١٠٠,٠

الأول . وبنفس النمط يختلف إجمالى التكاليف والنسب المئوية لنصيب القطاعات المستفيدة بالنسبة لسيناريو ٢ وسيناريو ٤ .

تقدير تكاليف مياه الرى للفدان ولوحدة المياه

يعطى جدول ٢ تكاليف مياه الرى للفدان من الأراضى الزراعية الحالية ولكل ١٠٠٠ متر مكعب من المياه المستخدمة فى الرى وتدخل ضمن هذه التكاليف الصرف الزراعى. ويبلغ متوسط التكاليف السنوية ٧٥ جنيه فى سيناريو ١ و ٧٣ جنيه فى سيناريو ٣ . وفى حالة زيادة تكاليف الشبكة لرفع مستوى صيانتها يكون متوسط التكاليف السنوية للفدان ١٠٩ جنيه فى سيناريو ٢ و ١٠٥ جنيه فى سيناريو ٤ . وفى المقابل يكون متوسط التكاليف لكل ١٠٠٠ متر مكعب من المياه حوالى ١١ جنيه فى سيناريو١ و ١٠ جنيه فى سيناريو ٣ وتزيد هذه التكاليف إلى حوالي ١٥ جنيه بالنسبة لسيناريو ٢ وسيناريو ٤ .

جدول ٢: المتوسط السنوى لتكاليف مياه الرى للأراضى الزراعية الحالية

سيناريو	متوسط التكاليف السنوية للفدان جنيه / فدان	متوسط التكاليف السنوية لوحدة المياه جنيه / ١٠٠٠ متر مكعب
١	٧٥,٢٢	١٠,٦٦
٢	١٠٩,١٧	١٥,٤٧
٣	٧٢,١٧	١٠,٣٠
٤	١٠٤,٨١	١٤,٨٥

تطبيق خطة إستعاضة تكاليف مياه الرى

من الضرورى قبل وضع خطة إستعاضة تكاليف مياه الرى إتخاذ عدة خطوات قانونية وسياسية وفنية وادارية وأن تقوم وزارة الأشغال العامة والموارد المائية بالمبادرة لدراسة شبكة الرى لمعرفة الوسائل الكفيلة برفع كفاءتها. كما يجب تقرير ما إذا كان الفلاح سيتحمل جميع هذه التكاليف بمفرده أم بالمشاركة مع الدولة بنسبة محددة وأيضاً مدى قدرة الفلاح فى المناطق المختلفة بجمهورية مصر العربية على تحمل هذه التكاليف سواء نقداً أو بالإلتزام بتسليم قدر يتفق عليه من محصول زراعى معين للدولة تقوم هى ببيعه وهى طريقة متبعة فى بعض الدول النامية.

الخلاصة

تم فى هذا الملخص شرح الغرض من دراسة تحديد تكاليف إدارة وصيانة وإحلال وتحديث شبكة الرى الرئيسية فى مصر فى الوضع الحالى وفى حالة رفع كاف لمستواها. إشترك فى هذه الدراسة نخبة من

المتخصصين فى مجالات مختلفة كالهندسة والإقتصاد والنماذج الرياضية مع التعاون الوفير من وزارة الأشغال العامة والموارد المائية وهيئة المعونة الأمريكية.

أثبتت الدراسة أن المتوسط السنوى لتكاليف إدارة وصيانة وإحلال وتحديث شبكة الرى علي مستوى الجمهورية لغرض الرى هو ٧٥ جنيه للفدان بأسعار ديسمبر ١٩٩١ . ويزيد هذا المتوسط إلى ١٠٩ جنيه للفدان فى حالة الادارة والصيانة المتميزة وفى المقابل تكون تكلفة المياه لكل ١٠٠٠ متر مكعب حوا لى ١١ جنيه و ١٦ جنيه لكل حالة على التوالى.

بالمقارنة فإن التكلفة المحسوبة تقارب التكلفة على المستوى العالمى لصيانة شبكة رى كبيرة بهذا القدر . بالإضافة فإنه يظهر من دراسة الفوائد الزراعية بإن الفلاح لديه القدرة المالية لتحمل الجزء الأكبر من هذه التكاليف إن لم يكن كلها وذلك طالما إرتفعت اسعار حاصلاته الزراعية إلى مستوى السوق العالمية وفى الحقيقة فإن ما سيعود على الفلاحين من فوائد نتيجة إتباع السياسة الجديدة للدولة بتحرير اسعار السلع الزراعية بالكامل والمتوقع تطبيقها فى السنة المالية ٩٢/١٩٩٣ يفوق بكثير مقدار ما يساهمون به فى تكاليف تحسين شبكة الرى وبالتالى فى زيادة إنتاجهم الزراعى.

ENGLISH SUMMARY

Background

Two considerations provided the motivation for this study of operation, maintenance, and rehabilitation (OM&R) costs of Egypt's Nile River irrigation system. The first consideration relates to the deteriorating operating condition of the numerous structures which make up the system. Most existing structures have been in place for many years. It is thought that improved water delivery performance—and therefore improved agricultural productivity—might be achieved by a general program of enhanced repair, replacement, and rehabilitation of the system's structural components. However, for years government budget allocations have been restricted, both for regular irrigation system maintenance and for rehabilitation and improvements to structural components. Both the responsible Ministry staff and international donor agencies think the irrigation system performance falls short of acceptable levels.

The second consideration derives from the major changes in financial policies being instituted by the Government of the Arab Republic of Egypt (GOARE), particularly toward the agricultural sector. New policies will allow farmers to sell more freely in open markets and permit most farm commodity prices to move toward international free market levels. These new policies are replacing a program requiring mandatory sales of major farm products to the government at low prices. Most of the farm sector's contributions to government revenues previously came from the government's resale of commodities on domestic or world markets at higher prices. The new pricing policies leave the GOARE seeking new revenue sources to replace the old mechanisms.

These two considerations have brought forth proposals for a program of enhanced spending on irrigation OM&R to improve system performance, together with suggestions that part or all of these expenditures be directly recovered from the agricultural sector. However, before such programs can be brought forth for serious public discussion and debate, further information is required. The first level need is for improved information on the costs of operating and maintaining the existing irrigation system as well as the agricultural sector's proper share of these costs. The second need is for estimating the costs of an "adequate" OM&R program as well as, again, the farm sector's appropriate portion of the costs. This study attempts to provide this required information.

Objectives and Scope of the Study

The overall objective of this study is to determine the net OM&R costs of the main irrigation and water supply system in Egypt, as it is currently supported, and what those costs might be under an enhanced or "acceptable" budget allocation. The analysis is limited to OM&R costs of the "main system," defined as the Nile River structures and the main and secondary canals, and excludes the "on-farm" portions (*mesqas* and below). The study was conducted for each of four policy scenarios. The first scenario reflects the recent and current budget allocations for OM&R in Egypt. Scenario 2 considers the costs of the system if improved to an "adequate" degree. The third and fourth scenarios incorporate planned reclamation of not yet developed "new new lands" into each of the first two scenarios.

Four Scenarios

For each scenario, the general approach of the study involved two stages. The first stage was to estimate systemwide OM&R costs for all water use sectors, or purposes. The second stage was to divide up or allocate the costs among the various purposes in order to isolate the specific portion due to the irrigation sector.

A more precise explanation of the four scenarios follows:

Scenario 1: This scenario represents the present water supply system, which delivers water to the old lands and the recently developed new lands (designated in this study as the "old new lands"). Scenario 1 is designed to reflect current or recent budget policy for expenditures on OM&R.

Scenario 2: This scenario incorporates the same geographic coverage as Scenario 1, but involves an OM&R policy upgraded to an "adequate" level for long-term sustainability. The improvements include: a) additional regulating and control structures; b) improved maintenance of existing canals, drains, and water regulating and control structures; and c) a program for more rapidly replacing deteriorating water control structures and pumping stations.

Scenario 3: This scenario represents the same budget policy as Scenario 1, but incorporates potential new lands. (Potential new lands ["new new lands"] refer to developments currently proposed, but not yet reclaimed.)

Scenario 4: This scenario modifies the "adequate" OM&R budget policy of Scenario 2 to include the new new lands referred to in Scenario 3.

Cost Estimation Procedures

Cost estimates are expressed in annual terms, so that they can later be presented in per feddan and per thousand cubic meters. Basic data for the cost estimates for Scenario 1 were derived from official government records of actual expenditures in the latest five-year period. Cost estimates for Scenario 2 were taken from the Irrigation Improvement (IIP), Structural Replacement (SR), and Preventive Maintenance (PM) programs. Information also was taken from the Five Year GOARE Plan, 1992/1993—1996/1997. No additional costs were required for Scenario 3 and Scenario 4.

Cost estimates were developed for three categories, namely personnel, recurrent maintenance costs, and durable capital investments. Expenditure data for each of the last five years was inflated to the base (current) year and averaged to derive an annual average cost at the current price level. Recurrent or variable costs (such as for expendables or labor) were treated in annual terms. Investments in durable capital were annualized according to their expected useful lifetimes within a 30-year planning period. Supplementary data sources included responses from a questionnaire mailed to each of the 22 irrigation directorates in the system.

Irrigation sector costs were broken down into regional detail. Separate irrigation cost estimates were derived for each of the following five regions: Upper Egypt, Middle Egypt, East Delta, Central Delta, and West Delta.

Cost Allocation among Water Service Sectors

The objective of the cost-allocation exercise was to provide the basis for an eventual irrigation cost recovery program. Considerable effort was devoted to carefully allocating costs to the appropriate water-use sectors (purposes) to assign irrigated agriculture its fair share. The following sectors were considered in the cost allocation: irrigation, rural water supply, navigation, hydropower, ground transportation, recreation and tourism, fishery, and flood control.

It is important to recognize that water supply to the major urban centers and major industries was not considered. The analysis assumes that the Nile water supply system provides no significant improvements to the water supply situation of the major metropolitan centers, i.e., Cairo and Alexandria, or industries drawing water directly from the Nile. This conclusion rests on the evidence that these municipal and industrial demands are met even in low-flow years.

The criteria for choosing a cost allocation procedure are economic efficiency (getting the most value of output for the value of inputs) and equity (fairness). Although some degree of arbitrariness is involved in any joint cost allocation procedure, one of two basic approaches is adopted in most cases. One approach, termed the "proportionate use of capacity" method), allocates costs according to physical measures such as water diversions, consumption, or required storage capacity. However, the capacity measure is ambiguous for non-consumptive uses such as hydropower or navigation. Furthermore, the method does not assure achievement of either economic efficiency or equity in the sharing of costs. For these reasons, the approach was rejected for this study.

The second approach, which was chosen for this study, allocates costs according to economic criteria. It is a version of what is called the "Separable Cost-Remaining Benefit" (SCRB) method. It is the procedure generally required for U.S. agencies by the U.S. Water Resources Council; World Bank authorities also recommended it. In the SCRB approach, costs are classified into two groups. Those costs which are incurred for a specific, identifiable, and separate purpose are allocated to that purpose. The other category, called joint costs (those which cannot be separated by specific service), are allocated in proportion to the lesser of remaining net benefits or the cost of the alternative single purpose project.

The overall conceptual approach and the specific definitions of cost categories imply that the costs derived in this study are heavily weighted toward the irrigation sector. This is because the costs of improving Egypt's irrigation system are mostly specific to and of benefit for the irrigation sector.

Benefit Estimation for Cost Allocation

To allocate joint costs according to the SCRB approach, monetary measures of incremental economic benefits (willingness to pay) for each water use sector or purpose are required. The cost allocation method specifies that benefits are incremental rather than total. The economic literature recommends several approaches to incremental benefit measurement. One approach measures benefits according to the incremental net income *with* as compared to *without* the proposed project. This approach is applied mainly to crop irrigation in this study, but is also applicable to other producers' goods. Another approach measures benefits as the cost of the most likely, economically feasible, alternative single-purpose project. This latter approach, called the alternative cost method, is applied in this study for most other sectors, including hydropower, water supply, and navigation.

Significant Assumptions

The following assumptions are described because they were of particular importance in determining the study results.

Interest rate: An interest rate of 12 percent in real (constant dollar) terms was selected. This is the World Bank's rate for appraising investments in Egypt. It is considered a reasonable estimate of the real social opportunity cost of capital in Egypt.

Price level: All prices date from December 1991, the time the study began.

Sunk capital investments not included: The costs of previous investments which are not incremental to a future OM&R program were treated as sunk costs and therefore not relevant to a future cost recovery policy. Costs which might be attributed to depreciation or replacement of long-lived main system investments, such as the High Aswan Dam (HAD) and the main canals, were assumed "sunk" and were ignored. This assumption was made because these structures are paid off; charging the present generation for investments which might not be replaced for several centuries would be inequitable. In general, prior costs of in-place durable capital structures were not considered for future cost recovery. In a similar way, budget allocations to service repayment of loans on previous irrigation investments were not considered estimated costs; they are financial transfers reflecting the sunk costs of prior investments. Therefore, only incremental OM&R costs, in addition to some system improvement investments, were considered.

Planning period: The sunk cost question is related to the issue of how long investment-type costs (for durable structures and equipment) are incorporated into the analysis. Cost estimation for a cost recovery policy was assumed a continuing process, envisioning a rolling five-year planning procedure. Thus, the only costs for durable investments included were those which would be included for the next five-year planning period. However, to derive costs of durable capital in annual terms for the cost estimation and allocation exercises, the estimated initial costs of these durables were annualized according to their expected service lifetimes over a 30-year planning period.

Secondary economic benefits not included: only direct benefits (those experienced by water users) were incorporated into the analysis. Secondary economic benefits, such as profits or value-added to the agribusiness sector, were not measured nor included in the benefit estimates for the cost allocation study. This follows current international agency procedures which recognize that purported secondary benefits (value added) are actually, from the total society's perspective, costs which must be paid to suppliers of capital and labor. They are not therefore excess profits which can pay for water system improvements.

Economic disbenefits ignored: "external" or "spillover" costs, which are actually damages or disbenefits to third parties (e.g., water pollution damages), often arise in connection with municipal water use, industries, and agriculture. They play an important role in environmental management theory. However, they usually arise from diffuse sources, and assessing individual or even sector responsibility through a water pollution tax is difficult on both technical and policy grounds. Moreover, the study team encountered no instance of external costs assessed as specific costs in any developing country. Hence, disbenefits were not considered. (One minor qualification is warranted regarding drainage of irrigated lands. Drainage programs arise in response to irrigation-induced externalities—waterlogging and salinization. In this study, they are charged to irrigation.)

Constraints to Cost Recovery Mechanisms

The main report contains a preliminary analysis of issues which could arise in connection with selecting and implementing a cost recovery program. Constraints to development of cost-sharing programs are identified, potential alternative mechanisms are listed and evaluated, and additional steps required for implementation are suggested.

Constraints may include technical, economic, administrative, political, and social issues, among others. A major technical obstacle is the difficulty in measuring water deliveries; the irrigation authority would encounter problems in linking water charges to actual water receipts. (Because the technology for water measurement is well-known, this obstacle might be identified as an economic one, with the cost of measurement the primary question.)

The farmers' attitude toward paying for water is a primary social constraint. Religious and cultural considerations, to say nothing of individual self-interest, bring forth significant objections to cost-sharing by farmers. Another social obstacle is the problem of achieving sustained group action among farmers along tertiary watercourses, brought about by conflicting interests among head-enders and tail-enders and by differences in social and economic status.

The major economic constraint is ability of farmers to pay for water. For small holders or tenant farmers of limited wealth, any new charge will be challenged as a threat to their economic well-being.

Potential Charging Mechanisms

A concern which must be addressed before selecting a charging mechanism is to identify the goals of a cost recovery policy. If the policy goal is merely to find a different way to collect more revenues, then policymakers should select the simplest and most effective method which is palatable to farmers and the Ministry. If cost recovery is only part of a broader program to encourage economic efficiency, equity, and improved people management where the water delivery system and the farmers interact, then policymakers should consider more complex programs in which cost recovery is only one of many public purposes. This section assumes a broad program, and views the definition of water rights for farmers and methods of enforcement of those rights as key questions in improved water management along mesqas and in farmers' fields.

Two broad categories of charging instruments may be considered. The first focuses on land area served, and may be based on *feddans* of land irrigated annually or seasonally. Charging rates might be varied according to farm size. A further refinement would be to vary charges by crops, according to their water use. Flat land charges are relatively easy and inexpensive to administer, but fail to penalize those who do not make the best economic use of the water in irrigation practices or choice of crops.

The other category would be some sort of volumetric charge. This approach requires both the resources and the political will to measure the water used and to charge accordingly. While it encourages economically efficient water use, and is fair in the sense that each user pays according to what he draws from the system, the cost of measurement and revenue collection and the adverse social attitudes toward water pricing represent significant drawbacks.

A combination of the two approaches might provide a suitable compromise. This could consist of a flat area charge together with a water rights or quota system emphasizing that farmers' water rights are limited to their proportionate share of the country's scarce water entitlement. A special additional land tax would recover the costs for this alternative. Each farmer's limited water quota would force careful, economical water use. From a broader policy perspective, policymakers might consider a drastic program revision in which the Ministry of Public Works Water Resources (MPWWR) is required to collect its own irrigation water revenues and only spend those revenues needed for OM&R. This approach would encourage the authority to obtain high levels of farmer contributions and streamline its own operational efficiency.

Implementation

Several steps are required for successful implementation. Legal and political actions are needed to draw up specific legal provisions authorizing cost recovery and to obtain parliamentary approval. Management initiatives might be necessary to assure that water supply officials fulfill their obligation for providing better water delivery. In this regard, farmers will only support an upgraded maintenance program if they perceive that system performance will improve as a result. Other steps include setting the exact rate to be recovered and the terms upon which it can be paid (cash or crops). A gradual phase-in would probably gain more acceptance than imposition of the entire cost recovery program in one year. Implementation of a long-term cost recovery program should anticipate price inflation, and include arrangements to have cost recovery mechanisms track changes in crop prices. Linking payment to a specified quantity of a major crop (or the equivalent cash value) has been the preferred solution in some countries.

Summary of Results

It should be reemphasized that the Separable Cost-Remaining Benefit (SCRB) method, which assigns separable or specific costs to the sector receiving the corresponding incremental benefits, largely dictates the proportion of costs assigned to the various service sectors. Because most of the benefits derived from the incremental cost to systems' OM&R accrue to the irrigated agriculture sector, the costs are mainly allocated to irrigation. This is particularly true under Scenario 2.

The results of the cost estimation and cost allocation efforts are summarized in Tables ES-1 and ES-2.

The bottom line of Table ES-1 shows the estimated joint costs for each of the four scenarios. For Scenarios 1 and 3, which represent multipurpose system expenditures under recent GOARE budget policies, the annual OM&R costs are estimated at Pounds Egyptian LE555.0 million.

In Scenario 1, 83.1 percent of annual system OM&R joint costs are allocated to the irrigated agriculture sector, while the next most significant costs, 7.6 percent are assigned to the River Tourism and Recreation sector. The remaining 9.3 percent of costs are charged to the other six sectors. Scenario 3, which represents the addition of new new lands to Scenario 1 assumptions, shows a decrease in the share to old agriculture, and a resultant increase in the other sectors.

Scenarios 2 and 4 reflect the estimated costs for providing an "adequate" level of OM&R expenditures. The sum of the joint system costs increase about 43 percent to LE791.7 million. The charges allocated to agriculture in Scenarios 2 and 4 increase significantly. The charges allocated to power also increase due to the installation of generating facilities at Esna. The percentage shares of the other sectors differ little from Scenarios 1 and 3.

Table ES-2 summarizes the average costs allocated to irrigated agriculture, first on a per feddan basis and then per 1,000 cubic meters (m^3). These are total costs including drainage.

Under current policies, the average cost to irrigated agriculture is about LE75 per feddan under Scenario 1 and LE73 per feddan under Scenario 3. The corresponding estimate under Scenario 2 is LE109 per feddan per year, and under Scenario 4 LE105 per feddan per year.

The cost per unit of water under Scenario 1 is estimated at about LE10.7 per 1,000 m^3 and about LE10.3 under Scenario 3. This cost would rise to about LE15.5 per 1,000 m^3 under Scenarios 2, and about LE14.8 under Scenario 4.

Table ES-1. Allocation of Annual OM&R Joint Costs to Beneficiary Sectors by Scenario (mil LE/Yr).

BENEFICIARY	Scen 1 (mil LE)	Scen 1 (%)	Scen 2 (mil LE)	Scen 2 (%)	Scen 3 (mil LE)	Scen 3 (%)	Scen 4 (mil LE)	Scen 4 (%)
Old Agriculture	461.3	83.1	624.0	78.8	444.8	80.1	595.2	75.2
New Agriculture	0.0	0.0	0.0	0.0	37.88	6.8	68.6	8.7
Rural Water Supply	1.2	0.2	1.3	0.2	1.1	0.2	1.2	0.2
Navigation	27.0	4.9	36.6	4.6	21.3	3.8	28.8	3.6
Hydro-Power	9.9	1.8	28.8	3.6	7.8	1.4	22.5	2.8
Ground Transport	8.7	1.6	11.3	1.4	6.5	1.2	8.3	1.1
River Tourism & Rec.	41.9	7.6	81.4	10.3	31.7	5.7	60.6	7.7
Fishery	1.2	0.2	2.0	0.2	0.9	0.2	1.5	0.2
Flood Control	3.8	0.7	6.4	0.8	3.0	0.5	5.0	0.6
TOTAL	555.0	100.0	791.7	100.0	555.0	100.0	791.7	100.0

Table ES-2 Average Annual OM&R Costs Allocated to Existing Agriculture

SCENARIO	COST/FED	COST/1000 M^3
1	75.22	10.66
2	109.17	15.47
3	72.72	10.30
4	104.81	14.85

This summary section has briefly described the motivation, objectives, procedures, and findings of a major study to determine the appropriate share for the irrigation sector of the costs of OM&R on Egypt's Nile River water supply system. Costs were determined under recent and current budget policy, and under a hypothetical "adequate" budgetary allocation. The study required the combined efforts of a large team of engineers, economists. and computer specialists, in addition to extensive cooperation from the MPWWR and USAID staffs over several months.

The findings suggest that the nationwide average annual OM&R expenditure, in December 1991 prices, allocatable for irrigation is about LE75 per feddan per year. This figure would rise to about LE109 per feddan under the "adequate" scenario (Scenario 2). The equivalent costs per 1,000 m^3 are about LE11 and LE16, respectively. These main system costs to farmers seem reasonable.

On a rough comparative basis, the costs under either scenario do not diverge much from international standards for large, multipurpose water supply systems. Moreover, it appears from our direct agricultural benefit studies that Egyptian farmers could pay most if not all of the estimated costs once prices for their crops reach international market levels. In fact, the added costs to farmers from full irrigation OM&R cost recovery would appear to be less than the added income from the policy change permitting farmers to receive market prices.

Conclusions

The major conclusions and recommendations of the study team are stated as follows:

1. The Nile River water delivery system in Egypt was divided into two major levels of hierarchy: five regions and the main stem of the river, including the HAD complex and the eight barrages below the dam. For the cost allocation process, joint works within each level of hierarchy are associated with a particular set of services. For Scenarios 1 and 3, all barrages on the main stem were treated as a single entity in the cost allocation process. However, for Scenarios 2 and 4, it was necessary to treat the Esna barrage as a separate unit because of the addition of hydroelectric generating facilities at the new barrage. In a similar way, it was necessary within the regions to identify and treat separately the navigable and non-navigable canals. For Scenarios 3

and 4, the new new agricultural lands were treated as additional geographical units in the cost allocation model. Although the system hierarchy outlined met the requirements of this study, with increased data additional spatial resolution could be added if necessary.

2. In terms of constant prices, the annual expenditures for OM&R on the existing system increased during the three water-short years of 1986-87 through 1988-89. However, during the last two years of the period, actual expenditures decreased by about five percent per year. If this trend continues it will inevitably result in deterioration of the system and loss of benefits.

3. In the present level of O&M (Scenario 1), personnel costs represent about 17 percent of total costs. The study team considers these costs reasonable; they do not indicate an excessively expensive bureaucratic structure. Although labor efficiency could doubtless be improved by some reductions or reallocation of the workforce, major cost savings could not be achieved.

4. Average replacement costs in Scenario 1 are low. They should be increased to adequately maintain the system.

5. Present maintenance costs are unusually high, indicating that parts of the system need replacement. An increase in replacement costs will produce a corresponding decrease in maintenance costs.

6. The findings suggest that the nationwide average annual OM&R costs of the main system allocatable to irrigation are about LE75 per feddan per year (in December 1991 prices). This figure would increase to about LE109 per feddan under Scenario 2. The main system costs to farmers seem reasonable and are not overly expensive by international standards. The equivalent costs per 1,000 m^3 are about LE11 and LE16, respectively.

7. The sensitivity studies indicated the relative sensitivities of the cost allocation results to variations in the benefits, costs, and discount rate. Sensitivities to joint cost estimates at various levels within the system hierarchy also were examined. From these results it is possible to identify points where emphasis should be placed in refining cost and benefit estimates.

8. On a rough comparative basis, the costs under either Scenario 1 and 2 are not out of line for large, multipurpose water supply systems. Moreover, it appears from our direct agricultural benefit studies that Egyptian farmers could pay most if not all of the estimated costs once prices for their crops reach international market levels. In fact, the added costs to farmers of a policy requiring full irrigation OM&R cost recovery would appear to be less than the added income from the policy change permitting farmers to receive market prices.

9. The application of a cost allocation model to the Nile River system is more of a continuing process than a definite conclusion. As insights are gained from use of the

model, it will be possible to evaluate data and specifications in terms of continually changing policies and social needs.

Recommendations

The findings of this report, which has required extensive research effort, could form the basis of an economically sound cost recovery program for Egypt's Nile River water supply system. The report and the value of the cost allocation model applied in it should be understood by GOARE officials and others influential in implementing a cost recovery program. In this regard, it is recommended that a workshop be held to discuss "where do we go from here." The workshop should not emphasize the technical details of cost allocation, but how the study results might be used to structure and implement a successful cost recovery program.

A task which must be performed before selecting a charging mechanism is the identification of goals that a cost recovery policy will satisfy. If the goal is merely to find a different way to collect more revenues, then policymakers should select the simplest, most effective method palatable to farmers and the Ministry. However, the cost recovery policy may be considered only a part of a broader program to encourage economic efficiency, equity, and improved people management at the point where the water delivery system and farmers interact. If this is the case, policymakers should consider more complex policies in which cost recovery is one of many public goals. This section takes the latter perspective, and assumes that the definition and methods of enforcement of water rights for farmers are the key questions in improved water management along mesqas and in farmers' fields.

Two broad categories of charging instruments may be considered. The first focuses on land area served, and may be based on feddans of land irrigated annually or seasonally. Charging rates might be varied according to farm size. A variation would be to determine charges by crops, according to their water use. Flat land charges are relatively easy and inexpensive to administer, but fail to penalize those who do not make best economic use of the water in irrigation practices or choice of crops.

The second category would be some sort of volumetric charge. This approach requires both the resources and the political will to measure the water used and to charge accordingly. While it encourages economically efficient water use, and is fair in the sense that each user pays according to what he draws from the system, the cost of measurement and revenue collection and the adverse social attitudes toward water pricing represent significant drawbacks.

A combination of the two approaches might provide a suitable compromise. This could consist of a flat area charge together with a water rights or quota system emphasizing that farmers' water rights are limited to their proportionate share of the country's scarce water entitlement. A special additional land tax would recover the costs for this alternative. Each farmer's limited water quota would force careful, economical water use. From a broader policy perspective, policymakers might consider a drastic program revision in which the MPWWR is required to collect its own irrigation water revenues and only spend those revenues needed for OM&R. This approach would encourage the authority to obtain high levels of farmer contributions and streamline its own operational efficiency.

Several steps are required for successful implementation. Legal and political actions are needed to draw up specific legal provisions authorizing cost recovery and to obtain Parliamentary approval. Management initiatives might be necessary to assure that water supply officials fulfill their obligation for providing better water delivery. Other steps include setting the exact rate to be recovered and the terms upon which it can be paid (cash or crops). A gradual phase-in would probably be more acceptable than would imposition of the entire cost recovery program in one year. Implementation of a long-term cost recovery program should anticipate price inflation, and include arrangements to have cost recovery mechanisms track changes in crop prices. Linking payment to a specified quantity of a major crop (or the equivalent cash value) has been the preferred solution in some countries.

Chapter 1

INTRODUCTION

1.1 Background

In spite of a harsh and unforgiving climate, human settlements have thrived in the lower reaches of the Nile River basin, in what is now Egypt, for thousands of years. The area is recognized by anthropologists as being one of the important "cradles of civilization". Yet, without the life-giving waters of the Nile, man could not long survive the dry, hot climate. The ancient Egyptians worshipped the Nile and gave thanks to their gods when the summer floods came. They also suffered much during the recurring periods of drought. The fact that the people of the Nile basin have survived so long and that civilization has been so successful attests to their ingenuity in managing the available land and water resources. Through this ingenuity they have met needs ranging from irrigation to household water supplies and even transportation.

As the population in the basin increased and as the demands of society became ever more complex and diverse, the requirements placed upon available water supplies continued to rise. Water was needed to irrigate vast areas of agricultural land, to generate electrical energy, to meet the growing demands of expanding villages and cities, and to provide a reliable and inexpensive means of transportation. Huge canals were constructed to convey water to thirsty crops, pipelines were installed to carry water for people and industry, and dams were built to regulate flows, divert water, and generate electricity. Thus, the waters of the Nile which once flowed relatively free to the sea are now captured, stored, and released in controlled quantities for a wide variety of human uses. A huge complex of dams, canals, pipelines and other means of conveyance, including the natural channels of the Nile River, now comprises one of the major river basin development systems in the world.

The heart of the water resources development system of the Nile River in Egypt is the High Aswan Dam (HAD). Built in the late 1960s, this dam annually traps and stores millions of cubic meters of runoff water in Lake Nasser. This water is then released in times of need to meet the requirements of hydroelectric power generation, navigation, water supply, irrigation, recreation, and water quality control. Barrages and pumps downstream from the HAD divert water to a complex system of canals which carry it to farms and villages in an irrigated area with an extent approaching seven million feddans. Many of the large canals also provide a means of transporting goods, supplies, and farm produce to and from various parts of the area. Lake Nasser and the Nile River channels below the HAD also support both private and commercial fishing.

As with all man-made systems, there is a continuing need for maintenance and modernization. Egypt now draws its full share of water from the generous Nile; it can continue to enlarge the area irrigated only by using available supplies with increasing efficiency. Continuous and adequate maintenance is required for the multipurpose HAD itself, the the navigation locks and control gates of several barrages downstream of the HAD, pumping stations, canal outlet and control works, canal embankments, open drains, and the many outfall structures in the system.

Weed control alone in the canals and drainage ditches is a major undertaking. For the system to meet the many purposes which it serves, efficient operation and high levels of maintenance are required.

As always, the waters of the Nile are available to anyone at no charge. However, the huge system which collects, stores, and delivers these waters to users in the right quantities, to the right locations, and at the right times is expensive to maintain, manage, and operate. For example, each year great quantities of weeds are removed from the canal banks and many worn structures are replaced.

How are these costs of operation, maintenance, and rehabilitation (OM&R) met? (To date they have been financed largely by the Government of the Arab Republic of Egypt [GOARE].) Are they being recovered in whole or in part from the system beneficiaries? To what extent are other sectors of the economy helping to meet these costs? Should an explicit cost recovery program be established? What proportions of the total OM&R costs should be borne by the various beneficiaries? This study was initiated to help answer some of these questions.

1.2 Concepts and Previous Research

Cost recovery can be defined as the process of directly or indirectly capturing some or all of the revenue supplied by Government to provide the services of a project. In the past, GOARE has recovered some system costs through taxation of irrigators and by crop management and artificial price controls for farm products. These practices, however, can seriously reduce farm production incentives. Carruthers and Clark (1981) state that a cost recovery program for irrigation water development projects has three important functions, namely, economic, financial, and social. The economic function is to ensure that resources (in this case water, land, and other related production inputs) are efficiently used by charging beneficiaries a price equivalent to the value that society places on the resources employed. The financial function is to cover the costs of the service provided. Finally, the social function is to foster the development of one economic sector (for example, the agricultural or farm sector) or region of the country by providing financial resources from elsewhere in the economy. Policies which promote this third function tend to mitigate the economic principles of the first two functions. Therefore the Government normally abandons this function when it is deemed that sufficient development has occurred.

Svendsen (1991) states that the purpose of a charging system for cost recovery is not an end in itself, but a way of achieving economic efficiency and equity within the national economy. He cites Small et al. (1986), who summarize the usefulness of a charging system for direct cost recovery from an irrigation development project as follows:

1. Irrigation efficiency is improved through:

   a. more efficient operation and maintenance of the irrigation facilities; and

   b. more efficient use of water by farmers.

2. Other Government objectives are promoted by:

a. improving irrigation investment decisions;

b. easing of the Government's direct financial burden; and

c. promoting increased equity in income distribution.

This study was undertaken to provide estimates of the OM&R costs for the Nile River system and to investigate the implications of allocating these costs among the various beneficiaries of the system. The analysis is limited to costs of the main system, defined as the Nile River structures and the main and secondary canals, and excludes the "on-farm" portions (*mesqas* and below). The study was conducted for each of four policy scenarios. Scenario 1 reflects the recent and current budget allocations for OM&R in Egypt. Scenario 2 reflects the costs of the system when improved to an "adequate" level. Scenarios 3 and 4 incorporate planned reclamation of undeveloped "new new lands" into each of the first two scenarios.

1.3 Objective

The broad objective of the study is to establish current and future cost requirements for operation, maintenance, and rehabilitation of the main system irrigation and drainage facilities in Egypt, and to explore various mechanisms to recover such costs from system beneficiaries. In the study, the costs of some major in-place facilities, such as the High Aswan Dam and existing canals, are treated as sunk costs. The justification is that through adequate maintenance these structures will continue to function for very long periods of time. Therefore, the capital costs for these structures are not included in the analysis.

1.4 Scope of Work

The following is the scope of work as originally designated:

1. Description of the Nile system in terms of function, operation, capacity, users, and indirect beneficiaries of the various components.
2. Classification of the irrigation system into levels of hierarchy that lend themself to phased development of cost-sharing programs from HAD to the field.
3. Collection of cost data for the major irrigation and drainage structures on the Nile River and main canals and drains.
4. Evaluation of the irrigation system's recurrent operation, maintenance, and rehabilitation (OM&R) cost budgets. Examination of the adequacy of OM&R procedures and budgets to sustain the system, per level of hierarchy. Determination of the gap between recurrent OM&R budgets and the funds required to operate, maintain, and rehabilitate the system at an adequate preventive maintenance level.
5. Allocation of the cost of multipurpose structures among various water use sectors, per level of hierarchy.

6. Allocation of the irrigation and drainage costs among direct (farmers) and secondary beneficiaries (agri-business) of irrigation water, per level of hierarchy.

7. Identification of constraints to development of cost-sharing programs at the various hierarchical levels of the irrigation system. Suggest appropriate charging mechanisms and additional steps required for implementation.

1.5 Study Team Composition

The study was funded by USAID through the Irrigation Support Project for Asia and the Near East (ISPAN). Peter Reiss, Technical Director of ISPAN, served as Project Coordinator.

In Egypt, the study team was led by the Egyptian consulting engineering firm of Elassiouti and Associates, with the principal being Ibrahim Elassiouti, Hydraulic Engineer. This firm acquired the services of four senior engineers, six staff engineers, a water resources economist to undertake the project, five ISPAN consultants, and a support team.

Senior Engineers:

- Mohamed Mohamedein, formerly First Undersecretary and Chairman of the Nile River Joint Commission—Senior Water Resources Planner.
- Yehia Sobhi, formerly with the Water Resources Planning Group, MPWWR—Financial Analyst.
- Sarwat Fahmy, formerly First Undersecretary and Chairman of EPADP—Senior Irrigation Engineer.
- Ahmed Mazen, formerly First Undersecretary and Head of Irrigation Department - Senior Irrigation Advisor.

Staff Engineers (Cairo University):

- Abdalla Bazaraa
- Ahmed Samy
- Mohamed Morsi
- Magdy Saleh
- Mohamed Elsherbini
- Ahmed Abul-Azm

Water Resources Economist:

- Raouf Khouzam, American University in Cairo.

Five Foreign Consultants (engaged by ISPAN):

- William Grenney—Engineer (water resources and environmental systems modeling)
- Parviz Hekmat—Engineer (cost estimation)
- Fletcher Riggs—Water Resources Economist (economics and institutions)
- Paul Riley—Engineer (water systems planning and management, cost allocation)
- Robert Young—Water Resource Economist (cost allocation and institutions)

Support Team:

- May Waly
- Ayman El-Degwey

Chapter 2

OVERVIEW OF THE NILE SYSTEM IN EGYPT

2.1 Introduction

The Nile River basin in Egypt receives essentially no rainfall. Thus, the basin depends almost entirely upon the river to provide water for diverse requirements, including irrigation, hydroelectric energy generation, inland navigation, rural and municipal water supplies, industrial supplies, recreation and tourism, and aquaculture for fish production. The river provides surface supplies and recharges groundwater aquifers which are pumped for many uses. From its source at Lake Plateau on the equator, the Nile River flows northward for a total distance of about 6,700 km. It flows across Egypt for more than 1,000 km before entering the Mediterranean Sea. Additional information on the Nile River system in Egypt is found in Appendix A.

2.2 System Description

The Nile River system is classified in this study according to the following hierarchy:

1. The High Aswan Dam (HAD) and the Old Aswan Dam;
2. The Nile River main channels, including barrages and pumps located on the main stem;
3. The main canals, open drains, pump stations, and associated structures within each directorate; and
4. Other canals and associated structures within each directorate.

2.2.1 High Aswan Dam (HAD)

The completion of the High Aswan Dam (HAD) in 1968 is the most recent major component of the system. The enormous storage in the reservoir formed by HAD (total storage 162 billion m^3, operational storage 90 billion m^3) is sufficient to make Egypt virtually independent of variations in the annual Nile flood. After nearly 7,000 years during which Egyptian farmers regularly suffered from the effects of annual droughts or floods, the impact of the dam on Egyptian agriculture was nothing less than revolutionary. It brought immense benefits from increased irrigation areas, greater crop intensities, and higher yields.

2.2.2 Main Channel and Barrages

Water delivery to the irrigated lands is based mainly on an extensive canal network. Water is supplied to the canals by several pumping stations and eight diversion barrages situated on the Nile River below the HAD Complex. The barrages are as follows:

- The Esna, Nag Hammadi, and Assuit barrages in the Nile valley
- The two Delta barrages at the bifurcation of the Damietta and Rosetta branches of the Nile;
- The Zifta and Faraskour barrages on the lower reaches of the Damietta branch, and the Edfina barrage near the outlet of the Rosetta branch.

These eight barrages provide water for about 80 percent of the irrigated area. The Faraskour and the Edfina barrages serve primarily as salinity intrusion barriers. The remaining 20 percent of the water is pumped directly from the Nile. There are at present approximately 670 irrigation pumping stations, of which about 400 are considered main pumping stations.

The pumping stations and barrages also serve navigation and rural water supply demands. Rural water supply includes water deliveries, both directly from the canals and from shallow groundwater aquifers recharged by the system, to individual residences, small villages, and towns within the irrigated regions, and specific industries not supplied directly from the river.

Hydropower is generated at the HAD and at the Old Aswan Dam. In the 10-year period 1980-81 to 1989-90, the average annual total quantity of electrical energy generated at these locations was 9.5 x 109 Kwh, with approximately one-third of this total from the Old Aswan Dam and the remainder from the HAD. The new Esna barrage which is currently under construction is being equipped with hydroelectric generators.

2.2.3 Irrigation System

As shown in Table 2.1*, the irrigation system is divided geographically into five regions: Upper Egypt, Middle Egypt, East Delta, Middle Delta, and West Delta. The Delta regions are situated in what is known as Lower Egypt. Except for the Fayoum area, the irrigated lands in Upper and Middle Egypt extend along both banks of the river. East Delta lands extend between the Damietta branch and the Suez Canal. Middle Delta lands extend between the two Nile branches. West Delta lands extend from the Rosetta branch to the western desert, where most newly reclaimed lands exist.

The basic administrative unit of the irrigation system is the directorate. Each directorate is responsible for the operation, maintenance, and rehabilitation of the irrigation system within its boundaries. At present there are 22 directorates within the existing irrigation system. The names of the directorates within each region are in Table 2.1.

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* Tables and figures appear at the end of the chapter.

2.2.3.1 Irrigation Canals

Between the HAD and the Mediterranean, barrages divide the Nile River channel into seven reaches (see Figure 2.1). All irrigation water diverted in the first reach of the river between the Old Aswan Dam and the Esna barrage is pumped. Pumping also occurs in some other reaches of the river. From the main canals (see Figure 2.2), the water flows consecutively through lower-order canals until it reaches the mesqas (distribution ditches to individual farmers), and eventually the on-farm ditches, or *marwas*. All canals upstream of the mesqas are part of the main system. The mesqas and marwas are owned, operated, and maintained by the farmers.

Table 2.2 shows the length of irrigation canals within each region classified in terms of channel bed width. The canals are equipped with many types of structures, including control, outlet, and transition works, flow regulators, tail-water escapes, weirs, and crossing structures (culverts, bridges, siphons, and aqueducts). The canal system within each directorate serves several purposes, including irrigation, navigation, and rural water supply.

2.2.3.2 Pump Stations

Pumps serve both irrigation and drainage needs. At present the system has about 400 main irrigation pump stations and about 100 drainage pump stations. The area served by a single station ranges between less than 100 feddans for irrigation to more than 100,000 feddans for drainage. Average discharge rates are about 6.5 cubic meters per second (m^3/sec) for irrigation and 20 m^3/sec for drainage. The range of pumping rates for drainage stations is less than 0.5 m^3/sec to a maximum of 75 m^3/sec.

2.2.4 Drainage System

The drainage works consists primarily of open drains, although the use of buried tile drains is increasing. The system is managed by a total of 5 central administrations, which are divided into 27 drainage directorates. It is noted that the drainage directorates are separate from the irrigation directorates. For this study, the entire drainage system is treated as a single component of the irrigation system. The rationale is that the drainage system can be regarded as responding to a collective problem, rather than serving the needs of specific directorates or individual farmers. In addition, detailed data on the drainage works is unavailable. However, a general description of the network of open drains, in terms of drain length as a function of bed width, is in Table 2.2. Drain terminal points are at the following locations:

- Irrigation canals (through mixing pumping stations)
- Nile River, including the two Delta branches
- Closed lakes (Lake Karoun and Wadi Rayan)
- Coastal lakes (Mariout, Manzala, and others)

- Mediterranean Sea
- Suez Canal

2.3 Administering the Nile System

The Ministry of Public Works and Water Resources (MPWWR) administers the Nile system and its irrigation and drainage structures. The Ministry schedules water releases from HAD, approves diversions from the system, and has the authority to implement national water quality legislation.

The MPWWR is directly responsible for the operation and maintenance of all public irrigation canals through its Irrigation Department (ID), and open drains through the Egyptian Public Authority for Drainage Projects (EPADP). The Weed Research Institute, which operates under the Water Research Center (WRC), provides technical support to both these agencies in weed control. Mesqa maintenance is the responsibility of farmers, who may undertake the work themselves, employ private contractors, or request the MPWWR to maintain the mesqas at their own expense. Where mesqa maintenance is unsatisfactory, the MPWWR has legal authority to perform the work at farmer expense. A brief description of the organizational structure of the Ministry and of the function of each of its units is in Appendix A. Appendix A also briefly discusses other ministries whose work relates to the Nile River system and their roles in fostering effective, multipurpose use of this resource.

2.4 Potential for Improving Performance in the Existing Irrigation System

The structural and administrative management system for water delivery from the Nile River is performing in a reasonably satisfactory fashion. There are only occasional reports that irrigated areas fail to receive expected water supplies due to problems with either structures or management.

However, most structural components in the system have been in place for many years, and some are beginning to deteriorate significantly. Many structures could well use improved technologies or designs. Moreover, budget limits in recent years have resulted in inadequate structure maintenance and replacement schedules.

Because this situation provides the justification for an enhanced OM&R program, the remainder of this section treats these issues in greater detail.

2.4.1 Operation

Although the HAD fully controls the flow of the Nile River, there is limited control over water distribution in the system. In many instances, main and secondary canal components which are required to serve areas of 10,000 feddans or larger operate without any effective control below the outlet. As a consequence, the tail-end of the command areas and some mesqas experience shortages of irrigation water. Waste and direct losses from canals in other parts of the system are substantial.

The principal canals operate continuously, while rotation is practiced at the command area level. Regulators are operated in accordance with the rotation schedule. In most cases, regulation is based on maintaining constant water levels downstream of regulators, with no specific control or flow measurement. Determination of levels is primarily based on experience. The flow is continuous during the rotation periods. In the three regions of lower Egypt, the system is run on an "on demand" basis, with farmers able to withdraw water at will, although there is some informal scheduling among the farmers during water shortages. Most farmers irrigate during the daylight hours only, even though the canals flow throughout the night.

The present irrigation system operates well when water supply is plentiful. However, it is vulnerable to major water shortages. The possibility that water shortages will occur in the future underscores the need to modernize the irrigation and drainage systems to ensure equitable and efficient water use.

2.4.2 Maintenance

Aquatic weeds are the most serious problem in irrigation and drainage channels, causing significant capacity losses. The types of aquatic weeds that grow in the channels are submersed, emersed, and mixed weeds. Floating weeds (mostly water hyacinth) are a major problem in the Nile River. They enter the irrigation system and major drains through the canal intakes at barrages.

The construction of HAD has greatly reduced the sediment load in the water below the dam and thus has reduced sediment deposits in the canals. However, the resulting increased penetration of water by sunlight has caused weeds to grow significantly in both canals and drains. Accordingly, maintenance requirements have shifted from silt removal to control of downstream weed propagation.

However, a traditional maintenance program oriented toward large-scale excavation of silt continued for sometime after the construction of HAD and before introduction of an integrated chemical/mechanical channel maintenance program. Through the prolonged practice of traditional maintenance, the backlog of pre-Aswan silt deposits in the canals was removed. A continuation of this program in subsequent years resulted in over-excavation and enlargement of canal sections. Over-excavation of channels reduces water flow velocity and creates conditions for increased aquatic weed growth.

Channel maintenance is generally carried out by the Irrigation Sector (IS) and the EPADP through contracts with four Public Excavation Companies (PECs). Until recently, maintenance of irrigation canals and drains was performed by a combination of mechanical weed mowing, chemical treatment, and desilting activities. However, the use of chemicals was banned by the Government in December 1990. At present, a new strategy based on the use of mechanical mowing is being formulated for future maintenance.

Weed control based exclusively on mechanical removal of biomass would be expensive and would require a large amount of specialized equipment with mowing attachments. In addition, implementation of such a program would require improvement and/or construction of a service road network that would allow transport and operation of the mowing equipment.

The majority of pump stations in Egypt are more than 20 years old and therefore require frequent repairs and overhauls. Shortage of spare parts is a major constraint on maintenance. The shortage is partly due to the limited foreign exchange allocation for imports, and partly to the diverse mix of makes and standards of equipment. The need for spare parts is progressively increasing as the age of the pumps and engines rise. The unavailability of standby units in most pumping stations creates two further difficulties. First, the dependability of the water supply from the pumps has been reduced. Second, the old existing pumps have to run more hours, causing more breakdowns and further increasing the need for repairs and spare parts.

2.4.3 Replacement

The present system includes a wide range of structures from HAD to small irrigation intakes. In the past, budgetary and other constraints have prevented adequate maintenance of many of these structures, although the HAD, major barrages, and large structures have received a relatively high degree of maintenance and are in good to fair condition. However, inadequate maintenance has resulted in the deterioration of many other structures to the degree that they must be replaced. Under the Structural Replacement Component of the Irrigation Management Systems Project, more than 16,000 small and medium structures for irrigation canals of up to 30 m^3/sec capacity have been replaced. Work is currently underway to replace the backlog of many deteriorated small and medium structures. Very few large structures have been replaced.

2.4.4 Implications

This situation presents Egypt with a pressing need to improve the operating effectiveness of its irrigation system. In the absence of enhanced OM&R programs, the country's important farm sector cannot achieve its full potential for productivity. A worst-case scenario might be the possible failure of significant system components, with associated losses to crop production. In particular, expenditures to increase the number of regulators and turnouts on the lower branches of the system will pay dividends in increased water to tail-end farmers and, accordingly, increased production. Repairs and rehabilitation of larger structures will reduce the risk of failure of components throughout the system.

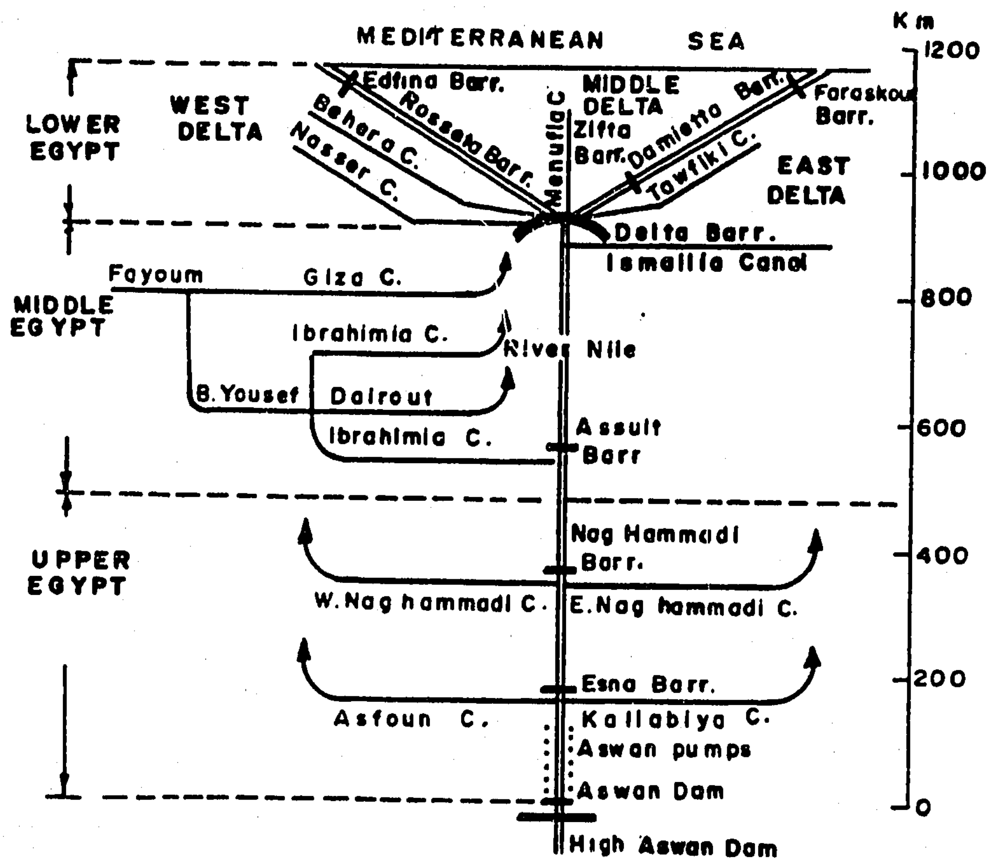

Figure 2.1 Schematic Diagram of the Irrigation System

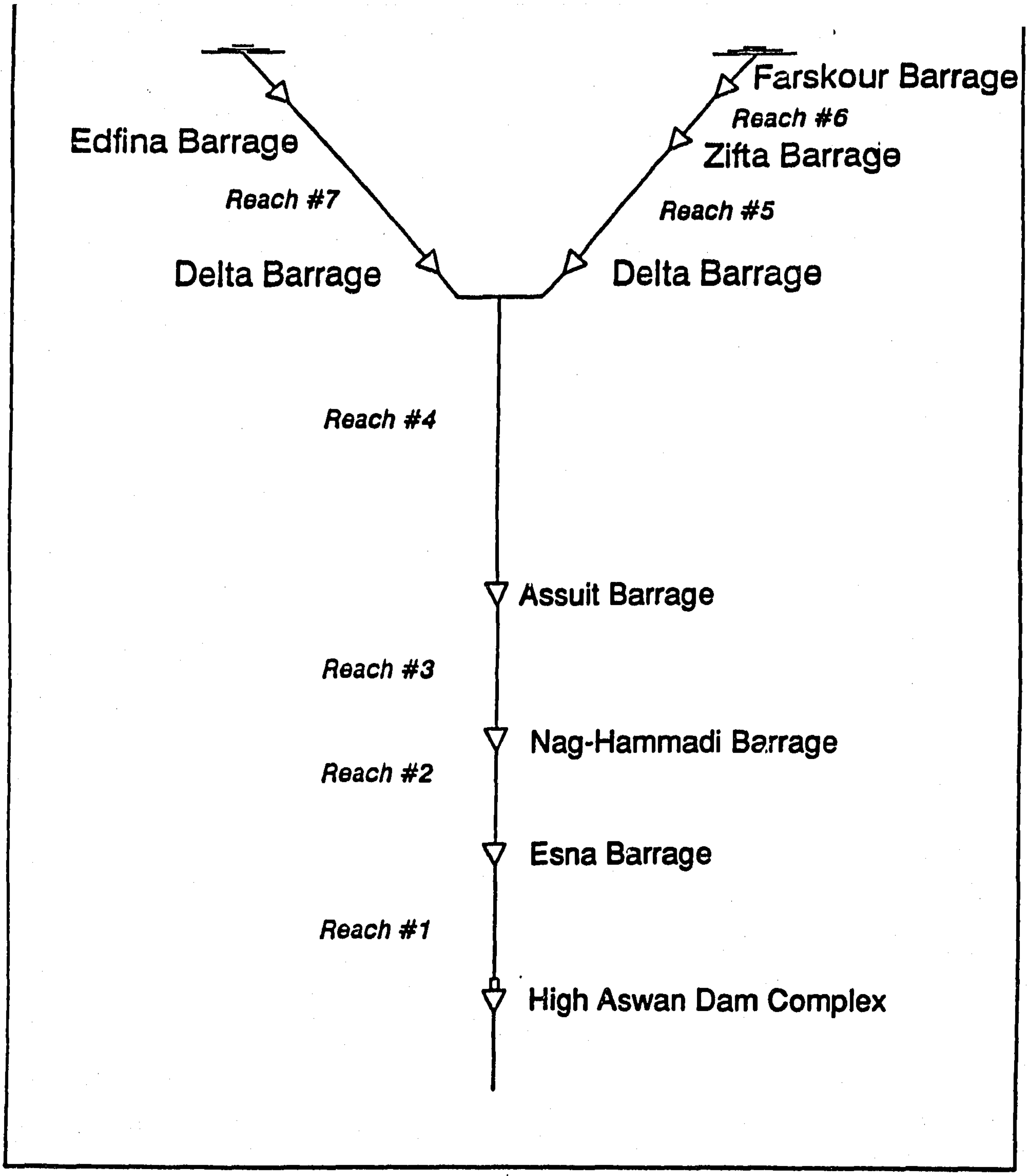

Figure 2.2 Schematic Diagram for the Nile Reaches

Table 2.1 Irrigation Directorates within the Five Regions of the Nile System

Region	Directorates
Upper Egypt	Aswan
	Kena
	Souhag
Middle Egypt	Assuit
	El Minnia
	Beni Suef
	El Fayoum
	Giza
East Delta	El Kalubia
	El Ismailia
	El Sharkia and El Salhia
	E. El Dakahlia
Middle Delta	El Menufia
	El Gharbia
	Kafr El Sheikh
	W. El Dakahlia
West Delta	El Behera and W. El Behera
	Behera
	El Nobaria and El Nasr

Table 2.2 Approximate Canal and Open Drain Lengths (Km) by Region

Region	Function	Bed Width (m)					Total
		<2	2-5	5-10	>10 Non Nav	> 10 Nav	
Upper Egypt	Canals	1992	3281	550	350	---	6173
	Open Drains	709	676	252	---	---	1637
Middle Egypt	Canals	3802	2638	727	214	57	7438
	Open Drains	2908	535	288	159	---	3890
East Delta	Canals	2499	3161	930	372	291	7253
	Open Drains	1301	1995	338	290	115	4039
Middle Delta	Canals	1766	2226	863	197	457	5509
	Open Drains	2656	1130	313	130	54	4283
West Delta	Canals	1348	1312	308	173	249	3390
	Open Drains	1063	1415	266	93	---	2837
Totals	**Canals**	**11407**	**12618**	**3378**	**1306**	**1054**	**29763**
	Open Drains	**8637**	**5751**	**1457**	**672**	**169**	**16686**

Chapter 3

STUDY APPROACH

3.1 Introduction

The study plan involved three concurrent activities which are described in this section of the report. The activities are: 1) development of a cost allocation methodology; 2) estimation of project costs; and 3) estimation of project benefits. Application of the methodology to the Nile River system and the results of the study are described in subsequent sections of this report.

The first step was to clearly define the questions that need to be answered in developing a cost allocation methodology. Four scenarios were formulated. Scenario 1 provides the base conditions against which others are compared. It includes current levels of costs and benefits. Scenario 2 presents a situation where OM&R costs are increased from the present level to an "adequate" level. Benefits are increased by the incremental amount that would be expected from the operation of an improved system. Scenario 3 is an extension of Scenario 1. It includes the expansion of irrigation into currently undeveloped (new new) lands. Costs and benefits for Scenario 3 are based on current levels of expenditures. Scenario 4 modifies Scenario 2 to include the new new lands.

The second step was to evaluate, select, and implement a cost allocation procedure. The purpose of the procedure is to allocate the project costs equitably among the project uses. These uses include: irrigated agriculture, rural water supply, navigation, flood control, commercial fishing, hydropower, river tourism, and river crossings for ground transportation. In addition, the costs to irrigated agriculture, rural water supply, and navigation are distributed among five geographical regions. The Adjusted Separable Cost Remaining Benefit (ASCRB) was selected for the cost allocation. To apply the ASCRB, costs must be estimated for the system services and benefits must be estimated for each system use.

An extensive effort was devoted to collecting cost data and estimating the incremental costs associated with enhancement of the current OM&R programs. Costs were summarized in three separate categories: capital costs for replacement and rehabilitation, non-personnel costs for OM&R, and personnel costs. These costs were further classified as specific costs (costs associated solely for a single use, such as power transmission lines) and joint costs (costs associated with more than a single use, such as the HAD). For reasons described later in this section, historical capital costs for the existing physical infrastructure were considered to be sunk costs; these costs were not included in the costs allocated to the various users.

The third step was to estimate benefits derived from both the existing level of OM&R and for the incremental increase that could be expected to accompany an elevated level of OM&R. Benefits were attributed to each user (beneficiary) of the system. Several approaches for calculating benefits are available. The best approach to use in a particular instance depends upon the type of benefit involved. Methods used to estimate benefits for each use are described in this section.

3.2 Description of Study Scenarios

3.2.1 Scenario 1

This scenario is defined as the present system, which supplies water to the old lands and the recently developed new lands (designated as the old new lands). Existing levels of OM&R inputs are assumed. This scenario raises the problem of identifying the incremental benefits associated with the present project. In other words, what benefits would be expected in the absence of the system? The issue is complicated by the fact that water resource development along the Nile River has occurred over a very long period of time (see Annex II). The study team decided to assume as sunk costs the capital costs for the construction of HAD and all the canals. The capital costs for these facilities were, in effect, excluded from the costs of the present system. It was further assumed that without a regular operating and maintenance program for these facilities, the entire system would eventually fail and cease to provide benefits. However, there are associated benefits under a program which provides a certain level of operation and maintenance inputs. Thus, it is assumed that, under Scenario 1, the current estimated annual OM&R costs correspond with the current annual benefits provided by the system.

The basis for the sunk cost assumption is that with appropriate maintenance, HAD and the canals will perform satisfactorily for a very long time. For example, the "dead" storage at HAD was designed to provide for silt accumulation over a period of 500 years. Obviously, at a certain time in the past, society paid a price for these structures. It is difficult to justify assessing the present generation for replacement costs of structures which likely will not need replacement until an indefinite time far in the future. Indeed, it is impossible to predict whether eventual replacement will be needed or will even be feasible. Thus, the study only assumed OM&R costs for these structures. The costs of the main stem diversion barrages also are assumed to be sunk. However, as these structures are replaced, as in the case of the Esna barrage, capital charges (R) are assumed from the time of replacement over a project life of 30 years and at a 12 percent discount rate. A capital (or replacement) charge is levied against all other physical works in the system, including pumps, flow control structures, and turnouts.

3.2.2 Scenario 2

This scenario involves a preventive maintenance program under which OM&R inputs are increased from the present level to an adequate level. Total joint costs and benefits are used, i.e., present levels plus the estimated incremental values of an adequate maintenance program. Agriculture is the primary beneficiary from the incremental inputs, although there is a slight increase in hydropower benefits resulting from the construction of the new Esna barrage. There is also some increase in navigation benefits because of the improved lock facilities at the Esna barrage. These increased benefits for agriculture, hydropower, and navigation are included in the cost allocation analysis for Scenario 2.

Because this study involves only the main water delivery system (the mesqa distribution ditches and the on-farm ditches are excluded), increased agricultural benefits result from increases in main system OM&R inputs. Thus, improved or replaced mesqas are not assumed. Increases in crop yields are assumed because of improved water delivery to the mesqas.

Crop yields for this scenario are taken from the results of the Irrigation Improvement Program (IIP) studies. In these studies, attainable yields under improved water management were estimated from observed yields in areas where water management was known to be good. For this study, it was assumed that good water management is now being achieved on about one-third of the total irrigated area. Thus, increased yield estimates from the IIP studies were applied uniformly to the remaining two-thirds of the irrigated area. To identify the increased benefits which might result from the adequate maintenance program of Scenario 2, no change in current agriculture cropping patterns was assumed.

The IIP studies assume significant improvements in the water delivery system at both the level of the mesqas and in the main system upstream from the mesqas. System improvements upstream involve the installation of additional flow control structures, channel improvements, and some night storage. These costs are included in Scenario 2 because increased water control within the main delivery system is directly linked to increased crop yields. For this reason, a schedule for implementing the system improvements was assumed, with the investments occurring over a 30-year period. However, because these costs represent only a small fraction (less than 10 percent) of the other incremental costs input to the system, agricultural benefits were not assumed to be linked to this investment schedule.

It might be argued that IIP main system costs, such as existing turnouts and other control structures in the canals, are actually specific to agriculture. It also might be argued that without the agricultural use the canals would not even exist. In any case, to be consistent with our treatment of existing in-canal works, the IIP costs are spread over other canal system facilities. They are allocated among system uses which, for the part of the system within regions, includes agriculture, rural water supply, and some navigation.

The costs of mesqa changes are borne by the individual farmers served and thus would enter the calculations of on-farm net benefits. However, as previously mentioned, for this study mesqa improvements are not included. It might be argued that some of the increased yields claimed for the preventive maintenance program of this study should be attributed to the mesqa improvements of the IIP studies. However, on a systemwide basis, some or all of these IIP changes are not needed. In addition, individual farmers are increasingly using diesel-powered pumps to draw water from subsurface and/or surface sources (mesqas or drains) on or adjacent to their farms. Pumped wells withdraw from the shallow aquifer which is, of course, recharged by the main distribution system. Through these practices, farmers can increase crop yields in the absence of mesqa improvements, providing there is adequate water delivery by the main system.

Current on-farm irrigation costs, including pumping, are included in the estimation of agricultural benefits. Other costs for this scenario involve mechanical weed control, a coordinated program of canal dredging, and regular replacement of turnouts and other water control structures. These costs are discussed in Sections 3.4 and Appendixes C and D of this report, and benefits are further discussed in Section 3.5 and Appendixes B and F.

3.2.3 Scenario 3

This scenario modifies the Scenario 1 system to enable delivery of water to new lands which are proposed for irrigation development. Because these new lands are not yet reclaimed, they are referred to as new new lands to distinguish them from the new lands which have been brought under irrigation since the 1950s (old new lands). Modifications include enlarged pumping and conveyance works, as needed. These costs are assigned as specific costs. Agriculture is assumed to be the only beneficiary of the development. Existing system joint costs involve canals, pumps, barrages, and HAD. Because the new new lands share in the costs of the existing system, costs for current users (Scenario 1 costs) are reduced. The portion of the costs of the existing system (Scenario 1) which should be borne by the new new lands as water delivery charges also are identified.

3.2.4 Scenario 4

This scenario modifies the Scenario 2 system to deliver water to new new lands which are currently proposed for irrigation development. In effect, this scenario is Scenario 3 under an adequate maintenance program. Like Scenario 3, it does not address the costs of the system modification or new land reclamation (both of which are specific to the new agriculture), but does identify the share of existing system costs which should be borne by the new new lands.

3.3 Cost Allocation Methodology

3.3.1 Alternative Procedures for Cost Allocation

A description of standard cost allocation criteria and procedures as applied to water resources projects is discussed at some length in Appendix B. This section summarizes these procedures. The problem of cost allocation arises in multipurpose projects because some costs cannot be easily identified with specific project purposes. Some costs are joint, i.e., a single element serves more than one purpose. An example is a dam which serves all project activities. Some way must be found, therefore, to allocate these costs among project purposes. A certain arbitrariness accompanies all cost allocation procedures, but several methods have been developed which for the most part address the problem.

The allocation of costs in a multipurpose project is important because it provides the basis for setting the prices or charges for project services. Price is significant for two reasons. First, it provides signals to beneficiaries on the scarcity of the service, and influences the economic efficiency on the use of project output. Second, the price controls how financing is raised and, consequently, how costs are distributed among beneficiaries, thereby affecting the distribution of income.

A distinction is made between cost allocation and cost sharing. Cost allocation refers to the largely technical process of dividing the total cost of a project among beneficiaries. Cost-sharing refers to the mainly political division of costs among beneficiaries (including the government), thus administratively establishing the relative amounts paid by the beneficiaries. The amount raised from beneficiaries is usually called the cost recovery. It is noted that cost allocation technicians normally prefer to concentrate on their technical task and to let the political process determine the eventual cost sharing and cost recovery procedures. This report is concerned with cost allocation.

As indicated in Appendix B, there are numerous possible methods for allocating the joint costs of water resources projects. These methods differ primarily on two considerations or dimensions. One dimension is the measurable unit on which costs are allocated, which can be either physical or economic. This measure is sometimes termed the allocation vehicle. The second dimension is the amount of cost to be allocated, which can consist of either total or only non-separable or joint costs.

Two broad approaches to cost allocation have received the most attention. The first is the Use of Facilities (UoF) or Proportionate Use of Capacity method. The UoF method adopts as its allocation vehicle a physical measure, such as reservoir capacity designated to a purpose, or the average annual amount of water diverted for the purpose. The UoF approach has most often been applied to total costs, although it has sometimes been used to allocate joint costs.

The second approach employs as its allocation vehicle some monetary measure of economic benefit. This measure may either be net benefit, least cost alternative, or the smaller of the two, which is often termed the justifiable cost. On the amount to be allocated, this approach usually selects joint costs. The most frequently used version of this approach is the Separable Cost Remaining Benefits (SCRB) method. In its recommended version, SCRB allocates joint costs proportionately to the smaller of net benefit or alternative cost. An important modification of this approach is the Adjusted Separable Costs-Remaining Benefits (ASCRB) procedure (see Appendix B).

There are also several highly sophisticated, theoretical approaches to cost allocation, based on the theory of games. The results of these studies have refined understanding of relevant issues, and have further specified the strengths and limitations of the various approaches. However, data and resource limitations prevented any applications of this nature in the present project.

3.3.2 Selection of Cost Allocation Procedure for Nile System

Gittinger (1982) recommends several guidelines for the cost allocation process to achieve economic efficiency and equity. Economic efficiency refers to the ratio of the value of outputs and the value of inputs, while equity refers to fairness in the distribution of total project costs among all users served by a multiple-purpose development. These criteria are summarized as follows:

1. The allocation to any purpose should not be less than the incremental cost of including that purpose in the plan. This incremental cost is usually called the separable cost. This criterion assures that no purpose is subsidized by another purpose.

2. No project purpose should be assigned a cost greater than the value of its justifiable cost. The justifiable cost can be measured either as the measure of its benefits, or the least-cost single-purpose alternative project for supplying the purpose, whichever is less. The least-cost alternative is incorporated: it would be inequitable to allocate to specific beneficiaries a cost greater than what they would incur without cooperating in a multipurpose scheme.

3. It is evident that the sum of cost allocations to purposes should equal total project costs.

4. The simplicity and workability of the procedure, although not critical factors, are also important. The chosen procedure must be accomplished within available resources. It should be simple enough to explain readily to representatives of beneficiary groups.

The UoF procedure has been criticized because it can violate either or both the first or second criteria. It may allocate costs to a purpose in excess of its net benefits and/or different from its separable or direct costs, thereby inadequately serving the cost-sharing goals of equity and economic efficiency. The UoF method also exhibits a certain arbitrariness in selecting a unit of measure. This shortcoming arises particularly when applied to non-consumptive purposes such as hydropower, navigation, or recreation. This procedure's advantage of simplicity and ease of application is outweighed by the possibility of inequitable, inefficient, or arbitrary results.

The SCRB approach, in contrast, was designed to avoid the problems of the UoF. It emphasizes the assignment of separable costs to their respective purposes (criterion 1), and assures that total assigned costs (separable plus allocated non-separable) do not exceed economic benefits (criterion 2). In the current study, the only system structure for which there are clearly identifiable separable costs is the HAD. Without separable costs, both the SCRB and the adjusted SCRB procedures simplify to the use of the justifiable cost proportions of the total project costs for each use sector. However, the procedure does not penalize sectors which earn benefits in excess of single-purpose alternative costs, as is the case for allocation on the basis of net benefits. Users are in no case penalized for participating in a multiple-purpose project.

The SCRB and ASCRB procedures may not be as simple to apply as the UoF method, but they adhere to the two principal objectives of cost allocation: economic efficiency and equity.

An equitable cost allocation fairly distributes among all project users the savings from multiple-purpose as compared to single-purpose development. It is noted that for nearly 40 years the U.S. Government has required use of the SCRB procedure for its water resources development projects. J.P. Gittinger of the World Bank recommends the SCRB method (including ASCRB) for cost allocation for water projects in his text, *Economic Appraisal of Agricultural Projects*. For these reasons, the decision was made to apply the ASCRB procedure in this study.

3.3.3 Definition of Project Costs and Benefits

Figure 3.1 depicts the cost allocation process for a project with three service sectors: irrigated agriculture, hydropower, and navigation. The project cost at the top of the figure is distributed among the service sectors at the bottom of the figure. The project cost is the cost of well-defined infrastructure. It includes the investment costs of physical works, operation and maintenance, rehabilitation, and management. A large water storage and delivery system may be composed of many projects, and the overall system may be disaggregated into a set of well-defined subsystems. To allocate costs among service sectors for the entire system, the cost allocation process may be applied to each project in the system, with the costs accumulated.

The project cost is divided into common works costs and specific costs. The term common works refers to the project infrastructure needed to create and operate two or more service sectors. It normally is a complex combination of structural and equipment components that are interdependent (that is, they depend upon each other to provide full functionality of the project infrastructure for all its service sectors). HAD is an obvious example of common works.

Specific cost refers to the cost for a facility that has the following characteristics:

- Its costs are identifiable and are included in the project cost.
- It functions exclusively for a single service sector.
- Other service sectors in the project would function as intended if this facility were absent.

An example of a specific cost is the electrical transmission line carrying power from a dam to the distribution system. Specific costs are assigned directly to the appropriate service sector, as indicated by the dashed lines in Figure 3.1.

The common works are divided into separable costs and joint costs. A separable cost is something which is "part" of the common works, but can be associated with a single service sector. There are two types of separable costs: separable cost of the common works and imputed costs. Separable cost of the common works refers to an identifiable facility which exists in conjunction with the common works, but functions for a single service sector. The penstock for hydropower is an example of a separable cost of the common works; it cannot exist without the presence of the common works. Imputed cost is the incremental cost to the common works of adding a particular service to a project containing all other services. It is calculated for each service by determining the added cost of providing that service over and above the cost of providing the remaining services. To calculate the imputed cost for a particular service, the cost of a structure which provides all of the remaining services is subtracted from the total cost of a structure at the same site which provides all services planned for the project.

The joint cost is the common works cost less the separable costs as indicated in Figure 3.1.

"Benefits" are the benefits attributed to each service sector as a result of the common works. Various alternative procedures are available for calculating the values of benefits (see Appendixes B and F). The selection of a particular benefit calculation method is limited by the availability of data necessary to make the calculations. The data requirements increase as the method becomes more sophisticated. Benefits are further discussed in Section 3.5.

"Single purpose alternative cost" is the cost of providing the same service with a single-purpose project in place of a multipurpose project. For example, the single-purpose cost for agriculture is the cost of a dam constructed solely for agriculture.

All costs and benefits are represented as present values in the cost allocation methodology. The benefits are compared to single-purpose alternative costs, and the lesser value is termed the justifiable cost. A service sector should not be assigned more than its justifiable cost. In other words, a particular service sector should not pay more for its share of the common works than either the benefits it receives or the costs of being separate. If no separable costs are identified for the common works, then the common works costs are allocated among the service sectors in direct proportion to their justifiable costs.

As might be expected, the classification of items into the mutually exclusive categories defined above requires a considerable amount of professional judgement. Consequently, a great deal of care must be taken to provide a consistent set of benefits, alternative costs, and separable costs to meet the criteria of economic efficiency and equity. As indicated at the bottom of Figure 3.1, the allocated costs (including separable costs) for each service sector are added to the specific costs for that sector to provide an estimate of the total sector costs.

3.3.4 Project Data Requirements for Cost Allocation

Data requirements for a study of this nature vary by the characteristics of the particular multiple-purpose project under investigation. At a minimum, sufficient data are required to obtain reasonable estimates of the following:

- all costs (operating, maintenance, and capital) associated with the physical features of the system;
- single-purpose alternative costs for each project use or purpose;
- benefits of the system for each project purpose.

It is noted that for cost allocation purposes, specific costs for a particular use (such as channel dredging costs for navigation) may not be required. However, it is important to identify all costs for the following reasons:

- to insure that they are properly categorized and are not overlooked in the analysis;
- to reach an appropriate estimate of total system costs for each use. For each use, specific, separable, and allocated joint costs are summed to reach an estimate of total costs.

This study collected a large amount of data. A wide variety of sources were used, including various government reports, the results of past studies, personal interviews, and information from questionnaires submitted to the irrigation and drainage directorates. Even so, in some cases the team members had to exercise considerable engineering judgment in reaching particular estimates. It should be emphasized, however, that this report describes the initial step in a continuing process rather than a final product. As data improves, the results of the cost allocation process will increase in accuracy.

Cost and benefit figures are expressed in December 1991 Egyptian pounds (LE). Future capital investments are discounted to the then-current rate of 12 percent. Capital investments in the past are increased on the basis of appropriate cost indices. All values are expressed in financial rather than economic terms. The general types of data collected for this study are indicated by Tables 3.1 and 3.2

3.4 Cost Estimation Methodology

Costs were estimated under Scenarios 1, 2, 3, and 4, the definitions of which are given in Section 3.2.

For each scenario, costs included the following cost categories:

- Capital Costs—The costs of development, improvements, rehabilitations, and replacements of system facilities
- Operation and Maintenance Costs—The costs of personnel and recurrent costs of facilities maintenance

The analyses did not include the costs of irrigation and drainage systems related to the mesqas and tile drains. The cost recovery for mesqas is the subject of another study and the costs of tile drains are currently being recovered under separate arrangements.

The annual costs of each scenario were estimated on the basis of constant prices in December 1992, the time of the study. The procedures for estimating costs under each scenario are described in the following sections.

3.4.1 Scenario 1

The costs of this scenario were estimated from governmental budgets detailing the actual annual costs incurred by the MPWWR. The input data were the official Ministry budget performance records, using the following budget classifications:

- Chapter 1 Salaries and wages of permanent staff
- Chapter 2 Recurrent costs of operation and maintenance
- Chapter 3 Capital costs of rehabilitation, replacement, development, and expansion as well as maintenance

Other input data were the annual costs incurred from nonbudgetary sources. These included foreign grants and the unpaid annual commitments, generally for channel maintenance and electricity, of various Ministry departments to private and public agencies.

The annual expenditures of the following Ministry departments and agencies were considered the annual costs of operation, maintenance, and rehabilitation of the system:

- Irrigation Department
- Mechanical and Electrical Department
- Egyptian Public Authority for Drainage Projects
- Aswan Dam Authority
- Water Research Center

To obtain more representative figures, estimates were based on the agencies' average annual costs over the past five years. Because Fiscal Year (FY) 1990-91 was the latest year with a complete record of actual costs, a five-year period from 1986-87 through 1990-91 was selected. This period corresponds to three years of low Nile flow, and the lowest levels at Lake Nasser in the recent past. Table C1.1 shows a summary of actual annual costs, in current prices, incurred by various MPWWR agencies. However, because a high rate of inflation and a devaluation of the Egyptian pound have had a major effect on costs, adjustments were necessary to determine a meaningful average annual cost. The following sections describe these conditions and the cost adjustments they required.

Cost Increases Due to Inflation

Construction costs in Egypt increased significantly from FY 1986-87 to December 1991. The indices for the wholesale prices of construction material, machinery and implements, and fuel (petroleum) are shown in Table 3.3. These indices indicate a rise of 247 percent in the cost of construction material, 233 percent in machinery and implements, and 366 percent in fuel. During the same period, the consumer price index increased by 245 percent and the rate of inflation (international inflation) in industrialized countries, major trading partners with Egypt, rose by more than 121 percent.

The price of fuel and electricity was heavily subsidized at the beginning of the five-year study period. However, government policy later shifted towards a gradual lifting of the subsidies. Consequently, the electricity rate increased by more than 660 percent during this period (Table C1.3). The sharp rise of the fuel index was also the direct result of this government policy.

Cost Adjustments

Annual costs—These were adjusted to December 1991 prices. Separate adjustments were made for each of the foreign and local currency portions of the expenditures. The foreign currency expenditures were for the import of goods and services from industrialized countries—prices were subject to inflation in those countries. The local currency expenditures were for the procurement of goods and services in Egypt, and were subject to local prices. Procedures that were used for adjustment of each foreign and local currency expense are described in the following sections.

Foreign currency—During the past few years the Egyptian pound has been devalued several times. At present, more Egyptian pounds are needed to pay for the import of a given set of foreign goods and services than were needed in FY 1986-87 (Table C1.4). To account for these changes, the foreign currency expenditures were adjusted by the rate of inflation in the industrialized countries and by the rate of exchange of the Egyptian pound. Two separate ratios were calculated of the rates in December 1991 corresponding to those prevailing during the fiscal year in which the foreign currency expenditures were incurred. The product of these two ratios was used to adjust the foreign currency expenditures.

Local currency—These costs were adjusted to December 1991 prices through a cost adjustment factor calculated with respect to the nature, composition, and proportion of inputs of plant and materials to the water works. The proportions of inputs were estimated and applied to the respective ratios of indices or prices of inputs in December 1991 to indices or prices prevailing in the fiscal year in which the respective costs were incurred. The resulting factors were used to adjust the local currency expenditures.

Cost adjustment factors—The factors derived for adjustment of foreign and local currencies were combined in proportion to actual expenditures in foreign and local currencies to arrive at composite cost adjustment factors for each fiscal year. Separate composite cost adjustment factors were calculated for construction and maintenance of civil and mechanical works. A summary of the cost adjustment factors is presented in Table 3.4.

Capital Costs

As mentioned in Section 3.2.1, the capital costs of the present system are regarded as sunk costs and are not included in this study. The annual costs incurred for rehabilitation and replacement of the existing facilities and structures were compiled and adjusted to constant December 1991 prices by applying the appropriate cost adjustment factors. The five-year average annual cost of these investments, including a ten percent contingency, are summarized in Table C1.5.

The capital costs incurred for horizontal expansion and modernization of the present system (channel maintenance) are not included in the cost analyses. These costs are not thought required to sustain the present level of service. However, they are presented in Table C3.5 to show the changes in total investment on the Nile system down to the mesqas.

Operation and Maintenance Costs

The annual operation and maintenance (O&M) costs incurred by various departments and agencies were compiled in two categories: personnel and non-personnel costs. The personnel costs include all salaries and salary-related costs of employees defined in Chapter 1 of the government budget. The annual cost of personnel for Scenario 1 was estimated by applying the average annual growth rate of personnel costs incurred during the study period up to FY 1990-91. This amount was then increased by five percent to allow for contingencies.

The non-personnel costs include recurrent costs of O&M defined in Chapter 2 of the government budget plus the respective capital costs incurred. The unpaid commitments of O&M, generally for channel maintenance and electricity, are also included in the non-personnel costs. The O&M costs of the mesqas are paid by the farmers and are not included. The annual non-personnel costs for the study period were inflated by applying the respective cost adjustment factors to produce the annual costs at constant prices. The average of the annual costs at constant prices was increased by 10 percent to account for contingencies.

A summary of estimated costs under Scenario 1 is given in Table C1.5. Detailed cost estimates are presented in Appendix D.

3.4.2 Scenario 2

This scenario analyzed the annual costs of upgrading the OM&R program for the present water supply system (which supplies the old lands and the old new lands) to an "adequate" level. The cost estimation is based on a 30-year planning horizon, envisioning rolling five-year planning periods beginning with the 1992-93 to 1997-98 Five Year Development Plan. As illustrated in Table C2.1, the costs of the proposed water resources development program for the 1992-97 plan were the basis of investments for these five years. The estimated cost of adequate replacements and rehabilitations of various system components with respect to the life expectancy of individual components were the basis of the investments in the subsequent 25 years. A comprehensive program for adequate operation and maintenance of the system was designed and an investment schedule for achieving its objectives was assumed. The present worth of all investments were calculated at an annual discount rate of 12 percent and annualized over a 30-year period.

The cost estimates required extensive systemwide data and information on physical conditions of various system components. The available information was limited, and in most instances the costs had to be approximated. Different contingency factors ranging from 10 to 25 percent were used, depending on the firmness of the available cost data for individual system components.

Capital Costs

This section outlines procedures for estimating the costs of proposed improvements of the irrigation system: replacement and rehabilitation of structures, pumping stations, buildings, and other investments in studies, research, and planning. These include activities under the Five Year Development Plan and the subsequent 25 years.

The costs of adequate replacement of the Nile system structures were estimated based on present conditions and the life expectancy of the structures. However, lack of information on the condition of some structures prevented uniform treatment. The life expectancy of a structure is very much dependent on workmanship during construction and subsequent maintenance.

The major structures on the Nile River are better maintained than other system structures and their condition is better known. At present, Esna Barrage is being replaced, Nag Hammadi Barrage is due for replacement under the 1992-97 Development Plan. It is estimated that replacement of Assuit and Zifta Barrages would be necessary in subsequent plans. The cost of replacing these barrages was estimated on the basis of the contracted construction cost of Esna Barrage adjusted to December 1991 prices, as illustrated by Table C2.2. The new Esna Barrage will have power plants; Nag Hammadi may also have them. Although power production may be feasible for the new barrages, as in the case of Esna Barrage, this study only estimated replacement of existing barrages.

At present, the smaller irrigation structures (up to about 30 m^3/sec discharge capacity) are being replaced under the Structural Replacement Project. A comprehensive inventory of these structures, together with replacement condition and costs, is available for each directorate. The actual cost of each structure that was built during the last five years was inflated to December 1991 prices. The average cost of each type of structure was then applied to the number of the corresponding structures in each directorate. The timing of the replacement of each structure was based on the recommendations of a condition inventory survey.

There is no record of recent replacement of structures with a discharge greater than 30 m^3/sec, nor is there information on their condition. Although these structures have generally received more care and attention than the smaller ones described above, their replacement during the next 30 years will inevitably be required. Eighty percent of these structures are bridges that need upgrading to 70 tons to match the newly adopted national bridge standard. Costs for this category of structures were estimated on the basis of larger structures recently replaced under the Structural Replacement Project. Figures used were average unit cost per discharge capacity or, in the case of bridges, cost per meter of span. Because the canal structures of the new old land are newer, it was assumed that they will not need replacement (see Table C2.3). Obviously, the estimated costs of these structures are approximate and will need revision when additional data become available.

The replacement costs of open drain structures were estimated by using the average cost of structures per feddan. A sample area of 87,700 feddans in East Dakahlia was selected and the actual average cost of its open drain structures was adjusted to constant December 1991 prices. Selection of this sample area was due merely to the availability of data. The annual replacement costs of drain structures were then calculated by applying the unit cost of structures per feddan to the open drain areas requiring replacements. These areas were determined from the construction year of the open drain and an assumed 30-year life expectancy of drain structures (see Tables C2.4 and C2.5).

The rehabilitation works proposed for the HAD, barrages, and intakes on the main stem of the Nile under the next five years of the development plan were assumed to continue at the same rate beyond the plan.

At present, the MPWWR Mechanical and Electrical Department (MED) is undertaking a condition inventory survey of pump houses, pumps, and engines. Data that are representative of the entire system will not become available during the span of this study. Instead of this data, the replacement plan for mechanical and electrical equipment and buildings proposed under the National Development Plan for the next five years is extended to the succeeding 25 years. According to MED, the proposed five-year plan corresponds well to the average replacement needs of the system.

Improvement of the main irrigation system is necessary to allow rational distribution of water and effective management and monitoring of the system. Additional control structures are needed, particularly in the old lands, for regulation and measurement of canal discharges. This program has particular significance for overall reduction of water demand, and has already begun as part of the IMS Project. Given the importance of water to Egypt and the savings that such a control system will bring, this program is expected to continue beyond the five-year plan. During the five-year plan, it is expected that improvement of the main irrigation network of 350,000 feddans will be completed. It was assumed that this program will continue at a faster pace as the need for additional water grows. A coverage of 5,500,000 feddans (old lands) by the end of the 30-year period was assumed. Based on the IIP experience, the average cost per feddan of such improvements was estimated and applied to the assumed annual implementation plan to arrive at the annual investments required for this program.

The five-year water resources development plan includes investments for studies, research, and planning. It was assumed that similar types of recurrent programs will continue at the same rate during the 30-year planning period. Research in water resources has traditionally received substantial foreign grants in addition to government funds. Hence, an amount equivalent to the average annual grants received in the past five-years was added to the annual cost of research derived from the five-year plan.

A summary of estimated capital costs is presented in Table C2.6.

Operation and Maintenance Costs

Several factors influence the O&M costs of the Nile River system and the procedures for their estimation. One factor is the future role of government versus the private sector both in terms of the level of control of the system hierarchy and the performance of support services. Another factor is the adoption of appropriate technology and its long-term cost effectiveness in delivering water services. A third factor is the management of the adequately rehabilitated physical system, as assumed under this scenario, and the efficiency of its administration. Hypothetical assumptions about the impact of these factors on O&M costs could be made. However, it was assumed that present policy decisions will hold throughout the planning period and that the net effect of appropriate technology will not translate into O&M cost savings.

The present organization, management, and control of OM&R face a number of problems. There are both deficiencies and excesses that make the system less efficient than possible. It was assumed the annual cost of personnel for an improved organization will remain the same, and that the savings from reducing excesses will cover the increased costs of improving deficiencies. Therefore, the annual cost of personnel for Scenario 1 was adopted. However, additional training programs were assumed to improve personnel qualifications to the standards required for adequate system O&M.

The present government policy is to replace the use of chemicals for channel weed control with new methods. Weed removal by mechanical means is now regarded as the logical replacement. This shift in policy requires new investments in mechanized equipment, service roads, and support facilities. It was assumed that weed removal and channel maintenance will be carried out by mechanical means, although biological weed control is an alternative. Biological weed control is less expensive, but is limited in coverage and implementation. This assumption, which results in a more conservative estimate of maintenance costs, is more suitable for long-range planning.

In estimating costs, it was assumed that service road maintenance will be a concurrent part of channel maintenance. Accordingly, the maintenance costs for 1 kilometer of channels with different bed widths, ranging from less than 2 meters to over 10 meters, were estimated using cost data compiled by the Channel Maintenance Project. The total cost was estimated by applying the unit rates to the length of each channel category to be maintained each year (see Tables C2.7 through C2.12). In this calculation, a more efficient use of equipment was assumed than is currently practiced. The unit rates were calculated based on the assumption that the works will be carried out by directorates (see Table 3.5). The costs of supervision of channel maintenance activities and maintenance of irrigation and drainage structures were estimated separately on an annual basis. The costs of removal of floating weeds from the Nile River were similarly estimated for six reaches of the river on an annual basis.

The annual costs of the following maintenance activities were calculated:

- One to three cycles of channel maintenance depending on the size of the channel bed width, and maintenance of service roads after each cycle (see Tables C2.13 and C2.14);
- Continuous, annual support services for maintenance of structures, and supervision of maintenance operations of irrigation and drainage systems (see Tables C2.7 and C2.15 through C2.18);
- Continuous removal of weeds in the Nile River in six reaches of the river (see Tables C2.7, C2.8, C2.19 and C2.20); and
- Erection of workshops and procurement of diagnostic and maintenance tools for the directorates, together with their replacement and maintenance requirements.

The total cost of the above activities was considered to be the cost of adequate maintenance. However, to reach this level of activities and operational efficiency, a 10-year transition period was assumed in calculating the annual cost.

To conform with the current government strategy, the estimated total cost of maintenance was increased to include overhead for the Public Excavation Companies (PECs) and private sector to annually carry 80 percent of the works. The annual cost of maintenance for each region was estimated in direct proportion to the total command area served by the region.

Because it is assumed that pump stations will be replaced during the planning horizon of Scenario 2, the annual O&M cost of pump stations is less for Scenario 1. The savings occur through a reduction in the annual costs of electricity and pump station maintenance. At present, these costs are high because of inefficient operation of the pumping equipment and the need of frequent repairs and replacement of parts. The study conducted by the World Bank for the Pumping Stations Rehabilitation Project II suggests that the increased pumping efficiency due to replacements will cause a reduction in the annual cost of power consumption and maintenance of 30 and 80 percent, respectively. It is estimated that the complete replacement of pumping equipment will take 15 years.

Cost estimates for this scenario are summarized in Table C2.1. Comparison of estimated annual costs indicate that OM&R in Scenario 2 are more than 60 percent higher than in Scenario 1 (see Table C2.22). Annual costs of O&M show an increase of 40 percent mainly because of a high rate of growth in non-personnel costs. As explained above, the annual cost of personnel in Scenario 2 was kept at the level of Scenario 1, except for minor increases for training. Given the magnitude of annual costs and the adopted rate of interest, the increase of the annual cost of personnel will have a minor impact on the total cost. As an example, a hypothetical increase of personnel costs of 100 percent over 10 years would result in an increase of 6.9 percent of total costs. Detailed costs are presented in Appendix D.

3.5 Benefits Estimation Methodology

As indicated by Section 3.3, cost allocation requires that direct and indirect project benefits be estimated for each user or beneficiary. Direct benefits are those which accrue to project users such as farmers. Secondary benefits are the increased value or profits added to the businesses linked to one or more of the direct beneficiaries of the system. Profits earned by businesses which sell fertilizers to farmers might be considered an example of secondary benefits from an irrigation project. The approaches for calculating the economic benefits of a water resources project are discussed in detail in Appendix B.

3.5.1 Direct Benefits

Estimating direct project benefits is an essential part of the cost allocation process. Several approaches for calculating direct benefits are available. Because the best approach for a particular instance depends on the type of benefit, different methods are employed in the various use sectors.

Benefit is defined as the amount of a publicly supplied good or service that a rational, informed user is willing to pay for it (Gittinger, 1982). Willingness to pay reflects the user's desire to avoid alternative consumption or not buy the good or service in question. Costs, in this context, represent the foregone value (the opportunity cost) of a project good or service.

Prices normally are used as a measure of benefit because they reflect the amount the user is willing to pay for the good or service. However, water is seldom priced, and on the rare occasion when it is priced, the charge might not accurately reflect the cost of supply. In the absence of market prices, some synthetic approach is necessary to approximate the market prices. The synthetic prices derived in this manner for benefit-cost analyses are termed shadow or accounting prices.

Benefit estimation requires that two rules be kept in mind. (These are further discussed in Section B.7.1.) The first rule stipulates that benefits and costs are measured as increments which would occur with as compared to without the project. This rule assures that the estimated benefits are due solely to the project. For example, the incremental benefits between Scenario 1 and Scenario 2 should be attributed to the incremental costs between the two scenarios. The second rule relates to which of two alternative accounting stances, financial or economic, are applied to the analysis. The financial stance measures gains and losses perceived by the individuals receiving them. However, the gains or losses might be influenced by government market interventions such as subsidies and price controls. The economic stance ideally includes social opportunity costs and social willingness to pay as measures of costs and benefits. In this way, financial prices theoretically are corrected for market interventions. Because the financial stance normally reflects the ability of farmers to pay, it is usually is applied in cost allocation studies involving agricultural projects. The study uses the financial price stances.

Methods for evaluating the direct benefits from a water resources development project are briefly described in the following paragraphs (see Appendix B.7.2 for more detail).

Method 1: Residual Valuation Approaches. These approaches achieve shadow-pricing by allocating the total value of output among each resource used in a productive process. For example, if labor, land, water, and capital are employed in production, and if labor, land, and capital are assigned shares according to their marginal values of productivity, water is assigned the remaining share of the total value of the output. This remaining share represents the shadow price of water. In this study, benefits from river tourism and commercial fishing are evaluated by variations of this method.

Method 2: Net Incremental Return. This approach is a variation on Method 1. Benefits are calculated as the increment in net income or profit from the project based on a "with" and "without" comparison. The calculations are identical to Method 1 with irrigation projects, because the "without case" net income is the pre-project net return or the rent to the land resource. In this study, it was decided to view land and water resources as a single (inseparable) production unit, and thus avoid assigning a certain share of project output to land. This assumption has the effect of assigning the residual value of output (after deducting labor and capital costs) to water. In the context of irrigated agriculture, the net incremental return method yields an estimate which is often called "net primary returns." The study uses this method and its terminology to evaluate benefits for irrigated agriculture.

Method 3: Cost of Next-Best Alternative. In this approach (sometimes called the "alternative cost" method), the willingness to pay is limited by the cost of the most likely (least cost), economically feasible alternative. The benefits are the cost incurred if the next-best economically feasible alternative were used. For example, a bridge crossing the Nile River at the site of a barrage might be the next-best, economically feasible alternative for a channel crossing at the same location. This study uses Method 3 to estimate benefits for hydropower, navigation, rural water supply, and road crossings of the Nile River channel.

Method 4: Avoided Damages. When a project avoids potential economic damages from either natural or man-made hazards, certain project benefits are the expected value of monetary damages or costs that the project prevented. For example, a flood control project reduces the probability of damages to infrastructure in the flood plain. This reduced damage is treated as a benefit. This study uses Method 4 to assess the flood control benefits resulting from the HAD.

3.5.2 Secondary Economic Benefits

3.5.2.1 Introduction

Indirect benefits take the form of increased value added, or increased profits to businesses linked by market transactions to the economic sector receiving direct benefits from a water resources project. It is sometimes argued that these businesses can reasonably be required to share part of their profits to help pay for OM&R of the water system.

Secondary economic benefits are defined as benefits induced by and stemming from various economic activities. "Induced by" benefits are the increments to economic activity that result from the increased or changed demand for inputs by the primary industry. For example, growth in the fertilizer industry may be induced by increases in agriculture activity. "Stemming from" activities are those which process and distribute the primary output. For example, processing plants are stemming from industries associated with agriculture. Benefits from food processing plants are often called secondary benefits because they are only one step removed from direct or primary benefits. Secondary benefits also are called backward linkages (induced by benefits) and forward linkages a (stemming from benefits). Tertiary benefits are increments to output which are further removed from, but still are related to, the primary benefits. They are the increments to the value of output in industries which are directly or indirectly linked to the secondary industries, either as providers of inputs or processors of outputs. They also include the effects on profits and wages generated by induced increases in consumer demand. Direct calculation of tertiary benefits associated with a particular project is difficult because it is hard to determine the degree to which growth in output in a given industry is due to changes in the primary industry. The further removed the tertiary industry is from the primary activity, the smaller the impact of the primary industry on the output of the tertiary industry and the more difficult the detection of these impacts.

Secondary benefits often are directly estimated. For example, development roles for processing plants often are projected on the basis of primary industry requirements. Value of output and expected employment are then projected for the secondary industries, and on this basis secondary benefits are estimated.

Tertiary benefits are not often directly estimated. Instead, multiplier values are used to estimate the combined secondary and tertiary benefits from changes in the primary industry. These multipliers are generally of two types:

- The Leontief-based coefficient deduced from an input-output table which is a matrix of the proportions of sales of each industry to all other industries, including exports. Multipliers in this category are used to estimate additional production resulting from changes in output from the primary sector;
- An employment-based multiplier. This coefficient relates the changes in employment in basic industries (primary industries) to changes of employment in non-basic (secondary and tertiary) industries. Output changes can be estimated by using values of the productivity of labor.

Multipliers in both categories are derived from statistical studies of long-term trends for a particular country or region. The input-output approach provides relatively precise estimates of multiplier values, but data requirements and modeling development are expensive and time-consuming.

3.5.2.2 Secondary Economic Benefits in Project Evaluation

From the perspective of project evaluation, secondary economic benefits have not been given full planning status in the United States or in major international lending agencies (such as the World Bank) for some time. For example, the United States Water Resources Council (1973) limits the use of secondary benefits to special cases. Gittinger (1982) takes a similar position and probably reflects World Bank practice.

The general argument against including secondary benefits in project appraisal is that, in focusing only on the positive economic linkages to project beneficiaries, the approach fails to consider the likely existence of offsetting secondary costs. While the effect of localized secondary effects in the project region are acknowledged, the offsetting costs are spread throughout the economy.

Water resource projects are not unique in throwing off secondary effects in related sectors of the economy. Fertilizers or pesticides, for example, have similar output-increasing effects as water. More generally, any alternative output-increasing public investment will generate secondary market impacts; these become secondary opportunity costs (foregone benefits) of any particular public investment in water resources. Even more generally, an alternative to public investment in water is private investment (made possible by lowering taxes, for example). This alternative use of funds would also generate secondary impacts. The offsetting secondary costs are likely to be diffused throughout the economy, so they are much less visible or tangible than the localized beneficial effects of water resource projects. However, the offsetting costs are not any less real. There is no reason to believe that water resource investments create special secondary net benefits any more than alternative public or private expenditures.

A final criticism of the secondary benefits argument is that it assumes public investment in productive capacity (such as irrigation) yields special benefits not generated by private sector investments. This proposition has been substantially tested in Eastern Europe and the Soviet Union in the past several decades, and it has been found wanting. The collapse of the economies of those nations has been accompanied by a collapse of intellectual support for central planning, for public ownership of the means of production, and for the expectation of unique benefits to public expenditures.

3.5.2.3 Charging Secondary Beneficiaries

The specific argument against charging secondary beneficiaries runs along similar lines. From the point of view of a business, the secondary value-added elements are actually costs. These costs must be paid out to capital and resource suppliers, and are not available to be paid as a tax to reduce farmer input costs. The secondary beneficiaries are presumed to be businesses which must pay out sales revenues to labor, management, materials supplies, and capital. (Capital owners provide both equity and debt used by businesses). Increased sales revenues due to increased crop production from irrigation must be paid out to labor, material suppliers, and capital owners. In addition, if crop prices paid by a business fall as a result of increased crop output, business profits will not increase over the long run, because the prices for its products will fall, and the benefits will accrue to the final consumer. Only in unusual cases, such as with short-run excess crop production capacity, will a processing business have excess profits to devote to paying for its suppliers' inputs. This situation will occur only in the short run.

The argument can be restated by asking the following question: "Is equivalent treatment warranted for fertilizer producers?" Secondary benefits similar to those created by irrigation could be attributed to fertilizer. However, no one suggests that processors of agricultural crops should contribute to fertilizer producers so that prices to farmers can be lowered.

This is not to argue that increased agricultural output has no indirect beneficiaries. The reduced commodity prices brought about by increased agricultural output will flow through to the final consumer, creating an increased consumer surplus to the economy as a whole. The general tax collection system should be used to create these public benefits.

3.5.2.4 Conclusion and Recommendation Regarding Secondary Economic Beneficiaries and Cost-Sharing

In conclusion, the study team decided to exclude secondary economic benefits in cost recovery considerations for the Nile River system. Historically, except in special cases, water resources development costs have not been allocated to agri-businesses or any other segment of the economy. Secondary benefits have been used where a case can be made relating to regional rather than national benefits. For example, secondary benefits might be appropriate for specific activities involving the new new lands (Scenarios 3 and 4) where regional development is the prime objective of the Government. Another exception could be cases where there are underemployed resources for which the water resources development under consideration could provide employment.

3.6 Economic Parameters Adopted for Cost Allocation

This section discusses some conceptual and empirical issues which arose in implementing the cost estimation and cost allocation procedures.

3.6.1 Interest Rates and Price Inflation

The interest rate used to annualize rehabilitation investments is important because total costs are very sensitive to this parameter. We can use either a financial or an economic rate of interest. The financial rate would reflect current market interest rates. The economic rate cannot be directly observed, but it is usually chosen to represent a real (inflation-adjusted) opportunity cost of capital.

A financial rate of interest has an advantage in that cost allocation is considered a financing issue rather than an economic evaluation issue. However, the reported market rate of interest reflects both the opportunity cost of capital plus the expectations of lenders regarding price inflation for the time period of contemplated loan transactions. Due to the unsettled state of financial markets in Egypt during this period of transition to a more decentralized economic system, present inflationary expectations might not be representative of those which might actually occur over the longer term.

In addition, it is questionable whether a financial rate is appropriate for setting cost recovery policy. A financial rate overstates, by the amount of the implied inflationary expectations, the real cost of capital to the economy. The team judged that the real cost of capital is the preferable measure for annualizing investment costs.

However, price inflation should not be ignored in a cost recovery policy. Otherwise, in a context of 10 or 20 percent annual inflation, the real value of repayments by beneficiaries would be reduced in only a few years to a negligible level of buying power. The recovering agency thus will have provided a probably unintended windfall subsidy to beneficiaries.

The suggested solution to this issue is comprised of two parts. The first part concerns the procedure for annualizing capital costs in the cost estimation study. A real interest rate, specifically the World Bank's suggested rate of 12 percent, was employed. The second part concerns a proposal that an annual inflationary factor be incorporated into whatever cost recovery policy is adopted. The inflationary factor can be chosen to reflect current and recent experience rather than the hazy expectations embodied in the market interest rates. Changing the factor annually seems sensible to avoid the shock of periodic large changes. Longer periods between revisions can be chosen if desired.

3.6.2 Planning Periods and Price Datum

To develop and cost out an OM&R plan, some initial decisions were made on the price level at which to present the costs and the planning period to be assumed. These assumptions will ensure consistency among the data.

Price level—A price level datum is selected so that all costs and benefits are expressed in equivalent units. A price level was adopted based on December 1991, when the project data collection began.

Planning periods—Two separate planning period concepts apply and must be distinguished. One relates to the period during which replacement investments might be undertaken and included in the replacement plan costs. This could range from 1 year to 50 years or longer. The longer the period, the more structural replacement must be included in the OM&R plan and costed out. It was assumed that whatever OM&R cost recovery policy is adopted will be periodically updated and that a long period is too demanding of resources. Moreover, recovering costs for expenditures planned for the distant future would be inequitable, imposing on present users costs for which they would receive only limited benefits, if any. A five year period was chosen, corresponding to the Egyptian Government planning cycle. The 1992-97 period was specifically selected.

The second concept relates to the length of the planning period over which structural investments are amortized. The conventional approach of amortizing over the useful life of each structure—or where numerous similar structures were costed as a group, the average expected life of the group—was used.

3.6.3 Drainage Costs

An issue with respect to allocating costs of drainage is whether drainage costs should be averaged systemwide or treated partly on an individual farmer and partly on a regional basis.

One viewpoint is that the farmer directly benefits from the drainage program in his region, and at least the on-farm portion of the costs should be allocated entirely to the farmers as a group.

However, a case can be made for treating all drainage costs, even on-farm or field drains, as a system cost. The cause of the drainage problem is not necessarily the individual farmer experiencing a high water table. The cause is more likely the cumulative actions over time of innumerable farmers, particularly those up-slope, who are using inefficient irrigation practices. While the individual who participates in a field drainage program clearly is better off than without the program, he is not fully responsible for the problem he faces. According to this point of view, therefore, drainage costs should be a collective burden.

3.6.4 Sunk Costs

We chose to treat the costs of previous investments as sunk and therefore not incremental to a future OM&R program nor relevant to a future cost recovery policy. Costs which might be attributed to depreciation or replacement of long-lived main system investments, such as the HAD and the main canals, were assumed sunk and were ignored in this analysis. This approach was taken on the grounds that such structures are paid for, and that charging the present generation for an investment which might not be replaced for several centuries is not equitable. More generally, any prior costs of durable capital structures already in place are not considered for future cost recovery. On the same grounds, budget allocations to service repayment of loans on previous irrigation system investments are also not included as part of the estimated costs. Such allocations are financial transfers reflecting sunk costs of previous investments. Therefore, only incremental OM&R costs, plus some system improvement investments, are considered.

3.6.5 Economic Disbenefits

External or spillover costs, which are actually damages or disbenefits to third parties (e.g., water pollution damages) often arise in connection with withdrawals from municipalities, industries, and agriculture. They have an important role in the theory of environmental management. However, they usually arise from diffuse sources, and assessing individual or even sector responsibility through a water pollution tax is difficult on both technical and policy grounds. Ideally, external costs should be internalized into the costs facing economic agents. However, little data exists on water pollution damages in Egypt and resources available to this study were not sufficient to develop such estimates. Hence, disbenefits were not considered. (One minor qualification is warranted here regarding drainage of irrigated lands. Drainage programs arise in response to irrigation-induced externalities—such as waterlogging and salinization—and are charged to irrigation.)

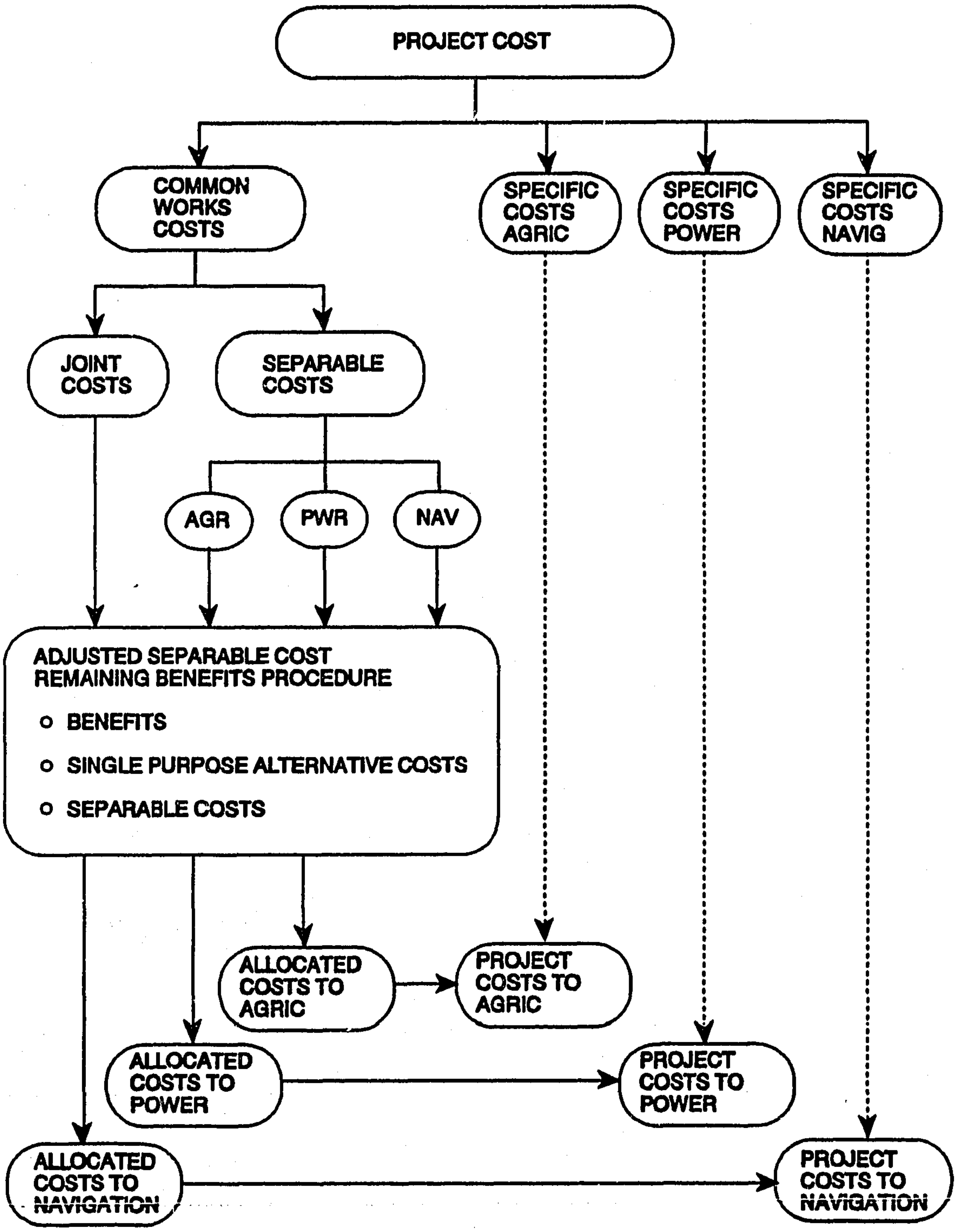

Figure 3.1 The Cost Allocation Process

Table 3.1 System Infrastructure Cost Data Needs

System Level	Structure	Data Needed
Nile Main Stem	HAD and Old Aswan Dam	Storage allocations, cost, year of construction, O&M costs
	Nile River Barrages	OM&R costs, year of construction, purposes served
Regions	Pump Stations (both irrigation and drainage)	System capacity, purpose, OM&R costs
	Open drains	Size, length, O&M costs
	Navigable canals	Size, length, O&M costs, structural replacement costs
	Non-navigable canals	Size, length, O&M costs, sturctural replacement costs
	Rural water supply systems (including industrial)	Source of supply, capacities

Table 3.? Data Needs for Cost and Benefit Estimates

Service Sector	Data Needed
1. Irrigated Agriculture	*Costs:* Land cultivation, seed, fertilizer, on-farm (mesqa and below) irrigation system costs, weed control, harvesting, product storage, labor, animal and mechanical power, other costs (if any) *For Benefit Estimates:* Farm-gate prices of crops, crop yields, crop area
2. Rural Water Supply (Domestic & M & I)	1. Village populations (number of dwellings supplied) 2. OM&R for an alternative single-purpose supply by village (or group of villages) 3. Water requirements for each major industry supplied directly from canals or by shallow groundwater pumping
3. Hydropower	1. Unit costs of thermal energy 2. Annual production of electrical energy as a function of time by the hydroelectric component of the project
4. Navigation	1. River channel dredging costs 2. The results of a study on the use of the river for transportation-traffic flows in tons per unit time between ports of origin and destination, and associated costs 3. The results of a land transportation (rail and road) study and associated cost estimates
5. River Tourism	1. Estimate of costs (OM&R) associated with recreational uses of the major system components; for example, costs associated with Nile River cruises 2. Estimates of revenues produced by this form of recreation
6. Road River Crossings	Costs of bridges crossing the river at the barrage sites and at the High Aswan Dam site
7. Commercial Fishing	1. Estimates of fish and other aquatic food production in the river before the existence of the current system 2. Estimates of fish and other aquatic food production in the reservoirs, river, and canals of the present system 3. Unit prices for fish and other aquatic food harvests 4. Costs of fish harvesting, and marketing
8. Flood Control	1. Estimated value of flood damage prevented by HAD 2. Flood frequency data

Table 3.2 Data Needs for Cost and Benefit Estimates

Service Sector	Data Needed
9. Improved Maintenance (Scenario 2)	1. Costs associated with upgrading the system maintenance (capital and increased maintenance costs) to an adequate level 2. Estimated benefits associated with system upgrading (for example, reduced agricultural risk benefits and increased crop yields)
10. New New Lands (Scenarios 3 & 4)	1. The same data as listed above for irrigated agriculture 2. Water requirements 3. Pumping lifts 4. Land preparation costs 5. Water distribution system costs in the new new lands 6. Components of the existing system required to deliver water to the distribution systems of the new new lands projects

Table 3.3 Changes in Local and International Price Indices
Egyptian Fiscal Year (FY) (1)

Description	FY 1986/87	FY 1987/88	FY 1988/89	FY 1989/90	FY 1990/91	December 1991 (2)
Construction Material (3)	100.0	117.7	141.1	171.7	221.3	247.7
Petroleum (3)	100.0	134.4	166.8	201.8	296.6	366.1
Machinery & Implements (3)	100.0	121.2	160.0	191.3	217.8	233.9
Consumer Price (3)	100.0	114.6	138.8	170.9	190.8	245.3
International Inflation (4)	100.0	103.2	107.2	112.3	117.9	121.2

Notes:
(1) July 1 through June 30th
(2) Estimate
(3) Source: Central Agency for Public Mobilization & Statistics, Egypt
(4) Inflation in Industrial Countries, International Financial Statistics, IMF February 1990

Table 3.4 Cost Adjustment Factors

Description	FY 1986/87	FY 1987/88	FY 1988/89	FY 1989/90	FY 1990/91	December 1991
Capital Costs						
Irrigation Works	2.65	2.04	1.72	1.43	1.17	1.00
Mechanical Works	2.69	1.88	1.68	1.37	1.18	1.00
Maintenance Cost						
Irrigation Works	2.47	2.05	1.61	1.33	1.15	1.00
Mechnical Works	4.73	3.49	3.00	2.00	1.23	1.00

Table 3.5 Channel Maintenance
Annual Costs
(L.E. / Kilometer)

DESCRIPTION	CANAL CYCLE PER YR	DRAIN CYCLE PER YR	CHANNEL OPERAT. SIDES	CANAL COST PER CYCLE	DRAIN COST PER CYCLE	CANAL ANNUAL COST	DRAIN ANNUAL COST
CHANNEL < 2 M.	3	3	1	594	594	1,783	1,783
CHANNEL 2-5 M.	2	3	1	2,051	2,051	4,102	6,152
CHANNEL 5-10 M.	2	2	2	4,102	4,102	8,203	8,203
CHANNEL > 10 M.	1	1	2	4,717	4,717	4,717	4,717

Chapter 4

APPLICATION OF COST ALLOCATION MODEL TO NILE SYSTEM

4.1 Introduction

In the application of cost allocation procedures, no system of use priorities is assumed. Fortunately, some uses, such as navigation, flood control, irrigation, and to some degree hydropower generation, tend to be complementary. For example, the need to regulate a river to provide more uniform flow for irrigation and navigation leads to the construction of reservoirs that also provide flood and flow control. Uses also can conflict. For example, reservoir releases to meet irrigation demands can exceed power needs and thus reduce the energy capability of the reservoir. In this case, a tradeoff exists between power and irrigation.

Table 4.1 depicts the approach taken in developing a cost allocation model for the Nile River system. The table indicates the two legulate a river to provide more uniform flow for irrigation and navigation leads to the construction of reservoirs that also provide flood and flow control. Uses also can conflict. For example, reservoir releases to meet irrigation demands can exceed powere Old Aswan Dams). As the table indicates, each structure for which costs were allocated is assigned to the spatial unit in which it is used. For example, pumps which divert water from the river to the irrigation canals serve the uses within the region and so are assigned to that hierarchy. Table 4.1 also illustrates the basis on which single-purpose alternative costs were determined and benefits estimated. The notes which accompany the table explain various assumptions which were made in the application of the cost allocation model to the Nile system.

4.2 Categorizing Costs

4.2.1 Specific Costs

The various structures listed under the "structure" column in Table 4.1 are treated as "common works" in this analysis. In fact, HAD is the only structure in the system for which separable costs are identified; the remaining structures (pumps, canals, and barrages) are termed joint works. However, some specific costs have been identified. Main channel dredging costs are assumed specific to navigation (Table 4.1, note 6). Costs of modifying particular canals and pumps to deliver water to the new new lands are specific to the agriculture of those lands (Table 4.1, note 3). OM&R costs for drainage canals are specific to agriculture, except for the pumps (Table 4.1, note 5). There is limited use of the drainage canal network for navigation (Table 2.2). However, because the total length of drainage canal used for this purpose is only one percent of the total length, this use was not considered in the cost allocation process.

4.2.2 Separable Costs

As indicated above, separable costs are only included for HAD in the analysis. If flood control were eliminated from the project, the volume of storage presumably could be reduced by 41 billion m^3. The separable costs to flood control are those of adding this storage increment to the reservoir. However, because the live storage jointly serves all remaining services, eliminating one of the services would not reduce the live storage requirements. Thus, with HAD there are no separable costs to any other services. An exception to this would be structures designed to serve a particular purpose but which depend on the common works for support. Examples for HAD are the penstocks which pass through it to supply water to turbines and a road crossing its top. If these costs could be identified (they were not in this study), they would be separable to the energy and transportation sectors, respectively.

If they could be identified, separable costs could be considered at other locations in the system. For example, O&M costs for flow control and other in-canal structures could be separable to irrigation because these works generally are not required for either rural water supply or navigation. However, these costs could not be identified, and therefore are allocated as joint O&M costs for the canals (Table 4.1, note 1). The IIP main system improvement costs have been identified and could be treated as separable costs to agriculture. However, as explained in Section 3.2.2, these costs also are included as joint irrigation canal costs, and thus are allocated to the three primary users of the canals, i.e., irrigation, rural water supply, and navigation.

4.2.3 Joint Costs

As indicated by Table 4.1, the cost allocation analysis is first applied by region. The joint costs to be allocated are those associated with navigable and non-navigable canals and pumps for both irrigation and drainage. For canals, only O&M costs are considered because the capital costs for canal construction are assumed to be sunk. However, replacement costs are included in the maintenance category for control gates, turnouts, and other structures within the canals that support the irrigation function.

OM&R costs for pumps were available only as a lump sum and could not be disaggregated by location or function such as irrigation or drainage. However, many drainage pumps lift water that is recycled in the irrigation canals and thus actually serve several purposes. For this reason, the lump sum pumping costs (OM&R) are assigned in proportion to the total irrigated area in each region. The costs then are allocated to the agricultural and rural water supply uses within each region.

Cost estimates are described in Section 3.3. Benefit data for each region are based on information collected for a directorate located within the region. These directorates are called representative directorates (see Section 4.3). Because there are no identifiable separable costs, joint directorate costs are allocated on the basis of the justifiable cost for each use sector. The procedure is repeated for each of the five regions within the project service area.

On the Nile River channel, costs are associated with barrages and HAD. For Scenarios 1 and 3, barrage O&M costs, like pump costs, are summed across all units and thus are allocated as a combined figure. Scenarios 2 and 4 include the new Esna Barrage which will be equipped with hydroelectric generators. Because of the additional use, costs for this structure are allocated separately from the other seven barrages on the river. For those structures, costs are treated as a combined figure. The justifiable costs for each use are the basis for the cost allocation. For Scenarios 1 and 3, the beneficiaries of the barrages are considered to be agriculture, navigation, and water supply. For Scenarios 2 and 4, the hydropower used at Esna is added. HAD benefits a broad range of users (see Table 4.1). As with canals, the capital cost of HAD is regarded as a sunk cost, and thus only the joint O&M costs of the structure are allocated to the eight uses shown in Table 4.1. Benefits derived from fishing in the canals and the aquaculture pond, although small, are included in the estimate of benefits derived from the fish harvest at Lake Nasser (Table 4.1, note 10).

4.3 The Region

Ideally, the study would be conducted with the directorate as the basic spatial unit of the project. Costs and benefits would be evaluated and joint costs allocated by directorate and then summed at the main points of diversion from the Nile River. However, this was not possible mainly because of the time required to obtain and process the necessary cost and benefit data.

The problem was handled, as Table 4.2 shows, by dividing the project service area into five major regions and selecting a representative directorate in each of five regions.

As indicated by the last column of Table 4.2, each representative directorate contains an IIP study area. Figure 4.1 shows the geographic locations of the study areas listed.

To the representative directorates, the team mailed a questionnaire to each of the 22 directorates in the system. Responses were then analyzed. A sample of this questionnaire is in Annex I. Only directorates in which an IIP study has been conducted were considered for selection. It was assumed that data from the IIP reports on soil type, crop yields, and other information could be applied to the entire directorate. Representative directorates were selected to represent average regional conditions on the basis of various factors, including soil type, main cropping patterns, crop yields, farm cultural practices, canal characteristics (size, length, bed width), system maintenance requirements, canal uses (navigable, non-navigable). The data for the representative directorates was then extrapolated to the regional level, as shown in Appendix E. The extrapolated information on canal characteristics was checked against actual data from the Middle Egypt and West Delta regions. Close agreement between the two was found.

4.4 Main Stem of the Nile River

4.4.1 Barrages

For Scenarios 1 and 3, the OM&R costs for the eight barrages on the main stem of the Nile River below Aswan (see Figure 2.2) are combined into a single number. As indicated by Table 4.1, the economic sectors which benefit from the barrages include agriculture, navigation, river tourism, rural water supply, and road crossings. (The tops of the barrages are used as road bridges across the Nile.) At present no hydropower is generated at any of the barrages. However, a new structure which includes hydroelectric turbines is being built at Esna. Hydropower at Esna thus is included in the analysis for Scenarios 2 and 4.

4.4.2 High Aswan Dam

As indicated by note 12 of Table 4.1, the High and the Old Aswan dams are operated and maintained like a single unit, with O&M costs for each combined. HAD provides about 70 percent of the total electrical generation of the two structures. The reservoir behind HAD contains a potential storage of 162 billion m^3. Of this total, 31 billion m^3 is allocated to dead storage for sediment accumulation at the bottom of the reservoir. 90 billion m^3 of live storage is provided on top of the dead storage to meet the needs of irrigation, hydropower, and all other purposes except flood control. This purpose is met through 41 billion m^3 of storage on top of the live storage. The dam is a rock-fill structure which is equipped with adequate spillway. In addition to the spillway at the dam itself, a second structure was built upstream to permit high flows to spill into the Toshka Depression. With adequate maintenance it is expected that the dam will perform as designed until sediment accumulation inhibits its operation.

4.5 Estimated System Costs

The annual OM&R costs of the system were estimated for Scenarios 1 and 2 using procedures described in Section 3.4. These cost estimates were also used for Scenarios 3 and 4. The costs for allocation are presented in Appendix D and are summarized in Tables 4.3 and 4.4. The costs exclude the capital costs of all structures presently in service but, except for HAD and the canals, include estimated replacement costs (see Section 3.2.1). Scenario 1 costs include an absence of system modernization because the costs of modernization were not deemed necessary to sustain the present level of service.

4.6 Single Purpose Alternative Costs

As indicated in Section 3.3.3, the single-purpose alternative cost is the cost of providing the same service with a single-purpose project instead of a multipurpose project. For example, the single-purpose alternative cost for flood control is the total cost, including capital and OM&R costs, of a storage structure at the HAD site built solely for flood control purposes. Presumably, the new reservoir would contain 30 billion m^3 of dead storage for sediment accumulation plus 41 billion

m^3 for flood storage (see Section 4.4.2). The estimate for such a structure should be made on the basis of a preliminary design for a new structure. Such an approach obviously was not feasible for this study. Thus an estimate was made on the basis of the proportion of the total storage in the existing reservoir required for flood control alone. This estimate amounted to (30+41)/162, or 44 percent, of the estimated cost (in December 1991 prices) of HAD. A project life of 30 years and a discount rate of 12 percent were assumed. This procedure for identifying the single-purpose alternative cost for flood control is actually an application of the use-of-facilities method of cost allocation. In a similar fashion, the single-purpose alternative cost for agriculture is the total cost (capital plus O&M) of the existing canal system required for irrigation water alone (see Table 4.1, note 2).

For each system user, the structures on which the single-purpose alternative cost is based are shown by Table 4.1. The actual cost estimates used in the application of the model were derived from cost data contained in Section 4.5 and from calculations shown in Appendix F.

4.7 System Benefits

The methods used to estimate user benefits at all system levels are indicated in the last two columns of Table 4.1. The actual benefit figures for each use as applied in the cost allocation analysis are in Appendix F.

4.7.1 The Region

The joint costs to be allocated at this level involve O&M costs for the irrigation canals (see Table 4.1, note 1) and OM&R costs for all pumps in the system (see Table 4.1, note 5). As previously indicated, O&M costs for open drains are assumed to be specific to agriculture and therefore are not included in the allocated costs (see Table 4.2). Like costs, benefits from the representative directorates within each region are extrapolated to the region level. The basis of this procedure is explained in Appendix E.

4.7.1.1 Agriculture

Agricultural benefits are estimated as net primary return to agriculture, taking land and water as a single, non-separable production unit (see Table 4.1, note 1). The basis for estimating these benefits is contained in Appendix F. Treatment of the proposed IIP main system improvement is briefly outlined under the heading of Scenario 2 (see Section 3.2.2). Costs for these improvements are given in Section 3.4 and Section 4.5. Because it is assumed that the improvements will be made over 30 years, the associated cost stream is discounted. However, as indicated by Appendix F, benefits from the implementation of the adequate maintenance program of Scenario 2 are assumed to reach their estimated increased levels over a five-year period. This assumption is consistent with the crop yield response changes which are used for the other main system improvements of Scenario 2. It is noted that the costs of the proposed IIP improvements to the main system represent less than 10 percent of the total incremental cost proposed for Scenario 2.

Agricultural benefits greatly exceed the single-purpose alternative costs for the irrigated lands. Therefore the single-purpose alternative cost governs the canal costs allocated to agriculture in the existing system (Scenarios 1 and 2). For Scenarios 3 and 4, it was not possible to estimate the agricultural benefits required by the analysis (see Table 4.1, note 3). For this reason, the single-purpose alternative cost was assumed with new new land.

4.7.1.2 Rural Water Supply

Individual residences, villages, and industries which are not near the Nile River channel draw water supplies either directly from the canals or pump water from the shallow groundwater aquifer beneath the agricultural lands (see Table 4.1, note 4). The groundwater aquifers are largely recharged by both canal seepage losses and by deep percolation from the irrigated fields. Therefore all sources of water supply (except the Nile River as a direct source), whether surface or subsurface, are considered the product of the canal system, and thus users are deemed beneficiaries. Benefits are derived from estimates of the incremental costs of the next-most feasible water supply system above the cost of the present system. The next-most feasible source of supply is assumed to be pumping the deep aquifer that underlies the irrigated lands. Apparently, this aquifer is recharged from the Nile River and is separated from the shallow aquifer by a clay layer of low permeability. The calculations to support the incremental cost estimates required by the study are contained in Appendix F.

4.7.1.3 Navigation

The benefits of the canals to navigation are based on a study of the type of freight carried, distances travelled, weight of the freight, and frequency of travel (for example, ton-km/month). The benefits are the savings compared to the next-most feasible alternative for carrying the freight (in this case, rail). The results of the study are detailed in Appendix F.

4.7.2 The Main Stem

4.7.2.1 Barrages

All OM&R costs for the barrages on the main stem of the Nile River are combined into a single figure. The economic sectors which benefit from these barrages include agriculture (the presently irrigated lands for Scenarios 1 and 2 and the new new lands for Scenarios 3 and 4), hydropower (Esna Barrage for Scenarios 2 and 4), navigation, river tourism, road transportation, and rural water supply (Table 4.1).

The tops of the barrages are used as road bridges across the Nile River. The annual benefits to the transportation sector are based on the estimated costs (OM&R) of a regular bridge crossing, and thus the savings the barrages provide the road transportation sector. At present, OM&R costs for the navigation locks which are specific costs for navigation cannot be separately identified. For this reason, all costs associated with these structures are regarded as joint costs. They are allocated on the basis of total systemwide benefits identified for agriculture, navigation, and water supply, and on the benefits identified for road transportation. At present no hydropower is generated at any of these structures, and this condition is reflected in Scenarios 1 and 3. However, a new structure which includes hydroelectric turbines is being built at Esna. The new structure will be included in the analysis for Scenario 2 and 4.

Under normal operating conditions, the barrages benefit river traffic by increasing the channel depth between Aswan and Luxor. No navigation benefits are assumed during the four summer months of high Nile River discharge in the absence of the HAD. (Navigation refers to river freight transport.) In a similar fashion, no navigation benefits are assumed during the approximately two months of annual closure for general maintenance (see Table 4.1, note 6). However, even during this period sufficient flows are normally released to provide the draft required by river tourist boats (see Table 4.1, note 7). Both navigation and tourism benefits are based on the estimated average increase in river traffic made possible by the barrages.

4.7.2.2 High Aswan Dam Complex

The High Aswan Dam and the Old Aswan Dam are treated as a single unit or complex (see Table 4.1, note 12). The term HAD refers to both structures. O&M costs at HAD are allocated on the basis of all benefits summed to this point in the system. Each of the benefit categories used in this analysis is briefly discussed in the following paragraphs:

1. *Irrigated agriculture*—Agriculture benefits as estimated for the irrigated lands are summed by region at HAD. For Scenarios 3 and 4, benefits from the existing irrigated lands and from the new new lands are treated separately.

2. *Commercial fishing*—An attempt was made to estimate incremental benefits to fishing resulting from the Nile River system. Yields from Lake Nasser and canals and fish ponds which depend upon system water provide modest project benefits. However, it is assumed there are no incremental benefits to commercial fishing on the main stem of the Nile River. As indicated earlier, estimated benefits from fishing in the canals and aquaculture ponds are small. Therefore to simplify the cost allocation procedure these benefits are lumped with those provided by Lake Nasser. The total benefits from commercial fishing are used in allocating the O&M costs for HAD (see Table 4.1, note 10).

3. *Flood control*—It is understood that HAD has eliminated virtually all the potential for system flooding. Estimates of agricultural benefits from the system implicitly include flood protection benefits for irrigated lands. Other flood control benefits are represented by prevented damage to dwellings, cities, transportation facilities, and the like. Average annual estimates of these benefits are normally developed through a flood frequency/damage study on the basis of current and estimated future

development and property values. However, because of time and data limitations, this analysis was not possible. Abdul-Atta (1978) estimated flood control at about 4 percent of the total annual benefits that HAD generates in increases of national income. This figure is used to estimate non-agricultural-related flood control benefits at approximately 4 percent of the sum of all other HAD benefits (see Table 4.1, note 11).

4. *Hydropower*—The benefits from the electrical energy generated at HAD plus those from energy generated at downstream barrages (Esna) are the basis for allocating the HAD's joint O&M costs. The allocation involves the sum of all benefits to the dam. Available O&M cost data do not include specific costs associated with the generation of electrical energy at HAD.

5. *Navigation*—The HAD regulates water flow and thus benefits river navigation. An estimate was made of the incremental benefits (those resulting from HAD construction) to navigation provided by the dam (see Appendix F). The benefits include those resulting from increased draft due to regulated river flows and reduced dredging costs to maintenance of navigable river channels. These benefits are added to those estimated for the navigable canals within the irrigated area (see Table 4.1, note 7).

6. *River tourism*—The benefits of tourism result from tour boats that use the Nile River. The traffic is particularly heavy between Aswan and Luxor. The river barrages and the controlled release of water from HAD benefit this industry. Even during annual system maintenance, sufficient water is released from HAD to maintain the channel depth required by the relatively shallow draft tour boats. Benefits are based on load factor figures (by month) and net primary revenues obtained from the Ministry of Tourism. No benefits are assumed for the four months of high summer flows normally experienced on the Nile in the absence of HAD (see Table 4.1, note 7).

7. *Road transportation*—Because of their close proximity to each other, the HAD and the Low Aswan Dam are operated and maintained like a single unit, and the O&M costs for each are combined. The Low Aswan Dam provides the main crossing of the Nile at Aswan. This crossing is treated as a part of HAD. The single-purpose alternative is a bridge, and the benefits are the savings in OM&R costs required for an equivalent bridge crossing.

8. *Rural water supply*—It is assumed that water supplies to metropolitan centers have not been significantly improved by the Nile River system. Even during low-flow years there is apparently sufficient water in the Nile River to meet existing M&I demands. Thus, no benefits are assumed for M&I uses derived directly from the Nile River by major cities. Water supply benefits from within the irrigated area are summed at HAD. Individual residences, villages, towns, and industries which are supplied either directly from the canals or from the shallow groundwater aquifers beneath the irrigated lands are assumed to be system beneficiaries (see Table 4.1, note 4).

4.8 Model Application

Computer implementation of the cost allocation process for the Nile River system is described in detail by Grenney (1992) (see Annex II). Figure 4.2 depicts the stages in the modeling procedure. The common works costs within each spatial category are represented by the boxes in the center column of the figure. The costs in each of these categories are allocated among the various system users (or service sectors) represented in the boxes on the right side of the figure. The model uses input data for both the common works and the separable costs of the infrastructures. Separable costs were identified only at HAD. Thus for all other structures (canals, pumps, and barrages), the separable costs are zero and the joint costs are equal to the common works costs. Cost allocation is performed using the Adjusted Separable Costs-Remaining Benefits (ASCRB) procedure, a variant of the SCRB method. The joint costs are then OM&R costs for particular structures. Because the costs of constructing the canals and HAD are considered sunk costs, replacement costs for those structures involve only appurtenances (such as flow control works), and these costs are included in the maintenance category.

The computer model begins the cost allocation process with the existing or old lands (see the bottom of Figure 4.2), including new lands. The model works up through the new new land development projects (shown in the figure as "new agriculture"), addressing only the effect of these projects on the costs allocated to existing system users. The model ends at HAD where benefits and allocated costs are accumulated for all system users.

It is emphasized that all cost allocation proportions are based entirely on projected economic benefits from the Nile River basin development (taking into account both separable and joint costs). They are not intended to constitute cost sharing and pricing policy recommendations. Except as they are incorporated into input data and/or model operating criteria, political and institutional considerations are not reflected in the model results. As project configurations, production costs, and other input quantities become more clearly defined, cost allocations suggested by the model will become more accurate and realistic. However, it is stressed that the relative benefits from the development program to each beneficiary will continuously change due to constantly shifting world and local prices and the extent to which each beneficiary uses the project.

The model is stored on the software possessed by the Egyptian team. The team members understand the model and are fully capable of changing the software (reprogramming the model) and operating the model as needed. As previously stated, all cost allocation procedures require extensive data, particularly those which involve benefit estimations. Much of the data used for this study is tentative in nature, and other information represents the best judgment of the authors based on examination of available reports and technical discussions with experts. The current emphasis is on the techniques proposed for estimating project costs and net benefits, and the basis for allocating total project costs among participating users. Cost allocation is a dynamic process which changes with shifting social needs and values. The use of the model and the application of its results should reflect this dynamic situation.

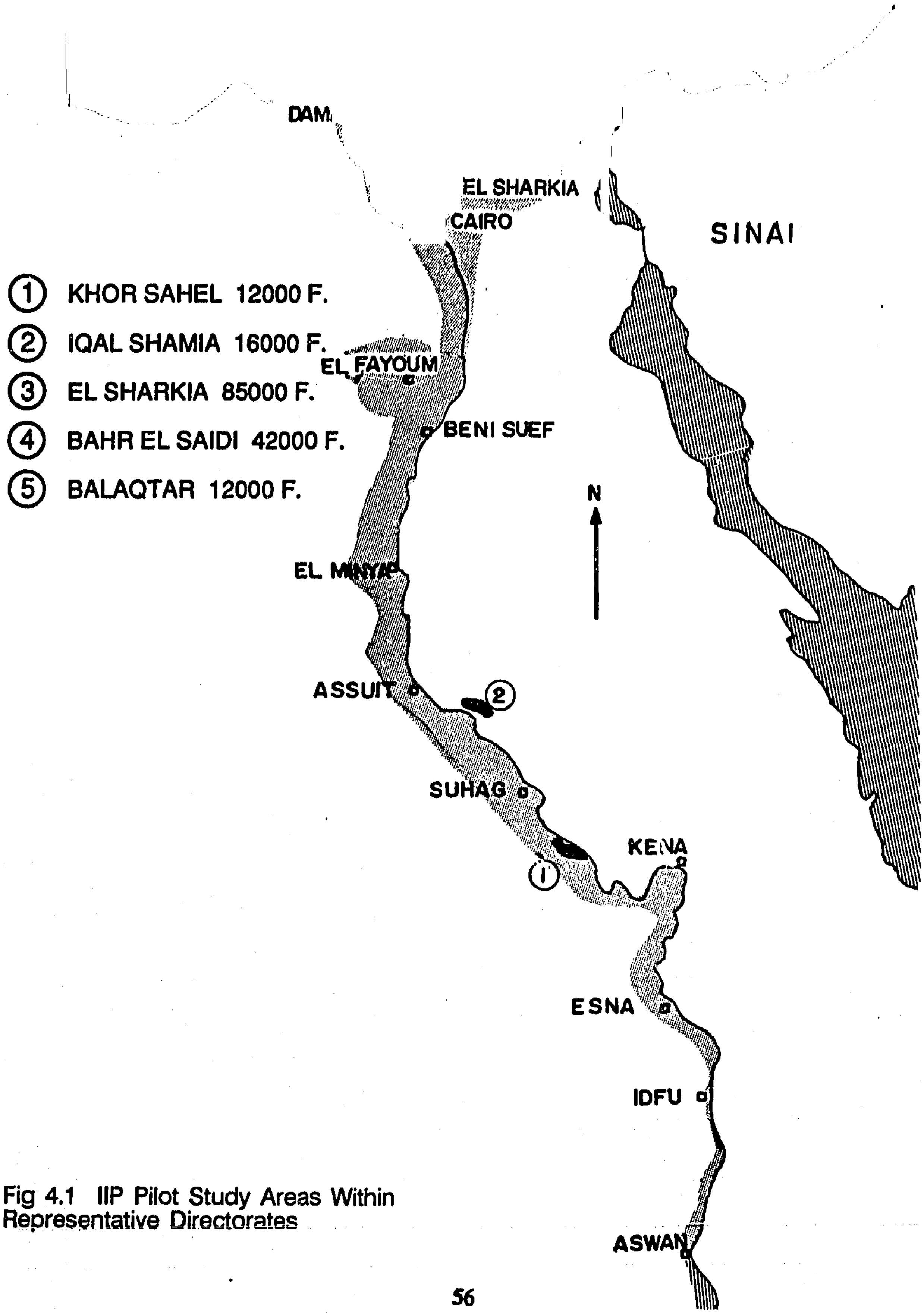

Fig 4.1 IIP Pilot Study Areas Within Representative Directorates

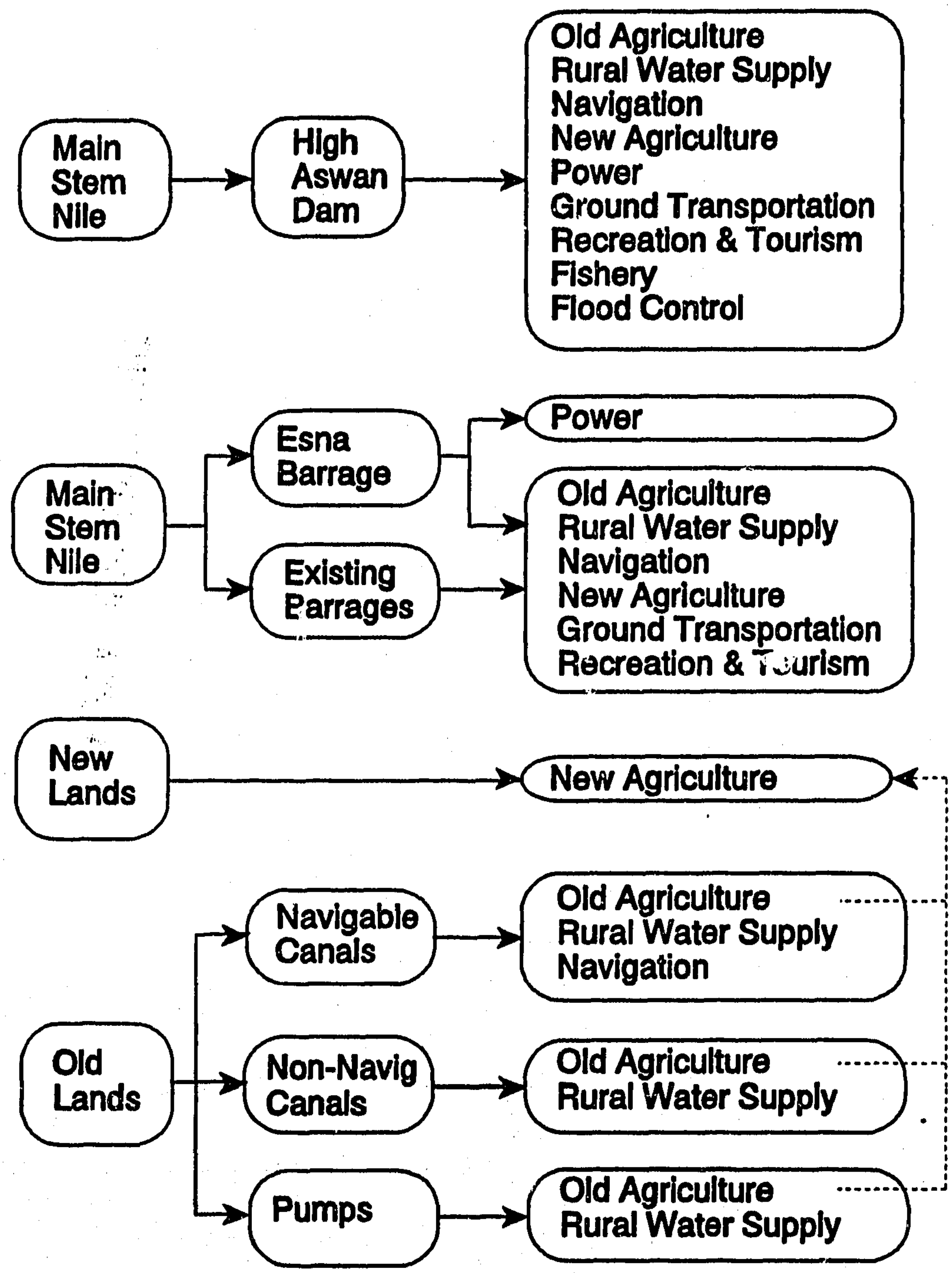

Figure 4.2 Cost Allocation Process for Nile River

Table 4.1 Estimation of Single Purpose Alternative Costs and User Benefits for the Cost Allocation Procedure.

System Level	Structure	Service Sector	Single Purpose Alternative Cost Determination	Benefit Estimation	
				Method (Sec. B.7)	Explanation
Region	Navigable Canals[1]	Agriculture	OM&R costs of the existing navigation canals[2]	2	Net primary returns/area served by navigable canals.
		Navigation	OM&R costs of the existing navigation canals[2]	3	Cost savings over rail transport
		Rural Water Supply[4]	OM&R costs of a pump and water distribution system drawing water from a deep aquifer.	3	Well and incremental pumping costs of a deep aquifer supply
	Non-nav. Canals[1]	Agriculture:			
		* Old lands and old new lands	OM&R costs of the existing canals[2]	2	Net primary returns/area served by non-navigable canals.
		* New new lands	OM&R costs of the existing canals carrying water to existing irrigated lands and new new lands[2]	2	Net primary returns for the new new land project[3]
		Rural Water Supply[4]	OM&R costs of a pump and water distribution system drawing water from a deep aquifer.	3	Well and incremental pumping costs of a deep aquifer supply
	Pumps[5]	Agriculture:			
		* Old lands and old new lands	OM&R costs of the existing pumps	2	Net primary returns for the region
		* New new lands	OM&R costs of the existing pumps jointly used to supply new new lands	2	Net primary returns for the new new land project[3]
		Rural Water Supply[4]	OM&R costs of a pump and water distribution system drawing water from a deep aquifer.	3	Well and incremental pumping costs of a deep aquifer supply

Table 4.1 (continued)

System Level	Structure	Service Sector	Single Purpose Alternative Cost Determination	Benefit Estimation	
				Method (Sec. B.7)	Explanation
Main Stem	Barrages	Agriculture			
		* Old lands and old new lands	OM&R costs of the existing barrages or substitute pumps	2	Net primary returns summed for the five regions
		* New new lands	OM&R costs of the existing barrages or substitute pumps jointly used to supply new new lands	2	Net primary returns summed for the new new land areas[3]
		Hydropower	OM&R plus capital costs of the new Esna Barrage (Sc. 2)	3	Cost savings over thermal energy alternative.
		Navigation[6]	OM&R costs of the river barrages	3	Cost savings over shipping by rail
		River Tourism[7]	OM&R costs of the river barrages	1	Net primary revenues from the Nile River to industry
		Road River Crossings	Bridges crossing the river at the barrage sites	3	OM&R cost savings over bridge crossings of the river
		Rural Water Supply[4]	OM&R costs of the existing barrages or substitute pumps	3	Well and incremental pumping costs of a deep aquifer supply summed for the five regions
Main Stem	High Aswan Dam (HAD)[8]	Agriculture:			
		* Old lands and old new lands	OM&R Costs of HAD[9] less costs separated for flood control	2	Summation of the net primary returns for regions
		* New new lands	OM&R Costs of HAD[9] less costs separated for flood control	2	Summation of the net primary returns for u. new land areas[3]
		Commercial Fishing[10]	OM&R costs of HAD[9] less costs separated for flood control	1	Value of direct output-market value of the fish harvest
		Flood Control	OM&R costs of HAD[9] for dead and flood control storages	4	Estimated value of flood damages prevcnt HAD.[11]

Table 4.1 (continued)

System Level	Structure	Service Sector	Single Purpose Alternative Cost Determination	Benefit Estimation	
				Method (Sec. B.7)	Explanation
		Hydropower	OM&R costs of HAD[9] less costs separated for flood control	3	Cost savings over thermal energy alternative.
		Navigation	OM&R costs of HAD[9] less costs separated for flood control	3	Cost savings over shipping by rail.[6]
		River Tourism	OM&R costs of HAD[9] less costs separated for flood control	1	Net primary revenues from the Nile River to[illegible] industry [7]
		Road River Crossing	Bridge crossing of the Nile at the High Aswan Dam site	3	OM&R costs savings over a bridge crossing river.[12]
		Rural Water Supply[4]	OM&R costs of pump and water distribution systems drawing water from deep aquifers summed for the five regions	3	Well and incremental pumping costs of the aquifer supply summed for the five regions.

Definitions

O= Operating costs

M= Maintenance costs

R= Replacement costs (capital costs). This item should not be confused with rehabilitation, which is a maintenance cost.

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Notes for Table 4.1:

1. Replacement (R) costs on canals are associated with control and turnout structures which generally would not be required for navigation or water supply purposes. If these costs could be identified, they could be made separable to agriculture, leaving primarily the canal O&M costs as joint. An important assumption of this study is that net primary returns for agriculture are estimated on the basis that water and land resources are a single, non-separable production unit.

2. In this study, excavation costs for canal construction are viewed as being sunk so that capital or replacement costs (R) for canal construction are not considered as costs to be allocated. However, the single-purpose alternative cost for a service such as navigation should include all costs, including capital costs, of providing that service. The reason for this statement is that in the cost allocation procedure being used, the justifiable cost is taken as being the lesser of benefits or the single-purpose alternative cost. The benefits accrue because of both capital and O&M investments. Thus, even though the capital costs of the canal construction are sunk, the benefits reflect these sunk costs. The corresponding single-purpose alternative costs, therefore, need to include the capital costs. For this reason, estimates of the capital or replacement (R) costs for the canals are included in this item. Costs for the two categories of canals, navigable and non-navigable, are calculated by multiplying the costs for all canals by a coefficient. The coefficient is the ratio of the wetted area of the canals in the category to the total wetted area of all canals.

3. The purpose of the analysis is to identify the share of the existing system costs which should be allocated to lands which are not yet reclaimed (designated as new new lands to differentiate them from lands that have been brought under irrigation since the 1950s old new lands). Thus, benefits for the new new lands need to be expressed at the point where the new new lands cease to share in the existing system. A similar procedure is used in evaluating the agricultural benefits for the old lands and the old new lands (the existing system), where net primary returns are based only on farm costs and benefit estimates (the mesqas and below). Therefore, net primary returns for the new new lands should include, in addition to on-farm figures, land reclamation costs, system capital, operating and maintenance costs, and any costs incurred by increasing carrying capacities as needed of specific components of the existing system to deliver water to the system of the new new lands (examples include enlarged canals and pumps). Because cost data are not available for specific new new land projects, benefits as expressed above could not be determined for this study. The benefits used in the analysis are only on-farm figures, and thus are larger than would be the case if costs for land reclamation and the new water delivery system were netted out. In the application of the cost allocation model, the justifiable cost turned out to be the single purpose alternative cost in each case (the canals, pumps, barrages, and the HAD). As additional cost data become available for the new new land developments, the benefit numbers can be adjusted appropriately. If net benefits fall below the single purpose alternative cost estimates, the justifiable costs should become the revised benefit figures and some changes in the cost allocation proportions (portions of existing system costs borne by the new new lands) would be expected.

4. Rural water supply includes deliveries to individual residences, village, towns, and industries not served directly from the Nile River. It is assumed that water supplies to major metropolitan centers situated near the Nile River (such as Luxor, Cairo, and Alexendria) do not depend upon the Nile River system. Even during low flow years there is apparently sufficient water in the Nile River to meet existing M&I demands in these centers. Costs and benefits for rural water supply are proportional for the region's population served by the two categories of canals, navigable and non-navigable. The proportion is calculated by the ratio of the population in each category to the total population in the region.

5. Pumps on the water supply and irrigation canals and drain pumps which recycle drainage water to the supply side can be considered as serving both agriculture and rural water supply. However, pumps which serve only a drainage function (that is, they do not recycle drainage water) benefit only agriculture, and thus should represent a specific cost to that sector. In the present analysis this separation could not be made.

6. Navigation refers to river freight transport. No system benefits are assumed during the four summer months of high Nile River discharge in the absence of the HAD. Similarly, no navigation benefits are assumed during the period of approximately two months of annual system closure for general maintenance. Under normal operating conditions, the barrages increase the channel depth between Aswan and Luxor. Benefits are based on the estimated average increment of river freight made possible by channel depth increases created by the barrages and by regulated flows from the HAD. Dredging costs are specific to navigation and are not included in the analysis.

7. Regulated releases from the HAD, coupled with the channel barrages, enable tourist boats to operate between Aswan and Luxor for most of the year. No benefits from the HAD are assumed during the four month period of high summer flow in the Nile River in the absence of the HAD. However, benefits are assumed for the period of approximately two months of annual system closure for general maintenance. Sufficient water is normally released from HAD storage even during this period to provide adequate channel depth for the relatively shallow draft tourist boats. Benefits reflect changes in the average state-room occupancy rates during different months of the year. Benefits also are based on the estimated average increase in tourist river traffic made possible by regulated releases from the HAD.

8. The cost allocation model is applied for several of the service sectors at more than one level within the system. To avoid the possibility of allocating costs which exceed the benefits for a particular service sector, total allocated costs and total benefits for each sector are summed at the HAD.

9. As in the case of canals (note 2), the capital or construction costs of the HAD are viewed as being sunk so that these costs are not considered as costs to be allocated. However, as explained in note 2, the single-purpose alternative costs for the HAD include all costs, including estimated capital (R) costs, of the dam to serve a particular purpose.

10. Commercial fish harvests from Lake Nasser and aquaculture ponds should be valued on the basis of net income (method 1). However, no costs of fishing were available to deduct from revenues. All benefits are assumed to apply to the HAD. No incremental fish harvest as a result of the dam was assumed for the main stem of the river.

11. Agricultural benefits implicitly contain flood control benefits for agricultural land. These flood control benefits thus are estimated by method 2. Other flood control benefits are represented by damages prevented to dwellings, cities, transportation facilities, and so forth. Average annual estimates of these benefits normally are developed through a flood frequency/damage study on the basis of current and estimated future development and property values (method 4). Because of time and data limitations, this kind of an analysis is not possible at this time. In his report A. Azim Abdul-Atta (1978) estimates flood control benefits as being about 4 percent of the total annual benefits of the HAD in terms of increases in national income (chapter VI, page 92). This figure is used in this study to estimate non-agricultural related flood control benefits as being approximately 4 percent of the summation of all other benefits at the HAD.

12. Because of their close proximity to each other, the High and the old Aswan Dams are operated and maintained as though they are a single unit, so the O&M costs for each are lumped together for this study. The Low Dam provides the main crossing of the Nile at Aswan. In the study, this crossing is treated as though it were a part of the HAD. The single purpose alternative is a bridge, and the benefits are the savings in OM&R costs required for an equivalent bridge crossing.

Table 4.2 Representative Directorates

No.	Region	Representative Directorate(s)	IIP Pilot Study Areas Within Representative Directorate
1	Upper Egypt	Kena	Khor Shel (12,000 F)
2	Middle Egypt	Assuit	Iqal Shamia (16,000 F)
3	East Delta	El Sharkia and El Salhia	Saidiya (8,500 F)
4	Middle Delta	El Gharbia	Bahr El Saidi (42,000 F)
5	West Delta	Behira and West Behira	Balaqtar (12,000 F)

Table 4.3 Scenario 1: Cost Summary (000)LE

DESCRIPTION	ANNUAL COST				TOTAL
	NILE STEM	REGIONS	PUMPS	OPEN DRAINS	
A. JOINT COSTS					
UPPER EGYPT	-	33,718	21,047	-	54,765
MIDDLE EGYPT	-	73,220	42,104	-	115,323
EAST DELTA	-	54,524	43,675	-	98,199
MIDDLE DELTA	-	45,683	39,765	-	85,448
WEST DELTA	-	35,415	35,735	-	71,150
SUBTOTAL	-	242,560	182,325	-	424,885
HIGH ASWAN DAM	36,145	-	-	-	36,145
BARRAGES & STEM	93,944	-	-	-	93,944
TOTAL JOINT COSTS	130,088	242,560	182,325	-	554,973
B. SPECIFIC COSTS					
NAVIGATION	2,801	-	-	-	2,801
AGRICULTURE	-	-	-	35,088	35,088
C. SEPARABLE COSTS					
FLOOD CONTROL	12,242				12,242
TOTAL	145,131	242,560	182,325	35,088	605,104

NOTE: ALL COSTS ARE CONSTANT DECEMBER 1991 PRICES

Table 4.4 Scenario 2: Cost Summary (000) LE

DESCRIPTION	ANNUAL COSTS				TOTAL
	NILE STEM	REGIONS	PUMPS	OPEN DRAINS	
A. JOINT COSTS					
UPPER EGYPT	-	42,134	26,136	-	68,270
MIDDLE EGYPT	-	75,413	52,285	-	127,697
EAST DELTA	-	78,297	54,236	-	132,532
MIDDLE DELTA	-	71,023	49,380	-	120,403
WEST DELTA	-	57,271	44,375	-	101,646
SUBTOTAL	-	324,137	226,412	-	550,549
HIGH ASWAN DAM	62,439	-	-	-	62,439
BARRAGES & STEM	138,654	-	-	-	138,654
ESNA BARRAGE	40,058	-	-	-	40,058
TOTAL JOINT COSTS	241,151	324,137	226,412	-	791,701
B. SPECIFIC COSTS					
NAVIGATION	29,312	-	-	-	29,312
AGRICULTURE	-	-	-	96,422	96,422
ELECTRICITY (1)	30,462				30,462
C. SEPARABLE COSTS					
FLOOD CONTROL	21,148	-	-	-	21,148
GRAND TOTAL	322,073	324,137	226,412	96,422	969,044

NOTE (1): ESNA BARRAGE POWER PLANT
NOTE (2): ALL COSTS ARE CONSTANT DECEMBER 1991 PRICES

Chapter 5

CHARGING MECHANISMS AND IMPLEMENTATION

5.1 Introduction

The Government has begun changing longstanding agricultural policies. New policies will allow farmers to sell more freely to open markets and to permit commodity prices received by farmers to move toward free-market levels. The policies will reduce or eliminate an important mechanism by which the government has collected "tax" revenues from the farm sector. Among other implications, these major policy shifts raise questions about the appropriate means of financing the operation and maintenance of the main irrigation system. Cost-sharing mechanisms for directly charging farmers have been proposed as a revenue source to help pay for system maintenance.

The purpose of this chapter is to provide, as called for in Task 7 of the Scope of Work, a *preliminary* discussion which will a) identify constraints to development of cost-sharing programs at the various hierarchical levels of the irrigation system; b) suggest appropriate mechanisms; and c) suggest additional steps required for implementation. Therefore, the scope of this chapter is limited primarily to the problem of recovering the farmers' share of main system OM&R costs, although some broader cost recovery issues arise in the course of the discussion**.

Public policy on a complex and controversial issue such as irrigation cost recovery mechanisms requires balancing of multiple, competing goals. Several social goals have been suggested for appraising public policy on water resource systems (Maass and Anderson, 1978; Bohm and Russell, 1985; Stone, 1988). These major criteria include economic efficiency, fairness, i.e., treating like individuals in a similar manner, correcting imbalances in the distribution of income and wealth, and individual choice. Long-term sustainability of the system is an explicit goal of Egyptian water policy, although economists might argue that this can be appropriately subsumed under economic efficiency. Lesser-order goals include minimal administrative costs, orderly conflict resolution, and local autonomy and control.

Considerations of economic efficiency and equity focus attention on recovery of irrigation costs. Pricing can ration scarce resources such as water and minimize economic wastage. Economic efficiency is attained when the incremental charge (price) equals marginal or incremental cost. The water user will only apply units of the resource as long as the incremental gain exceeds incremental costs. Economic waste occurs when water users apply more water than is economically efficient. (Precise marginal cost pricing requires volumetric measurement of water

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** The material in this chapter was prepared by R. A. Young from the literature cited; from discussions with Project staff members A. Mazen, I. Elassiouti; from meetings with MPWWR officials G. Elsayed, M. Abu Zeid; with IIP consultant M. Lowdermilk; and with the USAID staff members D. Clark, C. Weber, R. Erich, M. Allam, and D. Wendell. None of the above is responsible for the final contents of the chapter.

which, as discussed below, is difficult to achieve under most canal irrigation systems.) Furthermore, equitable cost distribution is sometimes defined as one in which no group in society subsidizes any other. Full cost recovery from water users can be termed equitable in that sense.

Focusing attention on capturing benefits—rather than recovering costs—seems appropriate to some analysts. However, this approach would likely force irrigators to pay more than their fair share. Such a policy would be inequitable and would also provide a disincentive to farmers to maximize productivity and profitability. Specific estimates of economic benefits do have an important role in assessing cost recovery mechanisms. Net returns (profits) to water for farmers cannot be less than charges without creating a negative net income situation and removing incentives to produce at all.

5.2 Constraint Identification

The term constraints is interpreted broadly in this section. It will refer to general obstacles or problems, rather than absolutely binding limitations or prohibitions.

Development of cost-sharing programs may include: technical, social, administrative, political and legal, and economic constraints. Placing an issue in a certain category is somewhat arbitrary; some issues fall into more than one specific category. The different kinds of constraints are outlined in the paragraphs that follow.

Technical constraints—Technical issues are often important obstacles to adopting cost recovery mechanisms. A primary technical problem is the accurate measurement of water received by each of the many farmers served by the system. Devices and personnel for precise measurement of water deliveries are often lacking, particularly if the situation calls for volumetric measurement to each plot. Another obstacle is identification of specific parcels of land receiving water and therefore obligated to share in the repayment program. In many localities throughout the world, maps purporting to show lands receiving water are inaccurate, and frequently show planned irrigated area instead of actual irrigated area. Another complication is how to treat lands which receive canal water only part of the year (while perhaps otherwise receiving only self-supplied groundwater or no water at all) or only at times when water supplies are in relatively generous supply.

Technical constraints of this sort can usually be overcome and are rarely absolutely binding. The technology to measure water or identify lands receiving water is well-known. However, technical constraints can usually be overcome only through considerable expenditure of resources. Technical constraints of the kind described above, therefore, can often be more fruitfully understood as cost constraints.

Social constraints—As the term is used here, social constraints refer mainly to farmer attitudes on paying for water and on group action in managing the water supply.

There are religious and political considerations on paying for water. The religious issue, in Egypt and in many other arid countries, stems from the Islamic prescription against paying for water, "a substance provided by God for all to share." Many are concerned that any proposal for collecting fees related to irrigation water supply would violate Islamic teachings. However, it is important to emphasize that this attitude does not necessarily include an official objection to paying an Irrigation Service Fee (ISF) for the resources and services required to capture, store, and deliver water. Policies which implement a cost recovery program are more likely to be successful if they make a careful, precise distinction between the water resource itself and the extensive services of capital, management, and labor necessary to supply irrigation water. It should be emphasized that payment is only for the services and not for the water resource itself.

Political attitude which has received little or no previous discussion is that many farmers perceive themselves as a mere instrument, as opposed to a provider of public resources. In this view, the farmer, by employing water resources, provides a public benefit in the form of helping to provide a plentiful, inexpensive, and secure food supply to the nation. The farmer contributes the hard work necessary to produce food and fiber and takes the risks associated with fluctuations in climate, levels of disease, and crop prices. From this perspective, it is not the farmer but the food and fiber consumers who should pay the costs of water supply and assume the risks of cost overruns and unanticipated external costs associated with public irrigation systems. (Examples of external costs or side effects are water quality degradation and/or waterlogging.) In this view, the farmers, the public, and the government are in a partnership, and the government's part of the bargain is to provide the water.

In sharp contrast, the growing worldwide impetus for cost recovery programs arises from the increasing emphasis on decentralized economic and political institutions—even in the agricultural sector—and from the corresponding principle that water should be treated as an economic commodity. In this view, the irrigation water supply sector should be organized under decentralized market principles, and society is best served when water price reflects the full costs of its supply. Thus the direct beneficiaries—the water users— should bear not only the full costs of delivering the water, but should also be responsible for the risks of cost overruns and unanticipated external costs.

Another attitude providing an obstacle or constraint to cost recovery is the belief that payment need be made only if full value is received. Many farmers believe they are only obligated to pay only if the other party to the arrangement (i.e., the government) delivers as much water as needed at the time required. This attitude has the practical effect of giving water users leverage in negotiations with authorities.

Water users associations (WUAs) have been suggested for playing a potentially important role in cost recovery. WUAs could serve as a collection organization and encourage farmers to participate in mesqa management. There is a literature on the possibility of self-sustaining WUAS. Sociologists (e.g., Freeman, 1989) and analysts of public administration (e.g., Ostrom, 1992; Gerards, 1992) have formulated principles for designing sustainable water users organizations. However, there are skeptics (e.g., Young, 1992) who call attention to problems with organizing WUAs and the great difficulty in practice of achieving and sustaining effective collective organizations of farmers. While not disputing the possibility of sustainable WUAs, skeptics emphasize conflicting interests between head-enders and tail-enders, and inadequate information and varying social power and status on tertiary watercourses (mesqas). These conditions make successful collective action much more difficult and costly in time and effort than is generally recognized. The long-run sustainability of WUAs for mesqa maintenance, water allocation, and revenue collection must be considered to be, at best, improbable. Young hypothesizes that, from society's overall perspective, mesqa management tasks would be most effectively and least expensively performed by the irrigation authority. Still, WUAs who successfully demonstrated management capacity could be offered a rebate on water charges to encourage self-management.

A final social constraint is the regressive (adverse) implication of water charges for the distribution of income and wealth in Egypt and similar countries. (A regressive policy favors the wealthy at the expense of the poor.) A large proportion of farmers are small landholders who fall on the lower end of the income scale. Setting aside the fact that many farmers are not necessarily poor, paying for water from the general treasury rather than from cost recovery is a simple mechanism for redistributing income to an important sector of the population.

Administrative constraints—Administrative constraints involve the concern that the charging mechanism be both simple and transparent. When there are a variety of mechanisms—e.g., if charges vary by region or according to whether specific programs (such as closed drainage or on-farm delivery system improvements) have been locally implemented—the simplicity constraint may be violated. On the other hand, betterment levies to capture drainage or on-farm improvements have been applied to date only to limited areas. Therefore, spreading these costs to the nation's farmers as a whole would be seen as unfair to those not yet receiving these special services.

Administrative mechanisms for imposing and collecting charges should be transparent. Farmers should easily understand the reasons for the charge, how it may vary between sectors or areas of the country, and how its level is initially set and changed over time.

It is important that fees collected stay within the water supply system. If OM&R costs are successfully recovered from water users, the revenues might go to the Finance Ministry, which may judge that the funds have more value elsewhere in the government budget than the MPWWR. If this happens, then the program will have failed in its goal to improve the system, and subsequent irrigation service fee collections will likely dwindle.

Political and legal constraints—Political and legal constraints derive from the social attitudes described above. Rural and farm-based members make up a significant proportion of the national Parliament. From considerations of principle (to say nothing of its financial self-interest), this bloc is likely to strongly resist any movement toward shifting any of the cost of the irrigation system away from the public treasury and toward the farmers.

The most significant legal problem is how to identify exactly who is responsible for payment from each parcel of land (i.e., owners or tenants). Parliament is considering a change in the laws on this subject. If adopted, the legislation would have a major effect on how costs are distributed between owners and tenants (and from the analyst's perspective, how ability to pay is determined). Another legal concern relates to making the charge volumetric to ration a scarce water resource. With such a mechanism, the charge must be levied upon the decision maker who chooses how much water to apply.

Economic constraints—Economic constraints take several significant forms. The major economic constraint is farmers' ability to pay. Ability to pay sets an upper bound on the costs which can be recovered from farmers. It is usually defined by net profit from crop production. Profits, in turn, depend on a number of considerations, including the productivity of soils on the specific plots, the managerial capability of farmers, the types of crops produced, the size (in feddans) of the farm, the quantity of inputs and resources employed in crop production, and market (or government-mandated) prices of crops and productive inputs. Productivity and profitability can vary widely among farms and farmers in the same region, and between the regions of the nation. An important consideration in establishing a cost recovery scheme in determining which, if any, of these factors should be taken into account.

Technical economic issues in determining ability to pay include such factors as the following: What interest rate and planning period should be used to amortize capital? How much, if any, amount should be charged for family labor in the profit calculations? Should wage rates be differentiated by age and/or sex of workers?

An economic consideration which will be important for gaining political acceptance of newly instituted cost recovery mechanisms on presently irrigated lands is the possible perception of an adverse impact on the wealth of owners of irrigated lands. Other factors being equal, a new water charge would reduce annual income. Market values for land tend to be based on the capitalized (i.e., present-discounted) value of the annual income stream. Increased costs from an irrigation service fee would not only have an immediate, adverse effect on net income, but an even more significant effect on the market value of lands. This partly explains the strong objections landowners have to new government taxes or charges. Of course, if those in the land market expect to gain more benefits from system maintenance than they stand to lose from the increase in costs, then their income and wealth will increase, and they will much less likely object to new fees.

Other considerations which might be classified as economic constraints are costs which derive from the technical constraints discussed above. Among these are the costs of identifying beneficiaries and measuring the water actually received. Another important economic consideration, sometimes classified as administrative, is the cost of actually collecting from beneficiaries, including but not limited to clerical services, record keeping, and the extra expense of collecting from those who miss payment deadlines. Mechanisms for resolving conflicts among water users and between water users and the Irrigation Department, such as informal tribunals or formal water courts, also require costly resources.

5.3 Suggested Charging Mechanisms

5.3.1 Preliminary Remarks

Costs may be recovered directly from those who receive the water, or indirectly from increases in government revenue associated with an irrigation project (such as by increased tax revenues from agribusiness, export taxes, etc.). The discussion here will focus on direct cost recovery mechanisms.

It is useful to consider two dimensions of revenue collection structure when reviewing charging mechanisms. One dimension is the overall administrative and organizational structure employed in water delivery and revenue collection. The second dimension refers to the specific mechanism by which irrigation costs are recovered from farmers.

5.3.2 Options for Administrative/Organizational Structure

Probably the most frequently adopted approach to administering cost recovery is to pass the job to an official tax collection agency, such as the revenue section of the national ministry of finance. These organizations have the experience, personnel, and procedures for revenue collection. Tax collection agencies are sometimes recommended as the low-cost method, because no new bureaucratic structure and associated personnel and operating budget is needed.

Policies which rely on central tax collection agencies to recover irrigation system costs have been criticized because they may return only a part of the revenues collected and/or an inadequate amount of funds to the irrigation agency for long-term system maintenance. The MPWWR has, according to this perspective, little incentive to assure maximum collection rates because its budget has little relation to the amount collected from farmers. Conversely, the finance ministry, receiving little income from irrigation service fees, tends to give little funding back to the Irrigation Department. Some critics of the typical administrative structure blame a significant portion of the problem of inadequate irrigation system management and declining infrastructure on this point (Easter, 1990; Small and Carruthers, 1991). These analysts hypothesize instead that an autonomous irrigation authority, which would neither receive funds from nor pay revenues to the central government, would have a better understanding of the financial needs for maintaining and upgrading the irrigation system. Moreover, such an authority could have the incentive to raise sufficient revenue and spend them effectively.

5.3.3 Options for Specific Charging Mechanisms

Two broad categories of charging mechanisms may be considered. One approach focuses on land area served, while the other measures volume of water. (It would be conceivable to institute a flat charge for each farm or family, but this would so favor larger farms that its adoption is unlikely.)

Area-based charges—One broad category of water charges are based on the land area served by the system. Three distinct types of charges can be distinguished. Each would collect revenue for irrigation cost recovery by an addition to the existing land tax.

One method charges according to the amount of lands that are actually both cultivable and served by the irrigation system. This approach is usually called a flat land charge. A flat land tax probably is the easiest type of system to administer, since the collection agency needs only to know the irrigable, cultivable area belonging to each owner, regardless of annual or seasonal variations in cropping practices.

A second type of area-based charge would impose a fixed charge on the actual areas cropped in each of two or three seasons of the water year. In this case, a flat charge would be imposed on each individual crop that receives irrigation water during the year. This approach, which might be called a partial crop-based land charge, requires more administrative and regulatory effort from the revenue collection authority, i.e., periodic visits to each landholding.

The third type of charge varies for each of the crops grown according to typical or required water use levels for each crop. Long-season crops such as rice or sugar cane that require large amounts of water would be charged much more than beans or wheat. Two drawbacks have been reported from this approach. One (Bowen and Young, 1986) is that because of the high fixed cost structure of farming, there is little response to crop charges. (See also Small and Carruthers, 1991, for similar findings in Asia.) The second problem has to do with incorrect reporting of actual crops by employees responsible for collecting the charge. For example, in return for gratuities, employees might underreport rice areas planted with rice and overreport bean-growing areas.

Volumetric charges—Charging by volume of water requires an ability to measure water deliveries with reasonable accuracy. The more precision in water measurement, the greater the resulting administrative costs.

One issue is the location at which the measurement is taken. The measurement can be made an outlet to the tertiary conveyance channel for a group of farmers, or at the outlet and the individual turnout. In the former case, the farmers must somehow divide up charges among themselves; in the latter case, the charging mechanism does it for them (see the discussion below).

A rather exact approach is to charge each "delivery" to a specific plot. The charge would depend on the area of the plot and assume that each delivery represents a similar volume of water. This might be called the delivery charge approach. The charge would likely be set according to the typical head and flow rates at the farmer's receiving point.

A second variation on the volumetric theme would be a charge based on the time during which water is received for each delivery. This might be called the delivery time method.

An exact approach to volumetric measures would actually attempt to measure water delivered to each farm, and charge accordingly. Some sort of measuring flume or similar device would be necessary, and an observer or automated instrument would have to record the time and rate of flow for each delivery.

Full volumetric pricing presents both political and economic obstacles in the Egyptian context (Bowen and Young, 1986). The political constraints, discussed above, stem from the religious and political objections to charging farmers for water. Bowen and Young found that, as with crop charges noted above, a large charge would be required to elicit significant changes in farmers' water use patterns. The level of charge necessary to ration water would likely be even larger than needed to recover system improvement costs.

Flat area charges combined with water delivery quotas—A type of middle ground approach has been suggested for Egypt, which draws on the simplicity of the flat rate approach, while avoiding at least some of the political and economic disadvantages of volumetric pricing (Bowen and Young). This approach, already practiced in parts of the western United States, would collect the desired level of revenues for cost recovery by means of a flat land charge. The allocative efficiency problem would be dealt with by creating annual or seasonal water delivery quotas (or "entitlements"), which would encourage farmers to make the most economical use of the water by selecting crops appropriate to their soils, climate, markets and water supply situation.

A more sophisticated version, long practiced in parts of the western United States, makes the entitlements marketable, so that those expecting high profitability from growing high water-using crops could buy entitlements from those who preferred less water-intensive crops. The quotas might be exchangeable on a temporary basis (rental) or by permanent sale. The advantage would be that water could move to its highest and best uses. The disadvantages would be the religious issue noted above, and the necessary administrative structure and recordkeeping to protect interests of both those a part of the transaction (assuring only the exacts entitlements are transferred) and parties not in the transaction (from some of their water being inadvertently sold.)

5.4 Steps Required for Implementation

If the charging mechanism is to serve only the single goal of recovering from direct beneficiaries the costs of an economically justified main system improvement program, the solution appears to be simple: a flat land tax can be designed to collect the appropriate amount of revenue and the collection task assigned to the Finance Ministry. This will be equitable, in the sense that each feddan in each region will bear an equivalent financial burden. Further, this is a low-cost method of recovering costs, even if, as is likely, the revenue agency imposes some collection fees.

However, if the charging policy is to satisfy further goals, particularly that of economic efficiency, some form of delivery quota approach or even a form of volumetric charge must be given serious consideration.

5.4.1 General Steps

A specific plan must be chosen to implement a cost recovery system. This will require completion of the study outlined under Scope of Work No. 3. Although the first steps have been taken in Study No. 2, it will be necessary before choosing a plan to estimate with more exactitude the ability of farmers to pay throughout the various regions of the country.

Once a plan is selected, a number of administrative and political tasks must be completed. These include: obtaining general Parliamentary approval and enacting the specific legal provisions necessary for implementation.

If the Finance Ministry is to collect the revenues, a formal agreement with that Ministry will be needed to remit an appropriate share of the proceeds.

5.4.2 Specific Steps for Implementation

This section discusses several topics that should be incorporated into any plan for implementing a cost recovery system.

What role might water users associations play in implementing a cost recovery program?—WUAs can serve at least four functions in improving water management in a large scale canal irrigation system. One function is to provide a collective organization to maintain the mesqas. A second role might be to provide a collective mechanism to divide or allocate the water along a mesqa among individual water users and their fields. A third is to aid in collecting revenues from farmers to pay for the system. A fourth purpose is to represent the farmers' needs and interests to the irrigation authority. For this last purpose, a hierarchy of councils of representatives should be formed. The mesqa WUA would form the first level of councils. The next or secondary canal level would be made up of elected representatives from individual mesqas. For the next level, representatives would be elected from the lower level, and so on.

Some advantages and disadvantages of relying upon WUAs for revenue collection, mesqa maintenance, and water allocation were mentioned above. If the government policy becomes one of relying on WUAs for assistance in cost recovery, a policy which establishes WUAs on each and every mesqa must be implemented.

Making payment contingent on actually receiving full water entitlements—As water supplies become more and more constrained because of drought, growing upstream diversions, or increased demands from municipal and industrial sectors and new land reclamation, some water users might not always receive their full entitlement. In addition, local farmers may not receive water due to general or partial system failure. In such cases, payment could be reduced accordingly. Such an approach is being tested in a pilot project in Indonesia (Gerards, 1992). In such a case, some mechanism must be adopted to avoid periodic serious shortfalls in OM&R operations due to occasional reductions of revenue collections. This could take the form of a special fund set aside from revenues and drawn on as necessary, or agreement with the Finance Ministry to make up such shortfalls.

Should interest on capital costs be included in the irrigation service fee?—This study has assumed that interest on durable capital items is an includable cost. The Irrigation Improvement Project (IIP) report on cost recovery (IIP, October, 1991) has followed a different approach, suggesting interest on capital improvements is not an element of the costs which are to be recovered. However, it should be noted that that report's recommendation to ignore interest costs is at odds with the fact that GOARE must pay interest on loans to improve the system or forego return on capital which might be productively invested elsewhere.

Gradual phase-in of water charges—Implementation of a water charging system will be controversial and unpopular. A gradual phasing in of the full charge might soften the negative impact. The Indonesian pilot project mentioned above is using a five-year phasing in program, starting at 20 percent of the desired level, and increasing an additional 20 percent each subsequent year. The IIP pilot studies recommended a full moratorium or waiver on payments for five years after the project is completed. (Waiving irrigation service fees for five years was the practice in the United States for newly constructed projects in which farmers were obligated to pay for land development costs and on-farm delivery systems.) A potential drawback to a five-year waiver in the case of on-farm rehabilitation and upgrading expenditures is the possibility that on-farm improvements would visibly depreciate by the end of five years, and farmers might lose the incentive to make full payment.

Keeping up with inflation—The common tendency of economies to experience inflation in general price levels poses a problem for implementing irrigation service fees. While a fixed level of charges can initially raise a satisfactory level of revenue, inflation can evolve the real purchasing power of fee collections. Some mechanism must be considered to assure that revenues rise at a parallel rate. An obvious choice is pegging the charges to increase each year at the same rate as a suitable index of prices received for agricultural commodities by Egyptian farmers.

Another approach, in use for some time in the Philippines (Svendsen, 1991), is to permit the charge to be paid in kind. The unit of payment would be in kilograms of the most important crop or its monetary equivalent. The service fee, in money or in kind over a period of time, would reflect the purchasing power of the crops produced. (This approach would be more difficult to implement in Egypt, which has a wide variety of crops. However, the method has promise. Given the importance of retaining purchasing power, it warrants additional study.)

Chapter 6

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

6.1 Summary

6.1.1 System Description

This document describes the Nile River system according to two basic levels of hierarchy, i.e., the main stem of the Nile and the existing irrigated lands. An additional level is added for lands which are proposed to be reclaimed, and which are termed the new new lands. Within the Nile main stem, joint costs occur for two types of structures: the HAD complex and the eight barrages on the river below the HAD. Within the irrigated lands, the only joint costs involve the irrigation canals, with the uses being navigation, rural water supply, and agriculture. To provide for spatial differences in the system, the irrigated area was divided into five regions, i.e, Upper Egypt, Middle Egypt, East Delta, Middle Delta and West Delta. Within each region a representative directorate was identified, with each directorate containing an Irrigation Improvement Program (IIP) study area. The data obtained from the results of the IIP studies were applied to the representative directorates. In turn, data from the representative directorates were extrapolated to the regions.

6.1.2 Study Scenarios

Four scenarios were identified for the study.

Scenario 1: This scenario represents the present water supply system, which delivers water to the old lands and the recently developed new lands (the old new lands). Scenario 1 is designed to reflect the budget policy in effect now and in the recent past for expenditures on OM&R.

Scenario 2: This scenario has the same geographic coverage as Scenario 1, but upgrades the OM&R policy to a level adequate for long-term sustainability. The improvements include: a) additional regulating and control structures; b) improved maintenance of existing canals, drains and water regulating and control structures; and c) a program for more rapidly replacing deteriorating water control structures and pumping stations.

Scenario 3: This scenario represents the same budget policy as Scenario 1, but incorporates potential new lands. Potential new lands refer to those developments currently proposed but not yet reclaimed (new new lands).

Scenario 4: This scenario modifies the adequate OM&R budget policy of Scenario 2 to include the new new lands referred to in Scenario 3.

6.1.3 Cost Data

OM&R cost data for the existing system were obtained from various sources, and were summarized for input to the cost allocation model (Scenario 1). Cost data also were assembled for upgrading the system to an adequate level of maintenance (Scenario 2). The capital costs of all in-place facilities such as the HAD complex, the eight Nile barrages on the Nile main stem, and the channels are treated as being sunk costs, i.e., not relevant to a future cost recovery policy. Capital costs are considered as structures are replaced and new improvements are made to the system. Costs are discounted at an interest rate of 12 percent over an assumed project life of 30 years. Structures for which costs are allocated are the HAD complex, the eight channel barrages, and the irrigation canals within the regions. All costs and benefits throughout this report are expressed in December 1991 prices.

6.1.4 Cost Allocation Results

In reviewing the study results, it is important to remember that the cost allocation procedure used (the Adjusted Separable-Costs Remaining Benefits [ASCRB] method) satisfies the two basic economic criteria of efficiency and equity. The efficiency criterion requires that each user's share of the system costs should not exceed the benefits which the user derives from the project. An additional part of this requirement is that the total costs allocated to each user should not exceed the cost of a single-purpose alternative project which could provide equivalent benefits. Equity refers to fairness in the distribution of total project costs among all the users of a multipurpose development. Thus, costs should be allocated as a function of the benefits which each user receives from the project. In this way, each user can be assured of having to pay only a fair share of project costs. The application of these two criteria introduces the notion of justifiable cost. This cost for a particular user is the lesser of the single-purpose alternative project cost or the project benefits. A cost allocation procedure which uses justifiable cost will not require a user to pay more than either the benefits received or the cost of a project constructed only to meet the needs of the particular user.

Table 6.1 shows the total OM&R costs for the present system in 1991 LE's for the five-year period 1986-87 through 1990-91. Several observations about the table follow.

1. In constant prices, the annual expenditures for OM&R on the existing system increased during the three water-short years of 1986-87 through 1988-89. However, during the last two years of the period real expenditures dropped by about 5 percent per year. This trend if continued will inevitably result in a loss of benefits from the system.

2. Personnel costs represent about 17 percent of the total current costs under Scenario 1. The study team considers these costs reasonable and not indicative of an excessively expensive bureaucratic structure. Although labor efficiency could doubtless be improved by some reduction or reallocation of the work force, major cost savings cannot be achieved.

3. Average replacement costs under Scenario 1 are low and should be increased for adequate system maintenance.

4. Present maintenance costs are unusually high, indicating that parts of the system need replacement. An increase in replacement costs will produce a corresponding decrease in maintenance costs.

Figure 6.1 shows the joint cost allocation results under the four scenarios. The following are brief observations on the figure.

1. For all scenarios, existing agriculture carries a major share of the project joint costs, ranging from about 75 percent under Scenario 4 to approximately 83 percent under Scenario 1.

2. Next to agriculture, river tourism has the largest share of joint costs, with shares ranging from 5.7 to 10.3 percent of the total. Tourism shares in the cost of the river barrages and the HAD.

3. The joint cost shares for both flood control and fishery are relatively small (the allocated proportions for all scenarios do not exceed 1 percent for either use). This condition results not because the benefits to these two sectors are small, but because the justifiable costs are the single-purpose structures at the HAD site. Furthermore, shares for users which involve only the HAD are low because the dam represents only a relatively small proportion (less than 10 percent) of the total joint costs for the system.

4. Navigation proportions are small (less than 5 percent) for all scenarios. Navigation shares in the costs of the barrages and the HAD. However, its relatively small benefits govern the allocation of joint costs for this use.

5. Scenario 2 represents the costs and benefits of the existing system under an adequate maintenance program. OM&R inputs are increased by nearly 50 percent to adequately maintain the system, with replacements made as appropriate. Allocated cost proportions actually drop in this scenario for agriculture and rural water supply primarily because shares allocated to power and tourism increase. The reason for the increase is that this scenario represents significant improvements in the main stem barrages and in HAD maintenance, particularly with the construction of the new Esna Barrage and its associated hydroelectric facilities.

6. Scenario 3 represents the existing system (Scenario 1) coupled with the new new land reclamation. The new lands assume about 6.8 percent of the total joint cost of the existing system, bringing the total share for agriculture (existing lands plus new new lands) to about 87 percent. Shares decline for other system users. A similar trend is observed under Scenario 4, in which the upgraded system (Scenario 2) is coupled with new land development.

7. Total system costs for the various system users are shown by Table 6.2a for Scenario 1 and Table 6.2b for Scenario 2. Costs for new land development were not estimated and are not included. Costs for Nile channel dredging specific to navigation are also not included. However, for existing agriculture and other uses total system costs are shown. For agriculture, costs do not include current on-farm (mesqas and below) costs. These costs are included in the estimation of agricultural benefits (see Appendix F.5). However, IIP mesqa improvement costs are not included. They would have to be included in the estimates of agricultural benefits if this program is implemented. Mesqa improvements are not included to identify agricultural benefits associated only with improvements in the main system above the mesqas. For the same reason, cropping patterns were assumed not to change under Scenario 2 from Scenario 1. This seemingly unrealistic assumption was made to enable identification of benefits attributable to improved main system deliveries. In fact, benefits are likely to rise as farmers change cropping patterns under an open market policy to maximize their agricultural returns.

8. Table 6.3 indicates under each of the four scenarios the costs to existing agriculture on a per feddan basis and by water delivery volume (in thousands of m^3). The cost increases by about 45 percent with improved maintenance from LE75.2 per feddan under Scenario 1 to LE109.2 per feddan under Scenario 2. Under Scenarios 3 and 4 there are cost reductions because a portion of the system costs is carried by the new lands. These estimates are made on the basis of the area of irrigated land in the existing system of 6.60 million feddans. As indicated by Table 6.2, the total costs to agriculture include the allocated joint costs plus the specific costs for open drains.

   Turning to cost per unit of water, a cost of about LE10.7 and 10.3 per thousand m^3 are estimated under current policies for Scenarios 1 and 3 respectively. These costs would rise to about LE15.5 and LE14.9 per thousand m^3 under Scenarios 2 and 4.

9. Tables 6.4 and 6.5 show the distribution across the basin hierarchy of costs allocated to existing agriculture. Table 6.4 shows the annual cost per feddan. For example, it indicates that existing agriculture is charged LE1.51 and 2.62 per feddan per year for the services of the High Aswan Dam complex (HAD) in Scenarios 1 and 2, respectively. Costs allocated for the main stem barrages, including Esna, are LE4.84 and 9.71 in Scenarios 1 and 2, respectively. In Scenario 1 the costs allocated within each region vary from LE53.9 in the West Delta to LE75.3 in Middle Egypt. In Scenario 2 there is much less variation among regions, with the Middle Delta lowest at LE81.2 and Upper Egypt highest at LE83.3.

   Drainage costs are shown in the middle of the Table 6.4, and the total cost per feddan is shown for each region at the bottom of the table. These costs are obtained for each region by summing the costs for the HAD, main stem barrages within the region, and drainage. The total regional costs vary from LE65.6 in the West Delta to 87.0 in Middle Egypt for Scenario 1. The last row in Table 6.4 shows the flat rate which is obtained by dividing the total costs by the total area. The flat rate varies from LE72.7 in Scenario 3 to LE109.2 in Scenario 2.

Table 6.5 is the same as Table 6.4 except that the units are expressed in terms of LE/1,000 m^3 of water. The total annual costs for the regions vary from LE9.44 to LE 11.8 in Scenario 1. The flat rate varies from LE10.3 in Scenario 3 to LE15.5 in Scenario 2.

In Scenario 1 the regional costs per feddan vary by more than 30 percent with Upper and Middle Egypt on the high side and the West Delta on the low side. The higher cost for Upper Egypt is caused by relatively high personnel costs: about 63 percent higher than the average for all five regions on a per area basis. The higher cost for Middle Egypt is caused by relatively high non-personnel and capital costs; about 34 percent and 26 percent above the average, respectively. The relatively low cost for the West Delta is caused by relatively low personnel costs, about 59 percent below the average on a per area basis.

In Scenario 2 the allocated costs per feddan among regions vary by only 2 percent, much less than in Scenario 1. This result may be attributed to the way in which costs for input to the model were estimated for "adequate OM&R": total basin costs were estimated and then proportioned out to the regions on the basis of area.

For all regions in both scenarios the justifiable costs for rural water supply are much lower than for irrigated agriculture, thus causing almost all of the cost within each region to be allocated to agriculture. Because there is no significant competing service for water within each region, the final allocation of costs to agriculture among all regions will be very similar to the distribution of the cost data input to the model. This accounts for the large variations in Scenario 1 and the small variations in Scenario 2; they both follow the trends of the input cost data.

6.1.5 Economic Disbenefits

External or spillover costs, which are actually damages or disbenefits to third parties (for example, water pollution damages), often arise with use of water by municipalities, industries, and agriculture. They have an important role in the theory of environmental management. However, they usually arise from diffuse sources, and assessing individual or even sector responsibility by means of a water pollution tax is difficult on both technical and policy grounds. Ideally, external costs should be internalized into the costs facing economic agents. However, little data exists on water pollution damages in Egypt and resources to this study were not sufficient to develop such estimates. Hence, disbenefits were not considered in this study (except that costs in mitigation of overirrigation practices are charged as a specific cost to the irrigation sector).

6.1.6 Sensitivity Studies

The sensitivity of a particular cost allocation result to input values for benefits or single-purpose alternative cost depends entirely upon two points:

- whether the justifiable cost for a particular service is derived from the benefits or the single-purpose alternative and
- the relative magnitude in terms of total system joint costs to the joint costs of the structures being allocated

For example, except at low levels where they become less than the single-purpose alternative cost, changes in flood control benefits have no effect on the costs allocated to flood control. However, even if flood control benefits represented the justifiable cost, the costs allocated to flood control would be low because flood control involves only the HAD, and the cost of this structure represents the less than 10 percent of the total system joint costs (Fig. 6.2a). There is little sensitivity associated with allocations involving the HAD because the costs for this structure are small in proportion to the total system joint costs. By the same token, the system is not very sensitive to the canal replacement costs (alternative costs) even though these costs govern the allocation of joint canal costs to users in the irrigated regions. These costs represent a large portion of the total justifiable costs which are used to allocate the joint canal costs. In other words, the justifiable cost for agriculture is much greater than the justifiable cost for rural water supply in each region, and dominates the allocation between agriculture and water supply. For this reason, the portion of costs allocated agriculture is rather insensitive to changes in the estimated single-purpose cost of the canals as indicated by Figure 6.2b.

For rural water supply the justifiable costs are the system benefits, which are the incremental costs of drawing from a deep aquifer supply. Thus, if the benefits to rural water supply are significantly increased, for example, the costs allocated to water supply also are significantly increased, although not in the same proportions because agriculture has much greater total justifiable costs. The sensitivity of rural water supply and agricultural allocated costs to changes in rural water supply benefits are shown by Figure 6.2c.

In addition to conducting sensitivity studies by changing the user benefits and/or single- purpose alternative costs, one can examine the effects for changes in the cost of the works at various system levels. If joint cost changes are applied uniformly throughout the system, no change in the cost allocation proportions would be expected. However, if joint costs change significantly at only one system level, a change in the overall allocation proportions will result. For example, a significant increase in OM&R costs for the irrigation canals will be reflected as an increase in the proportion of the total system costs allocated to agriculture. Similarly, for reasons already stated, a change in OM&R costs at the HAD will not have much effect on the overall allocation proportions.

The sensitivity of model results to the discount rate was also studied. Four additional runs were conducted for each scenario using discount rates of 6 percent, 9 percent, 15 percent, and 18 percent. Figure 6.3 shows the results for the existing agricultural sector. The present values (solid lines) and annual costs (dashed lines) are shown for Scenarios 1 and 2. The present values decrease significantly with increasing discount rates and the annual costs decrease slightly. The present values are discounted cost streams and will always decrease with increasing discount rate. The annual costs are calculated from the present values by the following formula:

$$A=P(1+r)^n[r/(1+r)^n-1]$$

where A is the annual cost, P is the present value, r is the discount rate, and n is the number of years. When r increases, P decreases and the tendency is to offset each other so that A changes less than either r or P. The amount that P changes will also depend upon the distribution of the values in the cost stream.

Figure 6.4 shows the relative changes in the annual cost allocations for four sectors: fishery, existing agriculture, rural water supply, and ground transportation. These sectors were selected to demonstrate a range of sensitivities. These results are from the sensitivity analysis on Scenario 2. The values in the figure are obtained by dividing the allocated annual cost for the specified discount rate by the allocated annual cost for the discount rate at 12 percent. Agriculture dominates the system and is insensitive to discount rate. The fishery sector decreases by about 50 percent over the range of discount rates. Water supply and transportation increase by about 50 percent and 118 percent, respectively, over the range of discount rates.

6.2 Conclusions

The following is a list of the study team's main final conclusions:

1. The Nile River water delivery system in Egypt was divided into two major levels of hierarchy, i.e., the main stem of the river, including the HAD complex and the eight barrages below the dam, and five regions. For the cost allocation process, joint works within each level of hierarchy are associated with a particular set of services. In this regard, under Scenarios 1 and 3, all barrages on the main stem were treated as a single entity in the cost allocation process. However, under Scenarios 2 and 4, it was necessary to treat the Esna Barrage as a separate unit because of the addition of hydroelectric generating facilities. Similarly, within the regions it was necessary to identify and treat separately the navigable and non-navigable canals. Under Scenarios 3 and 4, the new new agricultural lands (those not yet reclaimed) were added as an additional spatial unit in the cost allocation model. This degree of system hierarchy met the requirements of this study. With increased data, additional spatial resolution could be added if needed.

2. In terms of constant prices, the annual expenditures for OM&R on the existing system increased during the three water-short years of 1986-87 through 1988-89. However, during the last two years of the period, actual expenditures dropped by about 5 percent per year. This trend if continued will inevitably result in deterioration of the system and loss of benefits.

3. In the present level of O&M (Scenario 1), personnel costs represent about 17 percent of total costs. The study team considers these costs reasonable and not indicative of an excessively expensive bureaucratic structure.

4. Average replacement costs in Scenario 1 are low and should be increased if the system is to be adequately maintained.

5. Present maintenance costs are unusually high, indicating that parts of the system need replacement. An increase in replacement costs will produce a corresponding decrease in maintenance costs.

6. The findings suggest that the nationwide average annual OM&R costs of the main system allocatable to irrigation are about LE75 per feddan per year (in December 1991 prices). This figure would rise to about LE109 per feddan under Scenario 2. These main system costs to farmers seem reasonable. The equivalent costs per thousand m^3 are about LE11 and LE16, respectively.

7. Sensitivity studies indicated the relative sensitivities of particular cost and benefit estimates to the cost allocation results. Sensitivities to joint cost estimates at various levels within the system hierarchy also were examined. From these results it is possible to identify points where emphasis should be placed in refining cost and benefit estimates.

8. On a rough comparative basis, the costs under either Scenario 1 and 2 are not out-of-line with international standards for large, multipurpose water supply systems. Moreover, it appears from our direct agricultural benefit studies that Egyptian farmers could pay most if not all of the estimated costs once prices for their crops reach international market levels. In fact, the added costs to farmers of a policy requiring full OM&R cost recovery would appear to be less than the added income provided by the policy change permitting farmers to receive market prices.

9. The application of a cost allocation model to the Nile River system is more of a continuing process than it is a point of closure. As insights are gained from use of the model, new perspectives will be developed from which it is possible to evaluate data and specifications in terms of continually changing policies and social needs.

6.3 Recommendations

6.3.1 Dissemination of Study Results

This report has required extensive research effort. Its results have the potential of forming the basis for an economically sound cost recovery program for Egypt's Nile River water supply system. The report and the potential of the cost allocation model applied in the study should be understood by GOARE officials and by others who might be influential in implementing a cost recovery program. In this regard, it is recommended that a workshop be held to discuss "where do we go from here." The workshop should not emphasize the technical details of cost allocation but how the study results might be used to structure and implement a successful cost recovery program.

6.3.2 Cost Recovery

6.3.2.1 Potential Charging Mechanisms

A concern which must be addressed before selecting a charging mechanism is the identification of goals that a cost recovery policy is to satisfy. If the policy goal is solely to find a different way to collect more revenues, then the simplest effective method palatable to farmers and Ministry should be selected. If the cost recovery policy is considered as a part of a broader program to encourage economic efficiency, equity, and improved people management where the water delivery system and the farmers interact, consideration should be given to more complex policies in which cost recovery is only one public purpose. The latter perspective is taken: it assumes that definition of water rights for farmers and methods of enforcement of those rights are the key questions in improved water management along mesqas and in farmers' fields.

Two broad categories of charging instruments are considered. The first focuses on land area served, and may be based on feddans of land irrigated annually or seasonally. Charging rates might be varied according to farm size. A further refinement is to vary charges by crops according to their water use. Flat land charges are relatively easy and inexpensive to administer, but fail to penalize those who do not make best economic use of water in their irrigation practices or choice of crops.

The second category is some sort of volumetric charge. This approach requires both the resources and the political will to measure the water used and to charge accordingly. While it encourages economically efficient water use, and is fair in the sense that each user pays according to what he draws from the system, the cost of measurement and revenue collection and adverse social attitudes toward water pricing represent significant drawbacks.

A combination approach, consisting of a flat area charge and a water rights or quota system emphasizing that farmers' rights to water are limited to their proportionate share of the country's scarce entitlement, might provide a compromise. Costs would be recovered by a special, additional land tax. The farmer's limited water quota would force careful, economical water use. On a broader perspective, consideration might be given to a drastic policy revision to require the MPWWR to collect its own irrigation water revenues and permit those revenues to be spent only as needed for OM&R. This approach would encourage the Ministry to obtain high levels of farmer contributions and to streamline its operational efficiency.

6.3.2.2 Implementation

Several steps are required for implementation. Legal and political actions are needed to draw up specific legal provisions authorizing cost recovery and to obtain Parliamentary approval. Management initiatives might be necessary to assure that water supply officials fulfill obligations to provide better water delivery. Other steps include setting the exact rate to be recovered and the terms upon which it can be paid (cash or crops). A gradual phase-in would probably find more acceptance than imposition in one year of the entire cost recovery program. A long-term cost recovery program to anticipate price inflation and arrangements to have cost recovery mechanisms track changes in crop prices should be put into effect. Linking payment to a specified quantity of a major crop (or the equivalent cash value) is the preferred solution in some countries.

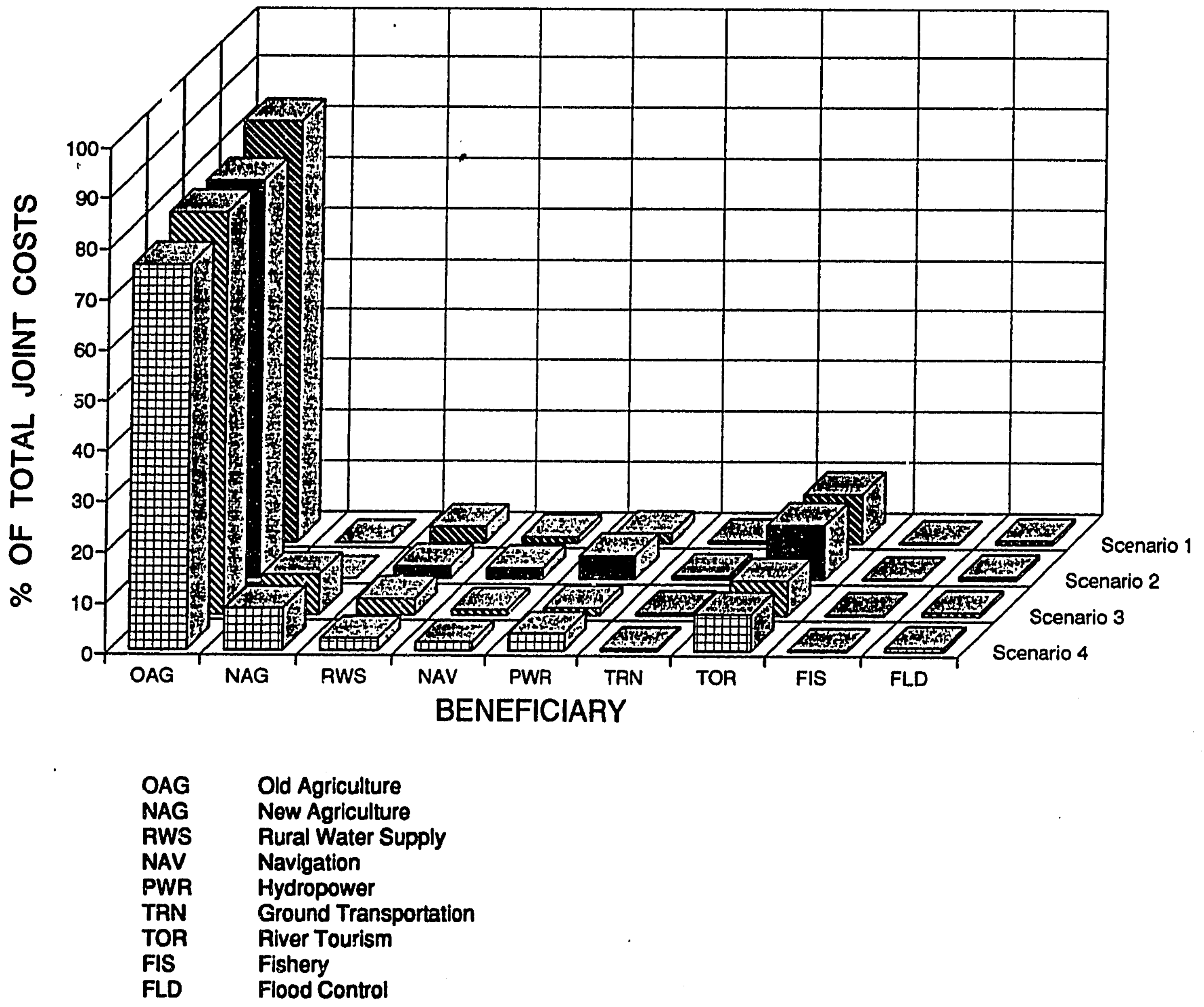

Fig 6.1 Joint Cost Allocation Proportions for the Four Scenarios

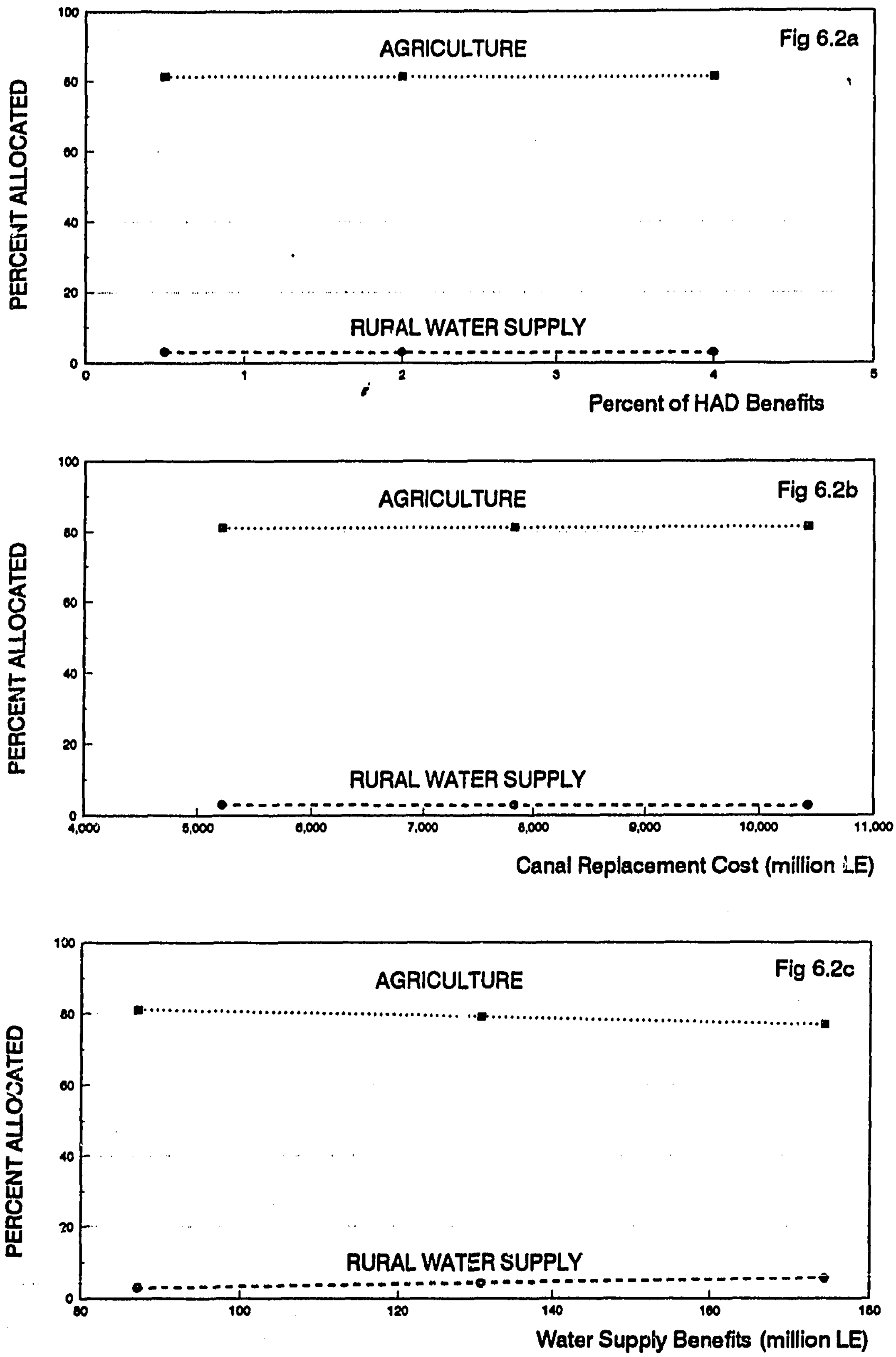

Fig 6.2 Sensitivity of Cost and Benefit Estimates to the Cost Allocation

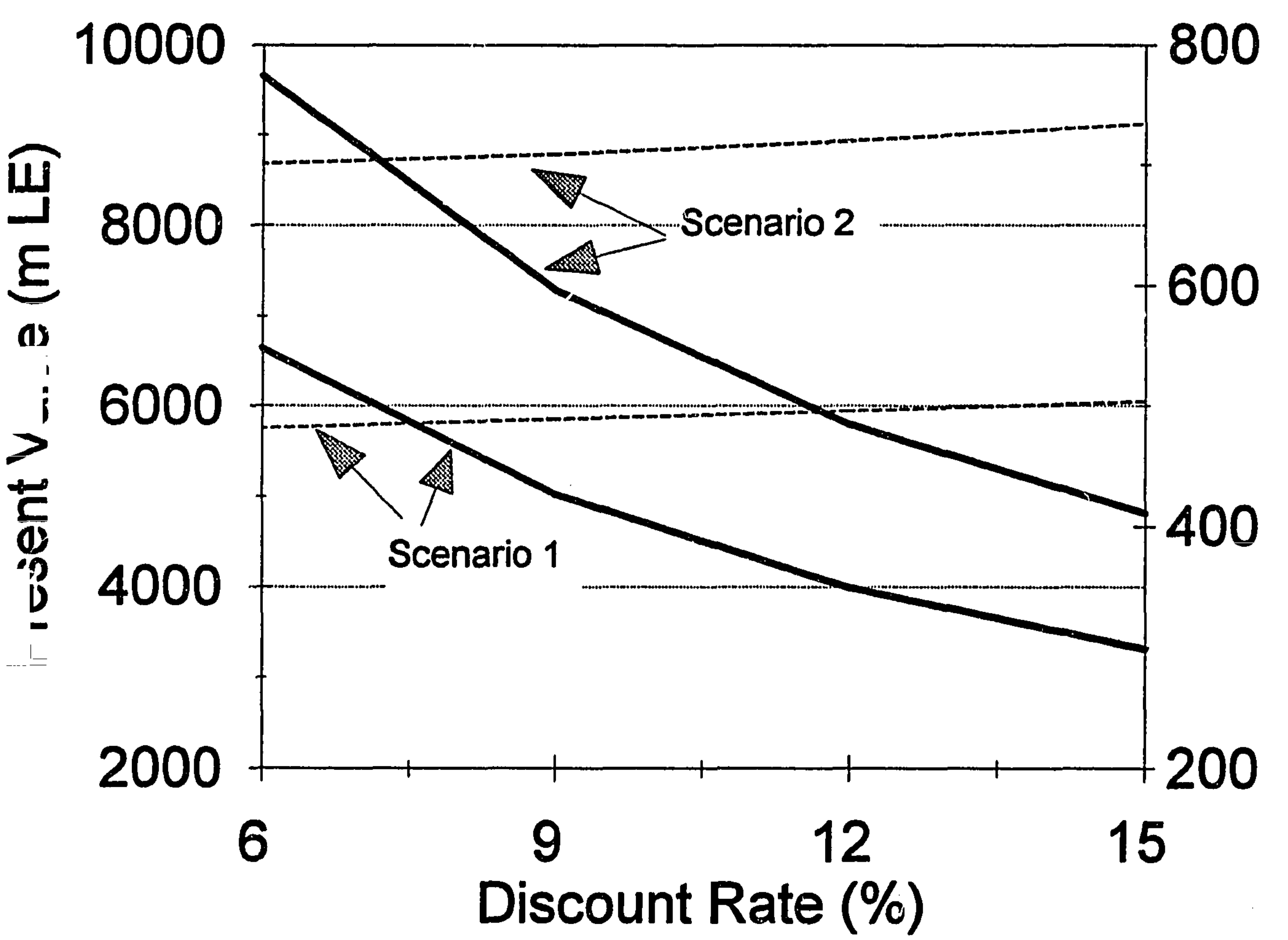

Figure 6.3 Results of Sensitivity Analysis on Discount Rate for Existing Agriculture

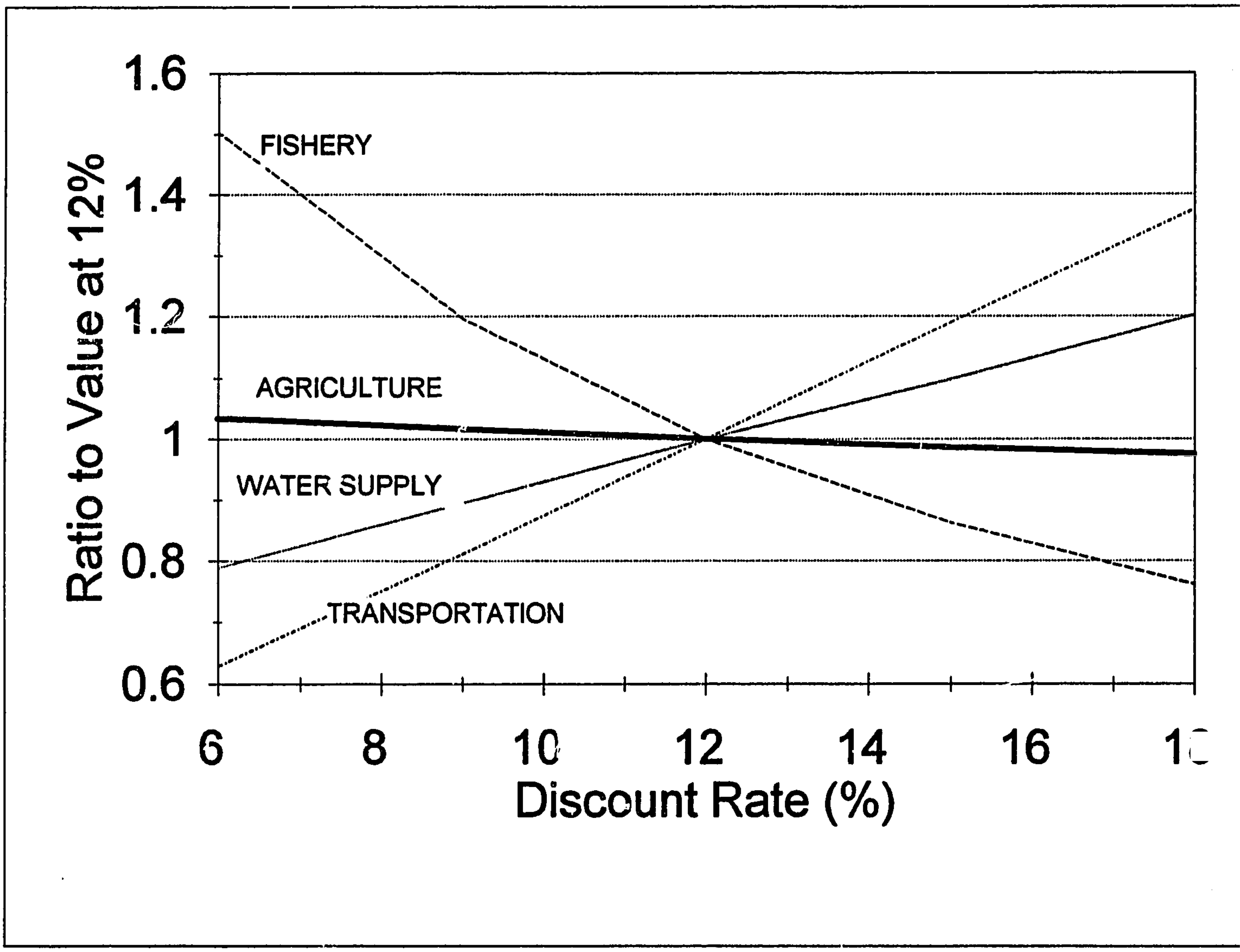

Figure 6.4 Results of Sensitivity Analysis on Discount Rate for Selected Sectors

Table 6.1 Historical OM&R Total Costs for the Present System in December 1991, in million LE

COST CATEGORY	FY 1986	FY 1987	FY 1988	FY 1989	FY 1990	AVERAGE ANNUAL COSTS (1)		
						BASE	INCL. CONTG	PERCENT
O&M Costs								
Personnel	69.4	79.9	91.3	103.3	114.5	114.5	120.2	20.6
Non-personnel (2)	186.2	217.3	256.2	233.9	204.5	219.9	241.9	39.6
Subtotal	255.6	297.2	347.5	337.1	319.0	334.4	362.1	60.2
Capital Costs								
Structural Replacement	72.6	90.6	87.6	90.0	98.6	87.9	96.7	15.8
Pump Station Rehab & Replacement	55.7	62.7	60.4	29.2	30.6	47.7	52.5	8.6
General Improvements	94.3	93.2	82.9	83.9	72.3	85.3	93.9	15.4
Subtotal	222.6	246.4	230.9	203.1	201.5	220.9	243.0	39.8
TOTAL COSTS	478.2	543.6	578.4	540.2	520.5	555.3	605.1	100.0

(1) Except Personnel Costs (See Section 3.4)
(2) Includes Capital Costs of Maintenance

Table 6.2a: Scenario 1
Summation of the Total Costs for the Various Users (Million LE)

	Joint Costs						
		Main Stem					
System User	Regions	Barrages	HAD	Total Allocated Joint Costs	Separable Costs	Specific Costs	Total
Existing Agriculture	419.4	32.0	9.9	461.3		35.1	496.4
Rural Water Supply	1.0	0.2	0.0	1.2			1.2
Navigation	4.6	21.2	1.2	27.0		2.8 (1)	29.8
Hydropower	0.0	0.0	9.9	9.9			9.9
Ground Transportation	0.0	8.6	0.1	8.7			8.7
New Lands (2)	0.0	0.0	0.0	0.0		New Systems (3)	0.0
Commercial Fishing	0.0	0.0	1.2	1.2			1.2
River Tourism & Recreation	0.0	32.0	9.9	41.9			41.9
Flood Control	0.0	0.0	3.8	3.8	12.2		16.0
Total	425.0	94.0	36.0	555.0	12.2	37.9	605.1

(1) Although there are specific costs for new agriculture and navigation, they were not estimated.

(2) Allocated costs of the present system to new lands.

(3) The costs of modifying the present system plus the cost of developing the new land.

Table 6.2b: Scenario 2
Summation of the Total Costs for the Various Users (Million LE)

System User	Joint Costs				Separable Costs	Specific Costs	Total
	Regions	Main Stem: Barrages	Main Stem: HAD	Total Allocated Joint Costs			
Existing Agriculture	542.6	64.1	17.3	624.0		96.4	720.4
Rural Water Supply	1.0	0.3	0.0	1.3			1.3
Navigation	6.9	27.6	2.0	36.5		29.3 (1)	65.8
Hydropower	0.0	11.5	17.3	28.8			28.8
Ground Transportation	0.0	11.2	0.1	11.3			11.3
New Lands (2)	0.0	0.0	0.0	0.0		New Systems (3)	0.0
Commercial Fishing	0.0	0.0	2.0	2.0			2.0
River Tourism & Recreation	0.0	64.1	17.3	81.4			81.4
Flood Control	0.0	0.0	6.4	6.4	21.1		27.5
Total	550.5	178.8	62.4	791.7	21.1	125.7	938.5

(1) Although there are specific costs for new agriculture and navigation, they were not estimated.

(2) Allowed costs of the present system to new lands.

(3) The costs of modifying the present system plus the cost of developing the new land.

Table 6.3 Average Annual OM&R Costs Allocated to Existing Agriculture

SCENARIO	COST/FED	COST/1000 M^3
1	75.22	10.66
2	109.17	15.47
3	72.72	10.30
4	104.81	14.85

Table 6.4 Annual OM&R Costs per Feddan Allocated to Existing Agriculture per Hierarchy (mil LE/Yr)

SCENARIO HIERARCHY	 mil FD	1	2	3	4
HAD	6.599	1.51	2.62	1.18	2.05
MAIN STEM BARRAGES	6.599	4.84	9.71	3.61	7.13
REGIONS					
UPPER EGYPT	0.762	71.71	83.27	71.71	83.27
MIDDLE EGYPT	1.524	75.30	83.06	73.04	80.56
EAST DELTA	1.581	61.29	82.31	61.29	82.31
MIDDLE DELTA	1.439	57.92	81.23	57.92	81.23
WEST DELTA	1.293	53.92	81.64	51.76	78.38
DRAINAGE	6.599	5.32	14.61	5.32	14.61
TOTAL REGIONAL					
UPPER EGYPT	0.762	83.38	110.21	81.82	107.06
MIDDLE EGYPT	1.524	86.97	110.00	83.16	104.36
EAST DELTA	1.581	72.96	109.25	71.41	106.10
MIDDLE DELTA	1.439	69.58	108.17	68.03	105.03
WEST DELTA	1.293	65.58	108.59	61.87	102.17
FLAT RATE		75.22	109.17	72.72	104.81

Table 6.5 Annual OM&R Costs per 1000 M^3 Water Allocated to Existing Agriculture per Hierarchy

SCENARIO HIERARCHY	mil M^3	1	2	3	4
HAD	46570	0.21	0.37	0.17	0.29
MAIN STEM BARRAGES	46570	0.69	1.38	0.51	1.01
REGIONS					
UPPER EGYPT	6340	8.62	10.00	8.62	10.00
MIDDLE EGYPT	11263	10.19	11.24	9.88	10.90
EAST DELTA	10154	9.54	12.82	9.54	12.82
MIDDLE DELTA	10609	7.86	11.02	7.86	11.02
WEST DELTA	8204	8.50	12.87	8.16	12.36
DRAINAGE	46570	0.75	2.07	0.75	2.07
TOTAL REGIONAL (1)					
UPPER EGYPT	6340	10.02	13.24	9.83	12.86
MIDDLE EGYPT	11263	11.77	14.88	11.25	14.12
EAST DELTA	10154	11.36	17.01	11.12	16.52
MIDDLE DELTA	10609	9.44	14.67	9.23	14.25
WEST DELTA	8204	10.34	17.12	9.75	16.11
FLAT RATE		10.66	15.47	10.30	14.85

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Appendix A

THE NILE SYSTEM IN EGYPT

A.1 Overview

The Nile River basin in Egypt receives essentially no rainfall. Thus, the country depends almost entirely upon the river to provide water for many diverse requirements, including irrigation, hydro-electric energy generation, inland navigation, rural and municipal water supplies, industrial supplies, recreation and tourism and aquaculture for fish production. The river provides surface supplies and recharges groundwater aquifers which are pumped for many uses. From its source in Lake Plateau at the equator the Nile River flows northward for a total distance of about 6700 Km. It flows across Egypt for more than 1000 Km before entering the Mediterranean Sea.

A.2 Nile System Development in Egypt

A.2.1 Early Times

For thousands of years the Nile River overflowed its banks during flood periods and inundated large areas of land in Egypt adjacent to the river. When the floods abated the river returned to its main channel leaving behind a layer of silt on the land. The first agricultural activity in Egypt was the sowing of seeds on this land which had been watered and fertilized by the natural floods. Archaeological evidence suggests that this first agriculture started in about 5200BC.

A revolution in agriculture occurred with the beginning of artificial irrigation, including deliberate flooding of areas contained by longitudinal and transverse dikes and subsequent draining through sluice gates. Basin irrigation was established by the First Dynasty (3050BC). The first recorded evidence of this type of irrigation is found on the mace head of the so-called Scorpion King which has been dated at about 3100BC. The mace head shows the Scorpion King cutting an irrigation channel which then bifurcates and appears to feed an irrigated field which is surrounded by unmistakable palm trees.

Although control of the flood waters in this way was an improvement on total dependence on the vagaries of the annual Nile flood, the variations in flood level from year to year were critical and no irrigation was possible except at times of flood (winter crops only). The second agricultural revolution came with the introduction of lift irrigation. Mechanized irrigation came with the introduction of the shadoof during the 18th Dynasty (1550- 1307BC). The more sophisticated Persian water wheel or saqia, was introduced in early Ptolemaic times (323-30BC). This device was able to lift substantial quantities of water. These lifting devices permitted increased reliability in years of low floods and also provided sufficient water for limited summer cropping to be introduced. Summer crops were, however, mainly limited to horticultural varieties because of the absence of the natural fertilizer provided by the Nile flood. This system of irrigation continued largely unchanged until the middle of the Nineteenth century.

The cultivatable area in ancient Egypt has been estimated at between 4 million and 5 million feddans. However, the area cultivated each year varied greatly, depending on flood levels, food demands and labour availability. It is thought that on the average about one feddan of area was cultivated per capita of population.

A.2.2 First Modern Development

The impetus for modern development was provided in 1805 by Mohamed Ali, the then ruler of Egypt. He recognized agriculture as being the primary revenue producer in the country. Accordingly, he instructed that cultivatable land be distributed among the people and he introduced high valued crops, such as sugar cane, vegetables, fruits and especially cotton. The production of cotton necessitated a radical change in the irrigation system since it needed to be planted before the natural rise of the flood, required regular watering and needed to be protected from inundation during the flood. For the first time controlled irrigation was required but the natural variation of water levels in the river system caused great problems.

Mohamed Ali called upon his engineers to take measures to solve this problem and the outcome was the construction of the first man-made structures on the Nile, the Delta Barrages. Two barrages were constructed at the head of the Delta, across the main Damietta and Rosetta branches, to raise the low summer water levels in the channel sufficiently to enable flows to enter the higher flood level canals. The construction of the Delta Barrages was started in 1843 but various engineering difficulties hindered the progress of the works, and it was not until 1861 that the barrages were completed. Fortunately the engineers were able to dissuade Mohamed Ali from his suggestion that stone from the pyramids be used for the construction. Mohamed Ali died in 1848 before completion of the barrages, but they served well until replaced by new structures in 1939. The original Delta barrages are still used as road bridges and stand as an elegant monument to the founder of modern irrigation in Egypt. Following completion of the first barrages, remodelling of canals was undertaken, resulting in the canal system largely as it is today.

In addition to benefiting from the improvement in irrigation supplies, cotton cultivation was given a great impetus by the American Civil War which resulted in high prices for Egyptian cotton. Production increased from 600,000 to 2,000,000 Kantar (45 Kg/Kantar) between 1860 and 1864, and by 1900 reached 6,440,000 Kantars.

By the end of the Nineteenth century, however, agricultural production was constrained by another factor. The natural flow in the river was sufficient to irrigate only 1.5 million feddans in a low year. This shortage of water for summer crops led to the first storage works on the Nile, the Aswan Dam.

A.2.3 First Half of 20th Century

The first half of the 20th century saw tremendous improvements in the Egyptian irrigation systems. The first Aswan Dam was completed in 1902 with a storage capacity of one billion (10^9) cubic meters, and it proved so successful that it was raised in 1912 and further raised in 1934 to increase the storage capacity to 5.1 billion cubic meters. Associated with the development of the Aswan Dam was the extension of the perennially irrigated areas with the construction of further barrages at Assuit (1902, remodeled 1938), Zifta (1902 and remodeled in 1954) on the Damietta branch, Esna (1908, remodeled 1947 and now being replaced), Nag Hammadi (1930) and Edfina (1951) on the Rosetta Branch to limit discharge of excess water to the sea.

A.2.4 Second Half of 20th Century

The completion of the High Aswan Dam (HAD) in 1968 is the most recent revolution in Egyptian agriculture. The enormous storage in the reservoir formed by the High Aswan Dam (total storage 162 billion cubic meters, live storage 90 billion cubic meters) is sufficient to make Egypt virtually independent of the vagaries of the year to year variations in the annual Nile flood. After nearly 7000 years during which Egyptian farmers regularly suffered from the effects of annual droughts or floods, the impact of the dam on Egyptian agriculture was nothing less than revolutionary and brought immense benefits from increased irrigated areas, increased cropping intensities and increased yields.

A.3 Description of the Nile System

The Nile River System is classified for purposes of this study in terms of the following hierarchy:

a. The High Aswan Dam (HAD) and the Old Aswan Dam;

b. The Nile River main channels, including barrages and pumps located on the main stem;

c. The main canals, open drains, pump stations and associated structures within each directorate; and

d. Other canals and associated structures within each directorate.

A.3.1 The Nile River Main Channel and Barrages

The main channel of the Nile downstream (north) of the HAD is divided into seven reaches by eight major multipurpose barrages, namely, Esna, Nag-Hammadi, Assuit, the two Delta barrages, Zifta, Faraskour, and Edfina, Fig. A.1. The barrage locations with respect to the HAD and the main (canals) served by each barrage are given by Table

A.1. The area irrigated within each river reach and the average total annual crop water requirements for each are given by Table A.2. The seven barrages also serve navigation, municipal and industrial demands. Table A.3 indicates the minimum navigation draft corresponding to specific minimum flows in each of the seven reaches of the river.

Hydropower is generated at the HAD and at the Old Aswan Dam power stations 1 and 2. Annual water releases and energy generated at these two locations are shown by Table A.4 for the 10 year period 1980/81 through 1989/90. For this period, the average annual total quantity of electrical energy generated was 9.5 x 109 KWH, with approximately one-third of this total being generated at the Old Aswan Dam, and the remainder at the HAD. A new Esna barrage is currently under construction which is being equipped with hydropower

generators.

A.3.2 The Irrigation System

The irrigation system is divided geographically into five regions, namely, Upper Egypt, Middle Egypt, East Delta, Middle Delta and West Delta as shown in Fig. A.2. The Delta regions are situated in what is known as Lower Egypt. Except for the Fayoum area, the irrigated land in Upper and Middle Egypt extends along both banks of the river. East Delta lands extend between the Damietta branch and the Suez Canal. Middle Delta lands extend between the two Nile branches. West Delta lands extend from the Rosetta branch to the western desert, where most newly reclaimed lands exist.

Two different spatial units are applied to the irrigation system within Egypt, namely, canal command areas and directorates. A command area in Egypt represents a unit which is served by a particular major canal. This spatial unit is often applied in model studies of the area. There are 50 command areas within the existing irrigation system. The directorate is an administrative unit, with each directorate being responsible for the operation, maintenance, and rehabilitation of the irrigation system within its boundaries. At present, there are 22 directorates within the existing irrigation system (Fig. A.3).

From the Nile River water enters the main canals and the rayahs very large canals). Intake rates are controlled by regulating structures for gravity intakes and by pumping rates for pump diversions. For both types of diversion works intake levels in the Nile are regulated by the eight barrages named in Section A.3.1.

All irrigation water diverted in the first reach of the river between the Old Aswan Dam and the Esna barrage is pumped. Pumping also occurs in some other reaches of the river. From the main canals (Fig. A.2), the water flows consecutively through lower order canals until it reaches the mesqas

(distribution ditches to individual farmers), and eventually the on-farm ditches, or marwas. All canals upstream of the mesqas are part of the main system. The mesqas and marwas are owned, operated and maintained by the farmers. The system contains several types of water control structures, including outlet and transition works, flow regulators, tail-water escapes, weirs and crossing structures (culverts, bridges, syphons, and aquaducts)

A.3.3 Drainage System

The drainage works consists primarily of open drains although the use of buried tile drains is increasing. The system is managed by a total of five central administrations, which are disaggregated into 27 drainage directorates, as shown in Fig. A.4. Table A.5 gives the location of each directorate and the area served by each. It is noted that the drainage directorates are not coincident with the irrigation directorates. For this study, the entire drainage system is treated as a single component of the irrigation system. The rationale for this approach is that the drainage system can be regarded as responding to a collective problem, rather than serving the needs of specific directorates. In addition, detailed data on the drainage works are

unavailable. However, a general description of the network of open drains in terms of drain length as a function of bed width is given in Table A.6. Characteristics of the drainage structures according to the hydraulic area and structure type are given in Table A.7. Drain terminal points are situated at the following locations:

- Irrigation canals (through mixing pumping stations);
- River Nile, including the two Delta branches;
- Closed lakes (Lake Karoun and Wadi Rayan);
- Coastal lakes (Mariout, Manzala and others);
- The Mediterranean Sea; and
- The Suez Canal.

A.3.4 Pump Stations

The spatial distribution of the main irrigation and drainage pumping stations operated by the Mechanical and Electrical Department (MED) is given in Table A.8. Areas served by a single station range between less than 100 feddans for irrigation to more than 100,000 feddans for drainage. Average discharge rates are about 6.5 m3/sec for irrigation and 20 m3/sec for drainage. Pumping discharge rates for drainage pumps range from less than 0.5 m3/sec to 75 m3/sec. Table A.9 gives the characteristics of the main pump stations on the Nile System.

A.4 System Description in Terms of Irrigation Directorates

The Nile system hierarchy is classified according to the order of canals starting with the HAD and the main stem (order 0) and descending through the system to principal canals, main canals, branch canals and sub-branch canals to the lowest order (order 7). As mentioned previously, the system is divided into 22 directorates as shown in Fig. A.3. Within each directorate the hierarchical order is defined in the same way as indicated above, starting from the Nile stem through which the water passes to reach the canal assigned. It is noted that the ordering system is not a consistent representation of canal size over the entire system. For example, a canal of order 3 at a particular location might be larger in capacity than a canal of order 1 at different part of the system. This deviation is attributed to differences in the cropped area served. Table A.10 presents the distribution of main canals up to the third order by directorate, area served and irrigation water requirements.

Classification of the irrigation canals in each directorate according to order, length and bed width is given in Table A.11.

The irrigation system contains structures which serve various functions. The numbers of these structures throughout the system as a function of size (hydraulic area) are shown by Table A.12. The irrigation system within each directorate serves several purposes, including irrigation, navigation, municipal and industrial water supplies. Table A.13 gives the main canals on each directorate up to the third order and the beneficiaries served by each. Municipal and industrial water demands from the irrigation network for each directorate are given in Table A.14. Minimum navigation water requirements and drafts are shown for the navigable canals in Table A.15.

A.5 Organization Aspect Of The Nile System

A.5.1 Role of the Ministry of Public Works and Water Resources (MPWWR)

The MPWWR administers the Nile system and its irrigation and drainage structures. The Ministry schedules water releases from HAD, approves diversions from the system and has the authority to implement the national water quality legislation. The organizational structure of the Ministry is represented by the general chart as shown in Fig. A.5.

The MPWWR is directly responsible for the operation and maintenance of all public irrigation canals through its Irrigation Department (ID), and open drains through the Egyptian Public Authority for Drainage Projects (EPADP). The Weed Research Institute, which operates under the Water Research Center (WRC), provides technical support to both of these agencies in weed control. Mesqa maintenance is the responsibility of the farmers, who may undertake the work themselves, employ private contractors, or request the MPWWR to maintain the mesqas at their own expense. Where mesqas maintenance is unsatisfactory, the MPWWR has legal authority to perform the work at the expense of the farmers.

A.5.1.1 Irrigation Department (ID)

The ID is responsible for providing technical guidance to and supervision of the field organization which operates and maintains the canal system and, at present, maintains some 8,200 Km of open drains. Under the direction of a First Undersecretary, the headquarters organization has three main departments, each headed by an undersecretary concerned respectively with budget and accounts, system maintenance and water distribution. The field units comprise the 22 Irrigation Directorates which are subdivided into 41 Inspectorates and 167 Districts. The ID has a work force of 9,500 staff (excluding helpers), of whom some 600 engineers and more than 1,000 technicians are directly concerned with O&M activities. Directorates range in size from 170,000 to 600,000 feddans of land under irrigation and are appropriately staffed to carry out all O&M functions. The directorate staff, in turn, provide supervision of the district engineers who, with technicians, are directly responsible for system O&M for areas up to 50,000 feddans.

A.5.1.2 Egyptian Public Authority for Drainage Projects (EPADP)

The EPADP, a semi-autonomous authority, was established in 1973 to implement drainage projects. In 1979, the Authority also was given responsibility for the maintenance of open drains associated with subsurface drains. At present, it is responsible for some 10,000 Km of open drains and will assume increasing responsibility for open drains from the ID with the expansion of subsurface drains. The Undersecretary for Maintenance in EPADP administers nine field Directorates which, in turn, are divided into 50 Centers and 214 Subcenters. Directorates range in size from 150,000 to 300,000 feddans of drained land and Centers from 40,000 to 50,000 feddans. The staffing structure and management functions of Drain Maintenance Directorates and Centers are similar to those of Irrigation Directorates and Districts, respectively.

A.5.1.3 Mechanical and Electrical Department (MED)

The MED is part of MPWWR with an overall responsibility for the operation and maintenance of pumping stations throughout the country. The MED is structured along regional lines. It has two Central Directorates for O&M, one for Lower Egypt in Tanta and the second in Nag-Hammadi for Upper Egypt.

There are seven Regional Directorates, four in Lower Egypt and three in Upper Egypt. A Directorate has three to four Inspectorates, each consisting of three or four Districts. In all, there are 26 inspectorates and 81 Districts. In addition there are General Directorates for workshops and electrical

laboratories as shown in the organizational chart in Fig. A.6.

A.5.1.4 High Aswan Dam Authority (HADA)

The HADA was established in 1972 after the HAD was constructed. It is responsible for operating and maintaining the HAD as well as the Old Aswan Dam. In coordination with the ID, releases from both dams are identified on a daily basis and regulations are managed by the HADA personnel. Studies on sedimentation and water quality of the High Aswan Dam reservoir as well as evaporation losses are conducted by this authority in cooperation with the HAD Side Effects Research Institute of the Water Research Center. There is close connection between the HADA of the MPWWR and the Hydro-power Authority of the Ministry of Electricity and Energy with regard to hydro-power generation from the Aswan Cascade. The HADA also is involved with both the Nile Water Sector and the Planning Sector in Nile River yield forecasting.

A.5.1.5 The Water Research Center (WRC)

The WRC was established in 1975 with eleven research institutes, including the Drainage Research Institute (DRI), the Groundwater Research Institute (GRI), The Water Distribution and Irrigation Methods Research Institute (WDIMI), The High Aswan Dam Side Effects Research Institute (HADSERI) and The Weed Control and Channel Maintenance Research Institute (WCCMRI).

The DRI undertakes monitoring and evaluation of drainage projects in

cooperation with EPADP, and also develops and prepares criteria and plans for reuse of drainage water for irrigation purposes. The strategic water management objectives of GRI are the conjunctive use of surface and groundwater and the monitoring of groundwater data, including water quality. The major activities of WDIMI are studying different alternatives for improving the irrigation water distribution system, improving on-farm irrigation management and defining irrigation water requirements for different crops. Among the activities of HADSERI are to plan and undertake pilot projects for a series of integrated projects designed to protect the resources of the Nile from degradation, erosion, pollution, and to utilize its full potential for economic development. WCCMRI is concerned with the optimum design of canals and with developing and testing various methods for maintaining irrigation and drainage canals, including mechanical weed control procedures.

A.5.2 Other Ministries Benefiting from the Nile River System

Key ministries which manage and carry out functions concerning the Nile River water are listed below. These ministries have many internal organizations which manage specialized functions.

A.5.2.1 Ministry of Agriculture and Land Reclamation (MALR)

The MALR initiates and implements most of the policies related to the agricultural sector. It is responsible for technical and economic studies of new technologies and for information dissemination through agricultural extension. Since virtually all agriculture in Egypt is irrigated agriculture, this ministry is involved in water issues, such as crop consumptive use and proper irrigation schedules.

There are semi-autonomous authorities linked to the Ministry. One of these, the Executive Authority for Land Improvement Project (EALIP) is also involved in the amelioration of deteriorated soils through drainage. Fishery Authority is one of MALR organizations.

Another important institutions is the Agricultural Research Center (ARC). Among its fifteen research institutes is the Soil and Water Research Institute (SWI). The activities of SWI are on farm water management and monitoring the effects of drainage on crop yields and soil.

The Public Authority for Land Reclamation (PALR) has overall responsibility for drawing up, planning and implementing all works for new lands, including irrigation and drainage systems.

The PALR is directly responsible for irrigation projects in the New Valley and desert areas outside the Nile Basin. Development plans are prepared and supervised by the quasi-autonomous General Authority for Rehabilitation Projects and Agricultural Development (GARPAD), and work is entrusted mainly to public land reclamation companies directly responsible to the PALR. Five of the public companies involved in tile drainage installation belong to this Authority.

A.5.2.2 The Ministry of Electricity and Energy

This Ministry is responsible for all projects which produces electrical energy, including fossil fuel plants which require cooling water. This ministry is involved in hydro-power facilities and operates the hydro-power plants at HAD and Aswan (1) and (2) power stations.

A.5.2.3 Ministry of Housing and Public Utilities

The Ministry is responsible for potable water and sewage treatment for the entire country through the following authorities:

- Greater Cairo Potable Water Organization
- Alexandria Potable Water Organization
- Greater Cairo Sewage Authority
- The executive organization for greater Cairo Sewage Systems
- Alexandria Sewage Authority
- The National Organization for Potable Water and Sanitary Drainage (NOPWASD) deals with potable water supply and sewage systems for all the governorates of Egypt except Cairo and Alexandria.

A.5.2.4 Ministry of Industry

This agency is responsible for industrial projects which use water and discharge effluent into water channels.

A.5.2.5 Ministry of Transportation

This ministry is responsible for inland water transport. It is therefore concerned with locks, dredging, proper navigation flows and navigational effects on river and canal banks.

A.5.2.6 Ministry of Health

The Ministry of Health is responsible for pollution control in all Egypt's governorates. The Environment Department identifies, samples, analyzes sources of pollution and submits reports to the responsible authorities to eliminate pollution from the various sources.

A.5.2.7 Ministry of Planning and International Cooperation

This Ministry is involved in the approval of projects, their budgets and in mobilization of international financing.

A.5.2.8 Ministry of Tourism and Civil Aviation

The Tourism Organization, established within the Ministry of Tourism and Civil Aviation is responsible for the Nile River Cruises and hotel-boats. The main lines of these cruises provide round tours between Luxor and Aswan. Public and Private travelling agencies share the management, operation and maintenance costs of the cruisers.

A.5.3 Donor Support to Irrigation and Drainage

A brief summary follows of externally supported programs and projects in the sector of irrigation and drainage:

A.5.3.1 USAID Program

Three projects funded by USAID relate to improving irrigation facilities and to strengthening manpower development. One of these, the Agricultural Canal Reconstruction and Maintenance Project (now completed) provided channel maintenance equipment amounting to about US $30 M between 1978 and 1982.

Egypt Water Use and Management Project (EWUP), 1975-1984, was an integrated research project which tested improvements at the farm level and in the delivery system in three areas, namely, Kafr El Sheikh, Giza and Menia.

The project identified major constraints to improving on-farm water

management. In addition, the project also determined optimal irrigation and improved water control practices for farm water delivery and drainage systems in representative pilot areas.

The ongoing Irrigation Management Systems IMS Project covers 10 sub-projects with USAID input totaling US$ 340 M. Bengining in 1981, this project is currently scheduled for completion in September 1995. The IMS goal to establish effective control of Nile waters for all uses, but particularly for their optimal allocation to and within agriculture as a means of helping increase productivity. A subgoal is to improve the operating efficiency of the water distribution system for agricultural irrigation and for other water users.

The purpose of IMS is to strengthen MPWWR's capability and capacity to plan, design, operate and maintain the water distribution system. Sub-projects include: the Irrigation Improvement Project (IIP), Structural Replacement (SR), Preventive Maintenance/Channel maintenance (PM/CM), Main System Management (MSM), Planning Studies and Models. (PSM), Professional Development (PD), Water Research Center (WRC), Project Preparation Department (PPD), Survey and Mapping (S&M) and Miscellaneous Component (MISC).

A.5.3.2 World Bank (IBRD)

In the past the Bank has sought to address major elements in the development strategy. The Bank served as the executing agency for Water Master Plan, a UNDP-financed project for planning water development and use. A technical assistance project was designed to help GOE to develop an institutional capacity to undertake planning and feasibility studies for agricultural projects. As a result, suitably equipped project preparation departments were established in the MPWWR and in Land Reclamation. The major component of Bank lending, in terms of number of projects and resources committed, was a series of six drainage projects covering about 3.2 million feddans of irrigated area. The ongoing Irrigation Pumping Stations rehabilitation project is the second phase of a national program to prevent crop losses due to irrigation/drainage pump failures and to strengthen the institution responsible for pumping stations.

A.5.3.3 Dutch-Egyptian Bilateral Programs

Dutch technical assistance for drainage and channel maintenance started in December 1975. A report on aquatic weed control was issued in 1978. The Dutch Government supported research by the Weed Research Institute (WRI). In addition, a four year (1983/87) program was supported which aimed at training the staff of EPADP in construction management and maintenance of drainage facilities.

A program of technical cooperation between Egypt and The Netherlands in 1976 included the establishment of the Egyptian-Dutch Advisory Panel on Land Drainage. Its objective is to provide the Government with integrated advice in its efforts to control water logging and salinity. Under the Panel, five separate projects were formulated:

- The Drainage Advisory Panel Project;
- The Pilot Areas and Drainage Technology Project;
- The Re-use of Drainage Water Project;
- The Fayoum Water and Salt Balance Model Project; and
- The Vertical Drainage Project.

These projects continue to the present day. The experience gained from them has led to a better understanding of Egypt's drainage problems and of the remedial measures that can be undertaken.

A.5.3.4 The Canadian International Development Agency (CIDA)

CIDA is currently funding two projects. The Integrated Soil And Water Improvement Project (ISAWIP) is an irrigation and drainage improvement program in some 50,000 feddans in the Dakahlia Governorate, East Delta. The other project is the River Nile Protection and Development Project (RNPD). This project began in January 1989 with the objective of identifying, defining and preparing for implementation projects to protect and to achieve optimum use of the Nile River downstream from the High Aswan Dam. The project is scheduled to end April 1992.

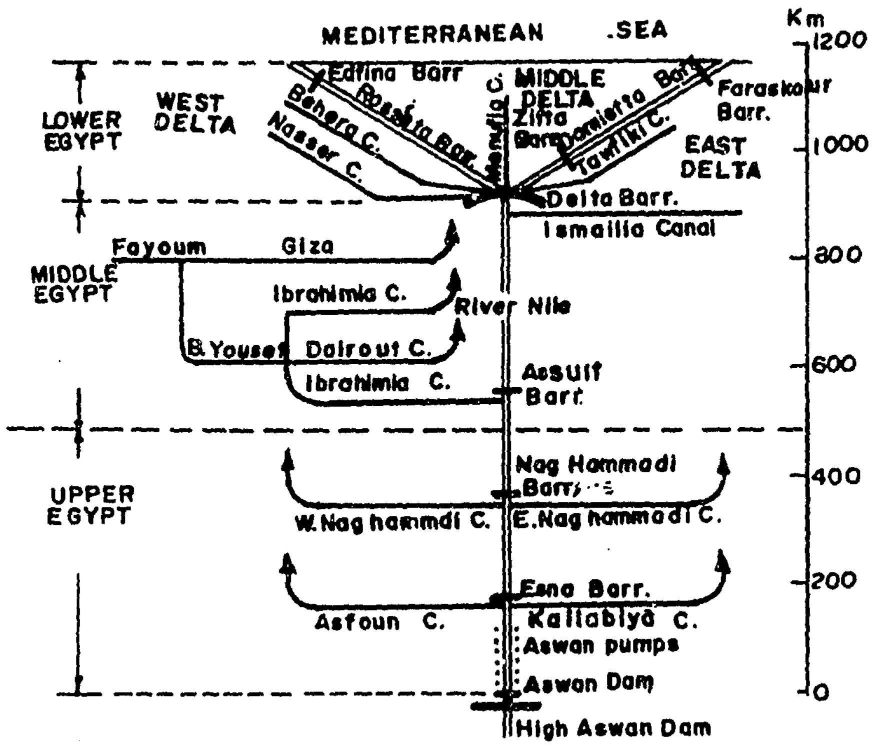

Fig. A. 1 Schematic diagram of the main regions of Egypt irrigation system.

Source : Amer et al., 1989 P. 27

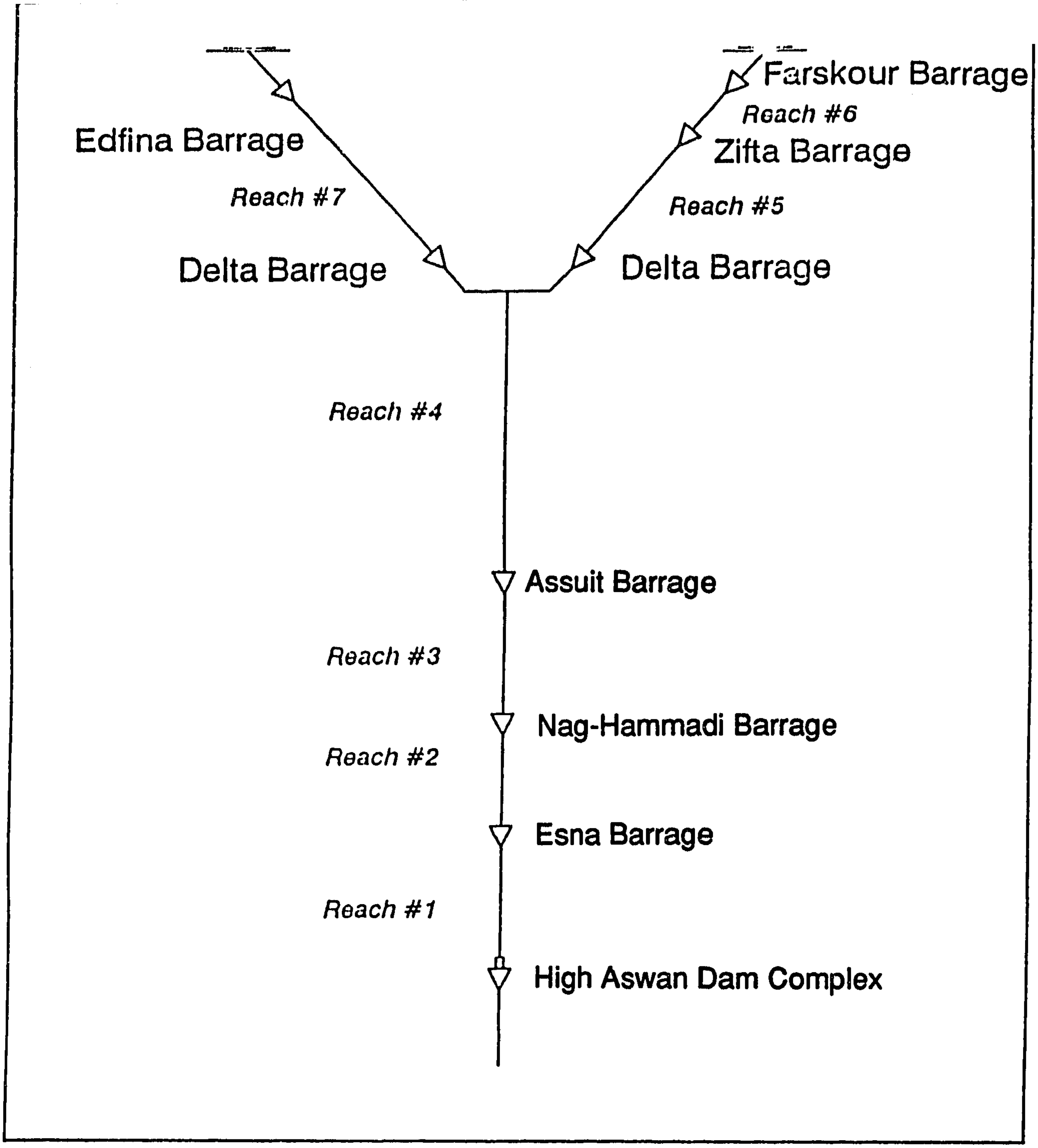

Fig. A .2 Schematic Diagram for the Nile Reaches

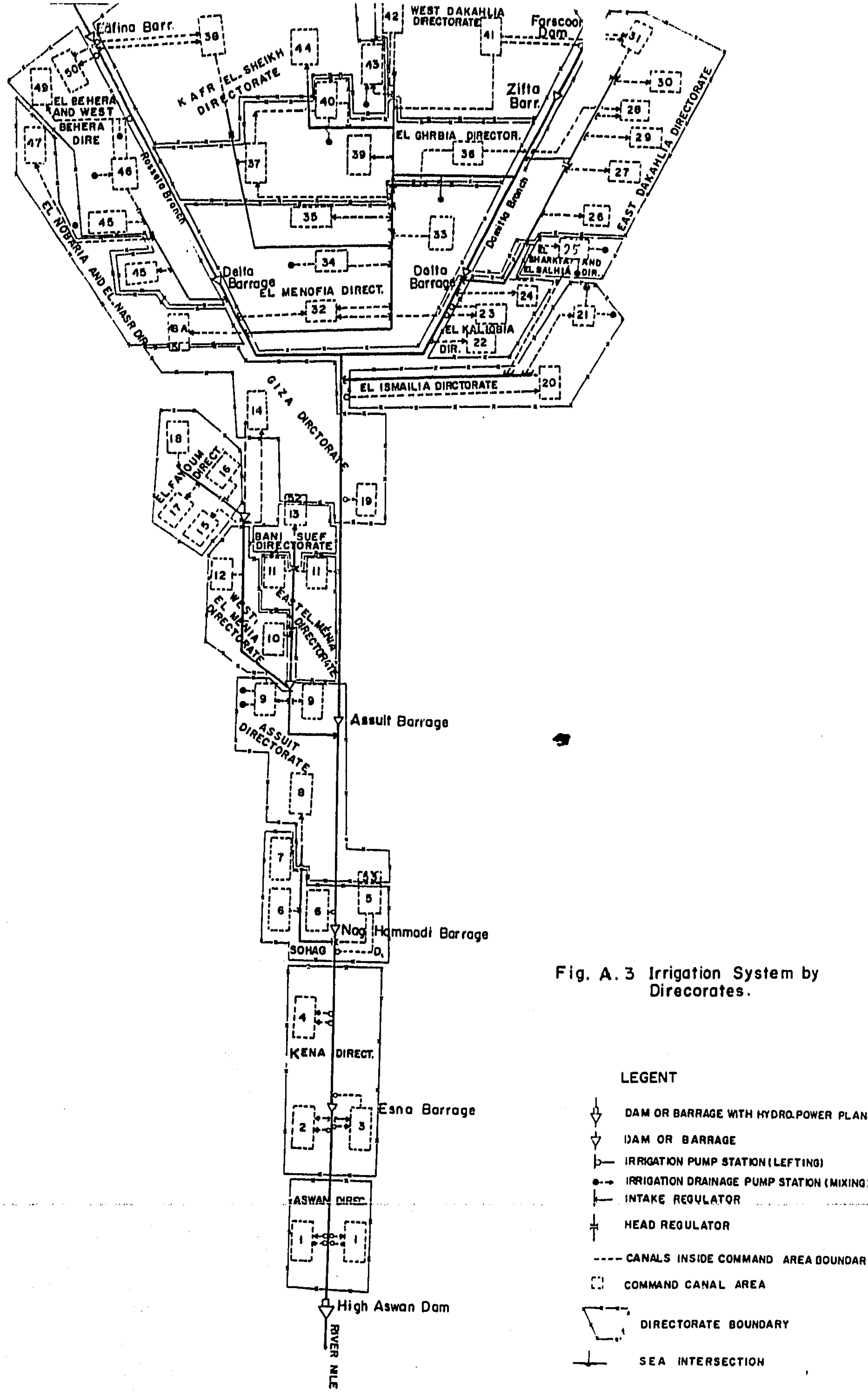

Fig. A.3 Irrigation System by Direcorates.

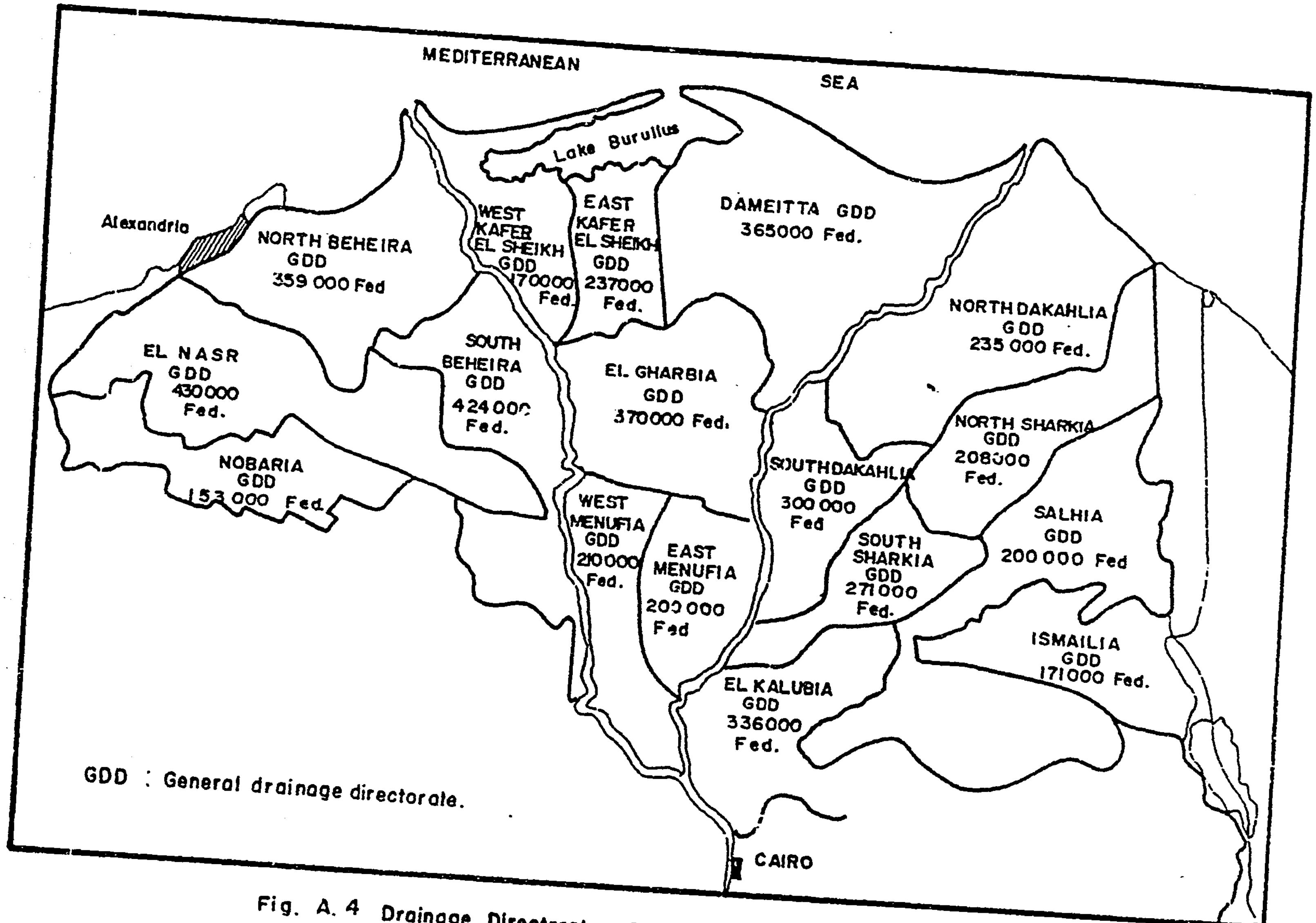

Fig. A. 4 Drainage Directorates Delta (EPADP).

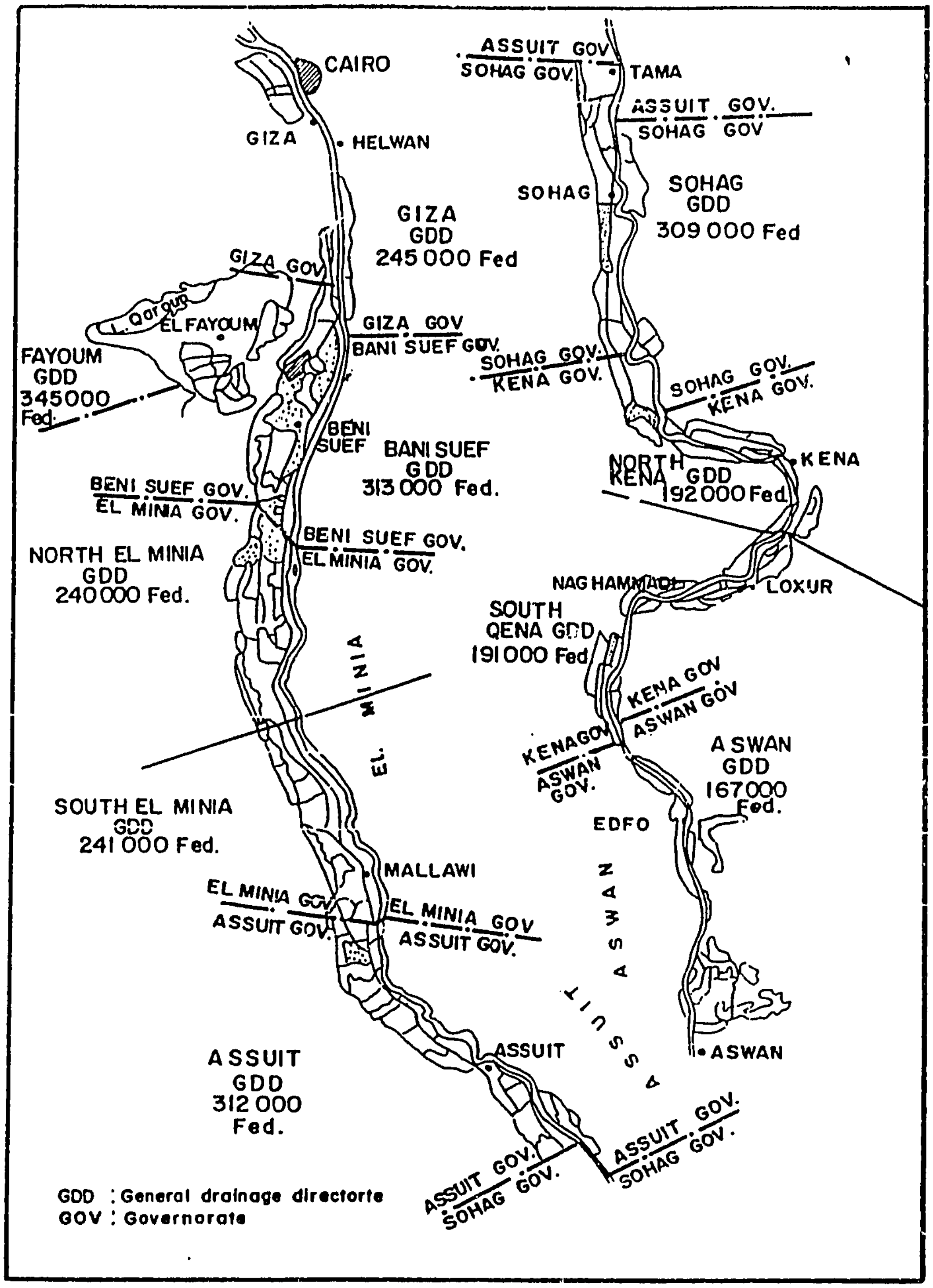

Fig A.4 Cont. Drainage Directorates (Upper Egypt)(EPADP).

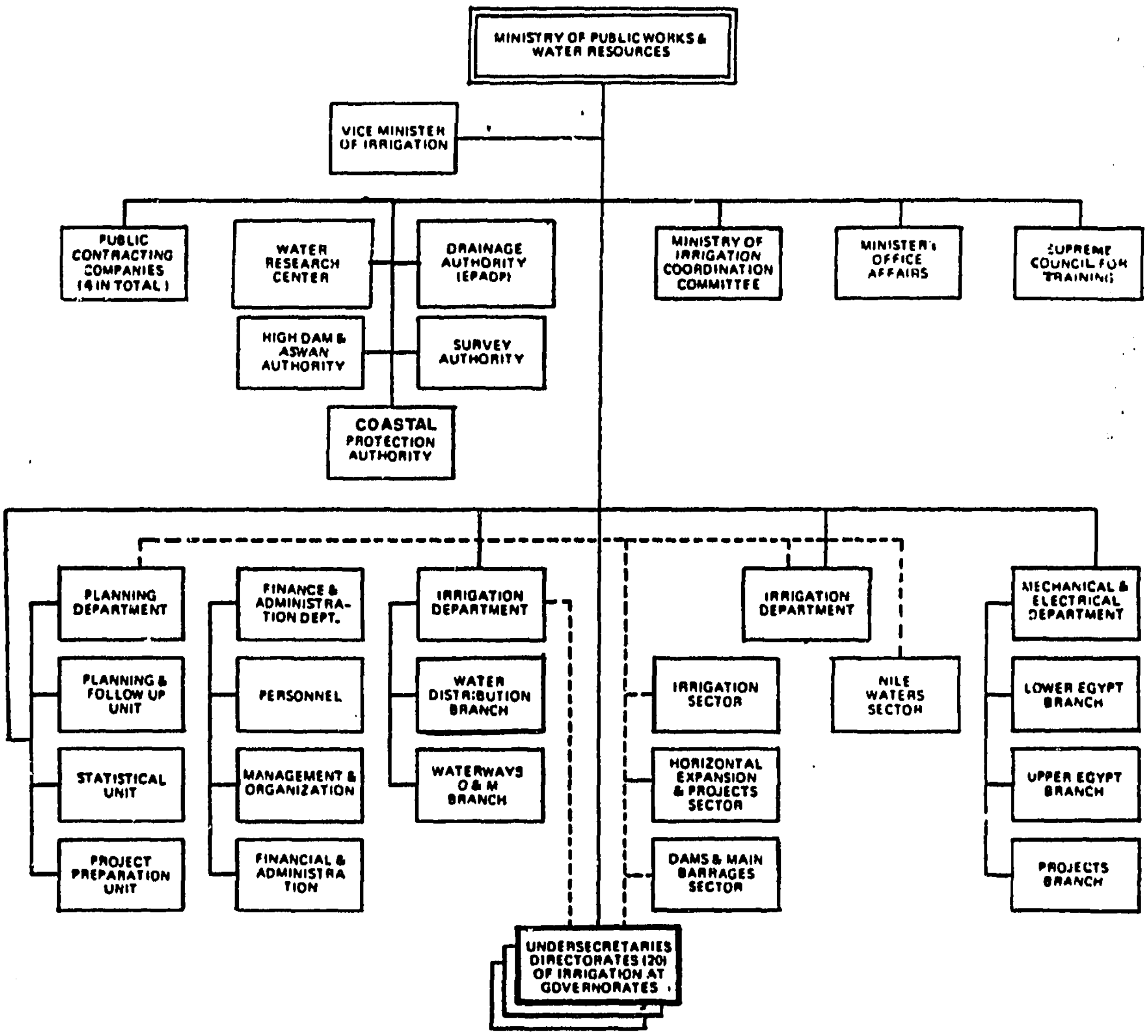

Fig. A. 5 Organizational structure of MPWWR.

Fig. A.6 PUMPING STATIONS REHABILITATION PROJECT II
MECHANICAL AND ELECTRICAL DEPARTMENT
Organization Chart

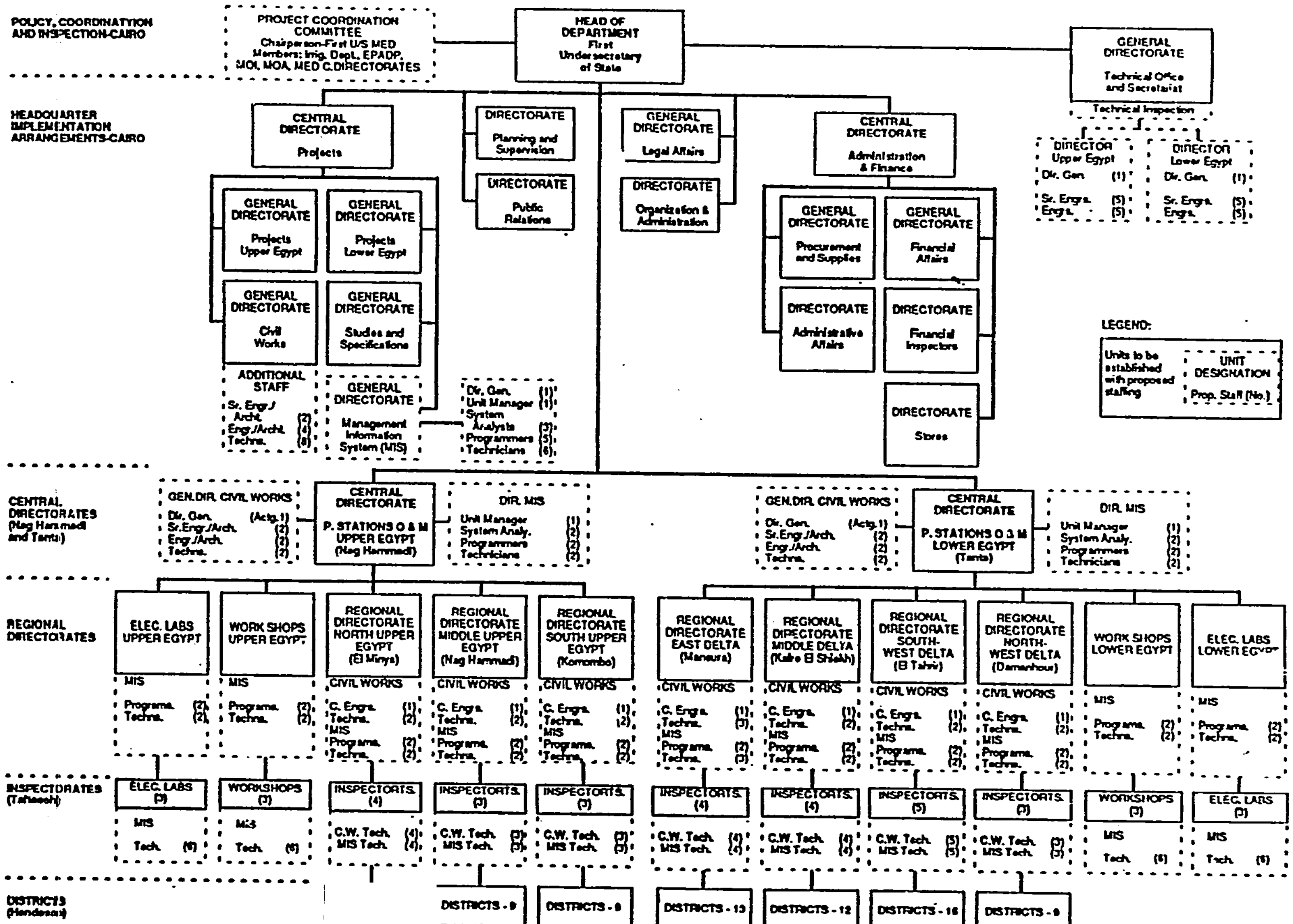

Table A.1 Location of barrages and canals on the Nile in Egypt

Barrage Name	Location D.S HAD (Km)	Main Canal from U.S
Esna	170.0	Kallabiya Canal to the East Asfoun Canal to the West
Nag-Hammadi	354.0	East and West Nag-Hammadi Canal
Assuit	547.0	Ibrahimia Canal to the West then To Bahr Youssef Canal
Delta	965.0	Ismailia Canal Rayah Al-Tawfiki Rayah Al-Behery Rayah Al-Naseri
Edfina (Rosetta Br.)	1176.0	El-Mahmodia Canal El Rashidia Canal
Zefta (Damietta Br.)	1052.0	El-Mansouria Canal Bustan P.S
Faraskour (Damietta Br.)	1208.0	El-Salam Canal to the East

Source : "Land Drainage in Egypt" Amer and Ridder, 1989.

Table A.2 Area irrigated and irrigation water requirements by reach for the Nile River

Nile Reach No.	Area Served (1000 Fed)	Irrigation Water Req. (Million m^3/year)
1	373.118	3179.928
2	688.061	4547.188
3	1342.110	9544.668
4	4138.317	24383.047
5	330.983	2591.636
6	62.000	489.231
7	302.102	1834.437

Source : "Water Demands Present & Future" MPWWR, 1990.

Table A.3 Navigation water demands for Nile reaches

Reach No.	Length (Km)	Minimum Discharge (M. m^3/day)	Minimum Draft (m)
Reach (1)			
- HAD to Esna Barrage	170.0	80.0	1.50
Reach (2)			
- D.S Esna Barrage To U.S Nag-Hammadi Barrage	184.0	80.0	1.50
Reach (3)			
- D.S Nag-Hammadi Barrage To U.S Assuit Barrage	193.0	80.0	1.30
Reach (4)			
- D.S Assiout Barrage To U.S Delta Barrage	418.0	70.0	1.90
Reach (5)			
- Damietta Branch (El-Mansouria to Zefta Barrage)	87.0	Small Boats Only Accoring to level	
Reach (6)			
- Damietta Branch (Zefta To Faraskour)	156.0	Small Boats Only According to level	
Reach (7)			
- Rosetta Branch Delta Barrage To Km 147)	147.0	70.0 (During Winter Closure Only)	1.50
- From Km 147 to Edfina Barrage	64.0	Edfina Pool	1.50

Source : "Water Demands Present & Future" MPWWR, 1990.

Table A.4 Annual water releases and energy generated from the HAD and old Aswan plants

Year	HAD Plant Water Release x 10^9 m^3 Turbines	Gates& leak	Total	Energy Million K.W.H	Aswan Dam Plant No. 1 & 2 Water Release x 10^9 m^3 Turbines	Gates& Leak	Total	Energy Million K.W.H	Total Energy Million K.W.H
80-81	52.345	4.341	56.686	8120.6	42.231	14.429	56.66	1794.4	9915.0
81-82	55.401	3.739	59.140	8567.6	45.244	13.896	59.14	1906.7	10474.3
82-83	56.430	2.310	58.740	8425.8	46.172	12.568	58.74	1840.7	10266.5
83-84	54.968	1.787	56.755	7747.9	45.844	10.911	56.76	1889.2	9637.1
84-85	54.969	1.264	56.233	6964.1	46.515	9.718	56.23	2039.6	9003.7
85-86	53.925	1.773	55.698	6602.3	47.102	8.596	55.70	2443.8	9046.1
86-87	53.691	1.484	55.175	6343.9	52.635	2.540	55.18	2760.8	9104.7
87-88	50.872	2.184	53.056	5598.5	50.388	2.668	53.06	2660.1	8258.6
88-89	50.540	2.470	53.010	6643.5	49.991	3.019	53.01	2678.7	9322.2
89-90	51.054	3.030	54.084	7211.8	51.530	2.554	54.08	2762.5	9974.3

Source : Annual Report of Electric Statistics, 1990.

Table A.5 Drainage directorates and their area served

No.	Directorate Name	Location	Total Area Served (1000 Fed)
	East Delta Region		
1	El Kalubia	Benha	336
2	South Sharkia	Zagazig	271
3	North Sharkia	Hussania	208
4	South El Dakahlia	Meet Ghamr	300
5	North El Dakahlia	Mansoura	235
6	El Salhia	Salhia	200
7	El Ismailia	Ismailia	171
	Middle Delta Region		
8	East Menofia	Shebin El Koum	200
9	West Menofia	Menouf	210
10	Gharbia	Tanta	370
11	Dameitta	Dameitta	365
12	East Kafr El Sheikh	Kafr El Sheikh	237
13	West Kafr El Sheikh	Dessouk	170
	West Delta Region		
14	North Behera	Kafr El Dowaar	359
15	South Behera	Damanhour	424
16	El Nobaria	Nobaria	153
17	El Nasr	El Ameria	430
	Middle Egypt		
18	Giza	Giza	245
19	El Fayoum	Fayoum	345
20	Beni Suef	Beni Suef	313
21	East El Minia	Maghagha	240
22	West El Minia	El Minia	241
	Upper Egypt		
23	Assuit	Assiout	312
24	Souhag	Sohag	309
25	North Kena	Kena	192
26	South Kena	Esna	191
27	Aswan	Kom Ombo	167

Source : EPADP.

Table A.6 Lengths of drains in km classified according to bed w h

Drainage Directorate	> 10m Nav.	> 10m Not Nav.	> 10m Total	5 to 10 m	2 to 5 m	≤ 2m	Total Length
East Delta							
El Kalubia	---	5	5	52	237	273	567
N. & S. El Sharkia	51	119	170	98	482	708	1,458
S. El Dakahlia	64	114	178	126	1,069	118	1,491
El Ismailia & El Salhia	---	52	52	62	207	202	523
Subtotal E.Delta	115	290	405	338	1,995	1,301	4,039
Middle Delta							
E. & W. El Menoufia	---	---	---	48	230	680	958
Gharbia	15	---	15	59	206	713	993
E. & W. Kafr El Sheikh	39	91	130	119	502	480	1,231
N.Dakahlia & Dameitta	---	39	39	87	192	783	1,101
Subtotal M.Delta	54	130	184	313	1,130	2,656	4,283
West Delta							
N. & S. El Behera	---	93	93	241	883	679	1,896
El Nobaria & El Nasr	---	---	---	25	532	384	941
Subtotal W.Delta	---	93	93	266	1,415	1,0613	2,837
Middle Egypt							
Giza	---	103	103	72	50	584	809
El Fayoum	---	---	---	68	120	819	1,007
Beni Suef	---	23	23	101	158	894	1,176
East El Minia	---	33	33	32	145	264	474
West El Minia	---	---	---	15	62	347	424
Subtotal M.Egypt	---	159	159	288	535	2,908	3,890
Upper Egypt							
Assuit	---	---	---	27	28	133	188
Souhag	---	---	---	112	128	156	396
N. & S. Kena	---	---	---	40	230	345	615
Aswan	---	---	---	73	290	75	438
Subtotal U.Egypt	---	---	---	252	676	709	1,637
TOTAL	169	672	841	1,457	5,751	8,637	16,686

Source : The World Bank Report, 1986.

Table A.7 Number of drainage structures by function and hydraulic area

Structure Type	Hydraulic Area (square meters)				
	< 3	3 to 6	6 to 12	12 to 24	> 24
Outlets	1577	272	221	98	31
Weirs	40	2	1	3	2
Bridges	3519	1610	1442	838	307
Crossing Works	135	99	106	261	287

Source : Water Master Plan, 1981.

Table A.8 Distribution of the pump stations operated by the MED

Region	Irrigation		Drainage	Total	Deep Well
	Main	Booster			
South Upper Egypt	89	—	7	96	—
Middle Upper Egypt	23	—	4	27	8
North Upper Egypt	63	35	16	114	—
East Delta	22	60	36	118	14
Middle Delta	130	52	22	204	43
North West Delta	10	—	12	22	—
South West Delta	66	125	1	192	182
Total	403	272	98	773	247

Source : The World Bank Report, 1990.

Table A.9 Characteristics of some of the main pump stations

Name of P.S	Type	Suction Canal	Delivery , Canal	No of Units	Q/unit (m^3/sec)	H (m)	Power/unit (KW)
UPPER EGYPT							
Aakab Kibli	I	Nile	Abu El Reach	2	0.25	8.77	100
Aakab Bahri	I	Nile	El Aakab	2	0.35	8.90	100
Abu El Reach	I	Nile	Abu El Reach	2	0.75	10.17	110
Aswan isl	I	Nile	Aswan Isl.	1	0.15	10.85	40
Aswan West	I	Nile	West Aswan	2	0.50	8.95	100
Bahreaf Isl.	I	Nile	Bahreaf	2	0.75	10.17	110
Balloula Isl.	I	Nile	Balloula	1	0.35	8.18	75
Beni Hemail	I	Nag Hammdi	Beni Hemail	6	8.00	2.00	261
Bousilia	I	Nile	Bousailia	4	0.90	8.50	143
Derb	I	Nile	El Ranan	3	7.50	4.50	470
Eklit	I	Nile	Eklit	3	0.50	7.70	88
Fares Isl.	I	Nile	Fares Isl.	2	0.75	7.64	110
Hagz	I	Nile	El Hagz	3	0.35	8.50	64
East El Kelh	I	Nile	El Kelh	5	2.14	7.98	220
Kelh Isl.	I	Nile	El Hagz	2	0.75	7.28	150
Khattara	I	Nile	El Hadara	2	1.60	9.70	450
Malkia Isl.	I	Nile	El Gezira Meska	2	1.00	7.12	112
Marashda	I	Nile	Ranan El Marashda	5	8.00	4.40	515
Namasa	I	Nile	El Namasa	6	8.00	2.05	330
New Biara	I	Nile	Kamel	6	2.94	24.50	850
Old Biara	I	Nile	Kamel	4	1.50	23.95	587
Owainia	I	Nile	El Owainia	2	0.50	10.00	90
Ramadi	I	Nile	El Ramadi	6	1.37	8.50	180
Sahel Hamam	I	Nile	El Hamam	1	0.50	10.00	100
Sahel Meniha	I	Nile	El Meniha	1	0.50	9.15	66
Salwa Kibli	I	Nile	Salwa Delivery	3	0.51	7.70	88
Salwa Bahri	I	Nile	Salwa Delivery	3	0.51	10.70	88
Sebaaia	I	Nile	Sebaaia	4	1.04	8.50	166
Sharawan	I	Nile	Sharawan	2	0.50	10.00	90
S. Kobania Isl.	I	Nile	El Kobania	1	0.25	7.77	40
Darwa	D	Darwa	Nile	2	1.00	3.40	53
Eklit D.P.S	D	Eklit	Nile	2	0.80	3.3	125
MIDDLE EGYPT							
Beni Soliman	I	Nile	Beni Soliman	2	0.42	7.00	75
Dir Abu Heness	I	Nile	Dir Abu Heness	3	0.80	6.00	95
Dir ElMaymoun	I	Nile	Priv. Meska	2	0.50	7.20	100
Gabal El Tair	I	Nile	Gabal El Tair	4	0.95	6.00	202
Kordahi	I	Nile	El Kordahi	2	0.70	6.00	140
Korimat	I	Nile	ElKhrman&Borombol	4	4.00	5.00	450
Lithi	I	Nile	Tarkhan & El Hagz	4	3.50	5.00	530
Sanour	I	Nile	Sanour	3	0.41	5.73	50
Sawada	I	Nile	Sawada	4	2.27	6.00	300
Sharouna Isl	I	Nile	E & W Gezira Isl	4	0.50	5.80	181
Sharouna	I	Nile	E & W Sharouna	2	0.70	6.50	105
Sheikh Fadal	I	Nile	El Maasara	4	1.85	6.80	343
Bardaman	D	Abu El Gabal	El Bahr El Youssefy	4	2.50	2.40	137
Beni Saleh Isl.	D	Beni Saleh	Nile	2	3.50	3.00	171
Dir El Sankoria	D	Dir ElSankoria	ElBahr ElYouessefi	4	3.50	2.90	150

Table A.9 (Cont.)

Name of P.S	Type	Suction Canal	Delivery Canal	No of Units	Q/unit (m^3/sec)	H (m)	Power/unit (KW)
<u>MIDDLE DELTA</u>							
Balamoun	I	Nile	Balamoun & EL Sahil	4	4.00	3.20	185
Fowa	I	Rasheed Br.	Fowa	4	1.75	2.50	248
Hamoul	I	El Gharbia	Bahr Tira	3	7.50	0.90	450
Kafr Saad	I	Nile	Balamoun & EL Sahil	4	8.00	2.30	260
Mahlet Roh	D	Mahlet Roh	Bahr Mit Yazid	4	2.50	3.45	135
East Menofia	D	El Karneen	R. Al Abbasy	5	4.60	3.60	450
<u>EAST DELTA</u>							
Bousat	I	Damietta Br.	El Sharkawi	4	3.50	2.20	120
Bahr El Bakar	D	Bahr El Bakar	El Manzala Isl	4	7.50	1.90	243
Upper Serw	D	Upper Serw	Nile (Damietta Br.)	3	8.00	6.90	86
Hanout	M	Haous	Hanout	3	5.00	3.95	346
<u>WEST DELTA</u>							
Etay El Baroud	M	Etay El Baroud	East El Khandak	3	2.50	4.75	170

Source : Water Master Plan, 1981.

I : Irrigation
D: Drainage
M: Mixing

Table A. Description of the irrigation network by directorate

NO.	Directorate Name	Canal Name	Intake from Nile Reach Number	Area Served (1000 fed)	Irri Req (M. m³/Year)
		Casil Canal	1	21.550	171.486
		Edfo & El Kalh	1	8.815	72.767
		El Bousilia Canal	1	4.137	38.036
		El Sebaaia Canal	1	4.375	45.177
		El Silsila Canal	1	13.505	149.008
1	Aswan	El Sirag Canal	1	3.100	27.251
		El Toisia Canal	1	24.810	168.020
		Ganabiat Casil	1	14.572	96.030
		Mehatat El Aaimaat	1	18.710	89.612
		Mehatat El Nile Canal	1	9.769	50.857
		Sahl El Ramadi Canal	1	8.285	45.285
		Asfon Canal	1	69.390	606.022
2	Kena	Kalabia Canal	1	172.100	1620.382
		Direct P.S	2	128.495	1054.472
		Dar El Salam P.S	2	33.139	199.438
3	Souhag	E. Nag Hammadi Canal	2	26.821	161.789
		W. Nag Hammadi Canal	2	267.768	1744.371
		E. Nag Hammadi Canal	2	91.513	557.014
4	Assuit	W. Nag Hammadi Canal	2	140.325	830.104
		Ibrahimia Canal	3	78.760	506.919
5	West El Minia	Ibrahimia Canal	3	284.118	2588.557
6	East El Minia	Ibrahimia Canal	3	198.882	1801.429
		Giza Canal	3	11.700	60.129
7	Beni Suef	Bahr Yousef	3	35.000	175.194
		Ibrahimia Canal	3	232.400	1295.263
		Giza Canal	3	141.700	1011.554
8	Giza	Ibrahimia Canal	3	16.800	141.735
		El Korimat & El Lithi P.S	4	47.100	331.389
9	El Fayoum	Bahr Yousef	3	342.750	1963.888
		Abou El Minaga Canal	4	54.737	397.429
		El Basousia Canal	4	46.316	289.961
10	El Kalubia	El Sharkawia Canal	4	159.427	808.678
		Rayah El Tawfiky	4	48.070	212.901
		Ismailia Canal	4	28.000	172.499
11	El Ismailia	Ismailia Canal	4	171.409	763.525
		Bahr Moiese	4	487.404	2537.195
12	El Sharkia	Eastern El Wadi Canal	4	9.825	51.716
		El Siniti Canal	4	2.165	11.140

Table A.10 (Cont.)

NO.	Directorate Name	Canal Name	Intake from Nile Reach Number	Area Served (1000 fed)	Irri Req ($M. m^3$/Year)
		Eastern El Wadi Canal	4	28.335	33.851
13	El Salhia	El Saidia Canal	4	105.263	488.253
		Ismailia Canal	4	83.330	365.220
	East	Rayah El Tawfiky	4	166.349	988.390
15	El	El Sharkawia Canal	4	49.991	306.137
	Dakahlia	El Mansouria Canal	5	308.333	2427.159
		Bahr Shebin	4	251.207	1847.981
	West	El Sahel Canal	4	23.926	188.789
16	El	Balamoom P.S	5	22.650	164.477
	Dakahlia	Kafr Saad P.S	6	62.000	489.231
		Bahr Nashrat	4	21.640	160.903
	Kafr	Bahr Tira from R. Abbasi	4	139.227	851.658
17	El	D.S Beltag I.R on R. Abbasi	4	140.890	1100.480
	Sheikh	El Kadaba Canal	4	132.624	1118.172
		El Kasid Canal	4	27.000	215.739
		Rashidia Canal	7	22.755	174.529
		Bahr El Malah Canal	4	57.384	428.566
		Bahr Shebin	4	57.055	282.524
		Direct Irr. from R.Abbasi	4	33.000	137.624
		El Bagouria Canal	4	40.818	263.441
18	Gharbia	El Kasid Canal	4	69.133	378.776
		El Sahel Canal	4	11.098	74.221
		Mit Yazeed Canal	4	33.069	243.832
		Tanta Navigable Channel	4	46.895	223.136
		Omer Bey Canal	4	23.777	112.634
		El Bagouria Canal	4	14.236	80.185
		Branch U.S El Kaman	4	215.838	1215.701
		Derwa Canal	4	9.060	52.189
19	El Menofia	Direct Irr. Tanta Canal	4	5.116	28.815
		El Nagail Canal	4	29.690	179.423
		Br.U.S Melig (R.Menofi)	4	91.403	514.824
		D.S Melig (R.Menofi)	4	14.405	81.139
20	El	El Rashidia Canal	4	58.863	364.343
	Behera	El Mahmoudia Canal	7	279.347	1659.908
	West	R.Beheri, Eastern Khandak	4	289.293	1630.218
21	El	El Tahadi Canal	4	18.067	96.460
	Behera	Rayah El Nasri	4	67.823	428.540
22	El Nubaria	Noubaria Canal	4	298.199	1825.963
	El Nasr	El Nasr Canal	4	429.950	2198.167

Source : "Water Demands Present & Future" MPWWR, 1990.

Table A.11 Lengths of canals by order in km classified according to bed width

Irr. Direct.	Order	B.W< 2m	2 to 5m	5 to 10m	> 10m	>10m Nav.
	1	110.00	79.90	41.90	---	---
	2	147.60	176.50	29.80	---	---
	3	104.40	47.40	1.70	---	---
Aswan	4	117.80	180.80	5.20	---	---
	5	3.20	17.50	---	---	---
	6	---	---	---	---	---
	7	---	---	---	---	---
	1	---	16.50	95.30	264.40	---
	2	635.10	673.90	140.40	---	---
	3	110.90	523.50	---	---	---
Kena	4	23.00	101.90	4.00	---	---
	5	---	---	---	---	---
	6	---	---	---	---	---
	7	---	---	---	---	---
	1	---	10.38	---	80.94	---
	2	74.78	288.39	166.30	4.97	---
	3	186.71	450.93	48.29	---	---
Souhag	4	195.93	521.59	16.40	---	---
	5	142.13	158.44	0.90	---	---
	6	105.00	29.80	---	---	---
	7	35.20	3.20	---	---	---
	1	---	0.32	---	33.10	---
	2	79.47	278.30	164.50	12.30	---
	3	357.10	472.26	13.60	18.0	---
Assuit	4	362.96	159.10	---	---	---
	5	71.71	8.65	---	---	---
	6	---	---	---	---	---
	7	---	---	---	---	---
	1	---	---	---	---	---
	2	---	---	---	19.00	---
	3	285.40	129.50	31.10	---	---
West El Minia	4	359.60	84.30	9.30	---	---
	5	131.90	28.30	0.60	---	35.00
	6	16.00	2.80	---	---	---
	7	6.40	---	---	---	---
	1	---	---	---	---	---
	2	113.70	183.60	75.00	---	---
	3	131.80	68.40	15.80	---	---
East El Minia	4	47.90	8.80	---	---	---
	5	3.00	---	---	---	---
	6	---	---	---	---	---
	7	---	---	---	---	---

Table A.11 (Cont.)

Irr. Direct.	Order	B.W< 2m	2 to 5m	5 to 10m	> 10m	>10m Nav.
	1	---	---	18.30	60.50	---
	2	166.70	130.00	35.00	---	---
	3	39.10	102.60	16.10	9.85	---
Beni Suef	4	241.30	27.90	---	---	---
	5	41.60	2.28	---	---	---
	6	1.76	---	---	---	---
	7	---	---	---	---	---
	1	56.40	10.90	35.63	8.55	---
	2	78.34	119.87	13.47	---	---
	3	152.76	91.59	6.51	1.34	22.10
Giza	4	179.65	67.40	71.67	---	---
	5	280.90	90.97	31.20	---	---
	6	174.54	3.40	---	---	---
	7	47.20	8.70	---	---	---
	1	---	---	---	---	---
	2	---	---	---	---	---
	3	23.40	63.90	62.80	24.10	---
El Fayoum	4	59.20	180.10	65.90	27.1	---
	5	128.40	192.60	50.00	---	---
	6	129.20	75.80	8.50	---	---
	7	34.40	45.30	2.00	---	---
	1	---	---	---	---	---
	2	26.00	249.50	53.00	24.60	---
	3	123.60	167.70	35.00	---	---
El Kalubia	4	118.60	234.40	24.70	---	---
	5	30.50	12.60	---	---	---
	6	6.10	---	---	---	---
	7	---	---	---	---	---
	1	3.20	---	---	---	---
	2	19.10	159.70	142.50	74.20	---
	3	59.00	131.70	29.20	---	---
El Ismailia	4	50.20	106.10	9.80	---	---
	5	2.20	27.10	---	---	---
	6	1.90	---	---	---	---
	7	---	---	---	---	---
	1	---	---	---	---	---
	2	---	---	---	---	79.80
El Sharkia	3	151.50	173.90	85.20	15.40	---
and	4	244.70	194.80	80.80	4.00	34.00
El Salhia	5	186.20	123.60	23.00	26.40	3.10
	6	170.30	94.10	8.70	2.60	---
	7	44.10	35.90	3.90	---	---

Table A.11 (Cont.)

Irr. Direct.	Order	B.W< 2m	2 to 5m	5 to 10m	> 10m	>10m Nav.
	1	14.00	0.30	42.00	---	---
	2	21.70	74.00	42.80	149.00	136.80
	3	399.30	638.80	224.90	25.00	34.00
E. El Dakhlia	4	378.00	441.40	88.60	21.80	3.10
	5	229.10	165.20	23.00	26.40	---
	6	175.90	94.10	8.70	2.60	---
	7	44.10	35.90	3.90	---	---
	1	---	---	---	---	---
	2	---	---	---	---	---
	3	53.50	50.20	18.20	41.90	262.00
W. El Dakhlia	4	96.60	187.00	43.50	39.50	---
	5	87.40	196.60	43.70	20.40	---
	6	33.10	73.70	4.00	8.70	---
	7	---	44.60	11.40	---	---
	1	---	24.30	14.00	---	---
	2	23.70	24.60	---	---	---
	3	19.70	18.20	51.60	26.60	35.00
Kafr El Sheikh	4	96.90	213.30	81.90	47.30	---
	5	94.10	204.00	70.20	---	---
	6	65.30	104.40	10.80	---	---
	7	24.00	51.90	---	---	---
	1	2.50	7.00	14.00	---	---
	2	19.20	13.60	---	---	---
	3	101.10	136.90	55.20	8.70	48.90
Gharbia	4	109.40	147.70	61.80	---	36.60
	5	119.60	196.80	40.00	---	---
	6	91.90	51.00	6.80	---	---
	7	3.70	7.10	---	---	---
	1	---	17.40	23.60	---	---
	2	38.00	92.10	123.90	---	74.50
	3	187.70	169.40	84.40	4.00	---
El Menofia	4	239.60	124.10	104.40	---	---
	5	184.60	52.80	---	---	---
	6	57.80	11.30	---	---	---
	7	16.10	5.60	---	---	---
	1	---	9.20	---	---	129.80
	2	260.50	284.00	113.40	52.80	---
El Behera	3	436.50	288.30	15.80	---	---
and	4	143.30	114.50	18.50	---	---
W.El Behera	5	82.00	40.50	---	---	---
	6	9.50	23.80	---	---	---
	7	6.20	---	---	---	---

Table A.11 (Cont.)

Irr. Direct.	Order	B.W< 2m	2 to 5m	5 to 10m	> 10m	>10m Nav.
	1	---	---	64.10	---	---
	2	---	21.25	23.10	---	119.00
El Nobaria	3	65.33	162.00	41.77	120.30	---
and	4	284.90	318.39	60.12	---	---
El Nasr	5	57.50	50.12	76.90	---	---
	6	2.00	---	---	---	---
	7	---	---	---	---	---

Source : Water Master Plan, 1981.

Table A.12 Number of irrigation structures by function and hydraulic area

Type	Hydraulic Area (square meters)				
	< 3	3 to 6	6 to 12	12 to 24	> 24
Intake Regulator	3986	1003	415	130	89
Head Regulator	1355	460	231	131	110
Weirs	65	32	25	18	22
Tail Escape	1737	16	4	2	2
Spillway	131	4	4	3	11
Bridges	3050	2446	269	1212	978
Crossing Works	500	53	5	8	1

Source : Water Master Plan, 1981.

Purposes served by the main canals

NO.	Directorate Name	Canal Name	Canal Order	Beneficiarics (1)	(2)	(3)	(4)	(5)
1	Aswan	Casil Canal	1	*			*	*
1	Aswan	Edfo & El Kalh	1	*				*
1	Aswan	El Bousilia Canal	1	*				*
1	Aswan	El Sebaaia Canal	1	*				*
1	Aswan	El Silsila Canal	1	*				*
1	Aswan	El Sirag Canal	1	*				*
1	Aswan	El Toisia Canal	1	*				*
1	Aswan	Ganabiat Casil	1	*				*
1	Aswan	Mehatat El Aaimaat	1	*				*
1	Aswan	Mehatat El Nile Canal	1	*				*
1	Aswan	Sahl El Ramadi Canal	1	*				*
2	Kena	Asfon Canal	1	*				*
2	Kena	Kalabia Canal	1	*				*
2	Kena	Direct P.S	1	*				*
3	Souhag	Dar El Salam P.S	1	*				*
3	Souhag	E. Nag Hammadi Canal	1	*		*		*
3	Souhag	W. Nag Hammadi Canal	1	*		*		*
4	Assuit	E. Nag Hammadi Canal	1	*				*
4	Assuit	W. Nag Hammadi Canal	1	*				*
4	Assuit	Ibrahimia Canal	1	*		*		*
5	West El Minia	Ibrahimia Canal	1	*	*	*	*	*
6	East El Minia	Ibrahimia Canal	1	*	*	*	*	*
7	Beni Suef	Ibrahimia Canal	1	*	*	*	*	*
7	Beni Suef	Bahr Yousef	2	*		*		*
7	Beni Suef	Giza Canal	3	*				*
8	Giza	Ibrahimia Canal	1	*	*	*	*	*
8	Giza	El Korimat & El Lithi P.S	1	*				*
8	Giza	Giza Canal	3	*				*
9	El Fayoum	Bahr Yousef	2	*	*	*		*
10	El Kalubia	Abou El Minaga Canal	1	*				*
10	El Kalubia	El Basousia Canal	1	*				*
10	El Kalubia	El Sharkawia Canal	1	*				*
10	El Kalubia	Rayah El Tawfiky	1	*	*	*	*	*
10	El Kalubia	Ismailia Canal	1	*	*	*	*	*

Table A.13 (Cont.)

NO.	Directorate Name	Canal Name	Canal Order	Beneficiaries (1)	(2)	(3)	(4)	(5)
11	El Ismailia	Ismailia Canal	1	*	*	*	*	*
12	El Sharkia	Bahr Moiese	2	*		*		*
12	El Sharkia	Eastern El Wadi Canal	2	*	*			*
12	El Sharkia	El Siniti Canal	2	*				*
13	El Salhia	Ismailia Canal	1	*	*	*	*	*
13	El Salhia	Eastern El Wadi Canal	2	*				*
13	El Salhia	El Saidia Canal	2	*		*		*
15	East El Dakahlia	Rayah El Tawfiky	1	*	*	*	*	*
15	East El Dakahlia	El Sharkawia Canal	1	*				*
15	East El Dakahlia	El Mansouria Canal	1	*	*			*
16	West El Dakahlia	Bahr Shebin	1	*	*	*	*	*
16	West El Dakahlia	El Sahel Canal	1	*		*		*
16	West El Dakahlia	Kafr Saad P.S	1	*				*
16	West El Dakahlia	Balamoom P.S	3	*				*
17	Kafr El Sheikh	Rashidia Canal	1	*				*
17	Kafr El Sheikh	Bahr Tira from R. Abbasi	2	*	*	*		*
17	Kafr El Sheikh	D.S Beltag I.R on R. Abbasi	2	*	*			*
17	Kafr El Sheikh	Bahr Nashrat	3	*				*
17	Kafr El Sheikh	El Kadaba Canal	3	*				*
17	Kafr El Sheikh	El Kasid Canal	3	*				*
18	Gharbia	Bahr Shebin	1	*	*	*	*	*
18	Gharbia	Omer Bey Canal	1	*				*
18	Gharbia	Bahr El Malah Canal	2	*	*	*	*	*
18	Gharbia	Direct Irr. from R.Abbasi	2	*				*
18	Gharbia	El Bagouria Canal	2	*		*		*
18	Gharbia	El Sahel Canal	2	*		*		*
18	Gharbia	Mit Yazeed Canal	2	*	*	*	*	*
18	Gharbia	Tanta Navigable Channel	2	*	*			*
18	Gharbia	El Kasid Canal	3	*		*		*
19	El Menofia	Derwa Canal	1	*				*
19	El Menofia	El Nagail Canal	1	*				*
19	El Menofia	El Bagouria Canal	2	*	*			*
19	El Menofia	Branch U.S El Kaman	2	*				*
19	El Menofia	Direct Irr. Tanta Canal	2	*				*
19	El Menofia	Br.U.S Melig (R.Menofi)	2	*	*	*		*
19	El Menofia	D.S Melig (R.Menofi)	2	*	*	*		*

Table A.13 (Cont.)

NO.	Directorate Name	Canal Name	Canal Order	Beneficiaries (1)	(2)	(3)	(4)	(5)
20	El Behera	El Rashidia Canal	1	*				*
20	El Behera	El Mahmoudia Canal	1	*	*	*	*	*
21	West El Behera	Rayah El Nasri	1	*				*
21	West El Behera	R.Beheri, Eastern Khandak	2	*		*		*
21	West El Behera	El Tahadi Canal	2	*				*
22	El Nubaria	Noubaria Canal	2	*	*	*		*
22	El Nasr	El Nasr Canal	3	*				*

Source : "Water Demands Present & Future", MPWWR, 1990.

(1) : IRRIGATION

(2) : NAVIGATION

(3) : MUNICIPAL

(4): INDUSTRIAL

(5) : TRANSPORT

Table A.14 Industrial and municipal water demand from the irrigation network, for each directorate

Directorate	Industrial Demand (Million m^3/year)	Municipal Demand (Million m^3/year)
Aswan	117.96	16.06
Kena	____	32.12
Souhag	34.80	25.55
Assuit	127.08	26.28
West El Minia	____	3.65
East El Minia	13.08	16.06
Beni Suef	617.52	24.09
Giza	511.20	1260.00
El Fayoum	____	35.77
El Kalubia	729.60	____
El Ismailia	1611.36	300.03
El Sharkia & El Salhia	____	50.74
East El Dakahlia	27.36	155.13
West El Dakahlia	4.92	____
Kafr El Sheikh	____	67.89
Gharbia	15.60	23.00
El Menofia	____	33.95
El Behera & West El Behera	854.52	426.32
El Nobaria & El Nasr	____	31.54

Source : "Water Demands Present & Future", MPWWR, 1990.

Table A.15 Navigation water demands for main canals

Canal Name	Length (Km)	Minimum Discharge (M. m^3/day)	Minimum Draft (m)
- Ismailia Canal	70.0	3.0	1.40
- Rayah Al Tawfiki (to Gamgara HR)	37.0	8.0	2.00
- Rayah Al Tawfiki (from Gamgara HR to Mit Gamgara HR)	29.0	4.0	1.50
- El Wadi El Sharki Canal	26.0	0.5	1.25
- El Mansouria Canal (to Al Bahr Al Soghier)	43.0	0.3	1.50
- Al Bahr Al Soghier	70.0	0.3	1.20
- Rayah Al Menoufi (intake to Karinan HR)	28.9	8.0	2.00
- Rayah Al Menoufi (Karinan HR to Santa HR)	45.9	3.0	1.50
- Rayah Al Menoufi (Bahr Shibin) (from Santa to Dimiera HR)	52.2	1.6	1.50
- Rayah Al Abbassi (intake to the end of Bahr Shibin)	7.0	6.0	2.00
- Bahr Al Mallah	24.5	0.6	1.00
- Bahr Basandeela	35.0	1.5	1.00
- Rayah Billkas	10.0	3.4	1.00
- El Bagouria Canal (to New El Koddatra)	85.0	4.5	1.75
- Tanta Canal (to El Dalgamoun Lock)	38.0	2.5	2.00
- Al Bahr Al Seieedy	20.0	0.5	1.25
- Rayah El Beheri (to El Khandak El Sharki)	94.0	8.0	1.50
- Rayah El Beheri (El Khandak El Sharki)	52.0	3.5	1.40
- El Mahmoudia Canal	67.0	3.0	1.40
- El Nobaria Canal	119.0	5.0	1.50
- Ibrahimia Canal (from intake to Malawy)	60.0	6.7	1.30
- Ibrahimia Canal (from Bahr-Youssef to Lahoon Barrage)	228.0	6.7	1.30

Source : "Water Demands Present & Future" MPWWR, 1990.

Appendix B

COST ALLOCATION PROCEDURES AND BENEFITS

B.1 Basic Principles

A major difficulty associated with the integrated and joint development and management of an important stream such as the Nile River is the formulation and implementation of an effective cost recovery program for the system. A procedure designed to distribute the costs required to build, maintain, and operate the joint aspects of a modern resources system among those who benefit from its use should be based on sound economic principles of efficiency and equity.

The procedure for dividing total financial costs among the responsible parties in a development program is called cost allocation. Once it is determined that a multipurpose or multiservice project is economically justified, the costs of the project should be allocated equitably among the economic sectors benefiting from the project. Each purpose will provide a service to one or more user sectors or beneficiaries. In this appendix "project service" is used as a synonym for "project purpose".

In discussing the need to allocate costs, a distinction should be made between the terms project evaluation, cost allocation, and cost sharing. Project evaluation deals with the estimation of benefits and costs in order to determinate project justification. Cost allocation is concerned with the distribution of total project costs among the various users served by the project. The rules of cost allocation have been developed based on a combination of economic and equity principles that are fairly straightforward and generally accepted. Cost sharing is the manner in which costs actually are shared by the users of the project, with costs not necessary being allocated in accordance with benefits. Differences between cost-allocation and cost-sharing plans result from administrative policies based on social considerations. This appendix deals with allocating project costs between the various users of the Nile River in Egypt.

Complications with cost allocation arise because joint costs (those which cannot be directly assigned to any purpose) in a multipurpose project must still be allocated. Selection of the method to be used for cost allocation in any particular instance depends on a number of considerations, among them being simplicity in terms of known conditions, flexibility to changing situations, and equitability of application to all participants. In a general sense, a successful cost allocation (and for that matter, cost sharing) policy and procedure should meet the four following basic principles:

1. The method adopted should ensure that adequate performance incentives are provided for all project participants.

2. The procedure should facilitate the obtaining of loans. Potential lenders need assurance of the stability and good intentions of parties to whom they loan.

3. The cost allocation method should provide an equitable distribution of costs among the various project beneficiaries. A guiding principle is that no country, economic sector,

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business, or person should be made worse off by having the project developed and being assessed a portion for repayment. The development of the project and the repayment mechanism should lower the economic status of no one; that is, everybody should be at least as well off as before.

4. The cost allocation method and repayment scheme should provide for efficient use of the capital and other resources required by the project. For example, care must be taken to avoid any penalties for full and efficient utilization of resources made available by the project; the additional benefits from full and efficient resource utilization should exceed the resulting additional costs, including repayment costs.

Gittinger (1982) proposes several guidelines for implementing these four criteria, including the following:

1. In general, no project service should be assigned costs in excess of the value of its benefits, or be supported by the benefits of another purpose. Thus, the costs allocated for irrigation water should not be greater than the contribution of that water to the irrigation benefits of the project. Similarly, as a general rule, no service should be subsidized by another purpose. That is, power users should not be charged high rates to make irrigation water available at low cost to farmers.

2. All cost incurred for a single service generally should be allocated to that service. The cost of irrigation canals, for example, should be wholly allocated to the irrigation service, and the costs of transmission lines entirely allocated to the power service.

3. The lesser of benefits or single service alternative cost establishes the maximum amount which can be charged to any one service. No service should be assigned costs which are any greater than those which would be incurred if that service were to be supplied by the most economic alternative single-service project. Thus, the lesser of project benefits to a particular service or the cost of an alternative single-service project establishes the maximum amount which can be charged for any one service. For example, it is not equitable to allocate to the hydropower component a cost more than either the hydropower benefits or the cost of the alternative thermal plant which could provide the same electrical service.

4. The sum of the allocations to all cost centers (each user group assigned a cost) should equal the total cost of the project.

5. The allocation process should be straightforward and simple enough to be easily understood.

6. The charges resulting from the cost allocation should be established sufficiently in advance to provide stability to the market for project goods and services.

7. The direct financial responsibility allocated to each user determines the price charged within the user group or economic sector for project services.

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Any one or more of the above guidelines as outlined by Gittinger may reasonably be violated to achieve other broad policy goals. For example, prices for some project inputs and outputs may be established at higher or lower levels than would result from the above guidelines in order to encourage production, regulate use of resources, or for other policy reasons. The repayment responsibility thus might be based on all or part of the projects costs allocated to a particular user on the basis of benefits. However, the guidelines by Gittinger are consistent with the four general criteria given earlier.

It is emphasized again that in a particular case, country interests and political agreements might dictate use of a cost-sharing formula which differs from that of a traditional cost allocation approach which follows the above guidelines. To propose cost sharing recommendations which deviate from the results of a cost-allocation procedure requires extensive study and a considerable input of planning and administrative policies. For example, a country might choose to subsidize certain services either internally or through foreign assistance because of long-term economic development or income redistribution objectives, public goods characteristics of certain services, or high costs of collecting revenues from certain users of project services. A cost-sharing scheme which deviates from cost-allocation principles might result in a loss in economic efficiency in order to achieve other objectives.

This section of the appendix briefly summarizes traditional cost allocation methods which follow the Gittinger (1982) guidelines referred to above. In cost allocation those costs which are incurred for a specific service and which are identifiable and separable for that service are allocated to that service. The joint costs (those that cannot be separated by economic sector, or services) are allocated according to an appropriate procedure. The total cost allocated to a service (specific plus separable plus allocated joint costs) can be used as a basis for calculating user fees or service charges. In this way, each use sector is allocated a share of project costs based on assumed and/or expected benefits. The resulting cost allocation represents a good starting point in subsequent cost sharing negotiations, with deviations resulting from planing and administration policies and decisions. These considerations must be addressed by the users involved and, therefore, are beyond the scope of this appendix.

B.2 Definition of Costs

For the purpose of this report, project costs are taken to include: 1) the cost of planning and installation; 2) the costs of project operation, maintenance, and replacement; and 3) interest costs.

The above costs are all readily identifiable and can be estimated for inclusion in a benefit-oriented analysis. Other categories which might be regarded as project costs, but which because of insufficient data might not be included are: 1) cost of external project diseconomies, such as increased incidence of water-borne diseases; 2) the associated costs which private parties must spend in order to realize project benefits, such as travel to and from the place of work; 3) social costs arising from differences between the true social values of project inputs and outputs (those values would be indicated by prices in a truly competitive economy) and values of project inputs and outputs indicated by actual prices. The actual prices might be influenced by price controls, monopolies, or other administrative or market constraints. These differences can be either positive or negative.

Installation costs may be allocated separately from annual operation, maintenance, and replacement costs. The installation costs normally are incorporated into cost sharing agreements prior to project construction according to predicted project output. Cost allocations may be adjusted from time to time during the life of the project as required by changing conditions.

B.3 Categorizing Costs

Once a formula for allocating costs is established, it needs to be incorporated into a legally binding cost-sharing agreement. The very need to allocate costs implies that it is impossible to attribute them precisely to the sectors where benefits are expected. Thus, as far as possible, specific and separable costs are assigned to those sectors using a project service, and the remaining joint costs then are allocated. Specific costs are those which are clearly linked with a particular user or beneficiary of the project. For example, costs associated with canals which supply only irrigation water are specific costs to agriculture. Similarly an electrical switch-yard is clearly a specific cost to energy. The use sector which receives the entire benefit stream from a given investment should be assessed the entire cost of that investment. Separable costs normally are defined as being those incremental investments in a multiple use facility which result from the inclusion of a particular use. Separable costs for a particular service include changes in project design to include that service as a purpose. For example, assume that a 110 meter high dam is constructed to serve both irrigation and hydro-power generation purposes. If the height could be lowered to 100 m to serve only irrigation, but would need to remain at 110 m to provide the designated energy output, the cost of the additional 10 meters in dam height is separable to electric power. Similarly, a power house which is built as part of a dam and penstocks which pass through the dam both depend to some extent upon the common works, and thus are separable, rather than specific, costs to energy.

B.4 Relationship between Cost Allocation and User Fees

The two major purposes of cost allocation are: 1) to obtain revenue to provide for repayment of the investment, and 2) to promote economic efficiency in resource use. The optimum use of project services is provided when prices charged equal the marginal cost of the goods and services produced by the project. If the fees for services fail to provide sufficient revenue, then the participants involved must assure that OM&R costs are met. Thus, in a multipurpose project, such as the Nile River basin development, an equitable assignment of the costs to all users (including the Government) is important for adequate system maintenance and operation. It is assumed that fees collected in the operation of an identifiable component of the Nile River basin project will be sufficient to repay both the costs of replacement and the operating and maintenance costs. To assume otherwise implies external subsidization. However, as a matter of public policy the Government might elect to support particular uses, such as agriculture and flood control, either in whole or in part. If a benefit-cost analysis of the proposed development program indicates that the benefits exceed costs, then the task of cost allocation (or the assessment of fees to support the project) is one of assigning costs in proportion to benefits received. On this premise, an equitable fee structure can be designed which would be sufficient to support the project, and yet would not result in the inefficient use of project services by destroying incentives. To ensure that the project resources are used efficiently, the basic principle upon which the cost allocation model is based is that costs are allocated to the economic sectors according to the benefits received. In practice, the usual procedure is to formulate rates or fees which will distribute costs among all users as nearly as possible in proportion to the benefits. This premise implies that all costs, including joint costs, are covered, and that sunk costs have been amortized.

The type of services provided in a river basin development usually are managed by a public organization because a perfectly competitive market does not exist. A number of options are available for establishing a fee structure, the most economically efficient of which is marginal cost pricing.

B.5 Cost Allocation Methods

Six principal methods are used for allocating joint costs of public works projects:

1. Equally among the use sectors.
2. Proportionally to the quantity of use made by the user of the services usually expressed in physical units such as volumes or flow rates.
3. Entirely to the highest priority user within the limit of the benefit received by that sector.
4. Proportionally to the benefits in excess of assigned separable costs (net benefits) derived by the given use sector.
5. Proportionally to the excess cost required to provide the service by some alternate means.
6. Proportionally to the smaller of the excess benefit or the excess cost of the alternative project (termed justifiable cost).

Of the six methods, various forms of methods 2 and 6 are most commonly applied, with method 2 being applied only occasionally. On March 12, 1954, an agreement was signed by the U.S. Department of the Interior, the Department of the Army, and Federal Power Commission ("Cost Allocation", memo 59981-2, Washington, D.C, March 1954) stating that the separable cost-remaining benefit (SCRB) method (a form of method 6) of cost allocation was the most acceptable method of apportioning costs among multiple purpose developments. Under certain circumstances the agreement provided that the alternative justifiable expenditure method (also a form of method 6) and the use-of-facilities method (method 2) could be employed.

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The two principal objectives of cost allocation are to achieve economic efficiency and equity (Section B.6). Economic efficiency refers to the ratio of the value of outputs and the value of inputs, while equity refers to fairness in the distribution of total project costs among all the users served by a multiple purpose development. Methods 1, 2, and 3 are not guaranteed to achieve these two basic objectives. Methods 4 and 5 each partly achieve this goal, while method 6 (which combines methods 4 and 5) adheres to both objectives. It was, therefore, decided that for the cost allocation model applied in this study a version of method 6 would be used.

Four different cost allocation procedures are discussed in detail in the following paragraphs. One of these procedures is based on the net benefit approach (method 4), while the remaining three are variants of method 6.

Benefits in excess of assigned separable costs (net benefits) method. This procedure for cost allocation involves a direct and straightforward application of estimated benefits. Benefits by sector and/or user are computed and from these are subtracted the separable costs to derive what is termed net benefits for each sector. Cost allocation by sector then is made in direct proportion to its calculated net benefits.

The alternative justifiable expenditure method. As previously indicated, this method, like the separable-costs-remaining-benefits (SCRB) procedure, is a variant of the sixth principal cost allocation method. For this reason, the alternative expenditure and the SCRB methods are closely related, the main difference being that the alternative justifiable expenditure method substitutes the specific costs of the various functions for the separable costs. Joint costs are derived by subtracting all specific costs from total project costs, and they are distributed among the various purposes in proportion to remaining benefits. However, with this formula, remaining benefits are calculated by subtracting specific costs and justifiable costs on a 1:1 basis. Total allocated costs are the sum of specific costs and allocated joint costs. An example of this procedure is illustrated in Table B.1. The alternative justifiable expenditure method is recommended in those instances where the data are not available for estimating separable costs or when the cost of obtaining such data would be prohibitive.

The separable cost remaining benefits (SCRB) method of cost allocation assigns to each function the separable costs (if any) of including each function in the multipurpose development plus a share of the joint or common costs of the project. Joint costs are allocated on the basis of the remaining benefits accruing to each function. Because the remaining benefits are limited by the alternative single purpose costs, Gittinger (1982) uses the perhaps more correct term "remaining justifiable expenditure" rather than "remaining benefits". The method is illustrated by the following simple example.

A multipurpose project involving flood control, power, irrigation, and navigation is proposed with a total estimated cost of 1765 units. Project benefits associated with each use are estimated; these are shown in row 1 of Table B.2. The alternative costs (row 2) are those for a single purpose project designed to provide services only for a particular use. For example, another way of providing for flood control, other than through the proposed project, would cost an estimated 400. The justifiable costs (row 3) then are either those benefits provided by the proposed project (row 1) or the alternate cost (row 2), whichever is smaller. The separable costs for a particular

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purpose (row 4) are found by subtracting the cost of the project without that purpose from the total project cost. For instance, in this example the cost of project without providing for flood control is 1385, thus yielding a separable cost of 1765 minus 1385, or 380.

The remaining benefits (row 5) are found by subtracting separable costs from limited benefits (row 3 minus row 4). The total of the separable costs is 1180, or 585 less than the total project cost. These allocated costs are distributed to each use (row 6) in the same proportion as the remaining benefits (row 5) which are associated with each service. For example, the proportion of the unallocated costs which are apportioned to flood control is given by: 20/650 x 585 = 18.

The total cost assigned to each use (row 7) is the sum of the separable costs (row 4) and the allocated joint costs (row 6). The total of the costs assigned to each service is equal to the cost of the entire project.

The adjusted separable costs remaining benefits method was developed to adjust for the potential inequity in the SCRB formula by applying a credit to the separable costs so that separable costs are subtracted from the justifiable costs on a greater than a 1:1 basis. The rationale for applying a credit to the separable costs in allocating joint costs is that the separable costs share in the benefit provided by the joint costs. For example, flood control storage provided near the top of a reservoir benefits from the joint costs incurred for other beneficiaries. Similarly, penstocks which pass through a dam are separable to energy, but also benefit from the joint costs of the structure which supports the penstocks. In the procedure the credit given to separable costs is in the same ratio as that of the justifiable costs for a purpose plus justifiable costs for all other purposes to the total project costs. This procedure provides better results than the SCRB method for meeting the equity criterion. The method is illustrated by Table B.3.

The rationale for this method is that it adjusts separable costs to reflect the assignment of a portion of project savings from multiple-purpose projects (as compared to single-purpose projects) to the separable costs. This adjustment decreases remaining benefits, joint costs, and total costs for those services with higher separable costs. Since allocated savings would increase to those purposes with higher separable costs, a more appropriate relationship emerges between the savings allocation to each purpose and the savings from purpose inclusion. As a result of this change in the SCRB method, each purpose is assigned a more reasonable proportional share of the savings resulting from multiple-purpose development.

In addition to the allocation of costs among services, Table (B.3) provides information about the advantages or disadvantages of the multipurpose project compared to single-purpose projects.

1. Comparison of the alternative cost (row 2) to total service sector cost (row 12) reveals the cost savings due to the multipurpose dam versus single-purpose dams.

2. Comparison of project benefits for energy and navigation (row 1) with total service sector costs (row 12) reveals the cost savings due to the multipurpose dam versus thermal power and rail/road transportation respectively.

3. When benefits (row 1) are less than alternative costs (row 2), a single-purpose dam is not economically feasible for the service.

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B.6 The Efficiency And Equity Of Cost Allocation Methods.

The two principle objectives by which cost allocation procedures are evaluated are economic efficiency and equity. The conditions for efficiency in cost allocation can be stated as: 1) the separable cost of adding each last increment of services should not exceed the benefits derived therefrom; 2) the sum of the total costs allocated to each service should not exceed the sum of the total benefits accruing from the use of each service; and 3) the total costs allocated to each service should not exceed the cost of a single-purpose alternative providing equivalent benefits. All three efficiency criteria are satisfied by the SCRB method. However, the alternative-justifiable-expenditure method and the use-of-facilities method employing specific costs do not necessarily satisfy efficiency condition (1) in those instances where separable costs exceed specific costs. In these cases, it is possible that the benefits from including a service may be equal to specific costs but less than separable costs. The service would be justified on the basis of specific cost but infeasible on the basis of separable costs. Since these methods cannot assure that the separable costs of adding a purpose will not exceed the benefits derived from its use they fail one of the efficiency tests.

With regard to equity of allocation, equity refers to fairness in the distribution of total project costs among all the users served by a multiple-purpose development. In this study equity is interpreted to mean that costs are allocated according to the increased benefits which result from the project. Thus, equity is based on the premise that the increased benefits provide each user with a means for paying his fair share of project costs. Specifically, an equitable cost allocation is one which permits all project users to share fairly in the savings multiple-purpose as compared to single-purpose construction. Once costs are allocated, equity in cost sharing is then concerned with the distribution of benefits and local costs among users. The "fairness" concept of equity in cost allocation must be emphasized. The objective of cost allocation is to distribute project costs equitably among the users served by providing for proportional sharing of the savings resulting from multipurpose development. This criterion, however, is not satisfied by any of the four cost allocation methods previously discussed in this section, because at least two procedural problems exist which do not provide for proportional sharing of project savings among users. A problem of equity arises with both the separable costs remaining benefits and the alternative-justifiable-expenditure methods of cost allocation because the separable costs are not credited with a part of project savings. Thus, all project savings accrue entirely to the joint cost. A more realistic and equitable basis may be to attribute a part of project savings to the separable costs. Equity in cost allocation dictates that the savings allocated to each function be proportional to the savings from the inclusion of each function in the project.

The justifiable costs in Table (B.2) total 1830 (project benefits by purpose limited by cost of single purpose alternatives). Total costs (line 7) are 1765. Thus, project savings are 65 units. For the procedure illustrated, all 65 units of the savings from the multiple-purpose project are credited to joint costs (line 5 minus line 6, where 65 units of remaining benefits are allocated to joint costs, or 650 - 585 = 65). A solution to the problem of equity, then, is to attribute a portion of the savings to the separable costs, as is done by the AJCRB procedure. For the use-of-facilities method of cost allocation, a further equity problem arises because of the difficulty in fairly defining the relative capacity required for each system use.

B.7 Calculating Economic Benefits of a System Improvement Project

B.7.1 Preliminaries

Estimating project benefits is an essential part of the cost allocation analysis. Several approaches are available for calculating benefits. The best approach to use depends on the type of benefit, so different methods are employed in the various sectors. In this section, we first briefly discuss the broad principles underlying conventional economic benefit estimation procedures. Then, we describe the basis for the several approaches used in the study.

Benefit-cost analysis is the public sector counterpart to the private-sector analysis of investment returns. It is applied in cases , as in water resource planning, where market prices for inputs and outputs cannot be used for investment appraisal. Market prices may be absent, or if available, may not reflect social valuation of beneficial and/or adverse effects. Both considerations are found in water resource planning. Water is seldom priced, and on the rare occasions when it is, the charge might not accurately reflect costs of supply. In the absence of appropriate market prices, some synthetic approach is necessary to approximate the market prices. The synthetic prices derived in this manner for benefit-cost analysis are usually called "shadow" or "accounting" prices.

The basic concept of "benefit" is defined as the amount a rational and informed user of a publicly supplied good would be willing to pay for it (Gittinger, 1982.) Willingness to pay reflects the user's willingness to forego alternative consumption opportunities, rather than do without the good or service in question. Costs, in this context, represent the foregone value (the opportunity cost) of goods and services displaced by a project.

Two rules should be kept in mind in the process of benefit estimation. One, the "with or without" principle, requires that benefits and costs are to be measured as increments which would occur with as compared to without the project. This rule assures that estimated benefits are solely due to the program or project, rather than measures of changes between before the project as compared to after, some of which would have occurred autonomously even in the absence of the project.

The second rule relates to which of two alternative "accounting stances" or viewpoints are taken for the analysis. The private accounting stance measures gains and losses as perceived by the individuals receiving them, which are likely to be influenced by government interventions into the market (such as minimum wage regulations or farm commodity price controls.) Benefits and cost from the private accounting stance are usually termed "financial" measures. The alternative accounting stance is from the public or social point of view. Ideally, the social accounting stance includes social opportunity costs and social willingness to pay as measures of costs and benefits, meaning that financial prices are corrected for market interventions or for external costs and/or benefits. The benefit and cost measures for the public accounting stance are usually called "economic" prices.

The choice of accounting stance for an irrigation cost allocation exercise in Egypt, where government agricultural policies are rapidly changing presents some difficulties. Cost allocation studies more often than not employ the financial prices, because that is the stance from which farmers ability to pay for irrigation must be calculated. On the other hand, in an economy with a policy objective of moving prices in the agricultural sector toward world market levels, the financial prices may have only a short-lived accuracy in reflecting conditions faced by farmers. Be that as it may, the financial price approach has been taken in this study.

B.7.2 Alternative Methods of Calculating Project Benefits

Each of the methods described and evaluated below are ways of approximating willingness to pay for water project benefits (Young and Haveman, 1985.)

Method No. 1. Residual Valuation Approaches.--Residual valuation achieves the task of shadow-pricing by allocating the total value of output among each of the resources used in a productive process. It applies to cases where water is an intermediate good; that is, it is used by producers in the production of other goods and services, and is not used for final consumption by households. The method assumes first, that the total value of production can be divided into shares, such that each resource is paid according to its marginal value productivity, and that the share allocation exactly exhausts the total value of output, and second, that market prices of each resource (excepting the one to be shadow-priced) are equal to returns to the resource at the margin.

Consider a simple example where four productive factors, capital (K), labor (L), land (S) and water (W) are used to produce a crop (Q). By the first of the above assumptions, we can write:

$$TVPq = (MVPk \times K) + (MVPl \times L) + (MVPs \times S) + (MVPw \times W)$$

where TVPq is the total value of output Q; MVPi represents the marginal value product of the i-th resource, and L, K, S, and W refer respectively to the quantities of labor, capital, land and water employed in production. By the second assumption, market prices for K, L, and S are substituted for the respective marginal value products. Then the expression can be solved for the remaining unknown, MVPw; which is the estimated shadow price of water.

The limitations of the residual approach should be acknowledged. First, if an input variable and its costs are omitted, its value will be assigned to the residual input, water, thereby overestimating the latter variable's shadow price. In agricultural contexts, land rents and family labor and management costs may be omitted or are at least, difficult to quantify. Second, distortions in either prices of non-water inputs or of outputs will bring about a distorted water shadow price.

Method No. 2. Net Incremental Return.--This approach is a variation on method 1. It is the method recommended by the U.S. Water Resources Council for calculating irrigation project benefits. In that agency's publications, it is called the "change in net income" method. Benefits are calculated as the increment in net income or profit from the project based on a with/without comparison. The calculations are identical to method 1 in the case of irrigation investments, because the "without" case net income is the pre-project net return or rent to the land resource. The same limitations or potential biases (due to omitted variables or to distorted prices) apply here, and should be carefully avoided.

In agricultural contexts, the net incremental return method yields an estimate often called the "net primary returns." It is this approach and terminology which is used in the present study for irrigation benefits.

Method No. 3: Cost of Next-Best Alternative.--In this approach, (sometimes called the "alternative cost" method), the willingness to pay is limited by the cost of the most-likely (i.e. least- cost) economically feasible alternative. The method is useful in cases where direct willingness to pay cannot be readily estimated, but where a substantially different economically feasible

alternative exists. The alternative must be economically feasible in its own right, or any project purpose becomes justifiable by applying the alternative cost approach.

The benefits are taken to be the cost which would be incurred if the next-best alternative were to be used. For example, a fossil-fuel fired steam generating plant might be the next best alternative to hydroelectric power production. The incremental cost of energy produced by a thermal plant of equal capacity is the benefit ascribed to the hydropower facility. In this study, the

alternative cost approach is heavily relied upon. It is found to be the method most appropriate for hydropower, navigation, urban water supply and river crossings.

Method No. 4. Avoided Damages.--In certain cases, where a project permits avoidance of potential economic damages from either natural or man-made hazards, benefits are taken to be the expected value (i.e. the probability-weighted value) of monetary damages or costs prevented by the project. For example, a flood control project permits floodplain dwellers to avoid or reduce the probability of damages to homes or businesses. A pollution control investment might reduce adverse health impacts from factory emissions. The benefit of avoiding these damages is infrequent, so the monetized damage-avoided measure of benefits must reflect the probability of damaging events.

B.7.3 Selection of Methodologies for Estimating Benefits

The selection of the particular benefit calculations method for allocating costs depends on three important considerations: 1) the nature of the project purpose and the type of benefits provided, 2) the needs and preferences of those performing the cost allocation, and 3) the availability of data. For this study, method 3 was chosen for estimating system benefits from the use of dams for river crossings (road transportation), navigation, water supply, and hydro-electric power generation. This method is based on the cost of providing the service compared with the next best available alternative. Because of its extensive use in evaluating navigation benefits, the procedure is sometimes known as "savings to shippers". The method requires data which are normally fairly easy to obtain. For evaluating agricultural benefits method 2 was selected because net primary returns can be calculated from available data. For flood control method 4 was selected because damage estimates are a measure of the value of the project to the users. Commercial fish harvests from Lake Nasser and aquaculture ponds are valued on the basis of market prices. This procedure is an application of method 1, but due to a lack of cost data, the gross value of fishery revenues was used. This procedure introduces a minor bias by overstating benefits to the fisheries sector. No incremental fish harvest as a result of the system was assumed for the main stem of the river. Tourism and recreation enjoyement result from boat trips on the Nile River. This sector benefits from water releases from the HAD and from an increased draft resulting from the downstream barrages. The benefits to this sector are estimated as net primary revenue (method 2). Dredging for navigation (river freight) also benefits the river tourism sector. Because the freight barges normally require more draft than the tourist boats, all channel dredging costs are assigned to the river navigation sector as specific costs. Table 4.1 indicates procedures applied in this study for estimating single purpose costs used in the cost allocation procedure. Also shown are the methods used for estimating the benefits for each service sector at three levels within the system.

Table B.1: Alternate justifiable expenditure method of cost allocation

Row No.	Item	Flood Control	Power	Irrigation	Navigation	Totals
1	Project benefits	500	1500	350	100	
2	Alternative costs (single purpose project)	400	1000	600	80	
3	Justifiable costs (Lesser of 1 or 2)	400	1000	350	80	1
4	Specific costs	120	300	100	30	
5	Remaining benefits (3 - 4)	280	700	250	50	1
6	Allocated joint costs[a]	265	665	238	47	1
7	Total allocated costs (4 + 6)	385	965	330	77	1

[a] Total joint costs of 1215 units are apportioned to each purpose in the same ratio as that of the remaining benefits of each purpose to the total remaining benefits.

Table B.2: The separable costs-remaining benefits method of cost allocation

Row No.	Item	Flood Control	Power	Irrigation	Navigation	Totals
1	Project benefits	500	1500	350	100	
2	Alternative costs (single purpose project)	400	1000	600	80	
3	Justifiable costs	400	1000	350	80	1
4	Separable costs	380	600	150	50	1
5	Remaining benefits (3 - 4)	20	400	200	30	
6	Allocated joint costs	18	360	180	27	
7	Total allocated costs (4 + 6)	398	960	330	77	1

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Table B.3. The adjusted separable costs-remaining benefits method of cost allocation.

Row No.	Item	Flood Control	Power	Irrigation	Navigation	Totals
1	Project Benefits	500	1500	350	100	2450
2	Alternative Costs (single purpose project)	400	1000	600	80	2080
3	Justifiable costs	400	1000	350	80	1830
4	Separable costs	380	600	150	50	1180
5	Cost for all other purposes (total cost less row 4)	1385	1165	1615	1715	
6	Justifiable costs for all other purposes (lesser of 5 or Σ of row 3 less just. cost for purpose)	1385	830	1480	1715	
7	Adjustment factor (3 + 6 / total cost)	1.01	1.04	1.04	1.02	
8	Adjusted separable costs (row 4 x row 7)	384	624	156	51	
9	Remaining benefits (row 3 - row 8)	16	376	194	29	615
10	Joint cost proportions (row 9 / Σ row 9)	0.026	0.611	0.315	0.048	1.000
11	Allocated joint cost row 10 x (total project cost - Σ row 4)	15	358	184	28	585
12	Total allocated costs (row 4 + 11)	395	958	334	78	1765

Appendix C

Tables of Cost Estimates

Table C1.1
Scenario 1: Actual Annual Expenditures
Current Prices (000 LE)

AGENCY	FY 1986/87	FY 1987/88	FY 1988/89	FY 1989/90	FY 1990/91
IRRIGATION DEPARTMENT	151,086,906	197,292,791	264,405,582	282,575,918	304,942,213
MECHANICAL & ELECTRICAL DEPARTMENT	60,208,629	83,466,579	87,388,206	82,122,642	103,036,879
PUBLIC AUTHORITY FOR DRAINAGE PROJECTS	9,563,000	13,085,000	23,018,800	33,413,000	37,891,000
HIGH ASWAN DAM AUTHORITY	15,808,616	16,817,929	15,428,976	11,762,467	12,527,398
WATER RESEARCH CENTER	10,981,881	17,781,497	18,433,799	25,185,377	27,941,432
TOTAL	247,649,032	328,443,796	408,675,363	435,059,404	486,338,922

NOTES:
(1) - INCLUDES GRANTS
(2) - INCLUDES EXPENDITURES ON DEVELOPMENT OF NEW LANDS
(3) - EXCLUDES EXPENDITURES ON MODERNIZATION OF THE NILE SYSTEM
(4) - EXCLUDES EXPENDITURES ON MESQAS AND TILE DRAINAGE SYSTEM
(5) - EXCLUDES EXPENDITURES FOR ACTIVITIES OUTSIDE NILE BASIN
(6) - EXCLUDES PAYMENTS OF INTERESTS AND INSTALLMENTS OF FOREIGN LOANS

Table C1.2
Wholesale & Consumer Price Indices

Description	FY 1986/87	FY 1987/88	FY 1988/89	FY 1989/90	FY 1990/91	December 1991(1)
Construction Material (2)	757.9	892.4	1,069.7	1,301.4	1,677.2	1,877.3
Petroleum (2)	469.4	631.1	783.0	947.3	1,392.2	1,718.4
Machinery & Implements (2)	323.9	392.7	518.4	619.7	705.3	757.5
Consumer Price (3)	100.0	114.6	138.8	170.9	190.8	245.3

(1) Estimate (2) 1965/66=100 (3) 1986/87=100
(4) Egyptian Fiscal Year: July 1 through June 30th
Source: Central Agency for Public Mobilization & Statistics, Egypt

Table C1.3
Changes in the Electrical Rate Schedules between July 1, 1985 and May 1, 1991

Category	Unit Cost	July 1985	May 1987	March 1989	June 1990	May 1991
High Tension	mill./Kwh	11.7	17.1	28.4	45.6	80.7
Fixed Annual Tariff	L.E./Kw	12.4	17.4	28.9	46.4	82.1
1-1000 Kwh	mill./Kwh	22.3	31.2	51.8	83.1	147.1
1000-1500 Kwh	mill./Kwh	21.0	29.4	48.8	78.3	138.6
1500-2500 Kwh	mill./Kwh	18.3	25.6	42.5	68.2	120.7
2500-3500 Kwh	mill./Kwh	15.7	22.0	36.5	58.6	103.7
3500-5000 Kwh	mill./Kwh	11.9	16.7	27.7	44.5	78.8
5000 and over	mill./Kwh	10.2	14.3	23.7	38.0	67.3
% increase over previous rate			40.6%	66.0%	60.5%	77.0%

Table C1.4
Exchange Rate of Egyptian Pound (LE)

Currency	FY 1986/87	FY 1987/88	FY 1988/89	FY 1989/90	FY 1990/91	December 1991(1)
US Dollar	1.35	2.23	2.38	2.60	2.83	3.32
ECU	1.15	1.85	2.15	1.89	N/A	2.51
Dutch Guilders	0.68	0.96	1.02	1.13	1.56	1.19
Canadian Dollar	1.81	2.82	2.86	3.04	3.29	3.81

Source: International Financial Statistics-February 1991
(1) Commercial Bank Rates

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Table C1.5
Scenario 1: Summary Costs of the Nile System

DESCRIPTIONS	1986–1987		1987 – 1988		1988 – 1989		1989 – 1990		1990 – 1991		AVERAGE ANNUAL (1) COSTS INCURRED	
	CURRENT PRICES	DEC 91 PRICES	CURRENT PRICES	DEC 91 PRICES	CURRENT PRICES	DEC 91 PRICES	CURRENT PRICES	DEC 91 PRICES	CURRENT PRICES	DEC 91 PRICES	DEC 91 PRICES	INCLUDING CONTING.
<u>OPERATION & MAINTENANCE COSTS</u>												
PERSONNEL	60,843,100	69,395,787	70,025,884	79,869,392	80,057,862	91,311,560	90,561,924	103,292,174	100,366,288	114,474,733	114,474,733	120,198,469
NON-PERSONNEL (2)	57,560,058	186,235,099	85,537,012	217,327,352	131,568,344	256,231,887	147,817,471	233,855,474	157,927,697	204,519,615	219,933,019	241,926,321
SUBTOTAL	118,403,158	255,630,886	155,562,896	297,196,744	211,626,206	347,543,447	238,379,395	337,147,648	258,293,985	318,994,347	334,407,752	362,124,790
<u>CAPITAL COSTS</u>												
STRUCTURAL REPLACEMENT	27,409,134	72,587,504	44,419,463	90,556,606	51,059,442	87,604,547	62,934,622	90,026,165	83,962,389	98,571,531	87,869,271	96,656,198
PUMP STATION REHAB & REPLACEMENT	20,684,630	55,672,906	33,172,643	62,678,450	36,858,775	60,367,972	21,218,820	29,200,384	25,992,149	30,575,674	47,699,077	52,468,985
GENERAL IMPROVEMENTS	35,619,818	94,331,826	45,713,337	93,194,387	48,310,897	82,888,768	58,627,027	83,864,275	61,609,203	72,328,974	85,321,646	93,853,811
SUBTOTAL	83,713,582	222,592,236	123,305,443	246,429,443	136,229,114	230,861,288	142,780,469	203,090,824	171,563,741	201,476,179	220,889,994	242,978,993
TOTAL COSTS (3)	202,116,740	478,223,122	278,868,339	543,626,186	347,855,320	578,404,735	381,159,864	540,238,472	429,857,726	520,470,527	555,297,746	605,103,784
DEVELOPMENT OF NEW LANDS	45,532,292	120,859,442	49,575,457	99,136,383	60,820,043	103,985,373	46,854,495	66,964,630	48,519,578	56,962,872	89,581,740	98,539,914
SUBTOTAL	247,649,032	599,082,563	328,443,796	642,762,570	408,675,363	682,390,108	428,014,359	607,203,102	478,377,304	577,433,398	644,879,486	703,643,698
MODERNIZATION OF OLD LANDS (4)	6,019,525	17,993,835	14,606,798	25,174,226	26,727,190	41,104,846	61,358,900	82,268,125	69,651,940	81,711,817	49,650,570	54,615,627
GRAND TOTAL	253,668,557	617,076,398	343,050,594	667,936,796	435,402,553	723,494,954	489,373,259	689,471,227	548,029,244	659,145,215	694,530,055	758,259,324

(1) – EXCEPT ANNUAL COST OF PERSONNEL (See Section 3.4)
(2) – INCLUDES CAPITAL COSTS OF MAINTENANCE
(3) – SEE SECTION 4.5
(4) – ESTIMATE

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Table C 2.1
Proposed Water Resources Development Plan (000 LE)
(1992-1997)

Description	Five Year Plan 92 - 97	FY 92/93	FY 93/94	FY 94/95	FY 95/96	FY 96/97
1-Ministry Headquarter						
Ministry Building	9,700	3,740	3,740	740	740	740
Water Master Plan	7,080	3,630	1,480	1,490	240	240
Nile Water Technical Commission	14,500	2,900	2,900	2,900	2,900	2,900
Sub-Total	31,280	10,270	8,120	5,130	3,880	3,880
2-Irrigation Deptartment						
Irrigation Improvment	560,000	141,850	141,650	116,500	82,500	77,500
Esna Barrage and Power Station	600,000	190,900	269,250	52,200	87,650	-
Nag Hammadi Lock	3,000	3,000	-	-	-	-
Groundwater Wells for Irrigation Purpose	19,200	8,000	7,000	1,500	1,500	1,200
Improvement of Irrigation Methods	100,000	20,000	20,000	20,000	20,000	20,000
Flash Flood Protection	15,000	3,000	3,000	3,000	3,000	3,000
Water Weed Control	15,500	1,100	3,600	3,600	3,600	3,600
Strenghtening Nile Barrages	22,000	7,500	3,500	3,500	3,500	4,000
Reuse of Drainage Water	10,000	2,360	2,360	2,360	2,360	560
Benefiting from Winter Closure	101,500	13,000	13,500	25,000	25,000	25,000
Jonglel Canal	500	100	100	100	100	100
Rehalitation and Replacement of Structures	100,000	14,000	19,000	20,000	23,000	24,000
Naga Hammadi Barrage	450,000	90,000	90,000	90,000	90,000	90,000
Sub-Total	1,998,700	494,810	572,960	337,760	342,210	248,960

Table C 2.1
Proposed Water Resources Development Plan (000 LE)
(1992-1997)

Description	Five Year Plan 92 - 97	FY 92/93	FY 93/94	FY 94/95	FY 95/96	FY 96/97
3-Mechanical and Electrical Deptartment						
Rehab. and Replacement Pump Stations - 1	34,255	16,830	6,665	3,900	3,995	2,865
Rehab. and Replacement Pump Stations - 2	345,560	7,085	68,540	130,915	105,780	33,240
Change Electrical Network, North Delta	49,500	7,250	22,260	18,230	1,760	-
Hamol and Mansour Pump Stations	538	340	198	-	-	-
Mahala Pump Station	2,018	1,478	278	158	104	-
El Khayam Subsidary Station.	55	55	-	-	-	-
El Atef Pump Station	4,205	1,060	320	1,650	590	585
Upper Badia Pump Station.	6,018	701	2,395	2,020	701	701
Eneiba El daima, Pump Station.	892	261	261	261	57	52
Drain 2 El Khatsa, Pump Station	1,434	600	520	210	104	-
Protection and Emergency Works	16,315	3,263	3,263	3,263	3,263	3,263
Laboratory and Workshop Installation	16,370	3,274	3,274	3,274	3,274	3,274
Sub-Total	477,680	42,197	107,974	163,881	119,628	43,060

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Table C 2.1
Proposed Water Resources Development Plan (000 LE)
(1992-1997)

Description	Five Year Plan 92 - 97	FY 92/93	FY 93/94	FY 94/95	FY 95/96	FY 96/97
4-High Aswan Dam Authority						
Rehabilitation of River Equipment	2,875	575	575	575	575	575
Machinery and Equipment for the Protection of the Dam Body and Reservoir	35,700	7,140	7,140	7,140	7,140	7,140
Rehab. of the Dam Body and Reservoir	20,185	4,037	4,037	4,037	4,037	4,037
Research Studies of Reservior, Spillways, Toshka, and Silt.	6,875	1,375	1,375	1,375	1,375	1,375
Rehab. and Replacement of the Regional Earthquake Center in Aswan	13,975	2,795	2,795	2,795	2,795	2,795
Rehab. and Replacement of Water Pipes Installed on the Dam Body	2,300	530	530	530	530	180
Rehab. and Replacement Central Conditioning	625	150	150	175	150	-
Rehab. and Replacement of Transport Facilities and Transportation	1,475	295	295	295	295	295
Sub-Total	84,010	16,897	16,897	16,922	16,897	16,397
5-Egyptian Public Authorly for Drainage						
Open Drain in 80000 fd, Delta	24,000	12,000	12,000	-	-	-
Open Drain in 80000 fd, Upper Egypt	24,000	12,000	12,000	-	-	-
Sub-Total	48,000	24,000	24,000	0	0	0

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Table C 2.1
Proposed Water Resources Development Plan (000 LE)
(1992-1997)

Description	Five Year Plan 92 - 97	FY 92/93	FY 93/94	FY 94/95	FY 95/96	FY 96/97
6-Water Research Center						
Water Research Center	4,772	1,282	1,485	1,926	928	952
Water Distribution and Irrigation Methods Institu	5,650	1,130	1,130	1,130	1,130	1,130
Research Institute for Channel Maintenance and Weed Resistance	2,820	564	564	564	564	564
Drainage Research Institute	2,646	558	558	510	510	510
Groundwater Research Institute	19,195	3,839	3,839	3,839	3,839	3,839
Water Resources Development Institute	7,853	2,100	2,500	1,423	1,150	680
High Aswan Dam Side Effects Institute	6,280	1,150	1,050	1,250	1,550	1,280
Hydr. and Sediment Research Institute	5,521	1,247	2,128	1,236	455	455
Structures, Soil Mech. and Found. Research Ins	1,412	354	353	275	220	210
Mechanical and Elect.ical Research Instiute	2,390	563	465	562	615	185
Staff Housing Project	300	150	150	-	-	-
Sub-Total	58,839	12,937	14,222	12,11[illegible]	10,361	9,205
Total	2,553,940	571,427	713,204	506,771	465,718	296,820

Note : Excludes proposed investments for development of the new lands.

Source: MPWWR, Document No 223, Dated November 12, 1991.

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Table C 2.2
Estimated Cost of Replacement of Nile Barrages (000 LE)

DESCRIPTION	ESNA BARRAGE								OTHER BARRAGES		
	CONSTRUCTION CONTRACT				ESTIMATED	DECEMBER 91 PRICES					
	FOREIGN (000 $)	FOREIGN (000 LE)	LOCAL (000 LE)	TOTAL (000 LE)	TOTAL (000 LE)	FOREIGN (000 LE)	LOCAL (000 LE)	TOTAL (1) (000 LE)	ASSUIT (000 LE)	ZIFTA (000 LE)	NAG HAMMADI (000 LE)
1. CIVIL WORKS											
MOBILIZATION	74	244	1,124	1,368	1,505	336	3,274	3,610	3,610	3,610	
GEOTECHNICAL INVESTIGATION	105	348	490	838	922	478	1,428	1,906	1,906	1,906	
COFFER DAM & DIVERSION	3,702	12,290	3,371	15,661	17,227	16,902	9,819	26,721	26,721	20,041	[illegible]
EARTHWORK	5,945	19,736	19,500	39,236	43,160	27,142	56,806	83,948	90,245	67,683	[illegible]
ROADS	237	786	553	1,339	1,473	1,081	1,612	2,693	2,693	2,020	2,
NAVIGATION LOCK	5,644	18,740	6,901	25,640	28,204	25,772	20,102	45,874	45,874	45,874	
POWER PLANT STRUCTURE	8,932	29,653	8,932	38,584	42,443	40,780	26,020	66,800	0	0	
SPILLWAY & RELATED STRUC	5,300	17,595	7,667	25,262	27,789	24,198	22,335	46,533	46,533	34,900	[illegible]
CLOUSURE DAMS	1,262	4,190	4,045	8,235	9,059	5,763	11,782	17,545	18,861	14,146	
DIAPHRAGM WALL	2,499	8,295	2,961	11,256	12,381	11,408	8,625	20,033	20,033	15,024	
FOUNDATION TREATMENT	3,714	12,330	1,904	14,234	15,657	16,957	5,546	22,503	22,503	16,877	
BUILDINGS	59	195	370	565	622	269	1,077	1,346	1,346	1,010	
MISC. WORK ITEMS	731	2,425	4,516	6,941	7,635	3,336	13,151	16,487	16,487	12,365	1
SUBTOTAL	38,201	126,828	62,332	189,160	208,076	174,422	181,578	356,000	296,812	235,457	[illegible]
2. MECHANICAL WORKS											
GATES, STOPLOGS AND TRASH RACKS	7,274	24,151	9,432	33,582	36,940	30,194	27,956	58,150	38,961	29,221	19,1
MONITORING EQUIP	271	900	234	1,133	1,246	1,125	692	1,817	1,817	1,363	[illegible]
AUXILIARY MECH EQUIP	2,874	9,542	628	10,170	11,187	11,930	1,868	13,798	6,899	5,174	[illegible]
HANDLING EQUIPMENT	3,829	12,711	957	13,667	15,034	15,892	2,835	18,727	9,363	7,023	4,
LOCK & POWER PLANT EQUIP	4,580	15,205	576	15,781	17,359	19,010	1,706	20,716	10,358	7,769	
POWER GENERATING UNITS	35,5[illegible]	151,115	4,813	155,928	171,520	188,929	14,259	203,188	0	0	
132 KV TRANSMISSION LINE	897	2,977	402	3,379	3,717	3,722	1,193	4,915	0	0	
TRANSFORMERS & SWITCHGEARS	3,714	12,329	886	13,215	14,537	15,415	2,625	18,040	0	0	
SUBTOTAL	58,977	228,930	17,926	246,855	271,541	286,216	53,134	339,350	67,398	50,548	29,1
3. ENGINEERING & COSNST. MGMNT							0	22,990	36,420	28,600	[illegible]
4. OVERHEAD & PROFIT	18,557	61,610	0	61,610	67,771	84,730	0	84,730	38,573	28,930	29,600
SUBTOTAL	115,736	417,368	80,257	497,626	547,388	545,368	234,712	803,070	439,200	343,535	337,675
5. CONTINGENCY								17,930	49,800	40,465	39,825
TOTAL COST								821,000	489,000	384,000	377,500
SPECIFIC COST OF POWER								303,300	0	0	0
JOINT COSTS								517,700	489,000	384,000	377,500

Table C 2.3
Estimated Cost of Replacement of Large Canal Structures

Descriptions	Number	Discharge m3/sec	Cost/ m3/sec (000)L.E.	Span Meter	Cost/ Meter (000)L.E.	Total Cost (000) LE
Intake Regulator	39	85	50	-	-	165,750
	50	60	40	-	-	120,000
Head Regulator	110	45	30	-	-	148,500
Other Structures	36	45	25	-	-	40,500
Bridges	978	-	-	40	13	489,000
Subtotal						963,750
Contingency						192,750
Total						1,156,500
Cost/Feddan						149

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Table C 2.4
Estimated Unit Cost of Drain Structures (LE)
Sample Area

CONTRACT				IMPLEMENTATION										
NO	NAME	EXECUTION DATE	AMOUNT	FY 1983/84	FY 1984/85	FY 1985/86	FY 1986/87	FY 1987/88	FY 1988/89	FY 1989/90	FY 1990/91	DEC 1991	DEC 1992	
1	STRUCTURES ON UPPER UMOM BEHERA (KM 16 TO OUTFALL)	10/22/83 02/21/85	420,000	210,000	210,000									
2	STRUCTURES ON ABDEL RAHMAN DRAIN AND ITS BRANCHES	09/15/85 06/14/87	620,000			217,000	403,000							
3	PILE BRIDGES ON ABDEL RAHMAN DRAIN & ITS BRANCHES	09/19/85 07/14/87	850,000			297,500	552,500							
4	STRUCTURES ON BRANCHES OF BASHMOUR DRAIN	06/14/86 05/14/88	350,000				175,000	175,000						
5	OUTFALLS OF RIGHT BANK BRANCHES OF LOWER SERO DRAIN	01/12/86 07/30/88	679,000				169,750	509,250						
6	STRUCTURES ON HEDODA AND KAFR-KANEESH DRAINS	10/01/88 03/31/90	412,000						164,800	247,200				
7	STRUCTURES ON RIGHT BANK BRANCHES OF LOWER SERO DRAIN	01/01/89 06/30/91	653,000						97,950	293,850	261,200			
8	STRUCTURES ON IYRAD AND TIL-BELAH DRAINS	11/25/91 11/24/92	402,000									20,100	381,900	
	TOTAL		4,386,000	210,000	210,000	514,500	1,300,250	684,250	262,750	541,050	261,200	20,100	381,900	4,386,000
	ADJUSTMENT FACTORS			3.52	3.14	2.76	2.52	2.13	1.75	1.44	1.17	1.00	0.85	
	DECEMBER 1991 PRICES			738,511	660,019	1,421,098	3,270,452	1,456,273	460,168	777,483	305,731	20,100	326,030	9,435,773
	AREA (fd)													87,700
	COST/ FEDDAN INCLUDING CONTINGENCY (LE)													130

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Table C 2.5
Estimated Cost and Schedule of Replacement of Open Drain Structures

YEAR	EXECUTED AREA (FD)	STRUCTURE REPLACEMENT YEAR	ESTIMATED COST (000) L.E.
1972	150,000	2002	19,500
1973	150,000	2003	19,500
1974	150,000	2004	19,500
1975	150,000	2005	19,500
1976	200,000	2006	26,000
1977	200,000	2007	26,000
1978	220,000	2008	28,600
1979	230,000	2009	29,900
1980	230,000	2010	29,900
1981	240,000	2011	31,200
1982	250,000	2012	32,500
1983	250,000	2013	32,500
1984	250,000	2014	32,500
1985	250,000	2015	32,500
1986	250,000	2016	32,500
1987	240,000	2017	31,200
1988	230,000	2018	29,900
1989	220,000	2019	28,600
1990	200,000	2020	26,000
1991	170,000	2021	22,100
1992	150,000	2022	19,500
1993	150,000	2023	19,500
TOTAL	4,530,000		588,900

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Table C2.6
Scenario 2: Capital Costs Summary

DESCRIPTIONS	ANNUAL COSTS (000)LE
1 - STRUCTURAL REPLACEMENTS	
REPLACEMENT OF NAG HAMMADI BARRAGE	33,373
REPLACEMENT OF ASSUIT BARRAGE	21,109
REPLACEMENT OF ZIFTA BARRAGE	11,741
STRENGTHENING OF NILE INTAKES & BARRAGES	4,616
ESNA BARRAGE (COMMON WORKS)	37,633
ESNA BARRAGE (ELECTRICAL WORKS)	30,462
OPEN DRAIN IMPROVEMENTS & REPLACEMENTS	15,096
REPLACEMENT OF SMALL STRUCTURES	28,304
REPLACEMENT OF LARGE STRUCTURES	15,918
SUBTOTAL	198,250
2 - REHABILITATION OF PUMP STATIONS	
REHABILITATIONS & REPLACEMENTS	106,597
SUBTOTAL	106,597
3 - GENERAL IMPROVEMENTS	
HIGH ASWAN DAM COMPLEX	18,224
NILE WINTER CLOSURE	10,867
WATER MASTER PLAN	2,967
NILE WATER TECHNICAL COMMISSION	2,900
MPWWR HEADQUARTERS BUILDING	1,356
MAIN SYSTEM MANAGEMENT (TELEMTRY)	4,887
WATER RESEARCH CENTER (1)	34,868
FLUSH FLOOD PROTECTION	3,693
PROFESSIONAL DEVELOPMENT PROJECT	1,248
PROJECT PREPARATION	1,402
RIVER BANK PROTECTION	27,733
RIVER TRAINING	1,579
REUSE OF DRAINAGE WATER	2,736
GROUNDWATER WELLS	2,348
IMPROEMENTS OF MAIN IRRIGATION SYSTEM	37,553
IMPROVING IRRIGATION METHODS	2,710
SUBTOTAL	157,070
TOTAL CAPITAL COSTS	**461,918**

NOTE : (1) INCLUDES ANNUAL COST OF EXPECTED GRANTS

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Table C2.7
Delivery Cost of Channel Maintenance Equipment

DESCRIPTION	ESTIMATED UNIT PRICE CIF US $	ESTIMATED UNIT PRICE CIF L.E.	CLEARING & TRANSPORT COST L.E.	DELIVERY COST L.E.	ECONOMIC LIFE HOURS	DELIVERY COST/HOUR L.E.
HYD.EXCAVATOR 1 CY,153 HP	110,000	364,100	18,205	382,305	10,450	37
TRACTOR 90 HP.W/HYD.ATTACH.	28,000	92,680	4,634	97,314	10,000	10
CRAWLER TRACTOR 120 HP	56,000	185,360	9,268	194,628	9,370	21
FRONT END LOADER 115 HP	60,000	198,600	9,930	208,530	9,600	22
MOTOR GRADER 12'MB,135 HP	110,000	364,100	18,205	382,305	13,850	28
BACKHOE LOADER 65 HP	32,000	105,920	5,296	111,216	7,100	16
PICKUP,3/4 T.DIESEL 75 HP	17,000	56,270	2,814	59,084	7,000	8
TRUCK,DUMP 7.5 MC.275 HP	65,000	215,150	10,758	225,908	9,800	23
TRUCK,F/W.BOOM 8 T.250 HP	83,000	274,730	13,737	288,467	10,350	28
TRUCK,FLATBED 2-4 T.175 HP	21,500	71,165	3,558	74,723	9,750	8
TRUCK,FLATBED 8 T.195 HP	41,000	135,710	6,786	142,496	9,750	15
TRUCK,LUBRICATION 210 HP	75,000	248,250	12,413	260,663	10,000	26
TRUCK,MECHANIC 175 HP	55,000	182,050	9,103	191,153	9,750	20
TRUCK TRACTOR	110,000	364,100	18,205	382,305	9,300	41
TRAILER 30 T.	30,000	99,300	4,965	104,265	8,800	12
CRANE,HYDR. 25 T.250 HP	180,000	595,800	29,790	625,590	13,515	46
AIR COMPRESSORS 185 CFM	15,000	49,650	2,483	52,133	10,250	5
GENERATORS 60 KW	25,000	82,750	4,138	86,888	10,500	8
WATER PUMP, 4"	26,000	86,060	4,303	90,363	4,500	20
WELDERS 250 AMP,28 HP	7,500	24,825	1,241	26,066	6,200	4
CONCRETE EQUIPMENT	1,100	3,641	182	3,823	3,500	1
FLOATING EXCAVATOR	350,000	1,158,500	57,925	1,216,425	13,200	92
WEED HARVESTERS 20 MC.	250,000	827,500	41,375	868,875	12,000	72
WEED HARVESTERS 10-15 MC.	145,000	479,950	23,998	503,948	13,200	38
BARGE,SELF PROP.& UNLOAD.	350,000	1,158,500	57,925	1,216,425	13,200	92
MOWING BOAT	45,000	148,950	7,448	156,398	11,314	14

* 1991 PRICES.

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Table C2.8
Norms For Calculation of Equipment Net Operating Hours/Year (Full Time Unit)

TOTAL HOURS / DAY	10.00
EQUIPMENT HOURS/DAY	9.00
EQUIPMENT EFFICIANCY	0.85
OPERATOR EFFICIANCY	0.85
IGNORANCE FACTOR	0.90
WORK EFFICIANCY	0.65
OFFICIAL HOLIDAYS / YEAR	16.00
FRIDAYS / YEAR	52.00
ANNUAL LEAVE	37.00
EQUIPMENT NET OPERATING HRS/DAY	5.85
NET WORKING DAYS/YEAR	260.00
EQUIPMENT NET OPERATING HRS/YEAR	1,521.59

Rates

CLEARING & TRANSPORT (%)	0.05
DELIVERY COST FACTOR	1.05
EXCHANGE RATE OF US $1.00 TO L.E.	3.31
INTEREST RATE (%)	0.09
INSURANCE RATE	0.00
TAX RATE	0.00

Table C2.9
Estimated O&M Costs of Equipment Used for Maintenance of Channels With Bed Width > 2 Meters

DESCRIPTION	OPER. HOUR/ KM.	FUEL/ HOUR L.E.	LUB/ HOUR L.E.	PARTS/ HOUR L.E.	TIRE/ HOUR L.E.	OPR'R/ HOUR L.E.	MECH/ HOUR L.E.	FUEL/LUB COST LE/HR	PARTS & TIRE LE/HR	LABOR COST LE/HR	TOTAL O&M COST LE/HR
ONE FLEET MIX :											
HYD.EXCAVATOR 1 CY,153 HP	20.00	4.35	3.69	20.06	0.00	2.14	1.07	8.04	20.06	3.21	26.10
CRAWLER TRACTOR 120 HP	2.00	5.86	3.66	19.86	0.00	2.14	1.07	9.52	19.86	6.41	29.38
FRONT END LOADER 115 HP	0.75	4.29	2.64	6.69	4.14	2.14	1.07	6.93	10.83	4.01	17.76
MOTOR GRADER 12MB,135 HP	1.25	5.96	3.89	15.52	4.47	2.14	1.07	9.85	19.99	4.01	29.84
PICKUP,3/4 T.DIESEL 75 HP	2.00	1.05	0.49	2.45	0.86	2.14	1.07	1.54	3.31	6.41	4.85
TRUCK,DUMP 7.5 MC.275 HP	2.25	8.98	3.22	10.82	5.63	2.14	1.07	12.20	16.45	7.21	28.65
TRUCK,LUBRICATION 210 HP	5.00	8.07	2.55	21.02	9.20	2.14	1.07	10.62	30.22	16.03	40.84
TRUCK,MECHANIC 175 HP	5.00	4.00	1.57	4.80	2.52	2.14	1.07	5.57	7.32	16.03	12.89
TRUCK TRACTOR	1.00	9.35	2.67	20.82	8.77	2.14	1.07	12.02	29.59	3.21	41.61
TRAILER 30 T.	1.00	0.00	0.35	1.80	0.80	0.00	1.07	0.35	2.60	1.07	2.95

BEST AVAILABLE DOCUMENT

Table C2.10
Estimated O&M Costs of Equipment Used for Maintenance of Channels With Bed Width < 2 Meters

DESCRIPTION	OPER. HOUR/ KM.	FUEL/ HOUR L.E.	LUB/ HOUR L.E.	PARTS/ HOUR L.E.	TIRE/ HOUR L.E.	OPR'R/ HOUR L.E.	MECH/ HOUR L.E.	FUEL/LUB COST LE/HR	PARTS & TIRE LE/HR	LABOR COST LE/HR	TOTAL O&M COST LE/HR
ONE FLEET MIX :											
TRACTOR 90 HP.W/HYD.ATTACH.	14.71	1.80	0.27	9.66	0.00	2.14	1.07	2.07	9.66	3.21	11.73
CRAWLER TRACTOR 70 HP	2.00	3.41	1.92	9.43	0.00	2.14	1.07	5.33	9.43	3.21	14.76
[illegible]	0.75	4.29	2.64	6.69	4.14	2.14	1.07	6.93	10.83	3.21	17.76
[illegible] HP	1.25	5.96	3.89	15.52	4.47	2.14	1.07	9.85	19.99	3.21	29.84
[illegible]	1.50	1.05	0.49	2.45	0.86	2.14	1.07	1.54	3.31	3.21	4.85
[illegible]	2.25	8.98	3.22	10.82	5.63	2.14	1.07	12.20	16.45	3.21	28.65
[illegible]	2.00	8.07	2.55	21.02	9.20	2.14	1.07	10.62	30.22	3.21	40.84
[illegible]	3.00	4.00	1.5[illegible]	4.80	2.52	2.14	1.07	5.57	7.32	3.21	12.89
[illegible]	0.50	9.35	2.67	20.82	8.77	2.14	1.07	12.02	29.59	3.21	41.61
[illegible]	0.50	0.00	0.35	[illegible]	0.80	0.00	1.07	0.35	2.60	1.07	2.95

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Table C2.11
Estimated Cost of Owning and Operating Channel Maintenance Equipment
(For Channels With Bed Width > 2 Meters)

DESCRIPTION	DELIVERY COST L.E.	AVAIL. HRS/YR. HOURS	ECON. LIFE YEARS (N)	N+1 / 2N	INTEREST COST/HR L.E. (A)	DELIVERY COST/HR L.E. (B)	OWNING CST/HR L.E. T1	O & M COST/HR L.E. T2	LABOR COST/HR L.E. T3	TOTAL COST/HR L.E. T
ONE FLEET MIX :										
HYD.EXCAVATOR 1 CY,153 HP	382,305	1,521	7	0.57	12.96	36.58	49.54	28.10	3.21	
CRAWLER TRACTOR 120 HP	194,628	1,521	6	0.58	6.60	20.77	27.37	29.38	3.21	
FRONT END LOADER 115 HP	208,530	1,521	6	0.58	7.07	21.72	28.79	17.76	3.21	
MOTOR GRADER 12'MB,135 HP	382,305	1,521	9	0.55	12.96	27.60	40.56	29.84	3.21	
PICKUP,3/4 T.DIESEL 75 HP	59,084	1,521	5	0.61	2.00	8.44	10.44	4.85	3.21	
TRUCK,DUMP 7.5 MC.275 HP	225,908	1,521	6	0.58	7.66	23.05	30.71	28.65	3.21	
TRUCK,LUBRICATION 210 HP	260,663	1,521	7	0.58	8.83	26.07	34.90	40.84	3.21	
TRUCK,MECHANIC 175 HP	191,153	1,521	6	0.58	6.48	19.61	26.08	12.89	3.21	
TRUCK TRACTOR	382,305	1,521	6	0.58	12.96	41.11	54.07	41.61	3.21	
TRAILER 30 T.	104,265	1,521	6	0.59	3.53	11.85	15.38	2.95	1.07	

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Table C2.12
Estimated Cost of Owning and Operating Channel Maintenance Equipment
(For Channels With Bed Width < 2 Meters)

DESCRIPTION	DELIVERY COST L.E.	AVAIL. HRS/YR. HOURS	ECON. LIFE YEARS	N+1 — 2N	INTEREST COST/HR L.E.	DELIVERY COST/HR L.E.	OWNING CST/HR L.E.	O & M COST/HR L.E.	LABOR COST/HR L.E.	TOTAL COST/HR L.E.
			(N)		(A)	(B)	T1	T2	T3	T
ONE FLEET MIX :										
TRACTOR 90 HP.W/HYD.ATTACH.	97,314	1,521	7	0.58	3.32	9.73	13.05	11.73	3.21	27.98
CRAWLER TRACTOR 70 HP	194,628	1,521	6	0.58	6.69	20.77	27.46	14.76	3.21	45.43
FRONT END LOADER 115 HP	208,530	1,521	6	0.58	7.15	21.72	28.87	17.76	3.21	49.83
MOTOR GRADER 12MB,135 HP	382,305	1,521	9	0.55	12.55	27.60	40.16	29.84	3.21	73.20
PICKUP,3/4 T.DIESEL 75 HP	59,084	1,521	5	0.61	2.13	8.44	10.57	4.85	3.21	18.62
TRUCK,DUMP 7.5 MC.275 HP	225,908	1,521	6	0.58	7.72	23.05	30.77	28.65	3.21	62.63
TRUCK,LUBRICATION 210 HP	260,663	1,521	7	0.58	8.88	26.07	34.95	40.84	3.21	79.00
TRUCK,MECHANIC 175 HP	191,153	1,521	6	0.58	6.54	19.61	26.14	12.89	3.21	42.24
TRUCK TRACTOR	382,305	1,521	6	0.58	13.16	41.11	54.27	41.61	3.21	99.08
TRAILER 30 T.	104,265	1,521	6	0.59	3.62	11.85	15.47	2.95	1.07	19.48

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Table C2.13
Annual Cost of Channel Maintenance
(Bed Width > 2 Meters)

DESCRIPTION	OPER. HRS/KM	OPER. HRS/DAY	OPER. HRS/YR	UNITS/ 1 MIX/ KM.	TOTAL UNITS	TOTAL HRS/YEAR	UNIT O & M LE/HR.	UNIT LABOR LE/HR.	OWNING CST/HR L.E.	UNIT TOTAL L.E./HR.	TOTAL EQUIPMENT L.E./YEAR
ONE FLEET MIX :											
HYD.EXCAVATOR 1 CY,153 HP	20.00	5.85	1,521	1.00	897	1,364,337	28.09	3.21	49.54	80.83	110,282,195
CRAWLER TRACTOR 120 HP	2.00	0.59	152	0.10	90	13,643	29.38	3.21	27.37	140.78	1,920,751
FRONT END LOADER 115 HP	0.75	0.22	57	0.04	34	1,919	17.76	3.21	28.79	109.70	210,476
MOTOR GRADER 12MB,135 HP	1.25	0.37	95	0.06	56	5,329	29.84	3.21	40.56	123.35	657,404
PICKUP,3/4 T.DIESEL 75 HP	2.00	0.59	152	0.10	90	13,643	34.69	3.21	10.44	121.94	1,663,653
TRUCK,DUMP 7.5 MC.275 HP	2.25	0.66	171	0.11	101	17,267	28.65	3.21	30.71	110.90	1,914,923
TRUCK,LUBRICATION 210 HP	5.00	1.46	380	0.25	224	85,271	40.84	3.21	24.90	141.50	12,066,162
TRUCK,MECHANIC 175 HP	5.00	1.46	380	0.25	224	85,271	12.89	3.21	26.08	121.12	10,328,003
TRUCK TRACTOR	1.00	0.29	76	0.05	45	3,411	41.61	3.21	54.06	141.05	481,109
TRAILER 30 T.	1.00	0.29	76	0.05	45	3,411	2.95	1.07	15.38	118.28	403,418
SUBTOTAL											139,928,093
CONTINGENCY											13,992,809
TOTAL											153,920,903

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Table C2.14
Annual Cost of Channel Maintenance
(Bed Width < 2 Meters)

DESCRIPTION	OPER. HRS/KM	OPER. HRS/DAY	OPER. HRS/YR	UNITS/ 1 MIX/ KM	TOTAL UNITS	TOTAL HRS/YEAR	UNIT O & M LE/HR.	UNIT LABOR LE/HR.	OWNING CST/HR L.E.	UNIT TOTAL L.E./HR.	TOTAL EQUIPMENT L.E./YEAR
ONE FLEET MIX :											
TRACTOR 90 HP.W/HYD.ATTACH.	14.71	5.85	1,521	1.00	582	885,222	11.37	3.21	13.38	27.96	24,746,495
CRAWLER TRACTOR 70 HP	2.00	0.80	207	0.14	79	16,364	29.38	3.21	27.37	87.91	1,438,481
FRONT END LOADER 115 HP	0.75	0.30	78	0.05	30	2,301	17.76	3.21	28.79	109.70	252,445
MOTOR GRADER 12'MB,135 HP	1.25	0.50	129	0.08	49	6,392	29.84	3.21	40.56	123.35	788,492
PICKUP,3/4 T.DIESEL 75 HP	1.50	0.60	155	0.10	59	9,205	34.69	3.21	10.44	121.94	1,122,407
TRUCK,DUMP 7.5 MC.275 HP	2.50	0.99	258	0.17	99	25,569	28.65	3.21	30.71	110.90	2,835,512
TRUCK,LUBRICATION 210 HP	2.00	0.80	207	0.14	79	16,364	40.84	3.21	34.90	141.50	2,315,551
TRUCK,MECHANIC 175 HP	2.00	0.80	207	0.14	79	16,364	12.89	3.21	26.08	121.12	1,981,990
TRUCK TRACTOR	0.50	0.20	52	0.03	20	1,023	41.61	3.21	54.06	141.05	144,261
TRAILER 30 T.	0.50	0.20	52	0.03	20	1,023	2.95	1.07	15.38	118.28	120,965
SUBTOTAL											35,746,599
CONTINGENCY											3,574,660
TOTAL											39,321,259

BEST AVAILABLE DOCUMENT

Table C2.15 Norms For Calculation of Support Equipment Net Operating Hours/Year (Full Time Unit)

TOTAL HOURS / DAY	10.00
EQUIPMENT HOURS/DAY	9.00
EQUIPMENT EFFICIANCY	0.90
OPERATOR EFFICIANCY	0.90
IGNORANCE FACTOR	0.90
WORK EFFICIANCY	0.73
OFFICIAL HOLIDAYS/YEAR	16.00
FRIDAYS / YEAR	52.00
ANNUAL LEAVE	37.00
EQUIPMENT NET OPER.HRS/DAY	6.56
NET WORK DAYS/YEAR	260.00
EQUIPMENT NET OPERATING HRS/YEAR	1,705.86

Rates

CLEARING & TRANSPORT (%)	0.05
DELIVERY COST FACTOR	1.05
EXCHANGE RATE OF US$ 1 TO L.E.	3.31
INTEREST RATE	0.09
INSURANCE RATE	0.00
TAX RATE	0.00

Table C2.16
Estimated O&M Cost of
Support Maintenance Equipment

DESCRIPTION	OPER. HRS/YR HOURS	FUEL/ HOUR L.E.	LUB/ HOUR L.E.	PARTS/ HOUR L.E.	TIRE/ HOUR L.E.	OPR'R/ HOUR L.E.	MECH/ HOUR L.E.	FUEL/LUB COST/YR L.E.	PARTS/TIRE COST/YR L.E.	LABOR COST/YR L.E.	O&M COST/YR L.E.	TOTAL COST/YR L.E.
BACKHOE LOADER 65 HP	1,170	2.94	1.63	5.96	1.66	2.14	1.07	5,347	8,915	3,750	14,262	18,012
PICKUP,3/4 T.DIESEL 75 HP	520	1.05	0.49	2.45	0.86	2.14	1.07	801	1,721	1,667	2,522	4,189
TRUCK,DUMP 7.5 MC.275 HP	600	8.98	3.22	10.82	5.63	2.14	1.07	7,320	9,870	1,923	17,190	19,113
TRUCK,F/W.BOOM 8 T.250 HP	600	5.71	2.09	7.08	3.49	2.14	1.07	4,680	6,342	1,923	11,022	12,945
TRUCK,FLATBED 2-4 T.175 HP	480	4.00	1.42	4.57	2.52	2.14	1.07	2,602	3,403	1,538	6,005	7,543
TRUCK,FLATBED 8 T.195 HP	480	4.45	1.86	4.93	2.71	2.14	1.07	3,029	3,667	1,538	6,696	8,234
TRUCK,LUBRICATION 210 HP	1,300	8.07	2.55	21.02	9.20	2.14	1.07	13,806	39,286	4,167	53,092	57,259
TRUCK,MECHANIC 175 HP	1,300	4.00	1.57	4.80	2.52	2.14	1.07	7,241	9,516	4,167	16,757	20,924
CRANE,HYDR. 25 T.250 HP	480	11.03	4.09	20.59	7.48	2.14	1.07	7,258	13,474	1,538	20,731	22,270
AIR COMPRESSORS 185 CFM	450	1.70	1.31	4.81	0.17	2.14	1.07	1,355	2,241	1,442	3,596	5,038
GENERATORS 60 KW	360	5.38	1.42	3.11	0.17	2.14	1.07	2,448	1,181	1,154	3,629	4,783
WATER PUMP, 4"	360	3.12	0.51	2.78	0.00	2.14	1.07	1,307	1,001	1,154	2,308	3,461
WELDERS 250 AMP,28 HP	450	3.16	1.02	2.22	0.17	2.14	1.07	1,881	1,076	1,442	2,957	4,399
CONCRETE EQUIPMENT	360	0.20	0.02	0.50	0.00	2.14	1.07	79	180	1,154	259	1,413

Table C2.17
Estimated Cost of Owning & Operating Maintenance Support Equipment Per Fleet

DESCRIPTION	DELIVERY COST L.E.	ECON. LIFE YEARS N	N+1 — 2N	INTEREST COST/YR L.E. (A)	DELIVERY COST/YR L.E. (B)	OWNING COST/YR L.E. T1	O & M COST/YR L.E. T2	LABOR COST/YR L.E. T3	ONE FLEET COST/YR L.E. T
BACKHOE LOADER 65 HP	111,216	4	0.62	6,207	26,721	32,928	14,262	3,750	50,940
PICKUP,3/4 T.DIESEL 75 HP	59,084	4	0.62	3,307	14,398	17,705	2,522	1,667	21,894
TRUCK,DUMP 7.5 MC.275 HP	225,908	6	0.59	11,935	39,323	51,258	17,190	1,923	70,372
TRUCK,F/W.BOOM 8 T.250 HP	288,467	6	0.56	15,120	47,544	62,665	11,022	1,923	75,610
TRUCK,FLATBED 2-4 T.175 HP	74,723	6	0.59	3,951	13,074	17,024	6,005	1,538	24,568
TRUCK,FLATBED 8 T.195 HP	142,496	6	0.59	7,534	24,931	32,465	6,696	1,538	40,700
TRUCK,LUBRICATION 210 HP	260,663	6	0.59	13,731	44,465	58,196	53,092	4,167	115,455
TRUCK,MECHANIC 175 HP	191,153	6	0.59	10,107	33,444	43,551	16,757	4,167	64,475
CRANE,HYDR. 25 T.250 HP	625,590	8	0.56	31,705	78,962	110,667	20,731	1,538	132,936
AIR COMPRESSORS 185 CFM	52,133	6	0.58	2,736	8,676	11,413	3,596	1,442	16,450
GENERATORS 60 KW	86,888	6	0.58	4,545	14,116	18,661	3,629	1,154	23,444
WATER PUMP, 4"	90,363	3	0.69	5,608	34,255	39,863	2,308	1,154	43,324
WELDERS 250 AMP,28 HP	26,066	4	0.64	1,496	7,172	8,668	2,957	1,442	13,066
CONCRETE EQUIPMENT	3,823	2	0.74	256	1,863	2,119	259	1,154	3,532
TOTAL									696,765

Table C2.18
Estimated Cost of Owning & Operating Maintenance Support Equipment Per Year

DESCRIPTION	NO. OF DIREC.	NO OF EQUIP PER DIREC.	NO OF EQUIP TOTAL	UNIT COST PER YEAR	TOTAL COST PER YEAR
BACKHOE LOADER 65 HP	24	2	48	50,940	2,445,141
PICKUP,3/4 T.DIESEL 75 HP	24	2	48	21,894	1,050,896
TRUCK,DUMP 7.5 MC.275 HP	24	1	24	70,372	1,688,918
TRUCK,F/W.BOOM 8 T.250 HP	24	2	48	75,610	3,629,273
TRUCK,FLATBED 2-4 T.175 HP	24	2	48	24,568	1,179,250
TRUCK,FLATBED 8 T.195 HP	24	2	48	40,700	1,953,584
TRUCK,LUBRICATION 210 HP	24	1	24	115,455	2,770,915
TRUCK,MECHANIC 175 HP	24	1	24	64,475	1,547,389
CRANE,HYDR. 25 T.250 HP	24	1	24	132,936	3,190,471
AIR COMPRESSORS 185 CFM	24	2	48	16,450	789,618
GENERATORS 60 KW	24	2	48	23,444	1,125,302
WATER PUMP, 4"	24	2	48	43,324	2,079,555
WELDERS 250 AMP,28 HP	24	1	24	13,066	313,593
CONCRETE EQUIPMENT	24	2	48	3,532	169,548
SUBTOTAL					23,933,452
CONTINGENCY					2,393,345
TOTAL					26,326,797

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Table C2.19
Estimated O&M Cost of
Equipment for Nile River Weed Control

DESCRIPTION	OPER. HOUR/ YEAR	FUEL/ HOUR L.E.	LUB/ HOUR L.E.	PARTS/ HOUR L.E.	TIRE/ HOUR L.E.	OPR'R/ HOUR L.E.	MECH/ HOUR L.E.	FUEL/LUB COST/YEAR LE	PARTS/TIRE COST/YEAR LE	LABOR COST/YEAR LE	O & M COST/YEAR LE	TOTAL COST/YEAR LE
CRAWLER TRACTOR 120 HP	351	5.86	3.66	19.86	0.00	2.14	1.07	3,342	6,971	1,125	10,312	11,437
FRONT END LOADER 115 HP	300	4.29	2.64	6.69	4.14	2.14	1.07	2,079	3,249	962	5,328	6,290
PICKUP,3/4 T.DIESEL 75 HP	300	1.05	0.49	2.45	0.86	2.14	1.07	462	993	962	1,455	2,417
TRUCK,DUMP 7.5 MC.275 HP	420	8.98	3.22	10.82	5.63	2.14	1.07	5,124	6,909	1,346	12,033	13,379
TRUCK,LUBRICATION 210 HP	260	8.07	2.55	21.02	9.20	2.14	1.07	2,761	7,857	833	10,618	11,452
TRUCK,MECHANIC 175 HP	520	4.00	1.57	4.80	2.52	2.14	1.07	2,896	3,806	1,667	6,703	8,369
FLOATING EXCAVATOR	960	10.02	4.79	15.42	0.00	2.14	1.07	14,218	14,803	3,077	29,021	32,098
WEED HARVESTERS	1,200	11.88	6.93	44.29	0.00	2.14	1.07	22,572	53,148	3,846	75,720	79,566
TUG BOAT	960	11.86	4.67	11.82	0.00	2.14	1.07	15,869	11,347	3,077	27,216	30,293

Table C2.20
Estimated Cost of Owning & Operating Nile River Weed Control Equipment Per Year

DESCRIPTION	DELIVERY COST L.E.	EXPECTED HRS/YEAR HOURS	AVAIL. HRS/YR HOURS	ECON. LIFE YEARS (N)	N+1 — 2N	INTEREST COST/YEAR L.E. (A)	DELIVERY COST/YEAR L.E. (B)	OWNING COST/YEAR L.E. T1	O & M COST/YEAR L.E. T2	LABOR COST/YEAR L.E. T3	TOTAL COST/YEAR L.E. T
CRAWLER TRACTOR 120 HP	194,628	351.00	1521	6	0.58	10,180	31,593	41,773	10,312	1,125	53,211
FRONT END LOADER 115 HP	208,530	300.00	1521	6	0.58	10,871	33,039	43,910	5,328	962	50,199
PICKUP,3/4 T.DIESEL 75 HP	59,084	300.00	1521	5	0.61	3,236	12,838	16,074	1,455	962	18,491
TRUCK,DUMP 7.5 MC.275 HP	225,908	420.00	1521	6	0.58	11,744	35,062	46,805	12,033	1,346	60,185
TRUCK,LUBRICATION 210 HP	260,663	260.00	1521	7	0.58	13,514	39,647	53,161	10,618	833	64,612
TRUCK,MECHANIC 175 HP	191,153	520.00	1521	6	0.58	9,944	29,820	39,764	6,703	1,667	48,133
FLOATING EXCAVATOR	1,216,425	960.00	1521	9	0.56	61,047	140,165	201,212	29,021	3,077	233,310
WEED HARVESTERS	868,875	1,200.00	1521	8	0.56	44,055	110,130	154,185	75,720	3,846	233,751
TUG BOAT	1,216,425	960.00	1521	10	0.55	60,290	123,345	183,635	27,216	3,077	213,928
COST/ YEAR / BARRAGE											975,820
COST / YEAR - SIX BARRAGES											5,854,918
CONTINGENCY											585,492
TOTAL COST / YEAR - SIX (6) BARRAGES											6,440,410

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Table C 2.21
Scenario 2: Annual Costs Summary (LE)
By Agency

AGENCY	OPERATION & MAINTENANCE COSTS			CAPITAL COSTS	TOTAL COSTS	PERCENT
	PERSONNEL	NON-PERSONNEL	TOTAL			
IRRIGATION DEPARTMENT	61,532,403	207,186,652	268,719,055	304,398,140	573,117,196	59.1
MECHANICAL & ELECTRICAL DEPARTMENT	37,326,553	82,488,580	119,815,134	106,597,086	226,412,220	23.4
PUBLIC AUTHORITY FOR DRAINAGE PROJECTS	6,272,030	72,318,945	78,590,976	17,831,096	96,422,072	10.0
HIGH ASWAN DAM AUTHORITY	14,703,641	18,223,734	32,927,375	18,223,734	51,151,109	5.3
WATER RESEARCH CENTER	6,434,724	638,752	7,073,477	14,868,009	21,941,436	2.3
TOTAL	126,269,352	380,856,664	507,126,017	461,918,065	969,044,082	100.0

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Table C2.22
Scenarios 1 & 2 - Comparison of Annual Costs (LE)
By Activity

DESCRIPTIONS	SCENARIO 1	SCENARIO 2	2 / 1 %
OPERATION & MAINTENANCE COSTS			
PERSONNEL	120,198,469	126,269,352	105
NON-PERSONNEL	241,926,321	380,856,664	157
SUBTOTAL	362,124,790	507,126,017	140
CAPITAL COSTS			
STRUCTURAL REPLACEMENTS	96,656,198	198,250,538	205
PUMP STATION REHAB. & REPLACEMENT	52,468,985	106,597,086	203
GENERAL IMPROVEMENTS	93,853,810	157,070,441	167
SUBTOTAL	242,978,993	461,918,065	190
TOTAL COSTS	605,103,783	969,044,082	160

Appendix D

Cost Tables for Cost Allocation Model Input

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Table D1.1
Scenario 1: Annual Costs Summary (LE)

GROUP	OPERATION & MAINTENANCE COSTS			CAPITAL COSTS	TOTAL COSTS	PERCENT
	PERSONNEL	NON-PERSONNEL	TOTAL			
A - MAIN STEM						
HIGH ASWAN DAM	14,003,468	14,343,419	28,346,887	20,039,451	48,386,337	8.00
BARRAGES & STEM	10,768,609	3,212,485	13,981,094	79,962,499	93,943,593	15.53
OTHER STEM COSTS	0	0	0	2,800,865	2,800,865	0.46
TOTAL - MAIN STEM	24,772,077	17,555,904	42,327,981	102,802,815	145,130,795	23.98
B - PUMP STATIONS	35,549,098	94,307,265	129,856,363	52,468,985	182,325,348	30.13
C - OPEN DRAINAGE SYSTEM	5,973,362	7,875,715	13,849,078	21,238,658	35,087,735	5.80
D - MAIN IRRIGATION SYSTEM	53,903,932	122,187,437	176,091,368	66,468,536	242,559,905	40.09
TOTAL	120,198,469	241,926,320	362,124,790	242,978,993	605,103,783	100.00

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Table D1.2
Scenario 1: Annual Costs Summary (LE)
Main Stem

GROUP	OPERATION & MAINTENANCE COSTS			CAPITAL COSTS	TOTAL COSTS
	PERSONNEL	NON-PERSONNEL	TOTAL		
HIGH ASWAN DAM	14,003,468	14,343,419	28,346,887	20,039,451	48,386,337
BARRAGES & STEM	10,768,609	3,212,485	13,981,094	79,962,499	93,943,593
OTHER STEM COSTS	0	0		2,800,865	2,800,865
TOTAL	24,772,077	17,555,904	42,327,981	102,802,815	145,130,795

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Table D 1.3
Scenario 1: Summary Main Stem Capital Costs (LE)

DESCRIPTIONS	Base Costs					Average Annual Costs	
	FY 1986/87	FY 1987/88	FY 1988/89	FY 1989/90	FY 1990/91	Base Costs	INCLUDING CONTINGENCY
1 - HIGH ASWAN DAM GROUP	30.215,234	25,777,671	18,362,826	8,442,324	8,290,357	18,217,682	20,039,451
2 - BARRAGES & STEM GROUP	48,921,069	73,443,455	48,577,781	91,596,063	100,927,536	72,693,181	79,962,499
3- OTHER STEM COSTS	3,725,544	3,092,170	2,537,663	1,788,289	1,587,539	2,546,241	2,800,865
TOTAL	82,861,847	102,313,297	69,478,270	101,826,676	110,805,431	93,457,104	102,802,815

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Table D 1.4
Scenario 1: Main Stem Capital Costs (LE) - FY 1986/87

PROJECT NAME	ACT. COSTS INCURRED	DECEMBER 1991 PRICES	
		BASE COSTS	COSTS INCL. CONTINGENCY
1 - HIGH ASWAN DAM GROUP			
REHABILITATION OF HIGH ASWAN DAM COMPLEX	11,083,233	29,351,683	32,286,851
NILE WATER COMMISSION	326,078	863,551	949,906
SUBTOTAL	11,409,311	30,215,234	33,236,758
2 - BARRAGES & STEM GROUP			
STRENGTHENING AND REPLACEMENT OF BARRAGES	9,401,937	24,899,113	27,389,025
WRC - MISC. GRANTS	2,682,000	7,102,730	7,813,003
WATER RESEARCH PROJECTS	5,489,000	14,536,498	15,990,147
WEED CONTROL	899,721	2,382,728	2,621,000
SUBTOTAL	18,472,658	48,921,069	53,813,176
3 - OTHER STEM COSTS			
IMPROVEMENT OF THE NILE COURSE	1,406,770	3,725,544	4,098,098
SUBTOTAL	1,406,770	3,725,544	4,098,098
TOTAL	31,288,739	82,861,847	91,148,031

Table D 1.5
Scenario 1: Main Stem Capital Costs (LE) - FY 1987/88

PROJECT NAME	ACT. COSTS INCURRED	DECEMBER 1991 PRICES	
		BASE COSTS	COSTS INCL. CONTINGENCY
1 - HIGH ASWAN DAM GROUP			
REHABILITATION OF HIGH ASWAN DAM COMPLEX	11,446,407	23,335,441	25,668,985
STUDIES TO UTILIZE NILE CLOSURE PERIOD DISCH.	20,000	40,773	44,851
NILE WATER COMMISSION	1,177,251	2,400,026	2,640,028
JONGLI CANAL PROJECT - PHASE 1	702	1,431	1,574
SUBTOTAL	12,644,360	25,777,671	28,355,439
2 - BARRAGES & STEM GROUP			
STRENGHTENING OF THE NILE BARRAGES	935,326	1,906,821	2,097,503
NAG HAMMADI LOCK	650,746	1,326,656	1,459,322
ESSNA BARRAGE	11,277,150	22,990,382	25,289,420
DEMMIATTA REGULATOR & LOCK	8,691,567	17,719,233	19,491,156
WATER RESEARCH PROJECTS	3,604,000	7,347,365	8,082,101
WRC - MISC. GRANTS	3,820,000	7,787,718	8,566,489
WRC - CANADIAN GRANT	7,046,400	14,365,281	15,801,809
SUBTOTAL	36,025,189	73,443,455	80,787,801
3 - OTHER STEM COSTS			
RIVER TRAINING	1,117,347	2,277,901	2,505,691
STUDIES FOR IMPROVING THE NILE COURSE	399,412	814,269	895,696
SUBTOTAL	1,516,759	3,092,170	3,401,387
TOTAL	50,186,308	102,313,297	112,544,626

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Table D 1.6
Scenario 1 : Main Stem Capital Costs (LE) - FY 1988/89

PROJECT NAME	ACT. COSTS INCURRED	DECEMBER 1991 PRICES	
		BASE COSTS	COSTS INCL. CONTINGENCY
1 - HIGH ASWAN DAM GROUP			
REHABILITATION OF HIGH ASWAN DAM COMPLEX	9,402,554	16,132,305	17,745,535
NILE WATER COMMISSION	1,300,037	2,230,521	2,453,573
SUBTOTAL	10,702,591	18,362,826	20,199,108
2 - BARRAGES & STEM GROUP			
STRENGHTENING OF THE NILE BARRAGES	108,736	186,562	205,219
NAG HAMMADI LOCK	6,057,249	10,392,643	11,431,907
DEMMIATTA REGULATOR & LOCK	6,305,710	10,818,937	11,900,830
ESSNA BARRAGE	1,596,483	2,739,144	3,013,059
WRC - MISC. GRANTS	3,492,000	5,991,352	6,590,487
WRC - CANADIAN GRANT	7,140,900	12,251,903	13,477,093
WATER RESARCH PROJECTS	3,612,000	6,197,240	6,816,964
SUBTOTAL	28,313,078	48,577,781	53,435,559
3 - OTHER STEM COSTS			
RIVER TRAINING	739,956	1,269,570	1,396,526
STUDIES FOR IMPROVING THE NILE COURSE	739,096	1,268,094	1,394,903
SUBTOTAL	1,479,052	2,537,663	2,791,430
TOTAL	40,494,721	69,478,270	76,426,097

Table D1.7
Scenario 1 : Main Stem Capital Costs (LE) - FY 1989/90

PROJECT NAME	ACT. COSTS INCURRED	DECEMBER 1991 PRICES	
		BASE COSTS	COSTS INCL. CONTINGENCY
1 - HIGH ASWAN DAM GROUP			
REHABILITATION OF HIGH ASWAN DAM COMPLEX	4,500,226	6,437,444	7,081,188
NILE WATER COMMISSION	1,401,552	2,004,880	2,205,368
SUBTOTAL	5,901,778	8,442,324	9,286,556
2 - BARRAGES & STEM GROUP			
STRENGHTENING OF THE NILE BARRAGES	682,419	976,181	1,073,799
NAG HAMMADI LOCK	5,972,961	8,544,149	9,398,564
DEMMIATTA REGULATOR & LOCK	5,037,428	7,205,896	7,926,485
ESSNA BARRAGE	32,174,233	46,024,314	50,626,746
WRC - MISC. GRANTS	7,813,400	11,176,844	12,294,528
WRC - CANADIAN GRANT	7,592,650	10,861,067	11,947,174
WATER RESEARCH PROJECTS	4,759,000	6,807,613	7,488,374
SUBTOTAL	64,032,091	91,596,063	100,755,669
3 - OTHER STEM COSTS			
RIVER TRAINING	1,003,396	1,435,329	1,578,862
STUDIES FOR IMPROVING THE NILE COURSE	246,744	352,960	388,256
SUBTOTAL	1,250,140	1,788,289	1,967,118
TOTAL	71,184,009	101,826,676	112,009,343

Table D1.8
Scenario 1 : Main Stem Capital Costs (LE) - FY 1990/91

PROJECT NAME	ACT. COSTS INCURRED	DECEMBER 1991 PRICES	
		BASE COSTS	COSTS INCL. CONTINGENCY
1 - HIGH ASWAN DAM GROUP			
REHABILITATION OF HIGH ASWAN DAM COMPLEX	4,607,059	5,408,670	5,949,537
NILE WATER COMMISSION	2,454,596	2,881,687	3,169,855
SUBTOTAL	7,061,655	8,290,357	9,119,392
2 - BARRAGES & STEM GROUP			
STRENGHTENING OF THE NILE BARRAGES	1,144,075	1,343,140	1,477,454
NAG HAMMADI LOCK	7,477,427	8,778,471	9,656,318
DEMMIATTA REGULATOR & LOCK	41,608	48,848	53,732
ESSNA BARRAGE	54,843,354	64,385,893	70,824,482
WRC - MISC. GRANTS	9,950,000	11,681,263	12,849,389
WRC - CANADIAN GRANT	8,226,750	9,658,174	10,623,991
WATER RESEARCH PROJECTS	4,286,000	5,031,748	5,534,923
SUBTOTAL	85,969,214	100,927,536	111,020,290
3 - OTHER STEM COSTS			
RIVER TRAINING	600,052	704,459	774,905
STUDIES FOR IMPROVING THE NILE COURSE	752,200	883,080	971,388
SUBTOTAL	1,352,252	1,587,539	1,746,293
TOTAL - MAIN STEM	94,383,121	110,805,431	121,885,975

Table D1.9 Scenario 1: Main Stem O&M Costs (LE)
Non Personnel Costs

DESCRIPTIONS	BASE COSTS					AVERAGE ANNUAL COSTS	
	FY 1986/87	FY 1987/88	FY 1988/89	FY 1989/90	FY 1990/91	BASE COSTS	INCLUDING CONTINGENCY
1 - HIGH ASWAN DAM GROUP	8,237,032	9,490,577	18,196,993	19,049,668	10,223,090	13,039,472	14,343,419
2 - BARRAGES & STEM GROUP	1,022,859	5,033,464	3,037,102	2,818,023	2,690,755	2,920,441	3,212,485
3 - OTHER STEM COSTS	0	0	0	0	0	0	0
TOTAL	9,259,891	14,524,041	21,234,095	21,867,691	12,913,845	15,959,913	17,555,904

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Table D1.10 Scenario 1 : Main Stem O&M Costs (LE) - FY 1986/87
Non Personnel Costs

DESCRIPTIONS	ACT. COSTS INCURRED	DECEMBER 1991 PRICES	
		BASE COSTS	COSTS INCL. CONTINGENCY
1 - HIGH ASWAN DAM GROUP			
MPWWR HEADQUARTERS	2,633,759	6,504,959	7,155,455
NILE CONTROL DEPARTMENT	6,193	15,296	16,825
DESIGN DEPARTMENT	6,536	16,143	17,757
GOE IRRIGATION DEPT. - SUDAN	13,653	33,721	37,093
MPWWR - HAD	674,908	1,666,914	1,833,605
SUBTOTAL	3,335,049	8,237,032	9,060,735
2 - BARRAGES & STEM GROUP			
DELTA BARRAGE	229,586	567,040	623,744
DAMS & LARGE BARRAGES	3,604	8,901	9,791
MPWWR - WRC	180,950	446,917	491,609
SUBTOTAL	414,140	1,022,859	1,125,145
TOTAL	3,749,189	9,259,890	10,185,880

Table D1.11
Scenario 1 : Main Stem O&M Costs (LE) - FY 1987/88
Non Personnel Costs

DESCRIPTIONS	ACT. COSTS INCURRED	DECEMBER 1991 PRICES	
		BASE COSTS	COSTS INCL. CONTINGENCY
1 - HIGH ASWAN DAM GROUP			
MPWWR HEADQUARTERS	3,902,490	8,013,203	8,814,524
NILE CONTROL DEPARTMENT	6,531	13,410	14,752
DESIGN DEPARTMENT	5,602	11,503	12,653
GOE IRRIGATION DEPT. - SUDAN	61,257	125,782	138,361
MPWWR - HAD	646,102	1,326,678	1,459,346
SUBTOTAL	4,621,982	9,490,577	10,439,635
2 - BARRAGES & STEM GROUP			
DELTA BARRAGE	286,673	588,642	647,506
DAMS & LARGE BARRAGES	10,274	21,096	23,206
MPWWR - WRC	226,188	464,445	510,889
WATER WEED CONTROL	2,102,629	3,959,282	4,355,210
SUBTOTAL	2,625,764	5,033,464	5,536,811
TOTAL	7,247,746	14,524,041	15,976,445

Table D1.12
Scenario 1 : Main Stem O&M Costs (LE) - FY 1988/89
Non Personnel Costs

DESCRIPTIONS	ACT. COSTS INCURRED	DECEMBER 1991 PRICES	
		BASE COSTS	COSTS INCL. CONTINGENCY
1 - HIGH ASWAN DAM GROUP			
MPWWR HEADQUARTERS	10,456,121	16,869,608	18,556,568
NILE CONTROL DEPARTMENT	19,873	32,063	35,269
DESIGN DEPARTMENT	9,815	15,835	17,419
GOE IRRIGATION DEPT. - SUDAN	104,363	168,376	185,214
MPWWR - HAD	688,689	1,111,111	1,222,222
SUBTOTAL	11,278,861	18,196,993	20,016,692
2 - BARRAGES & STEM GROUP			
DELTA BARRAGE	391,280	631,280	694,408
DAMS & LARGE BARRAGES	5,038	8,128	8,941
MPWWR - WRC	381,076	614,817	676,299
WATER WEED CONTROL	1,105,063	1,782,877	1,961,165
SUBTOTAL	1,882,457	3,037,102	3,340,813
TOTAL	13,161,318	21,234,095	23,357,505

Table D1.13
Scenario 1 : Main Stem O&M Costs (LE) - FY 1989/90
Non Personnel Costs

DESCRIPTIONS	ACT. COSTS INCURRED	DECEMBER 1991 PRICES	
		BASE COSTS	COSTS INCL. CONTINGENCY
1 - HIGH ASWAN DAM GROUP			
MPWWR HEADQUARTERS	13,210,855	17,628,792	19,391,671
NILE CONTROL DEPARTMENT	16,273	21,715	23,886
DESIGN DEPARTMENT	7,164	9,560	10,516
GOE IRRIGATION DEPT. - SUDAN	100,504	134,114	147,526
MPWWR - HAD	940,850	1,255,486	1,381,035
SUBTOTAL	14,275,646	19,049,668	20,954,634
2 - BARRAGES & STEM GROUP			
DELTA BARRAGE	261,570	349,044	383,948
DAMS & LARGE BARRAGES	18,032	24,062	26,468
MPWWR - WRC	506,161	675,430	742,973
WATER WEED CONTROL	1,236,996	1,769,487	1,946,436
SUBTOTAL	2,022,759	2,818,023	3,099,825
TOTAL	16,298,405	21,867,691	24,054,460

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Table D1.14
Scenario 1 : Main Stem O&M Costs (LE) - FY 1990/91
Non Personnel Costs

DESCRIPTIONS	ACT. COSTS INCURRED	DECEMBER 1991 PRICES	
		BASE COSTS	COSTS INCL. CONTINGENCY
1 - HIGH ASWAN DAM GROUP			
MPWWR HEADQUARTERS	7,713,285	8,871,294	9,758,424
NILE CONTROL DEPARTMENT	43,094	49,564	54.520
DESIGN DEPARTMENT	16,966	19,513	21,464
GOE IRRIGATION DEPT. - SUDAN	43,696	50,256	55,282
MPWWR - HAD	1,071,584	1,232,463	1,355,709
SUBTOTAL	8,888,625	10,223,090	11,245,399
2 - BARRAGES & STEM GROUP			
DELTA BARRAGE	317,926	365,657	402,222
DAMS & LARGE BARRAGES	3,712	4,269	4,696
MPWWR - WRC	505,640	581,553	639,708
WATER WEED CONTROL	1,481,501	1,739,277	1,913,204
SUBTOTAL	2,308,779	2,690,755	2,959,831
TOTAL	11,197,404	12,913,846	14,205,230

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Table D1.15
Scenario 1: Main Stem O&M Costs (LE)
Personnel Costs

DESCRIPTIONS	ACTUAL COSTS					PROJECTED ANNUAL COSTS	
	FY 1986/87	FY 1987/88	FY 1988/89	FY 1989/90	FY 1990/91	BASE COSTS	INCLUDING CONTINGENCY
1 - HIGH ASWAN DAM GROUP							
MPWWR HEADQUARTERS	744,614	1,049,008	1,821,002	1,945,821	2,110,525	2,795,343	2,935,111
NILE CONTROL DEPARTMENT	554,790	641,683	707,638	848,549	881,090	990,540	1,040,067
DESIGN DEPARTMENT	151,007	208,770	231,669	258,308	260,881	301,132	316,188
GOE IRRIG DEPT - SUDAN	1,631,268	2,002,564	2,547,368	2,384,134	1,423,676	1,435,326	1,507,092
MPWWR - HAD	4,050,475	4,725,420	5,337,733	6,321,391	6,848,755	7,814,295	8,205,009
SUBTOTAL	7,132,154	8,627,445	10,645,410	11,758,203	11,524,927	13,336,636	14,003,468
2 - BARRAGES & STEM GROUP							
DELTA BARRAGE	1,977,280	2,285,285	2,592,568	2,893,060	3,073,349	3,433,282	3,604,946
DAMS & LARGE BARRAGES	775,162	642,468	722,349	861,200	932,771	986,052	1,035,354
MPWWR - WRC	2,629,931	3,084,909	3,807,823	4,514,687	4,973,042	5,836,485	6,128,309
SUBTOTAL	5,382,372	6,012,662	7,122,740	8,268,947	8,979,162	10,255,818	10,768,609
TOTAL	12,514,526	14,640,107	17,768,150	20,027,150	20,504,089	23,592,454	24,772,077

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Table D1.16
Scenario 1: Pump Stations Summary Costs (LE)

DESCRIPTIONS	BASE COSTS					AVERAGE ANNUAL COSTS	
	FY 1986/87	FY 1987/88	FY 1988/89	FY 1989/90	FY 1990/91	BASE COSTS	INCLUDING CONTINGENCY
NON PERSONNEL COSTS	84,899,131	98,301,611	82,905,337	81,767,579	80,795,727	85,733,877	94,307,265
PERSONNEL COSTS	20,756,963	24,192,922	27,582,295	30,324,425	33,856,284	33,856,284	35,549,098
TOTAL O & M	105,656,094	122,494,532	110,487,633	112,092,004	114,652,011	119,590,161	129,856,363
CAPITAL COST	55,672,906	62,678,450	60,367,972	29,200,384	30,575,674	47,699,077	52,468,985
TOTAL	161,329,000	185,172,982	170,855,605	141,292,388	145,227,686	167,289,238	182,325,348

DECEMBER 1991 PRICES

Table D1.17
Scenario 1: Pump Stations Capital Costs (LE) - FY 1986/87

PROJECT NAME	CT. COSTS INCURRED	DECEMBER 1991 PRICES	
		BASE COSTS	COSTS INCL. CONTINGENCY
EL BAYAD OLYA PUMP STATION	1,039,729	2,801,577	3,081,735
GROUND WATER USE	1,349,299	3,573,343	3,930,678
FLOATING PS IN ASWAN	141,669	381,731	419,904
EAST MANOUFIA PS	917	2,471	2,718
DIESEL PS	330,547	890,668	979,734
REHABILITATION OF PS BUILDINGS & STAFF HOUSES	128,120	345,223	379,745
SHOUHOUR PS	114,081	307,394	338,134
SAADA PS	768	2,069	2,276
WADI ABBADI PS	133,317	359,226	395,149
TELECOMUNICATION - MED	13,316	35,880	39,468
MARIUTE PS	194,075	522,940	575,234
TOOLS FOR 2ND REPLACEMENT PROJECT - MED	17,268	46,529	51,182
EL MALLAHA PUMPING STATION	796,109	2,145,137	2,359,651
2ND REPLACEMENT PROJECT - MED	67,537	181,980	200,178
HAMOUL & MANSOUR PUMP STATIONS	1,473,422	3,970,175	4,367,192
REPLACEMENT OF SUPPORT UNITS - MED	4,777	12,872	14,159
PUMP STATION ON LOWER DRAIN 1	39,109	105,380	115,918
REPLACEMENT OF OLD CASTLE PS	23,513	63,356	69,692
NEW EQUIPMENT - MED	2,856,160	7,695,999	8,465,599
REPLACEMENT OF MACHINES & PUMPS	5,982,067	16,118,838	17,730,722
REPLACEMENT OF 30 PUMPING STATIONS	5,978,830	16,110,116	17,721,128
TOTAL	20,684,630	55,672,906	61,240,196

Table D1.18
Scenario 1 : Pump Stations Capital Costs (LE) - FY 1987/88

PROJECT NAME	CT. COSTS INCURRED	DECEMBER 1991 PRICES	
		BASE COSTS	COSTS INCL. CONTINGENCY
DRILLING 120 BOREHOLES FOR IRRIGATION	367,402	749,011	823,912
GROUND WATER USE - 140 BOREHOLES	1,006,613	2,052,151	2,257,366
IMPROVEMENT & REHAB OF PS	2,268,870	4,272,316	4,699,547
REPLACEMENT OF PS	29,529,758	55,604,971	61,165,469
TOTAL	33,172,643	62,678,450	68,946,295

Table D1.19
Scenario 1: Pump Stations Capital Costs (LE) - FY 1988/89

PROJECT NAME	ACT. COSTS INCURRED	DECEMBER 1991 PRICES	
		BASE COSTS	COSTS INCL. CONTINGENCY
DRILLING 120 BOREHOLES FOR IRRIGATION	1,603,106	2,750,507	3,025,558
GROUND WATER USE - 140 BOREHOLES	794,649	1,363,408	1,499,749
CONSTRUCTION OF 70 NEW PUMP STATIONS	2,910,692	4,751,404	5,226,545
EMERGENCY PUMPING UNITS	3,223,241	5,261,608	5,787,769
ELEVEN PUMP STATIONS	560,200	914,469	1,005,916
HAMOUL & MANSOUR PUMP STATIONS	2,394,829	3,909,311	4,300,242
EINABA PUMP STATION	314,204	512,906	564,196
PUMP STATION ON LOWER DRAIN 1	3,014,000	4,920,044	5,412,048
EL ATEF PUMP STATION	718,307	1,172,562	1,289,818
EL BAYAD OLYA PUMP STATION	130	212	233
EL MALLAHA PUMPING STATION	2,013,378	3,286,632	3,615,295
REPLACEMENT FOR 40 STATIONS	15,825,185	25,832,980	28,416,278
REPLACEMENT OF 30 PUMPING STATIONS	3,486,854	5,691,939	6,261,122
TOTAL - PUMP STATIONS	36,858,775	60,367,972	66,404,770

Table D1.20
Scenario 1 : Pump Stations Capital Costs (LE) - FY 1989/90

PROJECT NAME	ACT. COSTS INCURRED	DECEMBER 1991 PRICES	
		BASE COSTS	COSTS INCL. CONTINGENCY
DRILLING 120 BOREHOLES FOR IRRIGATION	317,835	454,654	500,119
GROUND WATER USE - 140 BOREHOLES	585,012	836,843	920,527
CONSTRUCTION OF 70 NEW PUMP STATIONS	947,377	1,301,451	1,431,596
EMERGENCY PUMPING UNITS	7,646,092	10,503,751	11,554,126
ELEVEN PUMP STATIONS	182,780	251,092	276,202
HAMOUL & MANSOUR PUMP STATIONS	1,660,620	2,281,262	2,509,388
EINABA PUMP STATION	210,062	288,571	317,428
PUMP STATION ON LOWER DRAIN 1	22,173	30,460	33,506
EL ATEF PUMP STATION	2,738,778	3,762,372	4,138,609
EL BAYAD OLYA PUMP STATION	700	962	1,058
EL MALLAHA PUMPING STATION	1,184,385	1,627,038	1,789,742
REPLACEMENT FOR 40 STATIONS	3,452,012	4,742,171	5,216,388
REPLACEMENT OF 30 PUMPING STATIONS	2,270,994	3,119,758	3,431,734
TOTAL	21,218,820	29,200,384	32,120,422

Table D1.21
Scenario 1 : Pump Stations Capital Costs (LE) - FY 1990/91

PROJECT NAME	ACT. COSTS INCURRED	DECEMBER 1991 PRICES	
		BASE COSTS	COSTS INCL. CONTINGENCY
DRILLING 120 BOREHOLES FOR IRRIGATION	3,651,295	4,286,607	4,715,267
GROUND WATER USE - 140 BOREHOLES	30,818	36,180	39,798
CONSTRUCTION OF 70 NEW PUMP STATIONS	750,608	883,263	971,589
EMERGENCY PUMPING UNITS	1,536,403	1,807,931	1,988,725
PUMP STATION ON LOWER DRAIN 1	23,916	28,143	30,957
HAMOUL & MANSOUR PUMP STATIONS	583,562	686,695	755,364
ELEVEN PUMP STATIONS	163,223	192,069	211,276
EL ATEF PUMP STATION	3,971,421	4,673,290	5,140,619
EINABA PUMP STATION	106,700	125,557	138,113
EL MALLAHA PUMPING STATION	1,873,569	2,204,685	2,425,153
REPLACEMENT FOR 40 STATIONS	11,863,151	13,959,725	15,355,698
REPLACEMENT OF 30 PUMPING STATIONS	1,437,483	1,691,529	1,860,682
TOTAL	25,992,149	30,575,674	33,633,242

Table D1.22
Scenario 1 : Pump Station O&M Costs (LE) - FY 1986/87
Non Personnel Costs

DESCRIPTIONS	ACT. COSTS INCURRED	DECEMBER 1991 PRICES	
		BASE COSTS	COSTS INCL. CONTINGENCY
1 - PUMP STATIONS GROUP			
MECHANICAL & ELECTRICAL DEPT.	14,288,734	79,361,926	87,298,119
REPLACEMENT OF OFFICE EQUIP/FURN	259,933	641,992	706,192
EQUIPMENT FOR LAB & WORKSHOPS	36,156	89,299	98,229
ROAD MAINTENANCE	90,000	222,285	244,514
IMPROVEMENT OF ADMIN. OFFICES	1,855,841	4,583,627	5,041,990
TOTAL	16,530,664	84,899,131	93,389,044

Table D1.23
'Scenario 1 : Pump Station O&M Costs (LE) - FY 1987/88
Non Personnel Costs

DESCRIPTIONS	ACT. COSTS INCURRED	DECEMBER 1991 PRICES	
		BASE COSTS	COSTS INCL. CONTINGENCY
1 - PUMP STATIONS GROUP			
MECHANICAL & ELECTRICAL DEPT.	20,466,506	84,163,646	92,580,011
MAINTENANCE OF PUMP STATIONS	6,201,249	12,642,297	13,906,527
STAFF HOUSING	728,401	1,495,667	1,645,234
TOTAL	27,396,156	98,301,611	108,131,772

Table D1.24
Scenario 1 : Pump Station O&M Costs (LE) - FY 1988/89
Non Personnel Costs

DESCRIPTIONS	ACT. COSTS INCURRED	DECEMBER 1991 PRICES	
		BASE COSTS	COSTS INCL. CONTINGENCY
1 - PUMP STATIONS GROUP			
MECHANICAL & ELECTRICAL DEPT.	23,197,755	81,299,493	89,429,443
EQUIPMENT FOR LAB & WORKSHOPS	69,352	113,210	124,531
STAFF HOUSING - 100 UNITS	869,967	1,492,634	1,641,898
TOTAL	24,137,074	82,905,337	91,195,871

Table D1.25
Scenario 1 : Pump Station O&M Costs (LE) - FY 1989/90
Non Personnel Costs

DESCRIPTIONS	ACT. COSTS INCURRED	DECEMBER 1991 PRICES	
		BASE COSTS	COSTS INCL. CONTINGENCY
1 - PUMP STATIONS GROUP			
MECHANICAL & ELECTRICAL DEPT.	33,381,817	80,981,415	89,079,557
EQUIPMENT FOR LAB & WORKSHOPS	46,404	63,747	70,122
STAFF HOUSING - 100 UNITS	505,020	722,417	794,658
TOTAL	33,933,241	81,767,579	89,944,337

Table D1.26
Scenario 1 : Pump Station O&M Costs (LE) - FY 1990/91
Non Personnel Costs

DESCRIPTIONS	ACT. COSTS INCURRED	DECEMBER 1991 PRICES	
		BASE COSTS	COSTS INCL. CONTINGENCY
1 - PUMP STATIONS GROUP			
MECHANICAL & ELECTRICAL DEPT.	50,244,508	80,630,901	88,693,991
EQUIPMENT FOR LAB & WORKSHOPS	54,838	64,530	70,982
STAFF HOUSING - 100 UNITS	85,432	100,297	110,327
TOTAL	50,384,778	80,795,727	88,875,300

Table D1.27
Scenario 1 : Summary Annual Costs
Open Drains

FY 1986/87	FY 1987/88	BASE COSTS			AVERAGE ANNUAL COSTS	
		FY 1988/89	FY 1989/90	FY 1990/91	BASE COSTS	INCLUDING CONTINGENCY
8,397,450	7,186,748	6,292,149	5,871,436	8,050,923	7,159,741	7,875,715
3,615,837	3,871,468	4,316,580	4,705,633	5,688,917	5,688,917	5,973,362
12,013,287	11,058,216	10,608,729	10,577,069	13,739,839	12,848,658	13,849,078
7,780,694	10,201,502	21,205,436	30,350,538	27,001,183	19,307,871	21,238,658
19,793,981	21,259,718	31,814,165	40,927,607	40,741,022	32,156,528	35,087,735

Table D1.28
Scenario 1 : Summary Average Annual Costs (LE)
Regions

REGIONS	OPERATION & MAINTENANCE COSTS			CAPITAL COSTS	TOTAL COSTS
	PERSONNEL	NON-PERSONNEL	TOTAL		
UPPER EGYPT	10,714,382	13,579,343	24,293,725	9,424,118	33,717,843
MIDDLE EGYPT	12,981,796	40,127,923	53,109,718	20,109,821	73,219,540
EAST DELTA	13,532,521	27,215,593	40,748,114	13,775,624	54,523,738
MIDDLE DELTA	12,070,368	18,843,020	30,913,388	14,770,032	45,683,420
WEST DELTA	4,604,866	22,421,558	27,026,424	8,388,940	35,415,364
TOTAL	53,903,932	122,187,437	176,091,368	66,468,536	242,559,905

NOTE: ALL COSTS ARE CONSTANT DECEMBER 1991 PRICES AND INCLUDE CONTINGENCY

Table D1.29
Scenario 1 : Capital Costs (LE)
Regions

FY 1987/88		FY 1988/89		FY 1989/90		FY 1990/91		AVERAGE ANNUAL COSTS			
DEC 91 PRICES	ACTUAL COSTS	DEC 91 PRICES	ACTUAL COSTS	DEC 91 PRICES	ACTUAL COSTS	DEC 91 PRICES	ACTUAL COSTS	DEC 91 PRICES	ACTUAL	DECEMBER 91 PRICES BASE COST	DECEMBER 91 PRICES INCL CONTG
3,104,012	1,964,238	4,004,555	2,961,095	5,080,459	1,575,529	2,253,749	1,607,373	1,887,050	1,853,075	3,265,965	3,592,562
4,628,824	3,558,915	7,255,451	2,422,679	4,156,679	1,227,183	1,755,451	837,107	982,761	1,958,747	3,755,833	4,131,416
2,346,640	793,359	1,617,396	1,175,485	2,016,823	636,788	910,907	712,221	836,145	840,789	1,545,582	1,700,140
10,079,476	6,316,571	12,877,402	6,559,260	11,253,962	3,439,501	4,920,107	3,156,701	3,705,956	4,655,611	8,567,380	9,424,118
3,924,294	1,919,551	3,913,330	2,658,030	4,560,480	1,403,502	2,007,669	1,510,418	1,773,226	1,794,664	3,235,799	3,559,379
9,375,105	4,292,001	8,750,094	5,189,347	8,903,551	4,414,074	6,314,206	2,571,041	3,018,393	4,001,315	7,272,270	7,999,497
2,915,878	1,566,147	3,192,855	2,241,127	3,845,183	1,215,371	1,738,553	1,258,603	1,477,595	1,476,457	2,634,013	2,897,414
4,116,951	2,551,709	5,202,092	3,197,007	5,485,222	1,699,613	2,431,248	1,858,818	2,182,245	2,172,343	3,883,551	4,271,907
1,395,184	770,481	1,570,756	1,039,667	1,783,795	566,901	810,935	612,813	719,441	703,337	1,256,022	1,381,624
21,727,412	11,099,948	22,629,127	14,325,178	24,578,231	9,299,461	13,302,611	7,811,693	9,170,899	10,148,116	18,281,656	20,109,821
2,637,563	1,634,727	3,332,668	2,558,300	4,389,368	1,356,549	1,940,504	1,483,618	1,741,762	1,605,828	2,808,373	3,089,210
1,585,305	358,249	730,352	558,448	958,149	297,287	425,260	325,134	381,706	427,546	816,154	897,770
8,094,420	2,967,677	6,050,114	3,532,364	6,060,605	1,942,360	2,778,490	1,899,558	2,230,074	2,679,684	5,042,740	5,547,014
2,259,396	1,693,981	3,453,468	3,467,069	5,948,576	3,121,358	4,465,013	2,686,279	3,153,681	2,364,368	3,856,027	4,241,630
14,576,684	6,654,685	13,566,601	10,116,180	17,356,699	6,717,554	9,609,267	6,394,588	7,507,222	7,077,426	12,523,295	13,775,624

Table D1.29
Scenario 1 : Capital Costs (LE)
Regions

FY 1987/88		FY 1988/89		FY 1989/90		FY 1990/91		AVERAGE ANNUAL COSTS			
DEC 91 PRICES	ACTUAL COSTS	DEC 91 PRICES	ACTUAL COSTS	DEC 91 PRICES	ACTUAL COSTS	DEC 91 PRICES	ACTUAL COSTS	DEC 91 PRICES	ACTUAL	DECEMBER 91 PRICES BASE COST	DECEMBER 91 PRICES INCL CONTG
1,636,115	1,226,676	2,500,787	2,510,636	4,307,590	2,260,294	3,233,285	1,945,236	2,283,700	1,712,128	2,792,295	3,071,525
4,789,930	2,390,330	4,873,094	3,773,783	6,474,817	2,008,996	2,873,812	2,063,643	2,422,709	2,409,087	4,286,872	4,715,560
4,418,739	2,058,002	4,195,586	2,639,201	4,528,174	1,960,553	2,804,515	2,157,716	2,533,150	2,096,799	3,696,033	4,065,636
2,493,858	1,545,661	3,151,091	2,409,412	4,133,916	1,282,639	1,834,777	1,402,784	1,646,864	1,516,436	2,652,101	2,917,311
13,338,642	7,220,669	14,720,558	11,333,032	19,444,497	7,512,482	10,746,389	7,569,379	8,886,423	7,734,450	13,427,302	14,770,032
2,486,047	2,181,204	4,446,753	2,188,339	3,754,614	951,863	1,361,612	1,715,235	2,013,702	1,595,079	2,812,546	3,093,800
14,068,529	1,469,464	2,995,752	1,994,251	3,421,608	1,239,620	1,773,241	1,541,478	1,809,689	2,311,421	4,813,764	5,295,140
16,554,576	3,650,668	7,442,506	4,182,590	7,176,222	2,191,483	3,134,853	3,256,732	3,823,391	3,906,500	7,626,310	8,388,940
76,276,789	34,942,492	71,238,194	46,516,240	79,809,610	29,160,479	41,713,226	28,189,094	33,093,891	33,522,104	60,425,942	66,468,536

Table D1.30
Scenario 1 : Distribution System O&M Costs (LE)
Non Personnel Costs

DIRECTORATE	FY 1986/87 ACTUAL COSTS	FY 1986/87 DEC 91	FY 1987/88 ACTUAL COSTS	FY 1987/88 DEC 91 PRICES	FY 1988/89 ACTUAL COSTS	FY 1988/89 DEC 91 PRICES	FY 1989/90 ACTUAL COSTS	FY 1989/90 DEC 91 PRICES	FY 1990/91 ACTUAL COSTS	FY 1990/91 DEC 91 PRICES	AVERAGE ANNUAL COSTS AVERAGED ACTUAL	AVERAGE ANNUAL COSTS DECEMBER 91 PRICES BASE COST	AVERAGE ANNUAL COSTS DECEMBER 91 PRICES INCL CONTG
A. UPPER EGYPT													
1 ASWAN	1,295,550	3,199,799	1,585,276	3,255,137	2,058,791	3,321,595	2,532,530	3,379,452	1,634,518	1,879,911	1,821,333	3,007,179	3,307,897
2 KENA	2,901,933	7,167,305	3,649,889	7,494,523	2,497,995	4,030,194	5,105,634	6,813,046	6,152,899	7,076,645	4,061,670	6,516,343	7,167,977
3 SOHAG	1,269,083	3,134,430	1,054,104	2,164,451	1,058,717	1,708,104	1,704,207	2,274,123	2,338,177	2,689,212	1,484,858	2,394,064	2,633,470
PREVEN. MAINT.	0	0	0	0	0	0	808,827	1,079,313	919,065	1,057,046	345,578	427,272	469,999
SUBTOTAL	5,468,566	13,501,534	6,289,269	12,914,112	5,615,503	9,059,893	10,151,198	13,545,934	11,044,659	12,702,814	7,713,439	12,344,857	13,579,343
B. MIDDLE EGYPT													
1 ASSUIT	976,784	2,412,499	1,840,999	3,780,227	2,040,749	3,292,486	3,166,778	4,225,803	2,830,396	3,255,328	2,171,141	3,393,269	3,732,596
2 EL-MENIA	2,482,817	6,132,156	4,326,194	8,883,219	10,825,218	17,465,098	11,552,856	15,416,330	7,457,321	8,576,902	7,328,881	11,294,741	12,424,215
3 BENI-SUEF	1,531,437	3,782,402	3,164,816	6,498,496	5,213,630	8,411,522	3,478,270	4,641,463	3,805,267	4,376,559	3,438,684	5,542,088	6,096,297
4 FAYOUM	2,772,534	6,847,711	4,409,219	9,053,699	10,339,271	16,681,085	7,280,954	9,715,830	3,975,724	4,572,607	5,755,540	9,374,186	10,311,605
5 GIZA	1,346,713	3,326,163	1,602,622	3,290,754	6,522,120	10,522,603	4,666,811	6,227,473	5,858,058	6,737,539	3,999,265	6,020,906	6,622,997
PREVEN. MAINT.	0	0	0	0	0	0	1,618,024	2,159,120	1,838,550	2,114,575	691,315	854,739	940,213
SUBTOTAL	9,110,285	22,500,931	15,343,850	31,506,395	34,940,988	56,372,794	31,763,693	42,386,019	25,765,316	29,633,510	23,384,827	36,479,930	40,127,923
C. EAST DELTA													
1 EL-KALUBIA	1,306,799	3,227,582	2,330,487	4,785,321	2,594,965	4,186,643	2,001,812	2,671,252	1,270,269	1,460,977	1,900,868	3,266,355	3,592,990
2 EL-ISMAILIA	1,651,706	4,079,447	1,921,079	3,944,660	2,838,961	4,580,299	1,472,318	1,964,684	3,299,594	3,794,968	2,236,731	3,672,811	4,040,093
3 EL-SHARGHIA	2,042,472	5,044,576	3,377,076	6,934,341	10,118,707	16,325,234	6,742,639	8,997,494	8,035,601	9,242,000	6,063,299	9,308,729	10,239,602
4 E. DAKAHLIA	2,214,262	5,468,870	3,733,285	7,665,765	7,160,904	11,553,199	6,859,298	9,153,166	3,646,168	4,193,574	4,722,784	7,606,915	8,367,606
PREVEN. MAINT.	0	0	0	0	0	0	1,678,410	2,239,699	1,907,166	2,193,493	717,115	886,638	975,302
SUBTOTAL	7,215,239	17,820,474	11,361,927	23,330,087	22,713,537	36,645,374	18,754,475	25,026,295	18,158,798	20,885,012	15,640,796	24,741,448	27,215,593

Table D1.30
Scenario 1 : Distribution System O&M Costs (LE)
Non Personnel Costs

	FY 1986/87		FY 1987/88		FY 1988/89		FY 1989/90		FY 1990/91		AVERAGE ANNUAL COSTS		
DIRECTORATE	ACTUAL COSTS	DEC 91	ACTUAL COSTS	DEC 91 PRICES	ACTUAL COSTS	DEC 91 PRICES	ACTUAL COSTS	DEC 91 PRICES	ACTUAL COSTS	DEC 91 PRICES	AVERAGED ACTUAL	DECEMBER 91 PRICES BASE COST	DECEMBER 91 PRICES INCL CONTG
D. MIDDLE DELTA													
1 W. DAKAHLIA	1,210,034	2,990,143	2,041,200	4,191,311	3,915,275	6,316,793	3,750,370	5,004,558	1,993,568	2,292,866	2,582,215	4,159,134	4,575,048
2 KHAFR EL-SHEIKH	1,577,071	3,897,086	2,859,367	5,871,300	5,058,172	8,160,711	3,950,156	5,271,156	5,564,207	6,399,571	3,801,955	5,919,965	6,511,961
3 EL-GHARBIA	1,633,003	4,035,229	1,660,510	3,409,619	2,274,888	3,670,239	2,223,024	2,966,441	2,666,493	3,066,818	2,091,744	3,429,670	3,772,636
4 EL-MENOFIA	1,653,796	4,084,609	1,379,666	2,832,946	2,095,788	3,381,285	1,266,842	1,690,496	1,809,052	2,080,648	1,641,029	2,813,997	3,095,396
PREVEN. MAINT.	0	0	0	0	0	0	1,528,133	2,039,167	1,736,408	1,997,098	652,908	807,253	887,978
SUBTOTAL	6,076,134	15,007,067	7,940,743	16,305,176	13,344,123	21,529,027	12,718,525	16,971,818	13,769,728	15,837,002	10,769,850	17,130,018	18,843,020
E. WEST DELTA													
1 EL-BEHERA	4,536,445	11,204,285	3,765,191	7,731,280	8,064,962	13,011,780	7,693,499	10,266,337	7,728,295	8,888,558	6,357,678	10,220,448	11,242,493
2 NOBARIA	1,475,536	3,644,335	3,420,531	7,023,570	5,690,839	9,181,437	10,731,172	14,319,861	11,318,290	13,017,525	6,527,274	9,437,346	10,381,080
PREVEN. MAINT.	0	0	0	0	0	0	1,373,262	1,832,505	1,560,429	1,794,699	586,738	725,441	797,985
SUBTOTAL	6,011,981	14,848,621	7,185,722	14,754,849	13,755,801	22,193,217	19,797,933	26,418,703	20,607,014	23,700,782	13,471,690	20,383,234	22,421,558
TOTAL	33,880,205	83,678,627	48,121,511	98,810,620	90,369,952	145,800,305	93,185,825	124,348,769	89,345,515	102,759,119	70,980,002	111,079,488	122,187,437

Scenario 1: Distribu tem O&M Costs (LE)
Personnel Costs

DIRECTORATE	ACTUAL COSTS					PROJECTED ANNUAL COST	
	FY 1986/87	FY 1987/88	FY 1988/89	FY 1989/90	FY 1990/91	BASE COST	INCLUDING CONTINGENCY
A. UPPER EGYPT							
1 ASWAN	1,496,483	1,724,751	1,883,793	2,080,893	2,409,029	2,714,414	2,850,135
2 KENA	2,030,624	2,533,138	2,792,675	3,063,874	3,531,858	4,061,454	4,264,527
3 SOHAG	1,674,366	2,112,838	2,301,190	2,547,318	2,966,581	3,428,305	3,599,720
SUBTOTAL	5,201,474	6,370,727	6,977,658	7,692,085	8,907,478	10,204,173	10,714,382
B. MIDDLE EGYPT							
1 ASSUIT	1,161,997	1,309,089	1,553,702	1,739,129	2,053,260	2,368,135	2,486,542
2 EL-MENIA	1,548,358	1,651,516	2,141,812	2,735,063	3,172,969	3,808,034	3,998,436
3 BENI-SUEF	1,522,310	1,629,940	2,000,109	2,246,517	2,466,003	2,785,785	2,925,075
4 FAYOUM	1,111,758	1,137,489	1,256,744	1,410,874	1,592,249	1,743,187	1,830,347
5 GIZA	1,603,598	1,008,601	1,124,138	1,325,517	1,604,929	1,658,473	1,741,396
SUBTOTAL	6,948,021	6,736,635	8,076,505	9,457,100	10,889,410	12,363,615	12,981,796
C. EAST DELTA							
1 EL-KALUBIA	1,554,429	1,950,196	2,153,593	2,382,257	2,710,935	3,119,642	3,275,624
2 EL-ISMAILIA	891,282	918,633	1,036,120	932,871	1,093,141	1,156,197	1,214,007
3 EL-SHARGHIA	2,167,598	2,944,409	2,900,475	3,646,429	3,691,956	4,257,861	4,470,754
4 E. DAKAHLIA	2,131,077	2,490,432	2,769,774	3,301,555	3,773,534	4,354,416	4,572,136
SUBTOTAL	6,744,386	8,303,670	8,859,962	10,263,112	11,269,566	12,888,115	13,532,521
D. MIDDLE DELTA							
1 W. DAKAHLIA	1,165,181	1,361,661	1,514,394	1,805,149	2,063,206	2,380,807	2,499,848
2 KHAFR EL-SHEIKH	1,054,443	1,098,709	1,199,285	1,564,533	1,754,624	2,000,085	2,100,089
3 EL-GHARBIA	1,874,216	2,171,739	2,371,194	2,890,843	3,309,261	3,817,627	4,008,508
4 EL-MENOFIA	1,689,124	2,085,163	2,261,319	2,629,494	2,881,135	3,297,069	3,461,922
SUBTOTAL	5,782,964	6,717,272	7,346,192	8,890,019	10,008,226	11,495,588	12,070,368
E. EAST DELTA							
16 EL-BEHERA	1,463,050	1,700,151	1,887,855	2,222,376	2,812,324	3,315,110	3,480,866
17 NOBARIA	600,844	701,835	890,612	986,306	949,926	1,070,476	1,124,000
SUBTOTAL	2,063,894	2,401,986	2,778,467	3,208,682	3,762,250	4,385,587	4,604,866
TOTAL	26,740,738	30,530,290	34,038,785	39,510,997	44,836,931	51,337,078	53,903,932

Table D2.1
Scenario 2: Annual Costs Summary (LE)

GROUP	OPERATION & MAINTENANCE COSTS			CAPITAL COSTS	TOTAL COSTS	PERCENT
	PERSONNEL	NON-PERSONNEL	TOTAL			
A - MAIN STEM						
HIGH ASWAN DAM	14,703,641	27,682,811	42,386,452	41,200,536	83,586,988	8.63
BARRAGES & STEM	10,987,200	15,617,623	26,604,823	112,049,207	138,654,030	14.31
ESNA BARRAGE	380,800	2,043,811	2,424,612	68,094,925	70,519,536	7.28
OTHER STEM COSTS	0	0	0	29,312,067	29,312,067	3.02
TOTAL - MAIN STEM	26,071,641	45,344,245	71,415,886	250,656,735	322,072,621	33.24
B - PUMP STATIONS	37,326,553	82,488,580	119,815,134	106,597,086	226,412,220	23.36
C - OPEN DRAINAGE SYSTEM	6,272,030	72,318,945	78,590,976	17,831,096	96,422,072	9.95
D - MAIN IRRIGATION SYSTEM	56,599,128	180,704,893	237,304,021	86,833,148	324,137,169	33.45
TOTAL	126,269,352	380,856,664	507,126,017	461,918,065	969,044,082	100.00

DECEMBER 1991 PRICES

Table D2.2
Scenario 2: Annual Costs Summary (LE)
Main Stem

GROUP	OPERATION & MAINTENANCE COSTS			CAPITAL COSTS	TOTAL COSTS	PERCENT
	PERSONNEL	NON-PERSONNEL	TOTAL			
HIGH ASWAN DAM	14,703,641	27,682,811	42,386,452	41,200,536	83,586,988	25.95
BARRAGES & STEM	10,987,200	15,617,623	26,604,823	112,049,207	138,654,030	43.05
ESNA BARRAGE	380,800	2,043,811	2,424,612	68,094,925	70,519,536	21.90
OTHER STEM COSTS	0	0	0	29,312,067	29,312,067	9.10
TOTAL	26,071,641	45,344,245	71,415,886	250,656,735	322,072,621	100.00

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Table D2.3
Scenario 2: Annual Costs Summary (LE)
Main Irrigation System by Regions

REGIONS	OPERATION & MAINTENANCE COSTS			CAPITAL COSTS	TOTAL COSTS
	PERSONNEL	NON-PERSONNEL	TOTAL		
UPPER EGYPT	11,250,101	20,860,026	32,110,127	10,023,756	42,133,883
MIDDLE EGYPT	13,630,885	41,729,589	55,360,475	20,052,095	75,412,569
EAST DELTA	14,209,147	43,286,967	57,496,114	20,800,453	78,296,567
MIDDLE DELTA	12,673,886	39,411,253	52,085,139	18,938,077	71,023,216
WEST DELTA	4,835,109	35,417,058	40,252,166	17,018,768	57,270,934
TOTAL - REGIONS	56,599,128	180,704,893	237,304,021	86,833,148	324,137,169

NOTE: ALL COSTS ARE CONSTANT DECEMBER 1991 PRICES

Table D2.4
Scenario 2: Annual Costs Summary (LE)
Open Drainage System

REGIONS	OPERATION & MAINTENANCE COSTS			CAPITAL COSTS	TOTAL COSTS
	PERSONNEL	NON-PERSONNEL	TOTAL		
ALL REGIONS	6,272,030	72,318,945	78,590,976	17,831,096	96,422,072
TOTAL	6,272,030	72,318,945	78,590,976	17,831,096	96,422,072

NOTE: ALL COSTS ARE CONSTANT DECEMBER 1991 PRICES

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Table D2.5
Scenario 2: Annual Costs Summary (LE)
Pump Stations by Regions

REGIONS	OPERATION & MAINTENANCE COSTS			CAPITAL COSTS	TOTAL COSTS
	PERSONNEL	NON-PERSONNEL	TOTAL		
UPPER EGYPT	4,308,864	9,522,232	13,831,097	12,305,245	26,136,342
MIDDLE EGYPT	8,619,699	19,048,818	27,668,517	24,616,116	52,284,633
EAST DELTA	8,941,392	19,759,733	28,701,125	25,534,807	54,235,932
MIDDLE DELTA	8,140,821	17,990,538	26,131,359	23,248,539	49,379,898
WEST DELTA	7,315,777	16,167,259	23,483,036	20,892,379	44,375,415
TOTAL - REGIONS	37,326,553	82,488,580	119,815,134	106,597,086	226,412,220

NOTE: ALL COSTS ARE CONSTANT DECEMBER 1991 PRICES

Table D2.6
Scenario 2: Annual Costs
(000)LE

DESCRIPTIONS		ANNUAL COSTS
A - MAIN STEM		
1 - HIGH ASWAN DAM GROUP		
CAPITAL COSTS:		
HIGH ASWAN DAM COMPLEX		18,224
WINTER CLOSURE		10,867
WATER MASTER PLAN		2,967
NILE WATER TECHNICAL COMMISSION		2,900
MPWWR HEADQUARTERS BUILDING		1,356
MAIN SYSTEM MANAGEMENT (TELEMTRY)		4,887
	SUBTOTAL	41,201
O&M COSTS:		
HAD (NON PERSONNEL)		27,683
PERSONNEL		14,704
	SUBTOTAL	42,386
	TOTAL HIGH ASWAN DAM	83,587
2 - BARRAGES & STEM GROUP		
CAPITAL COSTS:		
WATER RESEARCH CENTER (1)		34,868
REPLACEMENT OF NAG HAMMADI BARRAGE		33,373
REPLACEMENT OF ASSUIT BARRAGE		21,109
REPLACEMENT OF ZIFTA BARRAGE		11,741
STRENGTHENING OF NILE INTAKES & BARRAGES		4,616
FLUSH FLOOD PROTECTION		3,693
PROFESSIONAL DEVELOPMENT		1,248
PROJECT PREPARATION		1,402
	SUBTOTAL	112,049
O&M COSTS:		
RIVER WEED CONTROL		5,664
BARRAGES (NON PERSONNEL)		9,953
PERSONNEL		10,987
	SUBTOTAL	26,605
	TOTAL BARRAGES & STEM GROUP	138,654
3 - ESNA BARRAGE		
CAPITAL COSTS:		
ESNA BARRAGE (COMMON WORKS)		37,633
ESNA BARRAGE (ELECTRICAL WORKS)		30,462
	SUBTOTAL	68,095
O&M COSTS:		
ESNA BARRAGE (NON PERSONNEL)		2,044
PERSONNEL		381
	SUBTOTAL	2,425
	TOTAL ESNA BARRAGE	70,520
4 - OTHER STEM COSTS		
CAPITAL COSTS:		
RIVER BANK PROTECTION		27,733
RIVER TRAINING		1,579
	SUBTOTAL	29,312
TOTAL - MAIN STEM		322,072

Table D2.6
Scenario 2: Annual Costs
(000)LE

DESCRIPTIONS	ANNUAL COSTS
B - PUMP STATIONS	
CAPITAL COSTS:	
IMPROVEMENT & REPLACEMENT OF PUMP STATIONS	106,597
SUBTOTAL	106,597
O&M COSTS:	
PUMP STATIONS (NON PERSONNEL)	82,489
PERSONNEL	37,327
SUBTOTAL	119,815
TOTAL - PUMP STATIONS	226,412
C - OPEN DRAINAGE SYSTEM	
CAPITAL COSTS:	
OPEN DRAIN IMPROVEMENT & REPLACEMENT	15,096
REUSE OF DRAINAGE WATER	2,736
SUBTOTAL	17,831
O&M COSTS:	
OPEN DRAINAGE SYSTEM	72,319
PERSONNEL	6,272
SUBTOTAL	78,591
TOTAL - OPEN DRAINAGE SYSTEM	96,422
D - MAIN IRRIGATION SYSTEM (REGIONS)	
CAPITAL COSTS:	
REPLACEMENT OF SMALL STRUCTURES	28,304
IMPROEMENTS OF MAIN SYSTEM	37,553
IMPROVING IRRIGATION METHODS	2,710
GROUNDWATER WELLS	2,348
REPLACEMENT OF LARGE STRUCTURES	15,918
SUBTOTAL	86,833
O&M COSTS:	
MAIN IRRIGATION SYSTEM	178,842
WORKSHOPS AND TOOLS	1,863
PERSONNEL	56,599
SUBTOTAL	237,304
TOTAL - IRRIGATION SYSTEM - ALL REGIONS	324,137
GRAND TOTAL	969,044

NOTE: (1) INCLUDES ESTIMATED ANNUAL COST OF EXPECTED WATER RESEAECH GRANTS

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Table D2.7
Scenario 2: Annual Cost of Rehabilitation of High Aswan Dam (000 LE)

YEAR	CAPITAL COSTS					INCREMENTAL O&M COSTS				TOTAL COST	PRESENT WORTH	ANNUAL COSTS
	BLDG	CIVIL WORKS	MACHINERY & EQUIP		MISC.	BLDG	CIVIL WORKS	MACHINERY & EQUIP				
			MECH	TRANSP				MECH	TRANSP			
1992	3,270	4,664	8,742	0						16,676	14,889	1,848
1993	3,270	4,664	8,742	221						16,897	13,470	1,672
1994	3,275	4,671	8,754	222						16,922	12,045	1,495
1995	3,270	4,664	8,742	221						16,897	10,738	1,333
1996	3,173	4,526	8,483	215						16,397	9,304	1,155
1997	3,270	4,664	8,742	0						16,676	8,448	1,049
1998	3,270	4,664	8,742	221						16,897	7,643	949
1999	3,275	4,671	8,754	222						16,922	6,835	848
2000	3,270	4,664	8,742	442						17,118	6,173	766
2001	3,173	4,526	8,483	436						16,619	5,351	664
2002	3,270	4,664	8,742	221						16,897	4,857	603
2003	3,270	4,664	8,742	436						17,112	4,392	545
2004	3,275	4,671	8,754	222						16,922	3,878	481
2005	3,270	4,664	8,742	442						17,118	3,503	435
2006	3,173	4,526	8,483	436						16,619	3,036	377
2007	3,270	4,664	17,483	442						25,860	4,218	524
2008	3,270	4,664	17,483	658						26,075	3,798	471
2009	3,275	4,671	17,509	443						25,896	3,368	418
2010	3,270	4,664	17,483	657						26,074	3,027	376
2011	3,173	4,526	16,966	436						25,101	2,602	323
2012	3,270	4,664	17,483	442						25,860	2,394	297
2013	3,270	4,664	17,483	658						26,075	2,155	268
2014	3,275	4,671	17,509	664						26,119	1,927	239
2015	3,270	4,664	17,483	879						26,296	1,732	215
2016	3,173	4,526	16,966	658						25,323	1,490	185
2017	3,270	4,664	17,483	657						26,074	1,369	170
2018	3,270	4,664	17,483	658						26,075	1,223	152
2019	3,275	4,671	17,509	664						26,119	1,094	136
2020	3,270	4,664	17,483	879						26,296	983	122
2021	3,173	4,526	16,966	879						25,544	853	106
TOTAL	97,542	139,146	391,158	13,631	0	0	0	0	0	641,477	146,796	18,224

Table D2.8
Scenario 2: Annual Cost of the Winter Closure Project - Main Stem (000) LE

YEAR	CAPITAL COSTS					INCREMENTAL O&M COSTS				TOTAL COST	PRESENT WORTH	ANNUAL COSTS
		CIVIL	MACHINERY & EQUIP				CIVIL	MACHINERY & EQUIP				
	BLDG	WORKS	MECH	TRANSP	MISC.	BLDG	WORKS	MECH	TRANSP			
1992	102	9209	3,228	128	333					13,000	11,607	1,441
1993	106	9563	3,352	133	346					13,500	10,762	1,336
1994	197	17709	6,207	246	640					24,999	17,794	2,209
1995	197	17709	6,207	246	640					24,999	15,887	1,972
1996	197	17709	6,207	246	640					24,999	14,185	1,761
1997						12	1,582	1260	200	3,054	1,547	192
1998						12	1,582	1260	200	3,054	1,381	171
1999				128		12	1,582	1260	200	3,182	1,285	160
2000				133		12	1,582	1260	200	3,187	1,149	143
2001				246		12	1,582	1260	200	3,300	1,062	132
2002				246		12	1,582	1260	200	3,300	949	118
2003				246		12	1,582	1260	200	3,300	847	105
2004						12	1,582	1260	200	3,054	700	87
2005						12	1,582	1260	200	3,054	625	78
2006				128		12	1,582	1260	200	3,182	581	72
2007			3,228	133		12	1,582	1260	200	6,415	1,046	130
2008			3,352	246		12	1,582	1260	200	6,652	969	120
2009			6,207	246		12	1,582	1260	200	9,507	1,236	153
2010			6,207	246		12	1,582	1260	200	9,507	1,104	137
2011			6,207			12	1,582	1260	200	9,261	960	119
2012						12	1,582	1260	200	3,054	283	35
2013				128		12	1,582	1260	200	3,182	263	33
2014				133		12	1,582	1260	200	3,187	235	29
2015				246		12	1,582	1260	200	3,300	217	27
2016				246		12	1,582	1260	200	3,300	194	24
2017				246		12	1,582	1260	200	3,300	173	22
2018						12	1,582	1260	200	3,054	143	18
2019						12	1,582	1260	200	3,054	128	16
2020				128		12	1,582	1260	200	3,182	119	15
2021				133		12	1,582	1260	200	3,187	106	13
TOTAL	799	71,899	50,402	4,257	2,599	300	39,545	31,500	5,000	206,301	87,540	10,867

Table D2.9
Scenario 2 : Annual Cost of Preparation of Water Master Plan (000 LE)

YEAR	CAPITAL COSTS					INCREMENTAL O&M COSTS				TOTAL COST	PRESENT WORTH	ANNUAL COSTS
		CIVIL	MACHINERY & EQUIP				CIVIL	MACHINERY & EQUIP				
	BLDG	WORKS	MECH	TRANSP	MISC.	BLDG	WORKS	MECH	TRANSP			
1992	0	280	3250	0	100	0	0	0	0	3,630	3,241	402
1993	0	100	1280	0	100	0	0	0	0	1,480	1,180	146
1994	0	0	1290	0	100	0	0	0	0	1,390	989	123
1995	0	0	240	0	100	0	0	582	0	922	586	73
1996	0	0	140	0	100	0	0	606	0	846	480	60
1997	0	280	3684	0	100	0	6	620	0	4,690	2,376	295
1998	0	100	1714	0	100	0	6	620	0	2,540	1,149	143
1999	0	0	1724	0	100	0	6	620	0	2,450	989	123
2000	0	0	674	0	100	0	6	1202	0	1,982	715	89
2001	0	0	574	0	100	0	6	1226	0	1,906	614	76
2002	0	280	4118	0	100	0	11	1240	0	5,749	1,653	205
2003	0	100	2148	0	100	0	11	1240	0	3,599	924	115
2004	0	0	2158	0	100	0	11	1240	0	3,509	804	100
2005	0	0	1108	0	100	0	11	1822	0	3,041	622	77
2006	0	0	1008	0	100	0	11	1846	0	2,965	542	67
2007	0	280	4552	0	100	0	17	1860	0	6,809	1,111	138
2008	0	100	2582	0	100	0	17	1860	0	4,659	679	84
2009	0	0	2592	0	100	0	17	1860	0	4,569	594	74
2010	0	0	1542	0	100	0	17	2442	0	4,101	476	59
2011	0	0	1442	0	100	0	17	2466	0	4,025	417	52
2012	0	280	4986	0	100	0	23	2480	0	7,869	728	90
2013	0	100	3016	0	100	0	23	2480	0	5,719	473	59
2014	0	0	3026	0	100	0	23	2480	0	5,629	415	52
2015	0	0	1976	0	100	0	23	3062	0	5,161	340	42
2016	0	0	1876	0	100	0	23	3086	0	5,085	299	37
2017	0	280	5420	0	100	0	29	3100	0	8,929	469	58
2018	0	100	3450	0	100	0	29	3100	0	6,779	318	39
2019	0	0	3460	0	100	0	29	3100	0	6,689	280	35
2020	0	0	2410	0	100	0	29	3682	0	6,221	233	29
2021	0	0	2310	0	100	0	29	3706	0	6,145	205	25
TOTAL	0	2,280	69,750	0	3,000	0	428	53,628	0	129,086	23,900	2,967

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Table D2.10
Scenario 2: Annual Cost of MPWWR Headquarters Building (000 LE)

YEAR	CAPITAL COSTS					INCREMENTAL O&M COSTS				TOTAL COST	PRESENT WORTH	ANNUAL COSTS
	BLDG	CIVIL WORKS	MACHINERY & EQUIP MECH	MACHINERY & EQUIP TRANSP	MISC.	BLDG	CIVIL WORKS	MACHINERY & EQUIP MECH	MACHINERY & EQUIP TRANSP			
1992	3,000		600		140					3,740	3,339	415
1993	3,000		600		140					3,740	2,982	370
1994			600		140					740	527	65
1995			600		140					740	470	58
1996			600		140					740	420	52
1997						315		400		715	362	45
1998						315		400		715	323	40
1999						315		400		715	289	36
2000						315		400		715	258	32
2001						315		400		715	230	29
2002						315		400		715	206	26
2003						315		400		715	184	23
2004						315		400		715	164	20
2005						315		400		715	146	18
2006						315		400		715	131	16
2007						315		400		715	117	14
2008						315		400		715	104	13
2009						315		400		715	93	12
2010						315		400		715	83	10
2011						315		400		715	74	9
2012						315		400		715	66	8
2013						315		400		715	59	7
2014						315		400		715	53	7
2015						315		400		715	47	6
2016						315		400		715	42	5
2017						315		400		715	38	5
2018						315		400		715	34	4
2019						315		400		715	30	4
2020						315		400		715	27	3
2021						315		400		715	24	3
TOTAL	6,000	0	3,000	0	700	7,875	0	10,000	0	27,575	10,920	1,356

Table D2.11
Scenario 2: Annual Cost of Main System Management (Telemetry) (000) LE

YEAR	CAPITAL COSTS					INCREMENTAL O&M COSTS				TOTAL COST	PRESENT WORTH	ANNUAL COSTS
	BLDG	CIVIL WORKS	MACHINERY & EQUIP MECH	MACHINERY & EQUIP TRANSP	MISC.	BLDG	CIVIL WORKS	MACHINERY & EQUIP MECH	MACHINERY & EQUIP TRANSP			
1992	814	0	2,035	814	4,477					8,140	7,268	902
1993	669.5	0	1,674	670	3,682					6,695	5,337	663
1994	1231.5	0	3,079	1,232	6,773					12,315	8,766	1,088
1995	758.5	0	1,896	759	4,172					7,585	4,820	598
1996			608			52	0	868	695	2,223	1,261	157
1997			608			52	0	868	695	2,223	1,126	140
1998			608			52	0	868	695	2,223	1,006	125
1999			608	814		52	0	868	695	3,037	1,227	152
2000			608	670		52	0	868	695	2,893	1,043	130
2001			608	1,232		52	0	868	695	3,455	1,112	138
2002			608	759		52	0	868	695	2,982	857	106
2003			608			52	0	868	695	2,223	571	71
2004			608			52	0	868	695	2,223	509	63
2005			608			52	0	868	695	2,223	455	56
2006			608	814		52	0	868	695	3,037	555	69
2007			608	670		52	0	868	695	2,893	472	59
2008			608	1,232		52	0	868	695	3,455	503	62
2009			608	759		52	0	868	695	2,982	388	48
2010			608			52	0	868	695	2,223	258	32
2011			608			52	0	868	695	2,223	230	29
2012			608			52	0	868	695	2,223	206	26
2013			608	814		52	0	868	695	3,037	251	31
2014			608	670		52	0	868	695	2,893	213	27
2015			608	1,232		52	0	868	695	3,455	228	28
2016			608	759		52	0	868	695	2,982	175	22
2017			608			52	0	868	695	2,223	117	14
2018			608			52	0	868	695	2,223	104	13
2019			608			52	0	868	695	2,223	93	12
2020			608	814		52	0	868	695	3,037	114	14
2021			608	670		52	0	868	695	2,893	97	12
TOTAL	3,474	0	24,488	15,383	19,104	1,355	0	22,578	18,062	104,443	39,363	4,887

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Table D2.12
Scenario 2: Annual Cost of Water Research Projects (000 LE)

YEAR	CAPITAL COSTS					INCREMENTAL O&M COSTS				TOTAL COST	PRESENT WORTH	ANNUAL COSTS
		CIVIL	MACHINERY & EQUIP				CIVIL	MACHINERY & EQUIP				
	BLDG	WORKS	MECH	TRANSP	MISC.	BLDG	WORKS	MECH	TRANSP			
1992	1,307	6,859	3,550	362	859	0	0	0	0	12,937	11,551	1,434
1993	1,437	7,540	3,903	398	945	0	0	0	0	14,222	11,338	1,408
1994	1,224	6,423	3,324	339	805	0	0	0	0	12,114	8,623	1,070
1995	1,047	5,493	2,843	290	688	0	0	0	0	10,361	6,585	817
1996	930	4,880	2,526	257	611	0	0	0	0	9,205	5,223	648
1997	1,307	6,859	3,550	362	859	89	686	807	329	14,849	7,523	934
1998	1,437	7,540	3,903	398	945	89	686	807	329	16,134	7,298	906
1999	1,224	6,423	3,324	700	805	89	686	807	329	14,387	5,811	721
2000	1,047	5,493	2,843	687	688	89	686	807	329	12,670	4,569	567
2001	930	4,880	2,526	596	611	89	686	807	329	11,455	3,688	458
2002	1,307	6,859	3,550	651	859	178	1,373	1,615	658	17,050	4,902	608
2003	1,437	7,540	3,903	655	945	178	1,373	1,615	658	18,303	4,698	583
2004	1,224	6,423	3,324	700	805	178	1,373	1,615	658	16,299	3,735	464
2005	1,047	5,493	2,843	687	688	178	1,373	1,615	658	14,582	2,984	370
2006	930	4,880	2,526	958	611	178	1,373	1,615	658	13,729	2,508	311
2007	1,307	6,859	7,100	1,049	859	267	2,059	2,422	987	22,910	3,737	464
2008	1,437	7,540	7,805	994	945	267	2,059	2,422	987	24,456	3,562	442
2009	1,224	6,423	6,648	990	805	267	2,059	2,422	987	21,825	2,838	352
2010	1,047	5,493	5,686	945	688	267	2,059	2,422	987	19,594	2,275	282
2011	930	4,880	5,052	958	611	267	2,059	2,422	987	18,167	1,883	234
2012	1,307	6,859	7,100	1,049	859	357	2,745	3,229	1,316	24,821	2,297	285
2013	1,437	7,540	7,805	1,355	945	357	2,745	3,229	1,316	26,729	2,209	274
2014	1,224	6,423	6,648	1,388	805	357	2,745	3,229	1,316	24,134	1,781	221
2015	1,047	5,493	5,686	1,283	688	357	2,745	3,229	1,316	21,845	1,439	179
2016	930	4,880	5,052	1,247	611	357	2,745	3,229	1,316	20,368	1,198	149
2017	1,307	6,859	7,100	1,306	859	446	3,432	4,037	1,645	26,991	1,418	176
2018	1,437	7,540	7,805	1,355	945	446	3,432	4,037	1,645	28,641	1,343	167
2019	1,224	6,423	6,648	1,388	805	446	3,432	4,037	1,645	26,046	1,091	135
2020	1,047	5,493	5,686	1,645	688	446	3,432	4,037	1,645	24,118	902	112
2021	930	4,880	5,052	1,645	611	446	3,432	4,037	1,645	22,677	757	94
TOTAL	35,664	187,176	145,314	26,637	23,448	6,687	51,473	60,548	24,675	561,622	119,765	14,868

NOTE : THIS TABLE EXCLUDES THE COST OF GRANTS, WHICH IS ESTIMATED AT LE 20 MILLON ANNUALLY.

Table D2.13
Scenario 2: Annual Cost of Structures (000 LE) - Main Stem
Nag Hammadi Barrage

YEAR	CAPITAL COSTS					INCREMENTAL O&M COSTS				TOTAL COST	PRESENT WORTH	ANNUAL COSTS
			MACHINERY & EQUIP					MACHINERY & EQUIP				
	BLDG	CIVIL WORKS	MECH	TRANSP	MISC.	BLDG	CIVIL WORKS	MECH	TRANSP			
1992		43,587								43,587	38,917	4,831
1993		67,645	3,927							71,573	57,057	7,083
1994		94,704	7,855							102,558	72,999	9,062
1995		74,410	15,709							90,119	57,272	7,110
1996		47,352	9,818							57,170	32,440	4,027
1997		13,529	1,964							15,493	7,849	974
1998										0	0	0
1999										0	0	0
2000										0	0	0
2001										0	0	0
2002										0	0	0
2003										0	0	0
2004										0	0	0
2005										0	0	0
2006										0	0	0
2007										0	0	0
2008										0	0	0
2009										0	0	0
2010										0	0	0
2011										0	0	0
2012										0	0	0
2013			2,909							2,909	240	30
2014			3,325							3,325	245	30
2015			2,078							2,078	137	17
2016										0	0	0
2017			3,927							3,927	206	26
2018			7,855							7,855	368	46
2019			15,709							15,709	658	82
2020			9,818							9,818	367	46
2021			1,964							1,964	66	8
TOTAL	0	341,227	86,858	0	0	0	0	0	0	428,085	268,822	33,373

NOTE : CAPITAL COSTS INCLUDES PROVISIONS FOR COMPLETION OF THE NAG HAMMADI LOCK

Table D2.14
Scenario 2 : Annual Cost of Structures (000 LE) - Main Stem
Assuit Barrage

YEAR	CAPITAL COSTS					INCREMENTAL O&M COSTS				TOTAL	PRESENT	ANNUAL
		CIVIL	MACHINERY & EQUIP				CIVIL	MACHINERY & EQUIP				
	BLDG	WORKS	MECH	TRANSP	MISC.	BLDG	WORKS	MECH	TRANSP	COST	WORTH	COSTS
1992										0	0	0
1993										0	0	0
1994										0	0	0
1995										0	0	0
1996										0	0	0
1997										0	0	0
1998		47,821								47,821	21,632	2,685
1999		63,761								63,761	25,752	3,197
2000		115,568	19,003							134,571	48,528	6,024
2001		103,512	36,196							139,809	45,015	5,588
2002		55,791	30,767							86,558	24,883	3,089
2003		11,955	4,525							16,480	4,230	525
2004										0	0	0
2005										0	0	0
2006										0	0	0
2007										0	0	0
2008										0	0	0
2009										0	0	0
2010										0	0	0
2011										0	0	0
2012										0	0	0
2013										0	0	0
2014										0	0	0
2015										0	0	0
2016										0	0	0
2017										0	0	0
2018										0	0	0
2019										0	0	0
2020										0	0	0
2021										0	0	0
TOTAL	0	398,509	90,491	0	0	0	0	0	0	489,000	170,040	21,109

Table D2.15
Scenario 2: Annual Cost of Structures (000 LE) - Main Stem
Zifta Barrage

YEAR	CAPITAL COSTS					INCREMENTAL O&M COSTS				TOTAL COST	PRESENT WORTH	ANNUAL COSTS
		CIVIL	MACHINERY & EQUIP				CIVIL	MACHINERY & EQUIP				
	BLDG	WORKS	MECH	TRANSP	MISC.	BLDG	WORKS	MECH	TRANSP			
1992										0	0	0
1993										0	0	0
1994										0	0	0
1995										0	0	0
1996										0	0	0
1997										0	0	0
1998										0	0	0
1999										0	0	0
2000										0	0	0
2001		31,613								31,613	10,179	1,264
2002		47,420								47,420	13,632	1,692
2003		94,840	23,754							118,593	30,440	3,779
2004		79,033	27,147							106,180	24,334	3,021
2005		47,420	13,574							60,993	12,480	1,549
2006		15,807	3,393							19,200	3,508	435
2007										0	0	0
2008										0	0	0
2009										0	0	0
2010										0	0	0
2011										0	0	0
2012										0	0	0
2013										0	0	0
2014										0	0	0
2015										0	0	0
2016										0	0	0
2017										0	0	0
2018										0	0	0
2019										0	0	0
2020										0	0	0
2021										0	0	0
TOTAL	0	316,132	67,868	0	0	0	0	0	0	384,000	94,573	11,741

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Table D2.16
Scenario 2: Annual Cost of Structures (000 LE) - Main Stem
Strengthening of Nile Intakes & Barrages

YEAR	CAPITAL COSTS					INCREMENTAL O&M COSTS				TOTAL COST	PRESENT WORTH	ANNUAL COSTS
		CIVIL	MACHINERY & EQUIP				CIVIL	MACHINERY & EQUIP				
	BLDG	WORKS	MECH	TRANSP	MISC.	BLDG	WORKS	MECH	TRANSP			
1992	0	7,091	341	34	34					7,500	6,696	831
1993	0	3,309	159	16	16					3,500	2,790	346
1994	0	3,309	159	16	16					3,500	2,491	309
1995	0	3,309	159	16	16					3,500	2,224	276
1996	0	3,782	182	18	18					4,000	2,270	282
1997		7,091	341	34	34					7,500	3,800	472
1998		3,309	159	16	16					3,500	1,583	197
1999		3,309	159	50	16					3,534	1,427	177
2000		3,309	159	32	16					3,516	1,268	157
2001		3,782	182	34	18					4,016	1,293	161
2002		7,091	341	50	34					7,516	2,161	268
2003		3,309	159	34	16					3,518	903	112
2004		3,309	159	50	16					3,534	810	101
2005		3,309	159	32	16					3,516	719	89
2006		3,782	182	68	18					4,050	740	92
2007		7,091	682	66	34					7,873	1,284	159
2008		3,309	318	50	16					3,693	538	67
2009		3,309	318	66	16					3,709	482	60
2010		3,309	318	50	16					3,693	429	53
2011		3,782	364	68	18					4,232	439	54
2012		7,091	682	66	34					7,873	729	90
2013		3,309	318	84	16					3,727	308	38
2014		3,309	318	82	16					3,725	275	34
2015		3,309	318	66	16					3,709	244	30
2016		3,782	364	84	18					4,248	250	31
2017		7,091	682	84	34					7,891	414	51
2018		3,309	318	84	16					3,727	175	22
2019		3,309	318	82	16					3,725	156	19
2020		3,309	318	100	16					3,743	140	17
2021		3,782	364	100	18					4,264	142	18
TOTAL	0	124,800	9,000	1,632	600	0	0	0	0	136,032	37,181	4,616

Table D2.17
Scenario 2: Annual Cost of Flash Flood Protection (000 LE)

YEAR	CAPITAL COSTS					INCREMENTAL O&M COSTS				TOTAL COST	PRESENT WORTH	ANNUAL COSTS
		CIVIL	MACHINERY & EQUIP				CIVIL	MACHINERY & EQUIP				
	BLDG	WORKS	MECH	TRANSP	MISC.	BLDG	WORKS	MECH	TRANSP			
1992	0	1400	1300	100	200	0	0	0	0	3,000	2,679	333
1993	0	1400	1300	100	200	0	0	0	0	3,000	2,392	297
1994	0	1400	1300	100	200	0	0	0	0	3,000	2,135	265
1995	0	1400	1300	100	200	0	0	0	0	3,000	1,907	237
1996	0	1400	1300	100	200	0	0	0	0	3,000	1,702	211
1997	0	1400	1300	100	200	0	154	130	100	3,384	1,714	213
1998	0	1400	1300	100	200	0	154	130	100	3,384	1,531	190
1999	0	1400	1300	200	200	0	154	130	100	3,484	1,407	175
2000	0	1400	1300	200	200	0	154	130	100	3,484	1,256	156
2001	0	1400	1300	200	200	0	154	130	100	3,484	1,122	139
2002	0	1400	1300	200	200	0	308	260	200	3,868	1,112	138
2003	0	1400	1300	200	200	0	308	260	200	3,868	993	123
2004	0	1400	1300	200	200	0	308	260	200	3,868	886	110
2005	0	1400	1300	200	200	0	308	260	200	3,868	791	98
2006	0	1400	1300	300	200	0	308	260	200	3,968	725	90
2007	0	1400	2600	300	200	0	462	390	300	5,652	922	114
2008	0	1400	2600	300	200	0	462	390	300	5,652	823	102
2009	0	1400	2600	300	200	0	462	390	300	5,652	735	91
2010	0	1400	2600	300	200	0	462	390	300	5,652	656	81
2011	0	1400	2600	300	200	0	462	390	300	5,652	586	73
2012	0	1400	2600	300	200	0	616	520	400	6,036	559	69
2013	0	1400	2600	400	200	0	616	520	400	6,136	507	63
2014	0	1400	2600	400	200	0	616	520	400	6,136	453	56
2015	0	1400	2600	400	200	0	616	520	400	6,136	404	50
2016	0	1400	2600	400	200	0	616	520	400	6,136	361	45
2017	0	1400	2600	400	200	0	770	650	500	6,520	342	43
2018	0	1400	2600	400	200	0	770	650	500	6,520	306	38
2019	0	1400	2600	400	200	0	770	650	500	6,520	273	34
2020	0	1400	2600	500	200	0	770	650	500	6,620	247	31
2021	0	1400	2600	500	200	0	770	650	500	6,620	221	27
TOTAL	0	42,000	58,500	8,000	6,000	0	11,550	9,750	7,500	143,300	29,748	3,693

Table D2.18
Scenario 2: Annual Cost of Professional Development (000 LE)

YEAR	CAPITAL COSTS					INCREMENTAL O&M COSTS				TOTAL COST	PRESENT WORTH	ANNUAL COSTS
		CIVIL	MACHINERY & EQUIP				CIVIL	MACHINERY & EQUIP				
	BLDG	WORKS	MECH	TRANSP	MISC.	BLDG	WORKS	MECH	TRANSP			
1992	500	0	750	500	3250					5,000	4,464	554
1993	500	0	750	500	3250					5,000	3,986	495
1994						15	0	75	20	110	78	10
1995						15	0	75	20	110	70	9
1996						15	0	75	20	110	62	8
1997						15	0	75	20	110	56	7
1998						15	0	75	20	110	50	6
1999				500		15	0	75	20	610	246	31
2000				500		15	0	75	20	610	220	27
2001						15	0	75	20	110	35	4
2002						15	0	75	20	110	32	4
2003						15	0	75	20	110	28	4
2004						15	0	75	20	110	25	3
2005						15	0	75	20	110	23	3
2006				500		15	0	75	20	610	111	14
2007			750	500		15	0	75	20	1,360	222	28
2008			750			15	0	75	20	860	125	16
2009						15	0	75	20	110	14	2
2010						15	0	75	20	110	13	2
2011						15	0	75	20	110	11	1
2012						15	0	75	20	110	10	1
2013				500		15	0	75	20	610	50	6
2014				500		15	0	75	20	610	45	6
2015						15	0	75	20	110	7	1
2016						15	0	75	20	110	6	1
2017						15	0	75	20	110	6	1
2018						15	0	75	20	110	5	1
2019						15	0	75	20	110	5	1
2020				500		15	0	75	20	610	23	3
2021				500		15	0	75	20	610	20	3
TOTAL	1,000	0	3,000	5,000	6,500	420	0	2,100	560	18,580	10,051	1,248

Table D2.19
Scenario 2: Annual Cost of Project Preparation Project (000 LE)

YEAR	CAPITAL COSTS					INCREMENTAL O&M COSTS				TOTAL COST	PRESENT WORTH	ANNUAL COSTS
	BLDG	CIVIL WORKS	MACHINERY & EQUIP MECH	MACHINERY & EQUIP TRANSP	MISC.	BLDG	CIVIL WORKS	MACHINERY & EQUIP MECH	MACHINERY & EQUIP TRANSP			
1992	650	0	1,625	650	3575					6,500	5,804	720
1993			228			20	0	325	130	703	560	70
1994			228			20	0	325	130	703	500	62
1995			[illegible]			20	0	325	130	703	446	55
1996			228			20	0	325	130	703	399	49
1997			228			20	0	325	130	703	356	44
1998			228			20	0	325	130	703	318	39
1999			228	650		20	0	325	130	1,353	546	68
2000			228			20	0	325	130	703	253	31
2001			228			20	0	325	130	703	226	28
2002			228			20	0	325	130	703	202	25
2003			228			20	0	325	130	703	180	22
2004			228			20	0	325	130	703	161	20
2005			228			20	0	325	130	703	144	18
2006			228	650		20	0	325	130	1,353	247	31
2007			228			20	0	325	130	703	115	14
2008			228			20	0	325	130	703	102	13
2009			228			20	0	325	130	703	91	11
2010			228			20	0	325	130	703	82	10
2011			228			20	0	325	130	703	73	9
2012			228			20	0	325	130	703	65	8
2013			228	650		20	0	325	130	1,353	112	14
2014			228			20	0	325	130	703	52	6
2015			228			20	0	325	130	703	46	6
2016			228			20	0	325	130	703	41	5
2017			228			20	0	325	130	703	37	5
2018			228			20	0	325	130	703	33	4
2019			228			20	0	325	130	703	29	4
2020			228	650		20	0	325	130	1,353	51	6
2021			228			20	0	325	130	703	23	3
TOTAL	650	0	8,237	3,250	3,575	566	0	9,425	3,770	29,473	11,294	1,402

Table D2.20A
Scenario 2: Annual Cost of Esna Barrage Structure (000 LE) - Main Stem

YEAR	CAPITAL COSTS					INCREMENTAL O&M COSTS				TOTAL COST	PRESENT WORTH	ANNUAL COSTS
	BLDG	CIVIL WORKS	MACHINERY & EQUIP MECH	MACHINERY & EQUIP TRANSP	MISC.	BLDG	CIVIL WORKS	MACHINERY & EQUIP MECH	MACHINERY & EQUIP TRANSP			
1992	800	105,000	40,600	600						147,000	131,250	16,294
1993	1,000	105,625	48,000	400						155,025	123,585	15,342
1994	850	8,250	4,000	0						13,100	9,324	1,158
1995	0	21,269	16,000	0						37,269	23,685	2,940
1996	0	9,864	6,442	0						16,306	9,252	1,149
1997										0	0	0
1998										0	0	0
1999				600						600	242	30
2000				400						400	144	18
2001				0						0	0	0
2002				0						0	0	0
2003				0						0	0	0
2004										0	0	0
2005										0	0	0
2006				600						600	110	14
2007				400						400	65	8
2008				0						0	0	0
2009				0						0	0	0
2010				0						0	0	0
2011										0	0	0
2012										0	0	0
2013				600						600	50	6
2014				400						400	30	4
2015				0						0	0	0
2016				0						0	0	0
2017			40,600	0						40,600	2,132	265
2018			48,000							48,000	2,251	279
2019			4,000	600						4,600	193	24
2020			16,000	400						16,400	613	76
2021			6,442	0						6,442	215	27
TOTAL	2,650	250,008	230,084	5,000	0	0	0	0	0	487,742	303,141	37,633

NOTE (1): THIS TABLE INCLUDES THE ESTIMATED COSTS FOR COMPLETION OF CIVIL & MECHANICAL WORKS ONLY.

NOTE (2): THE AMOUNT SPENT ON CIVIL & MECHANICAL WORKS UP TO THE END OF FY 1991/92, ESTIMATED AT 149,000,000 LE, IS NOT INCLUDED.

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Table D2.20B
Scenario 2: Annual Cost of Esna Barrage Power Plant (000 LE) - Main Stem

YEAR	CAPITAL COSTS					INCREMENTAL O&M COSTS				TOTAL COST	PRESENT WORTH	ANNUAL COSTS
	POWER HOUSE	POWER PLANT	MACHINERY & EQUIP MECH	MACHINERY & EQUIP TRANSP	MISC.	POWER HOUSE	POWER PLANT	MACHINERY & EQUIP MECH	MACHINERY & EQUIP TRANSP			
1992	23,600	20,000		600						44,200	39,464	4,899
1993	8,600	105,225		400					120	114,345	91,155	11,316
1994		36,900		0		200			200	37,300	26,550	3,296
1995		52,381		0		300			200	52,881	33,607	4,172
1996		20,994		0		400			200	21,594	12,253	1,521
1997						600	2,015		200	2,815	1,426	177
1998						750	2,820		200	3,770	1,705	212
1999				600		800	4,029		200	5,629	2,273	282
2000				400		900	5,238		200	6,738	2,430	302
2001				0		950	6,044		200	7,193	2,316	288
2002				0		1,000	6,849		200	8,049	2,314	287
2003				0		1,000	7,252		200	8,452	2,169	269
2004						1,000	8,060		200	9,260	2,122	263
2005						1,000	8,060		200	9,260	1,895	235
2006				600		1,000	8,060		200	9,860	1,801	224
2007				400		1,000	8,060		200	9,660	1,576	196
2008				0		1,000	8,060		200	9,260	1,349	167
2009				0		1,000	8,060		200	9,260	1,204	149
2010				0		1,000	8,060		200	9,260	1,075	133
2011						1,000	8,060		200	9,260	960	119
2012						1,000	8,060		200	9,260	857	106
2013				600		1,000	8,060		200	9,860	815	101
2014				400		1,000	8,060		200	9,660	713	88
2015				0		1,000	8,060		200	9,260	610	76
2016				0		1,000	8,060		200	9,260	545	68
2017		20,000		0		1,000	8,060		200	29,260	1,537	191
2018		105,225				1,000	8,060		200	114,485	5,369	666
2019		36,900		600		1,000	8,060		200	46,760	1,958	243
2020		52,381		400		1,000	8,060		200	62,041	2,319	288
2021		20,994		0		1,000	8,060		200	30,254	1,010	125
TOTAL	32,200	471,000	0	5,000	0	24,899	179,327	0	5,720	718,145	245,376	30,462

NOTE (1): THIS TABLE INCLUDES THE ESTIMATED COSTS FOR COMPLETION OF ELECTRICAL WORKS ONLY.

NOTE (2): THE AMOUNT SPENT ON CONSTRUCTION OF POWER PLANT STRUCTURE UP TO THE END OF FY 1991/92, ESTIMATED AT 34,400,000 LE, IS NOT INCLUDED.

Table D2.21
Scenario 2: Annual Cost of River Bank Protection (000 LE) - Main Stem

YEAR	CAPITAL COSTS					INCREMENTAL O&M COSTS				TOTAL COST	PRESENT WORTH	ANNUAL COSTS
		CIVIL	MACHINERY & EQUIP				CIVIL	MACHINERY & EQUIP				
	BLDG	WORKS	MECH	TRANSP	MISC.	BLDG	WORKS	MECH	TRANSP			
1992	782	20,239	3,627	802	200	0	0	0	0	25,650	22,902	2,843
1993	782	20,239	3,627	802	200	0	0	0	0	25,650	20,448	2,538
1994	782	20,239	3,627	802	200	0	0	0	0	25,650	18,257	2,267
1995	782	20,239	3,627	802	200	0	0	0	0	25,650	16,301	2,024
1996	774	20,042	3,592	794	198	0	0	0	0	25,400	14,413	1,789
1997	782	20,239	3,627	802	200	59	505	272	80	26,565	13,459	1,671
1998	782	20,239	3,627	802	200	59	505	272	160	26,645	12,053	1,496
1999	782	20,239	3,627	802	200	59	505	272	240	26,725	10,794	1,340
2000	782	20,239	3,627	802	200	59	505	272	321	26,806	9,666	1,200
2001	774	20,042	3,592	794	198	59	505	272	400	26,635	8,576	1,065
2002	782	20,239	3,627	1,603	200	117	1,010	543	480	28,602	8,222	1,021
2003	782	20,239	3,627	1,603	200	117	1,010	543	560	28,682	7,362	914
2004	782	20,239	3,627	1,603	200	117	1,010	543	640	28,762	6,592	818
2005	782	20,239	3,627	1,603	200	117	1,010	543	721	28,842	5,902	733
2006	774	20,042	3,592	1,588	198	117	1,010	543	800	28,664	5,237	650
2007	782	20,239	7,254	1,603	200	176	1,515	815	880	33,464	5,459	678
2008	782	20,239	7,254	1,603	200	176	1,515	815	960	33,544	4,885	607
2009	782	20,239	7,254	1,603	200	176	1,515	815	1,040	33,624	4,372	543
2010	782	20,239	7,219	1,603	200	176	1,515	815	1,121	33,669	3,909	485
2011	774	20,042	7,219	1,588	198	176	1,515	815	1,200	33,526	3,476	431
2012	782	20,239	7,254	2,405	200	234	2,020	1,086	1,280	35,500	3,286	408
2013	782	20,239	7,254	2,405	200	234	2,020	1,086	1,360	35,581	2,940	365
2014	782	20,239	7,254	2,405	200	234	2,020	1,086	1,440	35,661	2,631	327
2015	782	20,239	7,219	2,405	200	234	2,020	1,086	1,521	35,705	2,352	292
2016	774	20,042	7,219	2,381	198	234	2,020	1,086	1,600	35,555	2,091	260
2017	782	20,239	7,254	2,405	200	293	2,525	1,358	1,680	36,735	1,929	240
2018	782	20,239	7,254	2,405	200	293	2,525	1,358	1,760	36,816	1,726	214
2019	782	20,239	7,254	2,405	200	293	2,525	1,358	1,840	36,896	1,545	192
2020	782	20,239	7,219	2,405	200	293	2,525	1,358	1,921	36,940	1,381	171
2021	774	20,042	7,219	2,381	198	293	2,525	1,358	2,000	36,790	1,228	152
TOTAL	23,400	606,000	162,900	48,000	6,000	4,388	37,875	20,363	26,008	934,933	223,395	27,733

Table D2.22
Scenario 2: Annual Cost of Structural Replacement (000 LE)
Small and Medium Size Irrigation Structures

YEAR	CAPITAL COSTS					INCREMENTAL O&M COSTS				TOTAL COST	PRESENT WORTH	ANNUAL COSTS
	BLDG	CIVIL WORKS	MACHINARY & EQUIP MECH	MACHINARY & EQUIP TRANSP	MISC.	BLDG	CIVIL WORKS	MACHINARY & EQUIP MECH	MACHINARY & EQUIP TRANSP			
1992		14,000								14,000	12,500	1,552
1993		19,000								19,000	15,147	1,880
1994		20,000								20,000	14,236	1,767
1995		23,000								23,000	14,617	1,815
1996		24,000								24,000	13,618	1,691
1997		40,670	636							41,306	20,927	2,598
1998		40,443	1,060							41,503	18,774	2,331
1999		40,142	707							40,849	16,498	2,048
2000		39,901	989							40,890	14,746	1,831
2001		39,777	1,342							41,120	13,239	1,644
2002		37,602	1,625							39,227	11,277	1,400
2003		31,694	2,332							34,026	8,734	1,084
2004		30,360	3,815							34,176	7,832	972
2005		27,025	2,755							29,780	6,094	756
2006		25,972	2,261							28,233	5,158	640
2007		25,153	2,751							27,904	4,552	565
2008		24,983	2,751							27,734	4,039	501
2009		24,788	2,698							27,486	3,574	444
2010		24,794	2,645							27,439	3,186	396
2011		24,473	2,579							27,052	2,804	348
2012		25,126	2,566							27,692	2,563	318
2013		24,743	4,060							28,803	2,380	296
2014		24,626	4,047							28,672	2,116	263
2015		24,472	3,968							28,440	1,874	233
2016		24,396	3,941							28,337	1,667	207
2017		24,423	3,941							28,364	1,490	185
2018		24,415	3,134							27,549	1,292	160
2019		24,245	3,108							27,352	1,145	142
2020		24,128	3,055							27,183	1,016	128
2021		23,954	3,002							26,956	900	112
TOTAL	0	822,306	65,767	0	0	0	0	0	0	888,073	227,994	28,304

Table D2.23
Senario 2: Annual Cost of Improvements (000 LE)
Main Irrigation System

YEAR	CAPITAL COSTS					INCREMENTAL O&M COSTS				TOTAL	PRESENT	ANNUAL
		CIVIL	MACHINERY & EQUIP				CIVIL	MACHINERY & EQUIP				
	BLDG	WORKS	MECH	TRANSP	MISC.	BLDG	WORKS	MECH	TRANSP	COST	WORTH	COSTS
1992	875	17,500	3,063	219	219					21,875	19,531	2,425
1993	875	17,500	3,063	219	219	9	175	31	2	22,092	17,611	2,186
1994	735	14,700	2,573	184	184	18	350	61	4	18,808	13,387	1,662
1995	525	10,500	1,838	131	131	25	497	87	6	13,740	8,732	1,084
1996	490	9,800	1,715	123	123	30	602	105	8	12,995	7,374	915
1997	1,938	38,750	6,781	484	484	35	700	123	9	49,304	24,979	3,101
1998	1,938	38,750	6,781	484	484	54	1,088	190	14	49,783	22,519	2,796
1999	1,628	32,550	5,696	407	407	74	1,475	258	18	42,513	17,170	2,132
2000	1,163	23,250	4,069	291	291	90	1,801	315	23	31,291	11,284	1,401
2001	1,085	21,700	3,798	271	271	102	2,033	356	25	29,641	9,544	1,185
2002	2,688	53,750	9,406	672	672	113	2,250	394	28	69,972	20,115	2,497
2003	2,688	53,750	9,406	672	672	139	2,788	488	35	70,637	18,131	2,251
2004	2,258	45,150	7,901	564	564	166	3,325	582	42	60,552	13,877	1,723
2005	1,613	32,250	5,644	403	403	189	3,777	661	47	44,986	9,205	1,143
2006	1,505	30,100	5,268	376	376	205	4,099	717	51	42,698	7,801	968
2007	2,750	55,000	9,625	688	688	220	4,400	770	55	74,195	12,103	1,502
2008	2,750	55,000	9,625	688	688	248	4,950	866	62	74,876	10,905	1,354
2009	2,310	46,200	8,085	578	578	275	5,500	963	69	64,556	8,395	1,042
2010	1,650	33,000	5,775	413	413	298	5,962	1,043	75	48,628	5,646	701
2011	1,540	30,8[illegible]	5,390	385	385	315	6,292	1,101	79	46,286	4,798	596
2012	2,750	55,000	9,625	688	688	330	6,600	1,155	83	76,918	7,119	884
2013	2,750	55,000	9,625	688	688	358	7,150	1,251	89	77,598	6,413	796
2014	2,310	46,200	8,085	578	578	385	7,700	1,348	96	67,279	4,964	616
2015	1,650	33,000	5,775	413	413	408	8,162	1,428	102	51,350	3,383	420
2016	1,540	30,800	5,390	385	385	425	8,492	1,486	106	49,009	2,883	358
2017	2,750	55,000	9,625	688	688	440	8,800	1,540	110	79,640	4,183	519
2018	2,750	55,000	9,625	688	688	468	9,350	1,636	117	80,321	3,767	468
2019	2,310	46,200	8,085	578	578	495	9,900	1,733	124	70,001	2,931	364
2020	1,650	33,000	5,775	413	413	518	10,362	1,813	130	54,073	2,021	251
2021	1,540	30,800	5,390	385	385	535	10,692	1,871	134	51,731	1,727	214
TOTAL	55,000	1,100,000	192,500	13,750	13,750	6,964	139,270	24,372	1,741	1,547,347	302,498	37,553

Table D2.24
Scenario 2: Annual Cost of Improving Irrigation Methods

YEAR	CAPITAL COSTS					INCREMENTAL O&M COSTS				TOTAL COST	PRESENT WORTH	ANNUAL COSTS
	BLDG	CIVIL WORKS	MACHINERY & EQUIP		MISC.	BLDG	CIVIL WORKS	MACHINERY & EQUIP				
			MECH	TRANSP				MECH	TRANSP			
1992	275	3050	1,050	50	575					5,000	4,464	554
1993	275	3050	1,050	50	575					5,000	3,986	495
1994	275	3050	1,050	50	575					5,000	3,559	442
1995	275	3050	1,050	50	575					5,000	3,178	394
1996	275	3050	1,050	50	575					5,000	2,837	352
1997						21	336	263	50	669	339	42
1998						21	336	263	50	669	302	38
1999				50		21	336	263	50	719	290	36
2000				50		21	336	263	50	719	259	32
2001				50		21	336	263	50	719	231	29
2002				50		21	336	263	50	719	207	26
2003				50		21	336	263	50	719	184	23
2004						21	336	263	50	669	153	19
2005						21	336	263	50	669	137	17
2006				50		21	336	263	50	719	131	16
2007			1,050	50		21	336	263	50	1,769	289	36
2008			1,050	50		21	336	263	50	1,769	258	32
2009			1,050	50		21	336	263	50	1,769	230	29
2010			1,050	50		21	336	263	50	1,769	205	25
2011			1,050			21	336	263	50	1,719	178	22
2012						21	336	263	50	669	62	8
2013				50		21	336	263	50	719	59	7
2014				50		21	336	263	50	719	53	7
2015				50		21	336	263	50	719	47	6
2016				50		21	336	263	50	719	42	5
2017				50		21	336	263	50	719	38	5
2018						21	336	263	50	669	31	4
2019						21	336	263	50	669	28	3
2020				50		21	336	263	50	719	27	3
2021				50		21	336	263	50	719	24	3
TOTAL	1,375	15,250	10,500	0	2,875	516	8,388	6,563	1,250	47,816	21,830	2,710

NOTE : THIS TABLE INCLUDES THE ESTIMATED COST OF IMPROVEMENTS TO THE MAIN IRRIGATION SYSTEM, ONLY.

Table D2.25
Scenario 2: Annual Cost of Ground Water Wells for Irrigation (000 LE)

YEAR	CAPITAL COSTS					INCREMENTAL O&M COSTS				TOTAL	PRESENT	ANNUAL
		CIVIL	MACHINERY & EQUIP				CIVIL	MACHINERY & EQUIP				
	BLDG	WORKS	MECH	TRANSP	MISC.	BLDG	WORKS	MECH	TRANSP	COST	WORTH	COSTS
1992	208	5,292	2,500	0	0					8,000	7,143	887
1993	182	4,630	2,188	0	0					7,000	5,580	693
1994	39	992	469	0	0					1,500	1,068	133
1995	39	992	469	0	0					1,500	953	118
1996	32	794	374	0	0					1,200	681	85
1997						8	279	300	0	587	297	37
1998						8	279	300	0	587	265	33
1999						8	279	300	0	587	237	29
2000						8	279	300	0	587	211	26
2001						8	279	300	0	587	189	23
2002						8	279	300	0	587	169	21
2003						8	279	300	0	587	151	19
2004						8	279	300	0	587	134	17
2005						8	279	300	0	587	120	15
2006						8	279	300	0	587	107	13
2007			2,500			8	279	300	0	3,087	503	63
2008			2,188			8	279	300	0	2,775	404	50
2009			469			8	279	300	0	1,056	137	17
2010			469			8	279	300	0	1,056	123	15
2011			374			8	279	300	0	961	100	12
2012						8	279	300	0	587	54	7
2013						8	279	300	0	587	48	6
2014						8	279	300	0	587	43	5
2015						8	279	300	0	587	39	5
2016						8	279	300	0	587	34	4
2017						8	279	300	0	587	31	4
2018						8	279	300	0	587	28	3
2019						8	279	300	0	587	25	3
2020						8	279	300	0	587	22	3
2021						8	279	300	0	587	20	2
TOTAL	500	12,700	12,000	0	0	188	6,975	7,500	0	39,863	18,916	2,348

Table D2.26
Scenario 2: Annual Cost of Structural Replacement (000 LE)
Large Structures of the Main Irrigation System

YEAR	CAPITAL COSTS					INCREMENTAL O&M COSTS				TOTAL COST	PRESENT WORTH	ANNUAL COSTS
	BLDG	CIVIL WORKS	MACHINERY & EQUIP		MISC.	BLDG	CIVIL WORKS	MACHINERY & EQUIP				
			MECH	TRANSP				MECH	TRANSP			
1992										0	0	0
1993										0	0	0
1994										0	0	0
1995										0	0	0
1996										0	0	0
1997		19125	3375							22,500	11,399	1,415
1998		19125	3375							22,500	10,178	1,264
1999		19125	3375							22,500	9,087	1,128
2000		19125	3375							22,500	8,114	1,007
2001		19125	3375							22,500	7,244	899
2002		25500	4500							30,000	8,624	1,071
2003		25500	4500							30,000	7,700	956
2004		25500	4500							30,000	6,875	854
2005		25500	4500							30,000	6,139	762
2006		25500	4500							30,000	5,481	680
2007		31875	5625							37,500	6,117	759
2008		31875	5625							37,500	5,462	678
2009		31875	5625							37,500	4,876	605
2010		31875	5625							37,500	4,354	541
2011		31875	5625							37,500	3,888	483
2012		31875	5625							37,500	3,471	431
2013		31875	5625							37,500	3,099	385
2014		31875	5625							37,500	2,767	344
2015		31875	5625							37,500	2,471	307
2016		31875	5625							37,500	2,206	274
2017		31875	9000							40,875	2,147	267
2018		31875	9000							40,875	1,917	238
2019		31875	9000							40,875	1,711	212
2020		31875	9000							40,875	1,528	190
2021		31875	9000							40,875	1,364	169
TOTAL	0	701,250	140,625	0	0	0	0	0	0	841,875	128,219	15,918

Table D2.27
Scenario 2: Annual Cost of Rehabilitation & Replacement (000) L.E.
Pump Stations

YEAR	CAPITAL COSTS					INCREMENTAL O&M COSTS				TOTAL COST	PRESENT WORTH	ANNUAL COSTS
	BLDG	CIVIL WORKS	MACHINERY & EQUIP MECH	MACHINERY & EQUIP TRANSP	MISC.	BLDG	CIVIL WORKS	MACHINERY & EQUIP MECH	MACHINERY & EQUIP TRANSP			
1992	2,424	6,034	33,463	193	83					42,197	37,676	4,677
1993	6,202	15,441	85,626	493	212					107,974	86,076	10,686
1994	9,413	23,436	129,962	748	323					163,881	116,647	14,481
1995	6,871	17,107	94,870	546	235					119,630	76,027	9,438
1996	2,526	6,289	34,876	201	87					43,978	24,954	3,098
1997	2,424	6,034	33,463	193	83					42,197	21,378	2,654
1998	6,202	15,441	85,626	493	212					107,974	48,842	6,063
1999	9,413	23,436	129,962	941	323					164,074	66,267	8,227
2000	6,871	17,107	94,870	1,039	235					120,123	43,317	5,378
2001	2,526	6,289	34,876	949	87					44,726	14,401	1,788
2002	2,424	6,034	33,463	739	83					42,743	12,288	1,525
2003	6,202	15,441	85,626	693	212					108,175	27,766	3,447
2004	9,413	23,436	129,962	941	323					164,074	37,601	4,668
2005	6,871	17,107	94,870	1,039	235					120,123	24,580	3,051
2006	2,526	6,289	34,876	1,141	87					44,919	8,206	1,019
2007	2,424	6,034	66,927	1,231	83					76,699	12,511	1,553
2008	6,202	15,441	171,252	1,441	212					194,549	28,335	3,518
2009	9,413	23,436	259,924	1,487	323					294,582	38,307	4,756
2010	6,871	17,107	189,740	1,239	235					215,193	24,985	3,102
2011	2,526	6,289	69,751	1,141	87					79,794	8,272	1,027
2012	2,424	6,034	66,927	1,231	83					76,699	7,099	881
2013	6,202	15,441	171,252	1,634	212					194,741	16,094	1,998
2014	9,413	23,436	259,924	1,979	323					295,074	21,773	2,703
2015	6,871	17,107	189,740	1,987	235					215,941	14,227	1,766
2016	2,526	6,289	69,751	1,687	87					80,340	4,726	587
2017	2,424	6,034	66,927	1,432	83					76,900	4,039	501
2018	6,202	15,441	171,252	1,634	212					194,741	9,132	1,134
2019	9,413	23,436	259,924	1,979	323					295,074	12,355	1,534
2020	6,871	17,107	189,740	2,180	235					216,134	8,080	1,003
2021	2,526	6,289	69,751	2,180	87					80,833	2,698	335
TOTAL	164,316	409,842	3,409,173	34,811	5,640	0	0	0	0	4,024,082	858,659	106,597

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Table D2.28
Scenario 2: Annual Cost of Structural Replacement (000 LE)
Open Drainage System

YEAR	CAPITAL COSTS					INCREMENTAL O&M COSTS				TOTAL COST	PRESENT WORTH	ANNUAL COSTS
		CIVIL	MACHINERY & EQUIP				CIVIL	MACHINERY & EQUIP				
	BLDG	WORKS	MECH	TRANSP	MISC.	BLDG	WORKS	MECH	TRANSP			
1992		17000			7000					24,000	21,429	2,660
1993		17000			7000					24,000	19,133	2,375
1994							510			510	363	45
1995							510			510	324	40
1996							510			510	289	36
1997							510			510	258	32
1998							510			510	231	29
1999							510			510	206	26
2000		19500					510			20,010	7,216	896
2001		19500					510			20,010	6,443	800
2002		19500					510			20,010	5,752	714
2003		19500					510			20,010	5,136	638
2004		26000					510			26,510	6,075	754
2005		26000					510			26,510	5,424	673
2006		28600					510			29,110	5,318	660
2007		29900					510			30,410	4,961	616
2008		29900					510			30,410	4,429	550
2009		31200					510			31,710	4,124	512
2010		32500					510			33,010	3,333	476
2011		32500					510			33,010	3,422	425
2012		32500					510			33,010	3,055	379
2013		32500					510			33,010	2,728	339
2014		32500					510			33,010	2,436	302
2015		31200					510			31,710	2,089	259
2016		29900					510			30,410	1,789	222
2017		28600					510			29,110	1,529	190
2018		26000					510			26,510	1,243	154
2019		22100					510			22,610	947	118
2020		19500					510			20,010	748	93
2021		19500					510			20,010	668	83
TOTAL	0	622,900	0	0	14,000	0	14,280	0	0	651,180	121,597	15,096

Table D2.29
Scenario 2: Annual Cost of Reuse of Drainage Water (000 LE)

YEAR	CAPITAL COSTS					INCREMENTAL O&M COSTS				TOTAL COST	PRESENT WORTH	ANNUAL COSTS
		CIVIL	MACHINERY & EQUIP				CIVIL	MACHINERY & EQUIP				
	BLDG	WORKS	MECH	TRANSP	MISC.	BLDG	WORKS	MECH	TRANSP			
1992	0	1,005	1,307	47	0	0	0	0	0	2,359	2,106	261
1993	0	1,005	1,307	47	0	0	0	0	0	2,359	1,881	233
1994	0	1,005	1,307	47	0	0	0	0	0	2,359	1,679	208
1995	0	1,005	1,307	47	0	0	0	0	0	2,359	1,499	186
1996	0	239	310	11	0	0	0	0	0	560	318	39
1997	0	1,005	1,307	47	0	0	94	277	40	2,770	1,403	174
1998	0	1,005	1,307	47	0	0	94	277	40	2,770	1,253	156
1999	0	1,005	1,307	94	0	0	94	277	40	2,817	1,138	141
2000	0	1,005	1,307	94	0	0	94	277	40	2,817	1,016	126
2001	0	239	310	58	0	0	94	277	40	1,018	328	41
2002	0	1,005	1,307	94	0	0	187	554	80	3,227	928	115
2003	0	1,005	1,307	58	0	0	187	554	80	3,191	819	102
2004	0	1,005	1,307	94	0	0	187	554	80	3,227	740	92
2005	0	1,005	1,307	94	0	0	187	554	80	3,227	660	82
2006	0	239	310	105	0	0	187	554	80	1,475	270	33
2007	0	1,005	2,614	141	0	0	281	831	120	4,992	814	101
2008	0	1,005	2,614	105	0	0	281	831	120	4,956	722	90
2009	0	1,005	2,614	141	0	0	281	831	120	4,992	649	81
2010	0	1,005	2,614	105	0	0	281	831	120	4,956	575	71
2011	0	239	620	105	0	0	281	831	120	2,196	228	28
2012	0	1,005	2,614	141	0	0	375	1,108	160	5,403	500	62
2013	0	1,005	2,614	152	0	0	375	1,108	160	5,414	447	56
2014	0	1,005	2,614	188	0	0	375	1,108	160	5,450	402	50
2015	0	1,005	2,614	152	0	0	375	1,108	160	5,414	357	44
2016	0	239	620	152	0	0	375	1,108	160	2,654	156	19
2017	0	1,005	2,614	152	0	0	469	1,385	200	5,825	306	38
2018	0	1,005	2,614	152	0	0	469	1,385	200	5,825	273	34
2019	0	1,005	2,614	188	0	0	469	1,385	200	5,861	245	30
2020	0	1,005	2,614	199	0	0	469	1,385	200	5,872	219	27
2021	0	239	620	199	0	0	469	1,385	200	3,112	104	13
TOTAL	0	25,554	49,842	3,256	0	0	7,029	20,775	3,000	109,4[illegible]	22,035	2,736

Table D2.30
Scenario 2: Annual Cost of River Weed Control (000 LE)

YEAR	CAPITAL COSTS					O&M COSTS				TOTAL COST	PRESENT WORTH	ANNUAL COSTS
	BLDG	CIVIL WORKS	MACHINERY & EQUIP: MECH	MACHINERY & EQUIP: TRANSP	MISC.	BLDG	WEED CONTROL	MACHINERY & EQUIP: MECH	MACHINERY & EQUIP: TRANSP			
1992							3,323			3,323	2,967	368
1993							4,103			4,103	3,271	406
1994							4,882			4,882	3,475	431
1995							5,661			5,661	3,598	447
1996							6,440			6,440	3,654	454
1997							6,440			6,440	3,263	405
1998							6,440			6,440	2,913	362
1999							6,440			6,440	2,601	323
2000							6,440			6,440	2,322	288
2001							6,440			6,440	2,074	257
2002							6,440			6,440	1,851	230
2003							6,440			6,440	1,653	205
2004							6,440			6,440	1,476	183
2005							6,440			6,440	1,318	164
2006							6,440			6,440	1,177	146
2007							6,440			6,440	1,051	130
2008							6,440			6,440	938	116
2009							6,440			6,440	836	104
2010							6,440			6,440	748	93
2011							6,440			6,440	668	83
2012							6,440			6,440	596	74
2013							6,440			6,440	532	66
2014							6,440			6,440	475	59
2015							6,440			6,440	424	53
2016							6,440			6,440	379	47
2017							6,440			6,440	338	42
2018							6,440			6,440	302	37
2019							6,440			6,440	270	33
2020							6,440			6,440	241	30
2021							6,440			6,440	215	27
TOTAL	0	0	0	0	0	0	185,419	0	0	185,419	45,627	5,664

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Table D2.31
Scenario 2: Annual Cost of O&M (000 LE)
Main Irrigation System - All Regions

YEAR	CAPITAL COSTS					O&M COSTS				TOTAL	PRESENT	ANNUAL
		CIVIL	MACHINERY & EQUIP				ALL	MACHINERY & EQUIP				
	BLDG	WORKS	MECH	TRANSP	MISC.	BLDG	WORKS	MECH	TRANSP	COST	WORTH	COSTS
1992							134,406			134,406	120,006	14,898
1993							140,158			140,158	111,733	13,871
1994							152,344			152,344	108,435	13,462
1995							177,404			177,404	112,743	13,996
1996							190,689			190,689	108,202	13,433
1997							195,330			195,330	98,960	12,285
1998							196,952			196,952	89,091	11,060
1999							197,580			197,580	79,799	9,907
2000							197,849			197,849	71,346	8,857
2001							198,130			198,130	63,793	7,919
2002							198,130			198,130	56,958	7,071
2003							198,130			198,130	50,855	6,313
2004							198,130			198,130	45,406	5,637
2005							198,130			198,130	40,541	5,033
2006							198,130			198,130	36,198	4,494
2007							198,130			198,130	32,319	4,012
2008							198,130			198,130	28,857	3,582
2009							198,130			198,130	25,765	3,199
2010							198,130			198,130	23,004	2,856
2011							198,130			198,130	20,540	2,550
2012							198,130			198,130	18,339	2,277
2013							198,130			198,130	16,374	2,033
2014							198,130			198,130	14,620	1,815
2015							198,130			198,130	13,053	1,620
2016							198,130			198,130	11,655	1,447
2017							198,130			198,130	10,406	1,292
2018							198,130			198,130	9,291	1,153
2019							198,130			198,130	8,296	1,030
2020							198,130			198,130	7,407	920
2021							198,130			198,130	6,613	821
TOTAL	0	0	0	0	0	0	5,743,444	0	0	5,743,444	1,440,604	178,842

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Table D2.32
Scenario 2: Annual Cost of O&M (000 LE)
Open Drainage System - All Regions

YEAR	CAPITAL COSTS					O&M COSTS				TOTAL	PRESENT	ANNUAL
		CIVIL	MACHINERY & EQUIP				ALL	MACHINERY & EQUIP				
	BLDG	WORKS	MECH	TRANSP	MISC.	BLDG	WORKS	MECH	TRANSP	COST	WORTH	COSTS
1992							8,663			8,663	7,735	960
1993							13,737			13,737	10,951	1,360
1994							21,855			21,855	15,556	1,931
1995							37,463			37,463	23,809	2,956
1996							56,119			56,119	31,843	3,953
1997							78,469			78,469	39,755	4,935
1998							93,999			93,999	42,520	5,279
1999							107,281			107,281	43,329	5,379
2000							117,058			117,058	42,212	5,240
2001							119,120			119,120	38,353	4,761
2002							119,120			119,120	34,244	4,251
2003							119,120			119,120	30,575	3,796
2004							119,120			119,120	27,299	3,389
2005							119,120			119,120	24,374	3,026
2006							119,120			119,120	21,763	2,702
2007							119,120			119,120	19,431	2,412
2008							119,120			119,120	17,349	2,154
2009							119,120			119,120	15,490	1,923
2010							119,120			119,120	13,831	1,717
2011							119,120			119,120	12,349	1,533
2012							119,120			119,120	11,026	1,369
2013							119,120			119,120	9,844	1,222
2014							119,120			119,120	8,790	1,091
2015							119,120			119,120	7,848	974
2016							119,120			119,120	7,007	870
2017							119,120			119,120	6,256	777
2018							119,120			119,120	5,586	693
2019							119,120			119,120	4,987	619
2020							119,120			119,120	4,453	553
2021							119,120			119,120	3,976	494
TOTAL	0	0	0	0	0	0	3,036,159	0	0	3,036,159	582,542	72,319

Table D2.33
Scenario 2: Annual Cost of O&M (000) L.E.
Directorate's Workshops & Tools

YEAR	CAPITAL COSTS					INCREMENTAL O&M COSTS				TOTAL COST	PRESENT WORTH	ANNUAL COSTS
	BLDG	CIVIL WORKS	MACHINERY & EQUIP MECH	MACHINERY & EQUIP TRANSP	MISC.	BLDG	CIVIL WORKS	MACHINERY & EQUIP MECH	MACHINERY & EQUIP TRANSP			
1992	1200		1,770							2,970	2,652	329
1993	1200		1,770			18		35		3,024	2,410	299
1994	1200		1,770			36		71		3,077	2,190	272
1995	1200		1,770			54		106		3,130	1,989	247
1996	1200		1,770			72		142		3,184	1,807	224
1997			620			90		180		890	451	56
1998			620			90		180		890	402	50
1999			620			90		180		890	359	45
2000			620			90		180		890	321	40
2001			620			90		180		890	286	36
2002			620			90		180		890	256	32
2003			620			90		180		890	228	28
2004			620			90		180		890	204	25
2005			620			90		180		890	182	23
2006			620			90		180		890	163	20
2007			620			90		180		890	145	18
2008			620			90		180		890	130	16
2009			620			90		180		890	116	14
2010			620			90		180		890	103	13
2011			620			90		180		890	92	11
2012			620			90		180		890	82	10
2013			620			90		180		890	74	9
2014			620			90		180		890	66	8
2015			620			90		180		890	59	7
2016			620			90		180		890	52	6
2017			620			90		180		890	47	6
2018			620			90		180		890	42	5
2019			620			90		180		890	37	5
2020			620			90		180		890	33	4
2021			620			90		180		890	30	4
TOTAL	6,000	0	24,340	0	0	2,430	0	4,855	0	37,625	15,008	1,863

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Table D2.34
Scenario 2: Annual Cost of O&M (000 LE)
High Aswan Dam Group - Non-Personnel Costs

YEAR	CAPITAL COSTS					NON PERSONNEL COSTS				TOTAL COST	PRESENT WORTH	ANNUAL COSTS
		CIVIL	MACHINERY & EQUIP				HIGH ASWAN DAM COMPLEX		OTHER			
	BLDG	WORKS	MECH	TRANSP	MISC.	BLDG	CIVIL	MECH	WORKS			
1992							1,594	532	13,540	15,665	13,987	1,736
1993							1,600	534	13,540	15,674	12,495	1,551
1994							1,664	555	13,540	15,759	11,217	1,393
1995							1,962	655	13,540	16,157	10,268	1,275
1996							2,883	962	13,540	17,384	9,864	1,225
1997							4,944	1,649	13,540	20,132	10,199	1,266
1998							8,329	2,777	13,540	24,646	11,149	1,384
1999							12,405	4,136	13,540	30,081	12,149	1,508
2000							16,128	5,377	13,540	35,044	12,637	1,569
2001							18,909	6,304	13,540	38,752	12,477	1,549
2002							20,758	6,920	13,540	41,217	11,849	1,471
2003							21,923	7,308	13,540	42,771	10,978	1,363
2004							22,647	7,550	13,540	43,736	10,023	1,244
2005							23,100	7,701	13,540	44,340	9,073	1,126
2006							23,388	7,797	13,540	44,725	8,171	1,014
2007							23,575	7,859	13,540	44,974	7,336	911
2008							23,699	7,900	13,540	45,139	6,574	816
2009							23,782	7,928	13,540	45,250	5,884	730
2010							23,840	7,950	13,540	45,330	5,263	653
2011							24,000	8,000	13,540	45,540	4,721	586
2012							24,000	8,000	13,540	45,540	4,215	523
2013							24,000	8,000	13,540	45,540	3,764	467
2014							24,000	8,000	13,540	45,540	3,360	417
2015							24,000	8,000	13,540	45,540	3,000	372
2016							24,000	8,000	13,540	45,540	2,679	333
2017							24,000	8,000	13,540	45,540	2,392	297
2018							24,000	8,000	13,540	45,540	2,136	265
2019							24,000	8,000	13,540	45,540	1,907	237
2020							24,000	8,000	13,540	45,540	1,702	211
2021							24,000	8,000	13,540	45,540	1,520	189
TOTAL	0	0	0	0	0	0	541,130	180,392	406,191	1,127,713	222,990	27,683

Table D2.35
Scenario 2: Annual Cost of Maintenance (000 LE)
Barrages & Main Stem Group (Non-Personnel Costs)

YEAR	CAPITAL COSTS					NON PERSONNEL COSTS				TOTAL COST	PRESENT WORTH	ANNUAL COSTS
		CIVIL	MACHINERY & EQUIP				CIVIL	MACHINERY & EQUIP				
	BLDG	WORKS	MECH	TRANSP	MISC.	BLDG	WORKS	MECH	TRANSP			
1992							581	939		1,520	1,357	168
1993							668	1,080		1,748	1,393	173
1994							769	1,242		2,010	1,431	178
1995							884	1,428		2,312	1,469	182
1996							1,043	1,685		2,728	1,548	192
1997							1,656	2,676		4,332	2,195	272
1998							2,637	4,259		6,896	3,119	387
1999							2,900	4,685		7,585	3,064	380
2000							3,190	5,154		8,344	3,009	374
2001							3,509	5,669		9,178	2,955	367
2002							4,247	6,861		11,108	3,193	396
2003							5,877	9,493		15,370	3,945	490
2004							7,718	12,467		20,185	4,626	574
2005							9,279	14,990		24,269	4,966	616
2006							10,159	16,410		26,569	4,854	603
2007							10,713	17,305		28,018	4,570	567
2008							11,057	17,862		28,919	4,212	523
2009							11,273	18,210		29,483	3,834	476
2010							11,410	18,431		29,841	3,465	430
2011							11,499	18,575		30,074	3,118	387
2012							11,558	18,670		30,228	2,798	347
2013							11,597	18,734		30,332	2,507	311
2014							11,625	18,779		30,403	2,243	279
2015							11,700	18,900		30,600	2,016	250
2016							11,700	18,900		30,600	1,800	223
2017							11,700	18,900		30,600	1,607	200
2018							11,700	18,900		30,600	1,435	178
2019							11,700	18,900		30,600	1,281	159
2020							11,700	18,900		30,600	1,144	142
2021							11,700	18,900		30,600	1,021	127
TOTAL	0	0	0	0	0	0	227,749	367,903	0	595,652	80,176	9,953

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Table D2.36
Scenario 2: Annual Cost of Maintenance (000 LE)
Esna Barrage Non Personnel Costs

YEAR	CAPITAL COSTS					INCREMENTAL O&M COSTS				TOTAL COST	PRESENT WORTH	ANNUAL COSTS
	BLDG	CIVIL WORKS	MACHINERY & EQUIP		MISC.	BLDG	CIVIL WORKS	MACHINERY & EQUIP				
			MECH	TRANSP				MECH	TRANSP			
1992							260	340		600	536	67
1993							260	340		600	478	59
1994							260	340		600	427	53
1995							290	363		653	41[illegible]	52
1996							291	549		840	477	59
1997							318	1,016		1,334	676	84
1998							547	1,422		1,969	891	111
1999						40	1,120	1,610		2,770	1,119	139
2000						40	1,620	1,684		3,343	1,206	150
2001						40	1,851	1,714		3,604	1,160	144
2002						40	1,941	1,727		3,708	1,066	132
2003						40	1,978	1,740		3,758	964	120
2004						40	1,994	1,740		3,773	865	107
2005						40	2,010	1,740		3,790	776	96
2006						40	2,010	1,740		3,790	692	86
2007						40	2,010	1,740		3,790	618	77
2008						40	2,010	1,740		3,790	552	69
2009						40	2,010	1,740		3,790	493	61
2010						40	2,010	1,740		3,790	440	55
2011						40	2,010	1,740		3,790	393	49
2012						40	2,010	1,740		3,790	351	44
2013						40	2,010	1,740		3,790	313	39
2014						40	2,010	1,740		3,790	280	35
2015						40	2,010	1,740		3,790	250	31
2016						40	2,010	1,740		3,790	223	28
2017						40	2,010	1,740		3,790	199	25
2018						40	2,010	1,740		3,790	178	22
2019						40	2,010	1,740		3,790	159	20
2020						40	2,010	1,740		3,790	142	18
2021						40	2,010	1,740		3,790	127	16
TOTAL	0	0	0	0	0	914	46,905	44,164	0	91,983	16,463	2,044

NOTE: THIS TABLE EXCLUDES THE COST OF POWER PLANT O&M.

Table D2.37
Scenario 2: Annual Cost of O&M (000 LE)
Pump Stations' Non Personnel Costs

YEAR	CAPITAL COSTS					NON PERSONNEL COSTS				TOTAL COST	PRESENT WORTH	ANNUAL COSTS
	BLDG	CIVIL WORKS	MACHINERY & EQUIP MECH	MACHINERY & EQUIP TRANSP	MISC.	ELEC	MISC. WORKS	MECH WORKS	OTHER			
1992						66,705	7,404	15,308	5,136	94,552	84,421	10,480
1993						66,705	7,404	15,308	5,136	94,552	75,376	9,357
1994						66,705	7,404	15,308	5,136	94,552	67,300	8,355
1995						66,705	7,404	15,308	5,136	94,552	60,089	7,460
1996						66,705	7,404	15,308	5,136	94,552	53,651	6,660
1997						59,234	7,404	10,513	5,136	82,286	41,688	5,175
1998						59,234	7,404	10,513	5,136	82,286	37,222	4,621
1999						59,234	7,404	10,513	5,136	82,286	33,234	4,126
2000						59,234	7,404	10,513	5,136	82,286	29,673	3,684
2001						59,234	7,404	10,513	5,136	82,286	26,494	3,289
2002						51,763	7,404	5,718	5,136	70,020	20,129	2,499
2003						51,763	7,404	5,718	5,136	70,020	17,972	2,231
2004						51,763	7,404	5,718	5,136	70,020	16,047	1,992
2005						51,763	7,404	5,718	5,136	70,020	14,327	1,779
2006						51,763	7,404	5,718	5,136	70,020	12,792	1,588
2007						45,359	7,404	1,607	5,136	59,506	9,707	1,205
2008						45,359	7,404	1,607	5,136	59,506	8,667	1,076
2009						45,359	7,404	1,607	5,136	59,506	7,738	961
2010						45,359	7,404	1,607	5,136	59,506	6,909	858
2011						45,359	7,404	1,607	5,136	59,506	6,169	766
2012						45,359	7,404	1,607	5,136	59,506	5,508	684
2013						45,359	7,404	1,607	5,136	59,506	4,918	611
2014						45,359	7,404	1,607	5,136	59,506	4,391	545
2015						45,359	7,404	1,607	5,136	59,506	3,920	487
2016						45,359	7,404	1,607	5,136	59,506	3,500	435
2017						45,359	7,404	1,607	5,136	59,506	3,125	388
2018						45,359	7,404	1,607	5,136	59,506	2,790	346
2019						45,359	7,404	1,607	5,136	59,506	2,491	309
2020						45,359	7,404	1,607	5,136	59,506	2,225	276
2021						45,359	7,404	1,607	5,136	59,506	1,986	247
TOTAL	0	0	0	0	0	1,568,890	222,110	181,802	154,068	2,126,870	664,461	82,489

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APPENDIX E

PROCEDURES FOR ESTIMATING REGIONAL COSTS AND BENEFITS

The following is a brief description of the procedures followed in developing costs and benefits at the regional level

E.1 Representative Directorate, D

Item	Costs	Benefits
Total for directorate	C_d	B_d
Navigable canals in directorate		
* Total	C_l	B_l
* Agriculture	C_{la}	B_{da}
* Navigation	C_{ln}	B_{ln}
* Water Supply	C_{ls}	B_{ds}
All other canals in directorate		
* Total	C_o	$B_{da} + B_{ds} = B_d - B_{ln}$
* Agriculture	C_{oa}	B_{da}
* Water Supply	C_{os}	B_{ds}

Estimates and calculations

- C_d - total O & M costs for the directorate estimated from field data = $C_l + C_o$
- C_l - total O & M for the navigable canals within the directorate estimated from available field data[1].
- B_{da} - estimated net benefits from all agriculture within the directorate. As indicated by Table (4.1), benefits from agriculture are estimated as net primary returns, to the land and water as a single production unit[2]. A detailed description of the manner in which these benefits are estimated in this study is given by Appendix F.
- B_{ln} - estimated navigation benefits from available data and comparison with the next most feasible transportation alternative (e.g. rail).
- B_{ds} - estimated water supply benefits to village and industries within the directorate[3].
- C_{la}, C_{ln}, C_{ls} - allocated joint O&M costs for the navigable canals within the directorate obtained by partitioning C_l
- C_o - total joint O&M costs for all other (non-navigable) canals within the directorate = $C_d - C_l$.
- C_{oa}, C_{os} - allocated joint O&M costs for all non-navigable canals within the directorate obtained by partitioning C_o
- C_{da}, C_{dn}, C_{ds} - total directorate O&M costs for agriculture, navigation, and water supply, respectively.

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$C_{da} = C_{la} + C_{oa}$
$C_{dn} = C_{ln}$
$C_{ds} = C_{ls} + C_{os}$
$\parallel \quad \parallel \quad \parallel$
$C_d = C_l + C_o$

Cost ratios for navigable canals case:
C_{da}/C_d, C_{dn}/C_d, C_{ds}/C_d
cost ratios for non-navigable canals case, $C_o = C_d$
C_{oa}/C_o, C_{os}/C_o

Notes

1.
$$C_l = \left(P_l \frac{L_l}{(P_o L_o + P_l L_l)} \right) C_d$$

in which,

C_l and C_d are as defined above.
P_l = average wetted perimeter for the navigable canals within the directorate.

$$P_l = \sum_{i=1}^{n} \frac{P_{li} l_i}{L_l}$$

in which,

P_{li} = wetted perimeter of navigable canal section of order i and length l.

L_l = total length of navigable canals within the directorate.

n = highest order of navigable canals within the directorate.

P_o = average wetted perimeter for all non-navigable canals within the directorate

$$P_o = \sum_{j=n+1}^{m} \frac{P_{oj} l_j}{L_o}$$

in which,

P_{oj} = wetted perimeter of non-navigable canal section of order j

L_j = length of the canal section of order j.

L_o = total length of all non-navigable canals within the directorate

n = highest order of navigable canals within the directorate

m = highest order canal section within the directorate

2. Agricultural benefits are taken as net primary returns taking land and water as a single, non-separable production unit, Appendix F. OM&R costs for canals are allocated between the users of the canals. However, the R portion refers mainly to replacement costs for control and turn-out structures which are needed for irrigation. Thus, increased equity would be achieved if these costs could be identified and assigned as specific costs to agriculture. At the present stage of the analysis this separation is not possible

3. Individual residences, villages, and industries which are not near the Nile River channel draw water supplies either directly from the canals or pump from the shallow groundwater aquifer beneath the agricultural lands (see Table 4.1,note 4). Since the groundwater aquifers are largely recharged by both canal seepage losses and from deep percolation from the irrigated fields, it is considered that all sources of water supply (except the Nile River as a direct source), whether surface or subsurface, results from the canal system, and thus the users are beneficiaries. Benefits are derived from estimates of the incremental costs of the next most feasible water supply systems above the costs of the present systems. In the case of this study, the next most feasible source of supply is assumed to be pumping from the deep aquifer underlying the irrigated lands. Apparently, this aquifer is recharged from the Nile River and is separated from the shallow aquifer by a clay layer of low permeability.

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E.2 Region, R

E.2.1 Canals

Item	Costs	Benefits
Total for directorate	C_r	B_r
Navigable canals within the region:		
* Total	C_{rl}	B_{rl}
* Agriculture	C_{rla}	B_{ra}
* Navigation	C_{rln}	B_{rln}
* Water Supply	C_{rls}	B_{rs}
All other canals within the region		
* Total	C_{ro}	$B_{ra} + B_{rs} = Br - B_{rln}$
* Agriculture	C_{roa}	B_{ra}
* Water Supply	C_{ros}	B_{rs}

E.2.2 Pumps

1. **Pumps**- All OM&R costs for the pumps, including those within the irrigated areas, are lumped together into a single figure. If costs could be associated with particular facilities, costs could be allocated on the basis of benefits provided to agriculture, water supply, and navigation by each installation. However, until these data are available, these costs will be allocated on the basis of the system wide benefits to water supply and irrigation as estimated above. As previously stated, it is assumed that the pumps provide no benefits to navigation.
For the purpose of this analysis the system-wide pumping costs (OM&R) will be divided among the five selected regions on the basis of irrigated area in each region. Thus,

$$C_{pri} = \left(\frac{A_{ri}}{A_T}\right) C_{PT}$$

in which,

C_{pri} = OM&R pumping costs for region i.

A_{ri} = area of irrigated agriculture in region i

A_T = area of irrigated agriculture within the total system.

C_{PT} = total system-wide OM&R costs for pumping.

C_{pri} will be allocated to agriculture and water supply in each region on the basis of the regional agriculture benefits, B_{ra}, and water supply benefits, B_{rs}.

Estimates and calculations

C_r - total O&M costs for the region estimated from field data[1]

C_{rl} - total O&M for the navigable canals within the region estimated from available field data[2].

B_{ra} - estimated net benefits from all agriculture within the region[3].

B_{rln} - estimated navigation benefits from available data on navigable canals within the region[4].

B_{rs} - estimated water supply benefits to village and industries within the region[5].

C_{rla} - , C_{rln}, C_{rls} - allocated joint O&M costs for the navigable canals within the region obtained by partitioning C_{rl} using B_{ra}, B_{rln}, and B_{rs}.

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C_{ro} - total joint O&M costs for all non-navigable canals within the region = $C_r - C_{rl}$.

C_{roa} - C_{ros} allocated joint O&M costs for all non-navigable canals within the region obtained by partitioning C_{ro} using B_{ra} and B_{rs}.

C_{ra}, C_{Rn}, C_{rs} - total O&M costs for the region for agriculture, navigation, and water supply, respectively.

$$
\begin{aligned}
C_{ra} &= Cl_{ra} + C_{roa} \\
C_{Rn} &= C_{rln} \\
C_{rs} &= C_{rls} + C_{ros} \\
\| \quad & \quad \| \quad \quad \| \\
C_r &= C_{rl} + C_{ro}
\end{aligned}
$$

Notes

1. The total O&M costs for the region are estimated from field data. The OM&R costs for all pumps within a region, including those for pumps on the Nile River (if any), enter into these costs. OM&R costs for pumps, together with O&M costs for non-navigable canals, are allocated between agriculture and water supply. Apparently, there is only one canal in the entire system which is supplied by pumps and which is used for navigation.

2. The total O&M costs for navigable canals within the region are assumed to be proportional to those of the representative directorate. Thus,

$$C_{rl} = \left(\frac{C_l}{C_d}\right) C_r$$

in which C_l and C_d are the O&M costs for the navigable canals within the directorate and the total directorate costs, respectively, and C_r represents the total O&M costs for the region.

3. B_{ra} is taken as being proportional to the irrigated area within the region. Thus,

$$B_{ra} = \left(\frac{A_r}{A_d}\right) B_{da}$$

in which A_r and A_d are the irrigated areas in the region and representative directorate, respectively, and B_{da} is the estimated net benefit to agriculture in the directorate.

4. B_{rl} is taken as being directly proportional to the length of navigable canal in the directorate, L_{dl}, and the region, L_{rl}. Thus,

$$B_{rln} = \left(\frac{L_{rl}}{L_{dl}}\right) B_{ln}$$

5. B_{rs} is taken as being proportional to the human population of the region, P_r, and of the directorate, P_d. Thus,

$$B_{rs} = \left(\frac{P_r}{P_d}\right) B_{ds}$$

All costs and benefits for specific uses as defined above are summed across the five regions of the Nile River system identified for this study.

APPENDIX F

ESTIMATION OF USER BENEFITS AND SINGLE PURPOSE ALTERNATIVE COSTS

F.1 Input for the High Aswan Dam

This Appendix includes examples of user benefits and single purpose alternative cost estimation. The procedure for these estimations are identified in chapter 3 Tables 3.1 and 3.2.

Table F.1 The High Aswan Dam

HAD BENEFITS		
HYDROPOWER (An. mil LE): (1)	5625	
GROUND TRANSP (Cap and O&M (mil LE)): (2)	35	0.18
FISHERY (An. mil LE): (3)	60	
FLOOD CONTROL (% of total benefits): (4)	4	
SINGLE PURPOSE ALTERNATIVES		
AG, NAV, POWER, FISH (% of OM&R): (5)	74	
RURAL WATER SUPPLY (Cap and O&M mil LE): (6)	--	--
GROUND TRANSP (Cap and O&M (mil LE)): (7)	35	0.18
FLOOD CONTROL (% of OM&R): (8)	44	
COMMON WORKS REPLACEMENT (mil LE): (9)	5600	
SEPARABLE COSTS		
AGRICULTURE (% of O&M):	0	
POWER (% of O&M):	0	
FLOOD (% of O&M):	26	
ANNUAL COMMON WORKS O&M (mil LE):	48.4	

Notes for Table F.1

(1) Hydropower benefit = Cost savings over thermal energy =
generated power (thermal-hydro) cost
thermal power cost = 0.568 LE/Kwh (1991)
hydropwer cost = 0.004 LE/Kwh
Total energy generated at the HAD and old Aswan Plants = 9974 million Kwh

<u>Source</u>: Egyptian Electricity Authority [1990].

(2) Benefit = cost of bridge at dam site = 35 million LE
O&M = 0.5% of capital cost

<u>Source</u>: Ministry of Transport [1991]

(3) Benefit = harvest x net market value of the fish harvest
harvest from Lake Nasser = 17.5 x 10^3 tons
harvest from Nile River Main Stem = 12.5 x 10^3 tons

total harvest = 30 x 10^3 tons
net market value = 2000 LE/ton
Total value = 60 million LE

Source : Academy of Science & Technology,Report on Fishery [1991]

(4) Benefit= 4% of total benefit of HAD

Source: Abul Atta (1978), updated.

(5) % OM&R for Ag., NAv., Power, Fish. = $\frac{Live\ Storage + Dead\ Storage}{Total\ storage} \times 100 = \frac{(90+30)}{162} = 74$

(6) Cost is assumed to exceed the summation of the regional benefits

(8) Cost of a bridge at Aswan = 35 million LE
O&M = 0.5%

(7) % OM&R for Flood Control = $\frac{(flood\ storage + dead\ storage)}{(total\ storage)} = \frac{(42+30)}{162} \times 100 = 44$

(9) Cost of HAD (main body only) in 1970 = 120 million LE
Assume a 12% inflation rate over 22 years.
Cost = 1450 million LE
Assume 1/2 the cost in LE. The exchange rate has changed from LE = \$2 to LE = \$0.30 in December 1991.
Multiply 1/2 the cost by $\left(\frac{2.00}{0.30}\right)$ = 4840 x million LE
Total estimated cost in December 1991 prices
= (726 + 4840) 10^6 = 5566 million LE
Use cost = 5600 million LE

(10) % of O&M = 42/162 x 100 = 26

F.2 Input for the Main Stem Barrages

Table F.2 Main Stem of the Nile

BENEFITS		
NAVIGATION (An. mil LE): (1)	36	
HYDROPOWER - ESNA (An.mil LE): (2)	300	
GROUND TRANSP (Cap and O&M (mil LE)): (3)	220	1
RECREATION & TOURISM (An. mil LE): (4)	920	
SINGLE PURPOSE ALTERNATIVES		
G. TRANSP (Cap and O&M (mil LE)):	220	1.1
Common Work Replacement (mil LE): (5)	3600	

Notes for Table F.2 :

(1) Navigation Benefit = Cost saving over shipping by rail

Traffic flow = 2391 million ton Km/Year
Cost by rail = 0.04 LE/ton-Km
Cost by river = 0.025 LE/ton-Km

Sources:
- Egypt National Transport Plan Report [1981]
- Actual Situation of inland Water Transport [1988], updated through Personal communication

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(2) Energy generated at Esna = 530 million Kwh
Benefit (see note 1 sec. F.1)

(3) Benefit = Total Cost of bridges at the existing barrages
= 105 million LE (Esna, Nag-Hammadi, and Assuit)
+ 75 million LE (Delta barrages, Faraskour barrage)
+ 40 x million LE (Zifta and Edfina barrages) = 220 million LE

O&M = .5%
Source: Ministry of Transport (Personal Communication)

(4) No. of Floating Hotels = 157
Average number of cabins (double room) = 55
95% occupancy (Nov.-Feb.)
75% occupancy March, April- Sept., Oct.
rate per cabin = 400 LE/day
operation, maintenance and service costs = 35% of total Revenue
Source: Tourism Autority and River Transport (Personal Communication)

(5) The estimated replacement cost for main stem barrages except Esna barrage (Scenario 2) is 3600 millionion LE.

Source: MPWWRn Dams and Main Barrages Sector (personal communication)

F.3 Input for Old Land Region

Table F.3 Input for Old Region

WETTED PERIMETER OF CANALS (meters): (1)	--	
PERCENT OF CANALS NAVIGABLE (%): (2)	--	
BENEFITS		
AGRICULTURE (An. mil LE): (see sec F.5)		
RURAL WATER SUPPLY (Cap and O&M (mil LE)): (3)	0.58	0.029
NAVIGATION (An. mil LE): (4)	1.43	
SINGLE PURPOSE ALTERNATIVES		
CANAL REPLACEMENT (mil LE): (5)	571	
RURAL WATER SUPPLY (An. OM&R mil LE): (6)	--	
COSTS		
CANAL O&M (An. mil LE):	33.7	
SYSTEM PUMPS OM&R (An. mil LE):	21.2	

Notes to Table F.3

(1) Wetted Perimeter = average wetted perimeter of the canals in the representative directorate.

(2) Percent of canal navigable =
$$\left(\frac{(Navigable\,canal\,wetted\,perimeter)}{(Total\,wetted\,perimeter)} x \frac{(Navigable\,canal\,lengths)}{(Total\,canal\,lengths)}\right)100 = \left(\frac{91.4}{71.8} x \frac{35}{1137.2}\right)100 = 3.9 (For\,Middle\,Egypt)$$

(3) Kena (Upper Egypt) has been taken as representative directorate
Rural water supply requirement from the irrigation system = 1.5 mil. m^3/year
The Kena Directorate benefit is the cost of pumping estimated at 0.174 mil LE/year + 5% O&M

Population of Kena Directorate is 2.30 million
Population of Upper Egypt is 7.70 million
Therefore, the region benefit = 0.174 x 7.7/2.31= 0.58 million LE

(4) Navigation benefit estimation is obtained as in section F.2 note 1
Traffic flow in canals within directorate = 58 million ton km/year
Directorate navigation canal length = 35 Km
Regional navigation canal length = 57 Km
Regional navigation benefit = 58 x 10^6 (.04 -.025) x 57/35 = 1.42 million LE

(5) Canal Replacement
For EL-Salam canal serving 400,000 fed, the estimated cost of the irrigation system is 270 million LE. Based on this value the Upper Egypt canal replacement to serve 846508 feddans is = 270 x 10^6 x 864508/400 000 = 571.4 million LE
Source: Preliminary Feasiblity Study to Provide the Fundmental Structures for Reclaiming 400,000 Feddans in Sinai, MPWWR 1990.

(6) It is assumed that the single purpose alternative cost is higher than the benefit.

F.4 New Lands

Because costs for new new land development were not available, it was not possible to derive an estimate of net primary returns (benefits) to these as yet not reclaimed areas at the points where the new new land systems leave the common works of the existing system. In the cost allocation model it is assumed that those new new lands projects which share canals and pumps to deliver water to the distribution system of the new new lands share also in the OM&R cost of these particular works. For those new new lands which are not served by an existing regional system, the cost allocation process begins at the main stem. In any case, the single-purpose alternative cost is assumed to be the cost of the structure for which costs are being allocated (a canal for the region, a barrage or pump for the main stem). In the case of the region, the same canals also serve as the single purpose alternative structure for some of the presently irrigated lands whithin the region. Thus, the same canals provide the alternative cost estimate for a portion of the existing lands and the new new lands. If the single purpose governs in both cases (an assumption for the new new lands) the same justifiable cost applies to both users, with the result that they share equally in the canal O&M costs. This allocation proportion (equal sharing) was applied in those cases where new new land projects share canals which currently are serving existing lands. Costs for enlarging these works to provide the new new lands are specific costs to the new new lands, and thus, are not included in this study.

F.5 Estimation of Agricultura Net Benefits

This section is a part of the team's effort to reach a suitable formula for the allocation of OM&R (Operation, Maintenance and Replacement) of the irrigation system above the mesqa hierarchy. This Section is concerned with benefit aspects; cost aspects are dealt elsewhere in the report. Specifically, three issues are addressed :

1. The combined share of water and land in the output value of the largest water consumer sub-sector; namely, plant production given the current level of OM&R (Scenario 1). 2. The expected increment in net benefit to be accrued by the plant sub-sector if the current level of OM&R is raised to an adequate level (Scenario 2). 3. The net benefits expected to be gained by the new lands as a consequence of enhancing OM&R.

A crude estimate of the first item is reached using the residual imputation method. The second question is addressed using IIP estimates of yield increment on the ground that improving OM&R is a prerequisite achieving the IIP increment in yield; other IIP benefits are excluded. New land net benefits are estimated by extrapolating the net present value (NPV) for El-Sallam canal (the most recent land reclamation feasibility study) to the 1.6 millionion feddans "priority" area of the Land Master Plan (LMP).

Due to time and resource limitations, results are reached by applying short-cut methods to available data. As such, results are only tentative: inferences should be made from this report only for the present study.

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5.1 billion. The increment in net benefit in the old land according to Scenario 2 is estimated at LE 1.1 billion, and the net benefit from the new land is LE 1.3 billion. In that, the total net benefit corresponding to enhancing the OM&R of the irrigation system estimated at LE 2.4 billion.

F.5.1 Methods of and Assumptions for Agricultural Benefits Estimation

For the purpose of this study, Egypt was divided into five regions: East, Middle and West Delta, Middle and Upper Egypt; they are represented by five irrigation command units (ICU): El-Saidia, Bahr El-Saedi, Balaqtar, Iqal Shamia, and Khor Sahel; in order. Estimates were first made for ICUs then extrapolated in proportion to the areas of the corresponding regions. The selected ICV's are considered representative of Egyptian agriculture on the grounds that they geographically cover the five main Egyptian regions listed above and encompass the main crops as shown in table F.5.

Table F.4 Summary of Estimated Agricultural Net Benefits[1] Million Constant 1988/89 LE

Scenario	Net Benefit
1	5103
2	1081
New Land	1302

Table F.5 Cropping Pattern

	E. DELTA	M. DELTA	W. DELTA	M. EGYPT	U. EGYPT
Crop					
WHEAT	40%	21%	30%	40%	48%
L BERSEEM	30%	47%	23%	13%	17%
S BERSEEM		19%	36%		
B BEANS				13%	
COTTON		22%	36%	18%	13%
MAIZE	57%	12%	18%	25%	31%
RICE	12%	60%	35%		
SORGHUM				10%	34%
SOYBEANS				15%	
CITRUS	14%			25%	18%

The rationale behind accruing benefits from raising the current insufficient level of OM&R is that enhancing the system's efficiency will result in water savings. Saved water will be used to ameliorate inadequacy, inequity, and irregularity of water availability to farmers, and to meet the water requirements of the new lands.

To assess the farm benefits, the team conceived two scenarios. Scenario 1 corresponds to the status quo with MPWWR maintaining the current less-than-adequate level of OM&R. In Scenario 2 OM&R inputs are raised to an adequate level.

1 Figures for Scenario 2 are increments in net benefits over Scenario 1.

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Scenario 1: In the short run, plant production is considered to be the output of four major factors of production; specifically, working capital, management, water and land. If a homogeneous production function of degree one is assumed, then by applying Euler's theorem, factors of production exhaust output in proportion to their productivities.

In the absence of representative values for factors of production, and given time limitations and available data, the residual imputation method is the most suitable procedure for estimating the share of production to attribute to each factor. According to this method, all factors except natural resources (water and land) are paid their shares. The residual is attributed to water and land combined since they are perfect complements in plant production.

The share of the working capital is known; it is the cost of inputs and services including labor, but excluding land rent and management. The share of management is judgementally assumed to be 10 percent of the gross margin (gross revenue less variable cost). Thus, a residual of 90 percent of the gross margin is attributed to water and land together. Mathematically,

Combined Water-Land Share = 0.9 x Gross Margin

The calculation of the water-land share in Scenario 1 is debatable. One perspective recommends attaching zero opportunity cost to land. Subsequently, the imputed residual is attributed to water alone. The justification of this hypothesis is that: a) without water, agriculture land in the Nile Valley and Delta will not be productive, b) the opportunity value of agricultural land outside of agricultural production is zero.

This hypothesis may hold in countries where fertile soil is abundant but where water is the constraint. This is not the case in Egypt which depends heavily on food imports as its population is fed by 4 percent of its area. Further, as a result of congestion, an estimated area of 40,000 feddans or more of fertile old land is annually encroached upon by urbanization. Moreover, the fertile top soil in many areas has been skimmed to be used to manufacture bricks. As such, it is difficult to accept that land has no viable alternative. In Egypt fertile land is as scarce as water.

In contrast, one may make the unconventional argument, to consider the "replacement cost of fertile land": how much would it cost to bring into production a feddan of land of a comparable fertility?. If this line is followed, imputed return to water might be negative. To avoid both of these arguments land and water were taken as a single, inseparable production unit with the residual being credited to these combined resources.

IIP data were used in this scenario. Data were based on field surveys supported by other previous reports. Only the main crops are included in this report: those which occupy at least 10 percent of the net irrigated area or provide at least 10 percent of the net returns in that area. Estimates of Scenario 1 are shown in table F.6.

Table F.6 Estimated Share of Benefits by Region[2]

Region	Area	Net Irrigated[3] Area	Benefit
	"000" Feddan		Million LE
West Delta	1437	1293	570
Middle Delta	1599	1439	929
East Delta	1757	1581	1549
Middle Egypt	1693	1524	1656
Upper Egypt	847	762	399
National	7333	6599	5103

Source of area figures: Nader (1990)

2 The estimated share is that of water and land combined

3 Net irrigated area is taken to be 90% of the gross area.

It is worth noting that not all IIP benefits have been included. One of the main IIP benefits is saving the cost of the irrigation pump at the farm level. This item should be attributed to IIP investment only. Consequently, it is not included among the benefits generated by improving OM&R of the main system.

Scenario 2: In the preceding section, the share of irrigation water in the value of plant production is calculated for the current level of OM&R. This section estimates the net increment in the value of plant production (net of corresponding increment in yield dependent cost) if OM&R is raised to an "appropriate" level.

In this scenario, only OM&R will be raised; all other factors are held constant. The impact of increasing OM&R can be visualized graphically as a parallel upward shift in the growth curve of plant production. In that instance, estimating a one-year shift or, equivalently, the increment in net benefit will suffice to know it for other years as well.

The same set of IIP studies which was used in Scenario 1 also was utilized in this scenario. Increment in net benefit is calculated according to the following formula:

Increment in Net Benefit = (GRw - GRw/o) - (YCw - YCw/o)

where GRw: gross revenue with project, GRw/o: gross revenue without the project, YCw: yield-dependent cost with the project, and YCw/o: yield-dependent cost without the project.

On the basis of experience, it is generally accepted that one third of the farms, those at the head of water courses, do not suffer water-related problems. As such, the calculations made here were confined to only two thirds of the net irrigated area. However, as the total area of major crops did not count for 100% of the net irrigated area, the difference was considered as part of the area of the top one third. Table F.7 provides the net benefits expected to be obtained in the five agriculture regions.

Table F.7: Increment in Net Benefits

Region	Million LE
West Delta	99
Middle Delta	271
East Delta	261
Middle Egypt	328
Upper Egypt	122
National Total	1081

Another benefit component to Scenario 2 is land reclamation. A distinction between two main types of new lands need to be made: those already reclaimed and lands now under reclamation or which will be reclaimed. The first category is included in the old land areas used above.

The NPV of the "priority" areas of the Land Master Plan (LMP) was estimated using the data of the El-Sallam canal study. The study area is assumed to be a representation of the LMP "priority" areas at large.

A net benefit stream of the net irrigated area served by El-Sallam canal project (330 thousand feddans) is obtained by deducting the cost of land development (farm development) from the net benefit estimated for farm agricultural production (total gross margins). The generated stream has been discounted at 12 percent. Then, values are extrapolated proportional to the regional "priority" areas. Estimated net present value is LE 2.9 billion (Table F.8)

F.6 Limitations and Reservations

A few reservations on the above results are stated. This study concentrated on the main traditional field crops cultivated in the ICUs under study. More profitable plant activities such as fruits and vegetables are left out as they were occupying relatively small areas.

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Furthermore, the major components of that cropping pattern was, at that time, mandated by the government or by false attractiveness under distorted market system. As Egypt is now moving to a more liberal economy, the cropping pattern is expected to change to a more profitable one. If that happens, return to water and land might increase above the values estimated in this report. Equally, return to water and land might not be realized because of unaccounted determinant factors or bad weather circumstances.

Before concluding, it is again emphasized that this section of Appendix reports the results of a preliminary and exploratory study. Further thorough research on two topics is imperative. First, the water share in plant production, and may be other uses as well, need to be estimated using more reliable methods. Also, charges for water are expected to bring about major structural changes: crops with high water requirements might be abandoned, technological changes in irrigation techniques will be induced by the change in relative prices of production factors, and costs of production are expected to rise and to be shifted, at least partly, to both consumers and demanders of agricultural intermediate products. The implications of these potential structural changes need to be further investigated.

Table F.8: NPV of Land Reclamation

LMP Priority Areas	Area 000 Fed	NPV Million LE
East Delta	612	1178
Middle Delta	59	114
West Delta	264	508
Middle Egypt	184	354
Upper Egypt	195	375
Sinai	212	408
Total	1526	2937

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IRRIGATION WATER COST RECOVERY IN EGYPT:

DETERMINATION OF WATER COSTS

ANNEXES

January 1993

ISPAN Report # 49

An Applied Study prepared for the USAID Mission to Egypt by the Irrigation Support Project for Asia and the Near East

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Annex I

COST INFORMATION SYSTEM

Magdy Saleh

TABLE OF CONTENTS

COST INFORMATION SYSTEM

1. Introduction

Several data have been essential to define the irrigation system in Egypt and its hierarchy, to determine the OM&R cost and then to allocate such cost among its beneficiaries. The required data were globally defined along with their appropriate sources. Initially a layout of the cost information system data base scheme was prepared in a flexible way to accept future modifications, expansions and improvements. Fine tuning the operation of the cost information system is an integrated process which lasts till a satisfactory limit is approached.

2. Sources of Data

Data have been collected from several sources to build the project's information system. The basic sources of data are a prepared questionnaire for irrigation and drainage directorates, the existing governmental statistics and data reports, and the ongoing projects for improving the irrigation system.

2.1 Questionnaire Tables

A set of questionnaire tables were prepared and distributed to the 22 irrigation directorates and the corresponding drainage directorates of the Nile System. The two main objectives of the questionnaire tables were: (1) to obtain a general physical description of the Egyptian Nile River irrigation system on a directorate-by directorate basis, and (2) to collect information at a similar level of detail on actual OM&R expenditures for years (1986-1990).

Tables A.1 through A.10 represent the Irrigation questionnaire tables entitled:

- Global directorate information (cover sheet), Table A.1.
- Description of canal network till rank 3 canals from the Nile (ranks) within the directorate, Table A.2.
- Annual maintenance cost (L.E.) Till rank 3 canals within directorate, Table A.3.
- Costs of partial rehabilitation and replacements for canals till rank canals within directorate, Table A.4.

- Cost of construction of irrigation structures on canal till rank 3 canals within directorate, Table A.5.
- Cost of maintenance of irrigation structure on canal till rank 3 within directorate, Table A.6.
- Cost of partial rehabilitation of irrigation structure on canal till Rank 3 within directorate, Table A.7.
- Cost of total rehabilitation or replacement for pumping stations on the net work within directorate, Table A.8.
- Cost of operation, maintenance, rehabilitation and partial replacement of pumping stations within directorate, Table A.9.
- Water supply station within the irrigation directorate, Table A.10.

The drainage questionnaire tables sample are shown in tables A.11 through A.17 with the following titles:

- Global directorate information (cover sheet), Table A.11.
- Drain network description until 2nd order inside the drainage directorate, Table A.12.
- Annual maintenance cost for drains till 2nd order inside the drainage directorate, Table A.13.
- Rehabilitation & partial replacement cost up to the second order inside the drainage directorate, Table A.14.
- Construction costs of hydraulic structures, Table A.15.
- Maintenance cost for structure on the drains up to the 2nd order, Table A.16.
- Rehabilitation cost for structures on drains up to 2nd Order, Table A.17.

The questionnaire tables are long and complex and some difficulties have been experienced in obtaining complete and accurate responses from the directorates within the available time frame. Several irrigation directorates completed the questionnaire tables: Kena, El Sharkia, Damietta, East Dakahlia, West Dakahlia and West El Behira; whereas the Fayoum and Benisuef drainage directorates responded to the drainage questionnaire tables.

2.2 Existing Governmental Statistics and Data

Data available from the Egyptian governmental statistical reports and analyses are collected. For example, the national level budget allocations are used to cross-check the questionnaire responses. Government statistical reports provide price index numbers to convert data expressed in monetary terms into equivalent forms. Another governmental source of data was the MPWWR information system developed in the eighties. Unfortunately, MPWWR data base was defined according to canal commands "CC" and drain commands "DC" for water balance calculations,

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whereas the cost computation was determined on irrigation directorates basis. Mapping the "CC" and "DC" into irrigation and drainage directorates for the current cost determination activities was complicated and inaccurate procedure.

2.3 Ongoing Projects For Improving The Irrigation System

Several ongoing projects help provide the basis for the OM&R computation. For example, the Irrigation Improvement Project (IIP experts assist in estimating costs of improving several types and sizes of structure. The Egyptian-Canadian Project ISAWIP in Dakahlia Governorate focuses more on drainage, but its program has necessarily included irrigation system rehabilitation as well. This experience can provide some indication of needs for improvement elsewhere in the system.

3. Cost Information System

Data collected from the above mentioned sources have been computerized to represent the "Cost Information System" CIS data base. CIS has been implemented in a modular form. Each module is responsible of carrying out a single or group of activities to serve the major CIS objectives: 1 Data manipulation; and 2 OM&R cost computation and allocation.

The first objective includes the CIS ability to retrieve available and report data in the data base through its "Retrieving Modules" and "reporting modules". The CIS data base are categorized as main stem data, directorate data and auxiliary data. The main stem data provide global information on the Irrigation and drainage system in Egypt. On the other hand, the directorate data give information similar to those of the main stem, but on a directorate level. The auxiliary data show the end-user, the budget data within the last five years and other data which are not directly related to either the main stem or the directorate data. Detailed information of the CIS data base is presented in the following sections.

The second objective of the CIS implementation is to design a tool which assists in determining the OM&R cost in different regions of the Nile System in Egypt and then allocating such a cost among system's beneficiaries. The CIS "Cost Computation" and "Cost Allocation" are responsible for both cost determination and allocation, respectively. Figure 1 shows the CIS main structure where the end-user requests an option through an input process from the "control unit". This unit routes the user selection to appropriate CIS modules. Results obtained from such modules are returned back to the Control Unit to be displayed as an output for the user who can request additional information or exit the system. This analysis cycle continues till the end-user approaches reasonable results for his task.

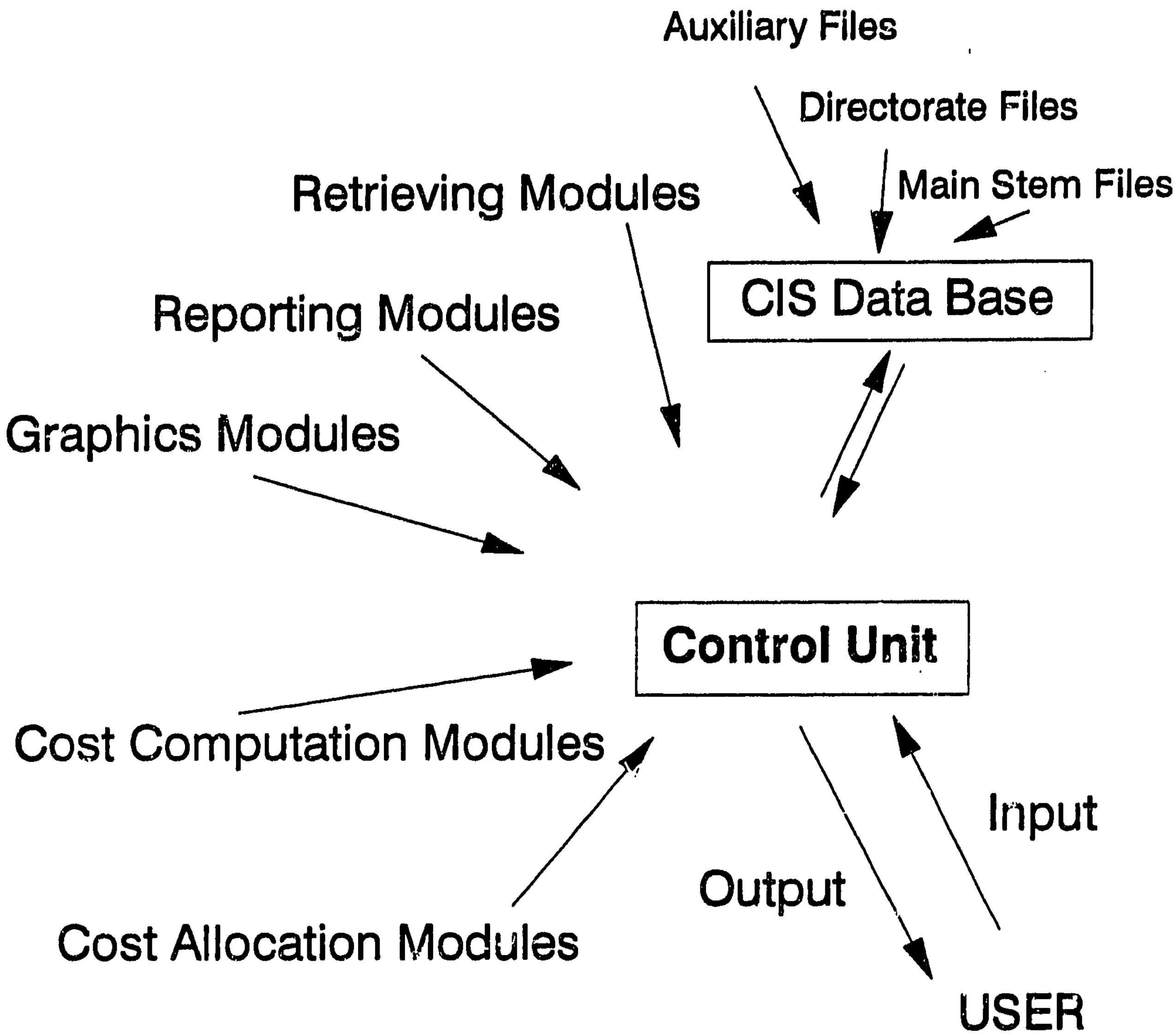

Figure 1 Cost Information System (CIS) Main Components

3.1 Main Stem Data

Currently, the main stem data files of the CIS are represented by four sets: the "Nile Reaches", "Main Barrages", "Pump Stations" and "Drainage Network". The main fields of each file are summarized in Figure 2:

- "Nile Reaches" data describe each of the Nile reaches of the main stem by: the area served (Area Served), length (Length) and the average width (Average Width) as shown in Table A.18.
- "Main Barrages" data file provides information about the main barrages that control the flow along the Nile reaches. At each barrage, this data set defines the area served (Area Served), the annual flow (Flow), the number of vents (# of vents), width of each vent (Vent Width), how far the barrage from the High Aswan Dam (Km from HAD) and the main canal from upstream (Main Canal from US) as shown in Table A.19.
- "Pump Stations" data show the main characteristics of several pump stations distributed on the Nile System. These characteristics include the type of the station whether irrigation, drainage, or mixing pump (Type), name of suction canal (Suction Canal), name of delivery canal (Delivery Canal), number of pump units (# units), flow for each unit (Q), static head lifted by each unit (Head) and the power supplied from each unit (Power). Table A.20 shows a sample of the 87 pump stations distributed along the irrigation system in Egypt.
- In each Drainage Directorate, the drainage network is defined by: the main drain (Main Drain), the directorate's region (Region), the area served (Area Served) and the total lengths of drains in each directorate (Total lengths). Table A.21 shows the drainage network data file.

3.2 Directorate Data

The information collected from the directorate questionnaires are the basis of the CIS directorate data files. The main fields of directorate' data files are summarized in Figure 3. The data obtained from "El Sharkia" irrigation directorate and transferred to the CIS data base will be used in this section to illustrate the structure of such data.

Nile Reaches

Reach Number	Area Served	Length	Average Width

Main Barrages

Name	Area Served	Flow	# of Vents	Vent Width	Km from HAD	Main Canal from US

Pump Stations

Station	Type	Suction Canal	Delivery Canal	# Units	Q	Head	Power/Unit

Drainage Network

Drainage Directorate	Main Drain	Region	Area Served	Total Lengths

Figure 2 Structure of the Main Stem Data Files

In general, the directorate data are classified as "Definition Data" and "Cost Data" files. In each directorate, "Definition Data" describe the irrigation network, its structures and its beneficiaries, as shown in Figure 3. Each canal in a directorate is defined by a unique serial number (Number), canal's name (Canal Name), canal's order (Order) which represents the number of branches from the Nile stem (order 0) till the current canal, the area served in feddan by the canal (Area Served), canal's length (Length), and its width (Width). Table A.22 illustrates the canal's network in El Sharkia irrigation directorate as sample of irrigation network definition.

A hydraulic structure in a directorate is defined by canal's number (Number), name (Canal Name) on which the hydraulic structure exists, and the structure's type (Structure Type). Table A.23 shows the structure of El Sharkia sample.

In addition to the physical description of the canal network, the beneficiary group for each canal is recorded by its name and a numerical representation code, as shown in Table A.24.

On the other hand, "Cost Data" in each directorate give the existing maintenance and rehabilitation cost of both the irrigation canal network and the controlling hydraulic structures. Such data are available on an annual basis for the years 1986 through 1991. Canal's maintenance is defined by canal number (Number), name (Canal Name), dredging cost (DRD COST) for a certain canal length (LEN), weed removal cost (WEED COST) for a certain canal length (LEN), lining cost (LIN COST) for a certain canal length (LEN), and rehabilitation year (Year).

Table A.25 is a sample of maintenance cost of the canals in El Sharkia directorate. The expenses of maintaining directorate's structures are defined in terms of associate canal's number (Number) and name (Canal Name), the amount of Egyptian pounds spent on either the "Mechanical & Electrical Cost" or the "Civil Cost" and maintenance year (Year). Table A.26 is an example of the cost data of the maintenance cost of the Hydraulic structures.

The rehabilitation cost of the directorate canal's network is represented in the CIS by the rehabilitated canal's number (Number), canal's name (Canal Name), cost of rehabilitation (Cost), the rehabilitated length (Length), and rehabilitation year (Year). A sample of El Sharkia canal network is shown in Table A.27.

Finally, the expenses of structures rehabilitation are described in terms of the associated canal's number (Number) and name (Canal Name), the amount spent on either the "Mechanical & Electrical Cost" or Civil Cost" and rehabilitation year (Year). No rehabilitation cost data of the Hydraulic structures were available in El Sharkia directorate.

Definition Data
Irrigation Network

Number	Canal Name	Order	Area Served	Length	Width

Hydraulic Structures

Number	Canal Name	Structure Type

Beneficiaries

Number	Canal Name	Order	Beneficiary Group	Beneficiary Code

Cost Data

Maintenance Cost
Irrigation Network

Number	Canal Name	DRD Cost	Len	WEED Cost	Len	LIN Cost	Len	Year

Hydraulic Structures

Number	Canal Name	Mechanical & Electerical Cost	Civil Cost	Year

Rehabilitation Cost
Irrigation Network

Number	Canal Name	Cost	Length	Year

Hydraulic Structures

Number	Canal Name	Mechanical & Electerical Cost	Civil Cost	Year

Figure 3 Structure of Irrigation Directorates' Data Files

3.3 Auxiliary Data

This set of data files contain information which are needed by the CIS modules. Currently, the CIS auxiliary data include the following tables is summarized on a field basis in Figure 4:

- Beneficiary groups table;
- Structure types table;
- Directorates table; and
- Annual MPWWR budget tables.

The "Beneficiary Group" table classifies the main Nile System users categories. Each category is defined by its name (Beneficiary Group) and a numerical code (Code). These groups have been modified several times to cope with the cost determination model. These groups are as shown in Table 28.

The "Structure types" has two fields, the structure type (Structure Type) and its numerical code (Code). Table A.29 defines the hydraulic structures available on the irrigation system as dam, barrage, intake regulator, head regulator, weir, lock, tail escape, syphon and aqueduct.

Global information of the current 22 irrigation directorates are shown in Table A.30 in terms of directorate name (Name), a three character representative code (Code), directorate's region (Region), area served in feddan (Area Served) and the water requirements (Water Requirements) in each directorate.

The MPWWR annual budget and loans for years 1986 through 1990 is shown in Table A.31. The annual budget has four main components as following:

(A) "Operation" named as "Chapter 1" represents the annual cost spent on operating the nile system.

(B) "Maintenance" named as "Chapter 2" gives figures for the amount spent on maintaining the Nile System. Chapter 2 has the following eight maintenance sub-components:

1. Irrigation Structures (M1);
2. Hydraulic Structures (M2);
3. Roads (M3);
4. Bridges (M4);
5. Equipments (M5);
6. Transportation (M6);
7. Furniture (M7); and
8. Others (M8).

Beneficiary Group

Beneficiary Group	Code

Structure Types

Structure Type	Code

Directorates

Number	Directorate Name	Region	Area Served	Water Requirements

Budget

Operation Chapter (1)	Maintenance Chapter (2)	Rehabilitation Chapter (3)	Loans Chapter (4)

Figure 4 Structure of Auxiliary Data Files

(C) "Rehabilitation"; named as "Chapter 3" defines the annual cost spent on the rehabilitation of the Nile System.

(D) "External Loans"; named as "Chapter IV" represents the amount of external loans extracted from other public companies for job activities done by those companies for the sake of MPWWR.

The annual budget figures for years 1986-1990 are shown in Table A.31 for MPWWR headquarter and the irrigation directorates.

3.4 Cost Computation Modules

Refer to:

A. Cost estimation methodology, Sec. 3.3 (Main Report);
B. Estimated system costs, Sec 4.5 (Main Report);
C. Tables of cost estimates, Appendix C (Main Report); and
D. Cost tables for cost allocation model input, Appendix D (Main Report).

3.5 Cost Allocation Modules

Refer to:

A. Cost allocation computer program description; Annex II;
B. Input-output files, Annex II, Appendices A through D; and
C. Model source code (Standard "C" Language), Appendices E&F.

3.6 Control Unit

The control unit represents the "Shell" program that manipulates the CIS data base, edits the cost data, generates the cost allocation input data files, execute the cost allocation model and finally display the obtained results. The shell can handle up to input and output data sets of four runs (scenarios). Options available for the end-user are:

File

Load:
load input data (1-4 runs)

Rename:
rename a data file

Update:
update existing data

Information:
display the available data files with short description of each one.

Edit Run

Global Data

to define the global data for each run.

FILE NAME	Input the name of the file which will hold cost allocation input and output data.
RUN NUMBER	Input the number of the run you will define its global data. To exit the global data entry, type "0" in the run number field.
RUN TITLE	Short description for the current run to be displayed in the generated cost allocation input file.
DESCRIPTION	Detailed description for the current run to be displayed in the generated cost allocation input file. Discount Rate. Basin Horizon. Number of Old Regions. Number of New Regions.

High Aswan Dam

to define "HAD Benefits", "Single Purpose Alternatives", "Separable Costs", and the "Annual Common Works O&M" for each run. Select the required run by moving the right and left arrows keys and press the Enter key to start editing.

The data entry for HAD are:

HAD BENEFITS

Hydropower (Annual mil LE).
Ground Trans. (Cap.).
Ground Trans. (O&M % of Capital).
Fishery (Annual mil LE).
Flood Control (% of total benefits).

SINGLE PURPOSE ALTERNATIVES

AG, NAV, POWER, FISH (% of OM&R).
Rural Water Supply (Capital).
Rural Water Supply (O&M % of Capital).
Ground Trans. (Capital).
Ground Trans. (OM&R % of Capital).
Flood Control (% of OM&R).
Common Works Replacement (mil LE).

SEPARABLE COSTS

Agriculture (% of O&M).
Power (% of O&M).
Flood (% of O&M).

ANNUAL COMMON WORKS O&M (mil LE)

Main Stem of the Nile

To define the Nile main Stem "Benefits", "Single Purpose Alternatives", and "costs" for each run by moving the right and left arrow keys and press the "Enter" key to begin editing. The data entry for Nile Main Stem are:

BENEFITS

Navigation (Annual mil LE).
Hydropower - Esna (Annual mil LE).
Ground Trans. (Capital mil LE).
Ground Trans. (O&M % of Capital).
Recreation & Tourism (Annual mil LE).

SINGLE PURPOSE ALTERNATIVES

Ground Trans. (Capital mil LE).
Ground Trans. (O&M % of Capital).

COSTS

Stem Except New Esna & HAD (Annual OM&R, mil LE).

Old Region

to define the old region "General" data, "Benefits", "Single Purpose Alternative" and "Costs" for each run. Select the required run to edit by moving the right and left arrow keys. The user can navigate through old regions by using "PgUp" and "PgDn" keys. The maximum number of old regions is controlled by the value entered in the global data screen. Press "Enter" key to begin editing the data. The data entry for an "Old Region" are:

GENERAL

Agricultural Area (mil Feddan).
Population (millions).
Wetted Perimeter of Canals (meters).
Percent of Canals Navigable (%).

BENEFITS

Agriculture (Annual mil LE).
Rural Water Supply (Capital mil LE).
Rural Water Supply (O&M % of Capital).
Navigation (Annual mil LE).

SINGLE PURPOSE ALTERNATIVES

Canal Replacement (mil LE).
Rural Water Supply (An. OM&R mil LE).

COSTS

CANAL O&M (An. mil LE).
System Pumps OM&R (An. mil LE).

New Region

to define the "New Region parameters. Select the required run to edit by moving the right and left arrow keys. The user can navigate the new region by using "PgUp" and "PgDn" keys. The maximum number of new region is controlled by the value entered in the global data screen. The data entry for a "New Region" are:

Number of Upstream Old Region.
Factor of Old Canals Delivery Water.
Potential Agricultural Area (mil Feddans).
Cost of New Delivery Systems (mil LE).

Execute

This command generates the Allocation model input files for the current set of data. The file naming convention is as follows:

<RUN_NUMBER.EXT>

<u>RUN_NUMBER:</u>
the number of the run (1 - 4); and

<u>EXT [INPUT FILES]:</u>
"HAD" for High Aswan Dam Data.
"STM" main stem data.
"Rxx" for old regions data.
"Nxx" for new regions data.

Then this command executes the model to produce the results for each run according to the following extensions:

<u>EXT [OUTPUT FILES]:</u>
"ECH" echo of input files.
"CAD" detailed cost allocation tables.
"RSU" summary of cost allocation results.

View Output

to display a summary of the results of the cost allocation model. Figure 6 shows a sample of such results.

Draw

to present the cost allocation results in a graphical form for comparison reasons.

Print

	This option used the "print" DOS command which requires that the DOS sub-directory to be on the path.
Input Tables	to get a hard copy of the cost allocation model input files
Short Output	to get a hard copy of the cost allocation model output summary.
Detailed Output	to get a hard copy of the cost allocation model detailed output files.
Data Base	
	to retrieve and display one of the CIS data base files: main stem files. directorate files. auxiliary files.
Quit	
	to exit the shell program

APPENDIX A

Table A.1 : Global Directorate Information

Irrigation Directorate Name : ____________________

1. The name of governorate(s) in which the directorate is located
2. Agriculture area served (feddan)
3. Map showing the irrigation network within the directorate and the boundary of the directorate.
4. Total annual discharge for the area served in the directorate (m^3/year)
5. Total canal lengths within the directorate (Km)
6. Total wages and incentives for directorate personnel (budget-Part I) in the last 5 years (L.E./year)
7. Total annual maintenance cost for canals and irrigation structures (Budge-Part II) in the last 5 years (L.E./year)
8. Total annual partial replacement and rehabilitation costs for canals and irrigation structures (Budget-Part III) in the last five years. (L.E./year)
9. Total annual full replacement and rehabilitation costs for irrigation structures (Budget-Part III) in the last five years. (L.E./year)

Table A.2 : Description of canal network till rank 3 canals from the Nile (rank 0) within the directorate

No	name of canal	Rank	Km from intake	Total served area (Fed.)	Length of canal (Km)	Width of canal at bed level (m)	Navigable or non-navigable	Total annual discharge (m^3/year)

APPENDIX A 3

Table A.3 : Annual maintenance cost (L.E.) Till rank 3 canals within directorate

No	Name of canal	Cost of maintenance for canals																	
		1986						1987						1988					
		annual dredging		weed control		lining repair		annual dredging		weed control		lining repair		annual dredging		weed control		lining repair	
		L	L.E.	L	L.E.	L	L.E.	L	L.E.	L	L.E.	L	L.E.	L	L.E.	L	L.E.	L	L.E.

Table A.3 (cont.): Annual maintenance cost till rank 3 canals within directorate

No	Name of canal	Cost of maintenance for canals											
		1988						1990					
		annual dredging		weed control		lining repair		annual dredging		weed control		lining repair	
		L	L.E.	L	L.E.	L	L.E.	L	L.E.	L	L.E.	L	L.E.

Table A.4 : Costs of partial rehabilitation and replacements for canals till rank 3 canals within directorate

No	Name of canal	Annual Cost of lining (L.E/year)		Cost of any change in canal capacity (L.E/year)				Remarks
		Length of portion lined (Km)	Cost (L.E\yr)	Description of cross section after modification			Cost (L.E.)	
				area served (fed.)	width of bottom (m)	length of modified portion (Km)		

Table A.5 : Cost of construction of irrigation structures on canals till rank 3 canals within directorate

No	Name and location of structure	Dimensions of structure			Area served at irrigation structure location (feddans)	Total annual discharge (m^3/year)	Estimate of construction cost (L.E.)	year of construction
		no of openings	dimensions of opening (width-height)	length of apron (m)				

APPENDIX A 7

Table A.6 : Cost of maintenance of irrigation structure on canals till rank 3 within directorate

No	Name of structure and location	Annual cost of maintenance of the structure (L.E /year)									
		1986		1987		1988		1989		1990	
		Mech. & Elect.	Civil Works	Mech. & Elect	Civil Works	Mech. & Elect.	Civil Works	Mech. & Elect.	Civil Works	Mech & Elect.	Civil Works

Table A.7 : Cost of partial rehabilitation of irrigation structure on canals till rank 3 within directorate

No	Name of Structure & Location	Cost of Partial rehabilitation and replacement of structure (L.E./year)									
		1986		1987		1988		1989		1990	
		Mech. & Elect.	Civil Works	Mech. & Elect.	Civil Works	Mech. & Elect.	Civil Works	Mech. & Elect.	Civil Works	Mech. & Elect.	Civil Works

APPENDIX A 8

Table A.8 : Cost of total rehabilitation or replacement for pumping stations on the network within directorate

No.	Name and location of pumping station	Type of station (irrigation-drainage or mixing)	Manometric head (m)	Total discharge/year (m3/year)	Total cost of P.S. at construction time or total replacement (L.E.)	Year of construction or full replacement	Remarks

Table A.9 : Cost of operation, maintenance, rehabilitation, and partial replacement of pumping stations within directorate

No	Name and location of P.S.	Annual operation cost		Cost of maintenance		Cost of partial rehabilitation and replacement		Remarks
		wages and intensives	Power, fuel, and oil	mechanical& electric works	civil works	mech.& elec. works	civil works	

Table A.10 : Water supply station within the irrigation directorate

No	Name and location of water supply station	Total annual discharge for station (m^3/year)	year of operation	Total annual discharge after increase the capacity of station (m^3/year)	Year of increase the capacity of station

Table A.11 : Global directorate information

Drainage Directorate Name: ————————

1- Governorate Name
2- Area Served (Feddan)
3- Drain Network map + physical boundaries
4- Total Annual Discharge (m^3/year)
5- Length of Drain Network (Km)
6- Salaries/Year for the last five years (chapter I) (L.E./year)
7- Annual Maintenance cost for drains and Hydraulics Structures for last 5 years (chapter II) (L.E./year)
8- Total cost of Rehabilitation and Partial Replacement for drains and structures for last 5 years (chapter III) (L.E./year)
9- Replacement cost of Hydraulic Structures for last 5 years (chapter III)

Table A.12 : Drain network description till 2^{nd} order inside the drainage directorate

No	Drain Name	order	Outlet Kilometer on next order	Area served (Fed.)	Length (Km)	Bed width (m)	Annual flow (m^3/year)				
							1986	1987	1988	1989	1990

Table A.13 : Annual maintenance cost for drains till 2nd order inside the drainage directorate

No	Drain Name	Maintenance cost of Drains (L.E./year)											
		1988				1989				1990			
		Annual Dredging		Weed Control		Annual Dredging		Weed Control		Annual Dredging		Weed Control	
		L.E	L	L.E	L	L.E	L	L.E	L	L.E	L	L.E	L

Table A.14 : Rehabilitation & partial replacement cost up to the 2nd order inside the drainage directorate

No	Drain Name	Cost of modification of cross section (L.E./year)							
		1987				1988			
		Modified cross section			Total Cost (L.E.)	Modified cross section			Total Cost (L.E.)
		Area served (fed.)	Bed width (m)	Modified length (Km)		Area served (fed.)	Bed width (m)	Modified length (Km)	

Table A.14 (cont.) : Rehabilitation & Partial replacement cost up to the second order inside the drainage directorate

No	Drain Name	Cost of modification of cross section (L.E./year)							
		1989				1990			
		Modified cross section			Total Cost (L.E.)	Modified cross section			Total Cost (L.E.)
		Area served (fed.)	Bed width (m)	Modified length (Km)		Area served (fed.)	Bed width (m)	Modified length (Km)	

Table A.15 : Construction costs of hydraulic structures

No	Structure Name & Location	Dimensions of structure			Area served (Fed.)	Total discharge (m^3/year)	Capital Cost (L.E.)	Installation date
		No of vent (m)	Dimensions of vent width x height (m x m)	Length of floor				

Table A.16 : Maintenance cost for structure on the drains up to the 2nd order

No	Structure Name & Location	Maintenance cost for structures (L.E./year)									
		1986		1987		1988		1989		1990	
		Mech. & Elec. works	Construction works	Mech. & Elec. works	Construction works	Mech. & Elec. works	Construction works	Mech. & Elec. works	Construction works	Mech. & Elec. works	Construction works

Table A.17 : Rehabilitation cost for structures on drains up to 2nd order

No	Structure Name & Location	Cost of Rehabilitation and Partial Replacement for structures (L.E./year)									
		1986		1987		1988		1989		1990	
		Mech. & Elec. works	Construction works	Mech. & Elec. works	Construction works	Mech. & Elec. works	Construction works	Mech. & Elec. works	Construction works	Mech. & Elec. works	Construction works

Table A.18 : Charachteristics of Nile reaches

Reach Number	Area Served (1000 Fed.)	Length (Km)	Average Width (m)
1	373.118	170	1000
2	688.061	184	900
3	1342.110	193	900
4	4138.317	418	850
5	330.983	87	375
6	62.000	156	200
7	302.102	211	500

Source: "Water Demands Present & Future" MPWWR, 1990.

Table A.19 : Main barrages on the Nile main stem

Name	Area Served (1000 Fed)	Flow (10^6 m^3/year)	# of vents	Vent Width	Km from HAD	Main Canal from Upstream
Esna	373.118	3179.962	120	5.0	170.0	Kallabiya Canal to the East Asfoun Canal to the West
Nag-Hammadi	688.061	4547.188	100	6.0	354.0	East and West Nag-Hammadi Canal
Assuit	1342.110	9544.668	111	6.0	547.0	Ibrahimia Canal to the West then to Bahr Youssef Canal
Delta	4138.317	24383.047	80	8.0	965.0	Ismailia Canal Rayah Al-Tawfiki Rayah Al-Behery Rayag Al-Naseri
Edfina (Rossetta Br.)	302.102	1834.437	46	8.0	1176.0	El-Mahmodia Canal El Rashidia Canal
Zefta (Damietta Br)	330.983	2591.636	50	5.0	1052.0	El Mansouria Canal Bustan P.S
Farasour (Damietta Br.)	62.000	489.231	5	5.25	1208.0	El-Salam Canal to the East

Sources: "Water Demands Present & Future" MPWWR, 1990

Table A.20 : Sample of Nile system pump stations (PS)

Name of PS	Type	Suction Canal	Delivery Canal	# Units	Q/Unit (m3/sec)	Head (m)	Power/unit(KW)
Aakab Kabli	I	Nile	Abu El Reash	2	0.25	8.77	100
Aakab Bahari	I	Nile	El Aakab	2	0.35	8.9	100
Abu el reash	I	Nile	Abu El Reash	2	0.75	10.17	110
Aswan isl	I	Nile	Aswan isl.	1	0.15	10.85	40
Aswan west	I	Nile	West Aswan	2	0.5	8.95	100
Bahreaf isl	I	Nile	Bahreaf	2	0.75	10.17	110
Balloula isl	I	Nile	Balloula	1	0.35	8.18	75
Beni Hemail	I	Naga-Hamadi	Beni-Hemail	6	8	2	261
Bousilia	I	Nile	Bousailia	4	0.9	8.5	142.5
Derb	I	Nile	El Ranan	3	7.5	4.5	470
Eklit	I	Nile	Eklit	3	0.5	7.7	88.3
Hagz	I	Nile	El Hagz	3	0.35	8.5	64
Fares isl	I	Nile	Fares isl.	2	0.75	7.64	110
East El Kelh	I	Nile	El Kelh Irrigaiton	5	2.14	7.98	---
Kelh isl	I	Nile	El Hagz	2	0.75	7.28	150
Khattara	I	Nile	El Hadara	2	1.6	9.7	450

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Table 20 (Cont.): Sample of Nile system pump stations (PS)

Name of PS	Type	Suction Canal	Delivery Canal	# Units	Q/Unit (m3/sec)	Head (m)	Power/unit(KW)
Malkia isl	I	Nile	El Gezira meskas	2	1	7.12	112
Marashda	I	Nile	Ranan El Marashda	5	8	4.4	515
Namasa	I	Nile	El Namasa	6	8	2.05	330
New biara	I	Nile	Kamel	6	2.94	24.5	850
Old biara	I	Nile	Kamel	4	1.5	23.95	587
Owainia	I	Nile	El Owainia	2	0.5	10	90
Ramadi	I	Nile	El Ramadi	6	1.37	8.5	180.17
Sahel hamam	I	Nile	El Hamam	1	0.5	10	100
Sahel meniha	I	Nile	Meniha	1	0.5	9.15	66
Salwa Kebli	I	Nile	Salwa Delivery	3	0.51	7.7	88.3
Salwa bahari	I	Nile	Salwa Delivery	3	0.51	10.7	88.3
Sebaaia	I	Nile	Sebaaia	4	1.04	8.5	166
Sharawna	I	Nile	Sharawna	2	0.5	10	90
South Kobania isl	I	Nile	ElKobania	1	0.25	7.77	40
Daraw	D	Daraw Drainage	Nile	2	1	3.4	53
Eklit D.P.S	D	Eklit Drainage	Nile	2	0.8	3.3	125.25
MIDDLE EGYPT							
Beni soliman	I	Nile	Beni Soliman	2	0.42	7	75
Dair Abu Heness	I	Nile	Dair Abu Heness	3	0.8	6	95
Dair El Maymoun	I	Nile	Private meska	2	0.5	7.2	100
Gabal El-Tair	I	Nile	Gabal El Tair	4	0.95	6	202
Kordahi	I	Nile	El Kordahi	2	0.7	6	140
Korimat	I	Nile	El Khorman & Borombol	4	4	5	450
Lithi	I	Nile	Intake Tarkhan & EL Hag	4	3.5	5	530
Sanour	I	Nile	Sanour	3	0.41	5.73	50
Sawada	I	Nile	Sawada	4	2.27	6	300
Sharouna Isl.	I	Nile	E & W Gezira isl.	4	0.5	5.8	180.75
Sharouna	I	Nile	E & W Sharouna Sahel El G	2	0.7	6.5	105
Sheikh Fadal	I	Nile	EL Maasara	4	1.85	6.8	342.5
Badraman	D	Abu EL Gabal drainage	ElBahr El Youssefy	4	2.5	2.4	137
Bani Saleh Isl.	D	Beni Saleh Drainage	Nile	2	3.5	3	171
Dair El-sankouria	D	Dair El-Sankouria Drainag	El Bahr EL Youssefy	4	3.5	2.9	150
MIDDLE DELTA							
Balamoun	I	Nile	Balamoune & El Sahel cana	4	4	3.2	185
Fowa	I	Rasheed Branch	Fowa	4	1.75	2.5	248.25
Hamoul	I	El Gharbia Main Drain	Bahr Tira	3	7.5	0.9	450
Kafr Saad	I	Nile	El Balamoun & Sahel	4	8	2.3	260
Mahlet Roh	D	Mahlet Roh Drainage	Bahr Mit Yazid	4	2.5	3.45	135
East Menoufia	D	El Kareneen	Rayah El Abbassy	5	4.6	3.6	450
EAST DELTA							
Bousat	I	Nile (Damietta Branch)	El Sharkawia	4	3.5	2.2	120.106
Bahr El Bakar	D	Bahr El Bakar Drainage	El Manzala isl.	4	7.5	1.9	243
Upper Serw	D	Upper Serw	Nile Damietta Branc	3	8	6.9	85.6
Hanout	M	Haous Drain	Hamout	3	5	3.95	346
WEST DELTA							
Etay El-Baroud Main	M	Etay EL Baroud Drainage	East EL Khandak	3	2.5	4.75	170

Table A.21 : Global definition of the drainage network

Drainage Directorate	Main Drain	Region	Area Served (1000 Fed.)	Total lengths (Km)
El Kalubia	South Bilbaise DPS	East Delta	336	267
	Kalubia Main Drain			
South El Sharkia	Bahr El Bakar	East Delta	271	825
North El Sharkia	Bahr Saft DPS	East Delta	208	633
	Principal Kasabi DPS			
	Additional Kasabi DPS			
	South Bahr Saft			
	Gamgara			
South El Dakahlia	El-Nizam	East Delta	300	1491
	Sadaka DPS			
	Kafr Shokr			
	Kafr Saad			
North El Dakahlia	El-Irad DPS	Middle Delta	235	431
	El-Genaina DPS			
	Bani Abeid DBS			
	El-Nizam DPS			
	El-Mataryiah DPS			
El Salhia	Bahr El Bakar DPS	East Delta	200	282
	El-Saeada DPS			
	Bilbaise			
El Ismailia	El-Ganayen DPS	East Delta	171	241
	Suez District Drains			
	Gabal Marayam			
	Ismailia Dist. Drains			
	Port Said Dist. Drains			
	Ismailia North			
	El-Mahsama			
	El-Kassassen DPS			
East El Menofia	Darwa DPS	Middle Delta	200	467
	East Menofia DPS			
	Mahallet Rouh DPS			
West El MenofiaA	Tala DPS	Middle Delta	210	491
	Sabal DPS			
Gharbia	Samatay DPS	Middle Delta	370	993
	El-Segaiya DPS			
	El-Mehala El-Kobra			
East Kafr El-Sheikh	No.6 DPS	Middle Delta	237	717
	No.5 DPS			
	No.7 DPS			
	Lower No.8 DPS			
	Upper No.8 DPS			
	Teara DPS			
	El-Mandoura DPS			
	El Borollus DPS			
West Kafr El-Sheikh	El-Zainy DPS	Middle Delta	170	514
	No.11 DPS			
	Zaghlool DPS			
Damietta	Lower El-Serw DPS	Middle Delta	365	670
	Upper El-Serw DPS			
	Faraskour DPS			
	Sihrigt			
	El-Senaniya DPS			
	Drain No.2 DPS			
	Lower No.1 DPS			
	Upper No.1 DPS			
	Hafeer Shehab El-Din			
	No.3 DPS			
	No.4 DPS			

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Table A.21 (Cont.): Global definition of the drainage network

Drainage Directorate	Main Drain	Region	Area Served (1000 Fed.)	Total lengths (Km)
North El Behira	El-Tabia DPS	West Delta	359	869
	El-Kalaa DPS			
	Mariout DPS			
	El-Doshodi DPS			
South El Behira	Rasheed DPS	West Delta	424	1027
	Zawyet El-Bahr DPS			
	South Tahreer			
	El-Bousily DPS			
	Edko DPS			
	Halk El-Gamal DPS			
	Khairi DPS			
	Zarkoum DPS			
	Shobra-Kheet DPS			
	Barseek DPS			
	West Khandak DPS			
	Itay El-Baroud DPS			
El Nobaria	El-Nasr Dist. Drain	West Delta	153	247
	El-Mazraa El-Aaliya			
	El-Horriya Dist.			
	El-Thawrah Dist.			
El Nasr	Mariout Dist.	West Delta	430	694
	Hares DPS			
	Trouga DPS			
	El-Shirishra DPS			
	Abu Hommus			
	El-Dellingat DPS			
	New Dellingat DPS			
Giza	Abunomros & Rawahi	Middle Egypt	245	809
	East Nile			
	El-Massandah			
El Fayoum	El-Fayoum (L.K)	Middle Egypt	345	1007
Beni Suef	Kosheishah DPS	Middle Egypt	313	1176
East El Menia	Kadkab	Middle Egypt	240	474
	Ihnasya			
	Bani Salem DPS			
	El-Shiekh Zayed			
	Abu Rahib			
	Damarees			
	Itsa			
	Makousa			
West El Menia	Mazoura	Middle Egypt	241	424
	Sakoula			
	Dair El-Sankouria			
	Minshat El-Dahab			
	Touna & Bani Khaled			
	El-Badraman			
Assuit	Massrrah	Upper Egypt	312	188
	El-Gabal El-Raisi			
	Manfaloot			
	Abnoub			
	Mankabad			
	El-Zinnar El-Raisi			
	El-Badari			
	Abu Teeg El-Raisi			
	Tema			
Souhag	Tehta El-Raisi	Upper Egypt	309	396
	Akhmeem El-Bahri			
	Kalfao			
	Akhmeem Elk-Qiblil			
	Souhag El-Raisi			
	El-Shewash			
	Abu El-Ihgar			
	El-Kheyam El-Raisi			

Table A.21 (Cont.): Global definition of the drainage network

Drainage Directorate	Main Drain	Region	Area Served (1000 Fed.)	Total lengths (Km)
North Kena	Sallam DPS	Upper Egypt	192	
	Nag-Hammadi El-Raisi			
South Kena	El-Rawi	Upper Egypt	191	
	El-Marashda			
	Hamad			
	Dundarah			
	El-Taramsah			
	Kift			
	El-Ballas & Khatra			
	Hegazah			
	Dunfeek EL-Gharbi			
	Dunfeek El-Sharki			
	El-Hubait Main Drain			
	El-Rayaynah			
	El-Bayadia			
	Armant El-Raisi			
	El-Sallamiya			
	El-Moalla & El-Shaghb			
	El-Mahameed			
	Kommair & ElMatana			
	El-Dair El-Kibli			
	EL-Hillah			
Aswan	El-Sebaiya	Upper Egypt	167	438
	El-Hegaz & El-Mahameed			
	Kifo			
	El-Radicya & Wadi Abdi			
	Attia Shenoda			
	El-Radicya Kibli			
	Selwa Bahri & Kibli			
	Abu Hour			
	Kom Ombo			
	Benban			
	El-Sikka El-Hadid			

Table A.22 : Irrigation Network Defenition in El Sharkia Directorate

Number	Canal Name	Order	Area Served (feddans)	Length (Km)	Width (m)
1	Tawfiky Rayah	1			
2	Intake Bahr Moiese	2	487,404.00	67.00	30.43
3	G 4 Right[1]	3	328.00	2.52	1.00
4	G 4 Left	3	248.00	1.17	1.00
5	G 5 Right	3	385.00	3.52	1.00
6	El Nigamia	3	1,450.00	3.67	1.50
7	G 5 Left	3	456.00	2.02	1.00
8	G 6 Left	3	479.00	1.62	1.00
9	G 6 Right	3	152.00	1.12	1.00
10	El Gedida	3	940.00	2.75	1.00
11	Kardida	3	960.00	2.66	1.40
12	El Sateh El Gedid	3	1,025.00	3.10	1.50
13	Intake Bahr Eissa	3	2,950.00	7.40	1.82
14	Intake Bahr Bondok	3	4,225.00	9.10	2.48
15	G 7 Left	3	261.00	2.27	1.00
16	G 7 Right	3	165.00	1.75	1.00
17	G 8 Left	3	802.00	1.46	1.00
18	G 8 Right	3	603.00	2.75	1.00
19	G 9 Left	3	599.00	1.56	1.00
20	Intake Bahr Fakhr	3	3,120.00	8.03	2.27
21	Intake El Siniti	3	10,867.00	20.40	3.63
22	EL Dababra	3	4,200.00	7.15	2.62
23	El Shams	3	900.00	3.06	1.53
24	G 10 Left	3	250.00	2.22	1.24
25	Intake Sharwida	3	6,050.00	5.75	1.78
26	Intake Bahr Shiba	3	545.00	1.96	1.00
27	Intake Bahr Mashtoul	3	42,692.00	37.30	5.14
28	Intake El Messiehia	3	32,961.00	19.60	4.47
29	Bahr Faqus	3	160,726.00	52.55	22.43
30	G Mahdia	3	450.00	1.20	1.00
31	G Abu Hatab	3	500.00	2.28	1.00
32	Sharshima	3	1,000.00	2.13	1.50
33	G El Gamal	3	300.00	1.30	1.00
34	Oum El Rish	3	5,780.00	5.52	3.50
35	G EL Shawayka	3	200.00	1.20	1.00
36	El Ahraz	3	2,500.00	6.86	1.72
37	G Taymour	3	850.00	2.45	1.50
38	El Arayed	3	2,100.00	3.40	2.00
39	G Shaheen	3	250.00	1.20	1.00
40	G El Sadi Right	3	2,000.00	7.16	1.77
41	Intake El Sadi	3	29,150.00	15.48	7.86
42	G El Sadi Left	3	3,300.00	7.14	2.24
43	Hanoura	3	1,100.00	7.00	2.22
44	Khoudaria South	3	4,350.00	5.80	2.92
45	G Talbega	3	450.00	0.78	1.00
46	Khoudaria North	3	800.00	2.99	1.50
47	El Mostagada	3	850.00	2.30	1.50
48	Sengaha EL Omoumy	3	1,000.00	3.74	1.50
49	Natora South	3	1,800.00	9.99	1.87
50	Moiese North	3	16,450.00	14.54	7.52
51	Sengaha East	3	2,250.00	7.38	1.90
52	El Ashry	3	1,200.00	4.26	1.50
53	Sengaha West	3	4,100.00	15.60	3.79
54	G Hanoute South	3	3,260.00	6.90	3.13
55	Hanoute	3	75,300.00	15.36	12.93
56	El Ismailia	1			
57	Eastern Wadi	2	9,825.00	8.00	4.00
58	El Sababa	3	8,820.00	20.34	2.95

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1 G: Ganabia

Table A.23 : Hydraulic Structures Definition in El Sharkia Directorate

Number	Canal	Structure Code
29	Bahr Faqus	10
2	Intake Bahr Moiese	3
2	Intake Bahr Moiese	10

Table A.24 : Beneficiaries of Canal Network in El Sharkia Directorate

Number	Canal Name	Order	User Group	User Code
3	G 4 Right	3	Irrigation	5
4	G 4 Left	3	Irrigation	5
5	G 5 Right	3	Irrigation	5
6	El Nigamia	3	Irrigation	5
7	G 5 Left	3	Irrigation	5
8	G 6 Left	3	Irrigation	5
9	G 6 Right	3	Irrigation	5
10	El Gedida	3	Irrigation	5
11	Kardida	3	Irrigation	5
12	El Sateh El Gedid	3	Irrigation	5
13	Intake Bahr Eissa	3	Irrigation	5
14	Intake Bahr Bondok	3	Irrigation	5
15	G 7 Left	3	Irrigation	5
16	G 7 Right	3	Irrigation	5
17	G 8 Left	3	Irrigation	5
18	G 8 Right	3	Irrigation	5
19	G 9 Left	3	Irrigation	5
20	Intake Bahr Fakhr	3	Irrigation	5
21	Intake El Siniti	3	Irrigation	5
22	EL Dababra	3	Irrigation	5
23	El Shams	3	Irrigation	5
24	G 10 Left	3	Irrigation	5
25	Intake Sharwida	3	Irrigation	5
26	Intake Bahr Shiba	3	Irrigation	5
27	Intake Bahr Mashtoul	3	Irrigation	5
28	Intake El Messlehia	3	Irrigation	5
29	Bahr Faqus	3	Irrigation	5
30	G Mahdia	3	Irrigation	5
31	G Abu Hatab	3	Irrigation	5
32	Sharshima	3	Irrigation	5
33	G El Gamal	3	Irrigation	5
34	Oum El Rish	3	Irrigation	5
35	G EL Shawayka	3	Irrigation	5
36	El Ahraz	3	Irrigation	5
37	G Taymour	3	Irrigation	5
38	El Arayed	3	Irrigation	5
39	G Shaheen	3	Irrigation	5
40	G El Sadi Right	3	Irrigation	5
41	Intake El Sadi	3	Irrigation	5
42	G El Sadi Left	3	Irrigation	5
43	Hanoura	3	Irrigation	5
44	Khoudaria South	3	Irrigation	5
45	G Talbega	3	Irrigation	5
46	Khoudaria North	3	Irrigation	5
47	El Mostagada	3	Irrigation	5
48	Sengaha EL Omoumy	3	Irrigation	5
49	Natora South	3	Irrigation	5
50	Moiese North	3	Irrigation	5
51	Sengaha East	3	Irrigation	5
52	El Ashry	3	Irrigation	5
53	Sengaha West	3	Irrigation	5
54	G Hanoute South	3	Irrigation	5
55	Hanoute	3	Irrigation	5
57	Eastern Wadi	2	Irrigation	5
58	El Sababa	3	Irrigation	5
2	Intake Bahr Moiese	2	Muncipal & Irrigation	3

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Table A.25 : Maintenance Cost of the Canal Network in El Sharkia Directorate

Number	Canal Name	DRD_COST	DRD_LEN	WEED_COST	WEED_LEN	LIN_COST	LIN_LEN	Year
33	G El Gamal	732.00	0.88	0.00	0.00	0.00	0.00	86
34	Oum El Rish	3,111.00	2.52	0.00	0.00	0.00	0.00	86
36	El Ahraz	6,588.00	6.81	0.00	0.00	0.00	0.00	86
37	G Taymour	2,196.00	2.46	0.00	0.00	0.00	0.00	86
41	Intake El Sadi	30,010	12.95	0.00	0.00	0.00	0.00	86
42	G El Sadi Left	7,320.00	7.10	0.00	0.00	0.00	0.00	86
43	Hanoura	4,393.00	6.10	0.00	0.00	0.00	0.00	86
44	Khoudaria South	4,758.00	5.24	0.00	0.00	0.00	0.00	86
45	G Talbega	0.00	0.00	0.00	0.00	0.00	0.00	86
46	Khoudaria North	4,026.00	2.99	0.00	0.00	0.00	0.00	86
48	Sengaha EL Omoumy	3,660.00	3.70	0.00	0.00	0.00	0.00	86
33	G El Gamal	730.00	0.88	0.00	0.00	0.00	0.00	87
34	Oum El Rish	0.00	0.00	0.00	0.00	0.00	0.00	87
36	El Ahraz	9,311.00	6.81	0.00	0.00	0.00	0.00	87
37	G Taymour	2,196.00	2.46	0.00	0.00	7.70	3.00	87
41	Intake El Sadi	42,750	12.95	0.00	0.00	0.00	0.00	87
42	G El Sadi Left	9,000.00	7.10	0.00	0.00	0.00	0.00	87
43	Hanoura	5,500.00	6.10	0.00	0.00	0.00	0.00	87
44	Khoudaria South	5,500.00	5.24	0.00	0.00	0.00	0.00	87
45	G Talbega	1,000.00	0.65	0.00	0.00	0.00	0.00	87
46	Khoudaria North	5,129.00	2.99	0.00	0.00	3,235.00	140.00	87
48	Sengaha EL Omoumy	4,793.00	3.70	0.00	0.00	0.00	0.00	87
2	Intake Bahr Moiese	0.00	0.00	78,000.00	26.00	5,250.00	100.00	88
3	G 4 Right	0.00	7,200.00	7.05	0.00	0.00	0.00	88
4	G 4 Left	4,300.00	9.00	0.00	0.00	0.00	0.00	88
6	El Nigamia	3,450.00	3.68	0.00	0.00	0.00	0.00	88
8	G 6 Left	7,275.00	6.98	0.00	0.00	0.00	0.00	88
12	El Sateh El Gedid	5,000.00	4.92	0.00	0.00	0.00	0.00	88
13	Intake Bahr Eissa	5,750.00	7.39	0.00	0.00	6,468.00	140.00	88
14	Intake Bahr Bondok	6,612.00	9.03	0.00	0.00	2,150.00	50.00	88
18	G 8 Right	2,700.00	5.00	0.00	0.00	0.00	0.00	88
20	Intake Bahr Fakhr	6,000.00	8.03	0.00	0.00	0.00	0.00	88
21	Intake El Siniti	17,250	20.40	0.00	0.00	1,922.00	80.00	88
22	EL Dababra	6,300.00	7.15	0.00	0.00	0.00	0.00	88
23	El Shams	0.00	0.00	0.00	0.00	0.00	0.00	88
24	G 10 Left	2,825.00	4.23	0.00	0.00	0.00	0.00	88
25	Intake Sharwida	2,700.00	4.71	0.00	0.00	0.00	0.00	88
27	Intake Bahr Mashtoul	0.00	0.00	0.00	0.00	0.00	0.00	88
28	Intake El Messiemia	18,401	19.60	0.00	0.00	1,420.00	50.00	88
29	Bahr Faqus	156,050	44.20	0.00	0.00	6,390.00	110.00	88
30	G Mahdia	4,100.00	4.56	0.00	0.00	0.00	0.00	88
31	G Abu Hatab	2,715.00	2.80	0.00	0.00	0.00	0.00	88
32	Sharshima	1,725.00	2.12	0.00	0.00	0.00	0.00	88
38	El Arayed	7,187.00	8.06	0.00	0.00	4,170.00	100.00	88
39	G Shaheen	5,750.00	5.00	0.00	0.00	0.00	0.00	88
40	G El Sadi Right	9,000.00	7.10	0.00	0.00	0.00	0.00	88
47	El Mostagada	1,725.00	1.87	0.00	0.00	0.00	0.00	88
49	Natora South	9,000.00	9.87	0.00	0.00	0.00	0.00	88
50	Moiese North	37,375	14.35	0.00	0.00	10,776	230.00	88
51	Sengaha East	7,500.00	5.83	0.00	0.00	0.00	0.00	88
52	El Ashry	5,175.00	4.18	0.00	0.00	12,142	200.00	88
53	Sengaha West	25,000	17.20	0.00	0.00	0.00	0.00	88
54	G Hanoute South	8,750.00	7.75	0.00	0.00	0.00	0.00	88
55	Hanoute	47,130	15.27	0.00	0.00	0.00	0.00	88
57	Eastern Wadi	5,175.00	3.00	32,619.00	10.30	0.00	0.00	88
58	El Sababa	33,350	20.34	0.00	0.00	5,170.00	190.00	88
2	Intake Bahr Moiese	5,870.00	11.60	22,000.00	11.00	0.00	0.00	89
3	G 4 Right	4,312.00	7.05	0.00	0.00	0.00	0.00	89
4	G 4 Left	2,300.00	9.00	0.00	0.00	0.00	0.00	89
6	El Nigamia	3,400.00	3.68	0.00	0.00	0.00	0.00	89
8	G 6 Left	5,750.00	6.98	0.00	0.00	0.00	0.00	89

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Table B.25 (cont.): Maintenance Cost of the Canal Network in El Sharkia Directorate

Number	Canal Name	DRD_COST	DRD_LEN	WEED_COST	WEED_LEN	LIN_COST	LIN_LEN	Year
12	El Sateh El Gedid	2,300.00	4.92	0.00	0.00	0.00	0.00	89
13	Intake Bahr Eissa	4,887.00	7.39	0.00	0.00	11,621	212.00	89
14	Intake Bahr Bondok	5,175.00	9.03	0.00	0.00	3,671.00	160.00	89
18	G 8 Right	2,300.00	5.00	0.00	0.00	0.00	0.00	89
20	Intake Bahr Fakhr	4,600.00	8.03	0.00	0.00	4,690.00	180.00	89
21	Intake El Siniti	15,812	20.40	0.00	0.00	1,313.00	65.00	89
22	EL Dababra	5,865.00	7.15	0.00	0.00	0.00	0.00	89
23	El Shams	2,300.00	3.06	0.00	0.00	0.00	0.00	89
24	G 10 Left	2,300.00	4.23	0.00	0.00	0.00	0.00	89
25	Intake Sharwida	4,025.00	4.71	0.00	0.00	0.00	0.00	89
27	Intake Bahr Mashtoul	31,625	24.50	0.00	0.00	1,919.00	65.00	89
28	Intake El Messlehia	16,272	19.60	0.00	0.00	1,263.00	50.00	89
29	Bahr Faqus	71,875	15.45	57,900.00	19.30	0.00	0.00	89
30	G Mahdia	2,875.00	4.56	0.00	0.00	0.00	0.00	89
31	G Abu Hatab	0.00	0.00	0.00	0.00	0.00	0.00	89
32	Sharshima	1,437.00	2.12	0.00	0.00	0.00	0.00	89
38	El Arayed	5,157.00	8.06	0.00	0.00	6,290.00	30.00	89
39	G Shaheen	4,887.00	5.00	0.00	0.00	0.00	0.00	89
40	G El Sadi Right	8,775.00	7.10	0.00	0.00	7,370.00	40.00	89
47	El Mostagarla	1,437.00	1.87	0.00	0.00	0.00	0.00	89
49	Natora South	8,487.00	9.87	0.00	0.00	660.00	50.00	89
50	Moiese North	30,475	14.35	0.00	0.00	3,885.00	180.00	89
51	Sengaha East	5,720.00	5.83	0.00	0.00	0.00	0.00	89
52	El Ashry	4,600.00	4.18	0.00	0.00	0.00	0.00	89
53	Sengaha West	20,125	17.20	0.00	0.00	4,460.00	220.00	89
54	G Hanoute South	8,200.00	7.75	0.00	0.00	0.00	0.00	89
55	Hanoute	3,475.00	15.27	0.00	0.00	0.00	0.00	89
57	Eastern Wadi	0.00	0.00	0.00	0.00	0.00	0.00	89
58	El Sababa	20,412	20.34	0.00	0.00	668.00	30.00	89
2	Intake Bahr Moiese	0.00	0.00	141,750	42.00	2,097.00	50.00	90
3	G 4 Right	5,462.00	7.50	0.00	0.00	0.00	0.00	90
4	G 4 Left	4,025.00	9.00	0.00	0.00	0.00	0.00	90
6	El Nigamia	3,420.00	3.68	0.00	0.00	0.00	0.00	90
8	G 6 Left	4,290.00	6.91	0.00	0.00	0.00	0.00	90
12	El Sateh El Gedid	2,012.00	4.92	0.00	0.00	0.00	0.00	90
13	Intake Bahr Eissa	1,437.00	7.39	0.00	0.00	1,750.00	45.00	90
14	Intake Bahr Bondok	1,150.00	9.03	0.00	0.00	1,000.00	25.00	90
18	G 8 Right	1,265.00	5.00	0.00	0.00	0.00	0.00	90
20	Intake Bahr Fakhr	3,162.00	8.03	0.00	0.00	1,592.00	40.00	90
21	Intake El Siniti	10,821	20.40	0.00	0.00	2,788.00	93.00	90
22	EL Dababra	7,119.00	7.15	0.00	0.00	0.00	0.00	90
23	El Shams	2,121.00	3.06	0.00	0.00	0.00	0.00	90
24	G 10 Left	1,748.00	4.23	0.00	0.00	0.00	0.00	90
25	Intake Sharwida	2,070.00	4.71	0.00	0.00	0.00	0.00	90
27	Intake Bahr Mashtoul	19,550	24.50	0.00	0.00	9,561.00	220.00	90
28	Intake El Messlehia	127655	19.60	0.00	0.00	1,902.00	50.00	90
29	Bahr Faqus	82780	19.30	28,000.00	14.00	24352	510.00	90
30	G Mahdia	3,100.00	4.56	0.00	0.00	0.00	0.00	90
31	G Abu Hatab	2,142.00	2.80	0.00	0.00	853.00	30.00	90
32	Sharshima	1,955.00	2.12	0.00	0.00	0.00	0.00	90
38	El Arayed	4,600.00	8.06	0.00	0.00	1,162.00	40.00	90
39	G Shaheen	3,737	5.00	0.00	0.00	0.00	0.00	90
40	G El Sadi Right	6,900.00	7.10	0.00	0.00	757.00	35.00	90
47	El Mostagada	862.00	1.87	0.00	0.00	0.00	0.00	90
49	Natora South	0.00	0.00	0.00	0.00	1,132.00	30.00	90
50	Moiese North	17,250	14.35	0.00	0.00	0.00	0.00	90
51	Sengaha East	3,960.00	5.83	0.00	0.00	0.00	0.00	90
52	El Ashry	3,960.00	4.18	0.00	0.00	0.00	0.00	90
53	Sengaha West	15,533	17.20	0.00	0.00	4,460.00	0.00	90
54	G Hanoute South	6,325.00	7.75	0.00	0.00	0.00	0.00	90
55	Hanoute	21,850	15.27	0.00	0.00	0.00	0.00	90
57	Eastern Wadi	0.00	0.00	0.00	0.00	8,353.00	1.00	90
58	El Sababa	16,100	20.34	0.00	0.00	0.00	0.00	90

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Table A.26 : Structures Maintenance Cost in El Sharkia Directorate

Number	Canal Name	Structure Type	Mechnical & Electrical	Civil	Year
2	Intake Bahr Moiese	3	15,000	10,000	86
2	Intake Bahr Moiese	10	25,000	10,000	86
2	Intake Bahr Moiese	3	15,000	10,000	87
2	Intake Bahr Moiese	10	25,000	10,000	87
2	Intake Bahr Moiese	3	15,000	10,000	88
2	Intake Bahr Moiese	10	25,000	10,000	88
2	Intake Bahr Moiese	3	20,000	15,000	89
2	Intake Bahr Moiese	10	25,000	10,000	89
2	Intake Bahr Moiese	3	20,000		90
2	Intake Bahr Moiese	10	25,000	10,000	90

Table A.27 : Rehabilitation Cost of Canal Network in El Sharkia Directorate

Number	Canal Name	Cost	Length (Km)	Year
52	El Ashry	24,653	0.25	90

Table A.28: Basic Nile System Beneficiary Groups

Beneficary Group	Code
Navigation & Municipal & Industrial & Irrigation	1
Municipal & Industrial & Irrigation	2
Municipal & Irrigation	3
Industrial & Irrigation	4
Irrigation	5
Navigation & Municipal & Irrigation	6
Navigation & Irrigation	7

Table A.29: Basic Types of Hydraulic Sturctures

Structure	Code
Dam	1
Barrage	2
Intake Regulator	3
Head Regulator	4
Weir	5
Lock	6
Tail Escape	7
Syphon	8
Aqudect	9
Bridge	10
Suction Bit	11

2

Table A.30: Area Served and Water Requirements of Irrigation Directorates

Directorate Name	Code	Region	Area Served (1000 fed)	Water Requirements ($M.m^3$/year)
Aswan	ASW	Upper Egypt	131.628	953.529
Kena	QEN	Upper Egypt	369.985	3280.876
Sohag	SOH	Upper Egypt	327.728	2105.598
Assuit	ASU	Middle Egypt	310.598	1894.037
West of Menia	WMN	Middle Egypt	284.118	2588.557
East of Menia	EMN	Middle Egypt	198.882	1801.429
Beni-Suef	BEN	Middle Egypt	279.100	1530.586
Fayoum	FAY	Middle Egypt	205.600	1484.678
Giza	GIZ	Middle Egypt	342.750	1963.888
El-Kalubia	KAL	East Delta	336.550	1881.468
El-Ismailia	ISM	East Delta	171.409	763.525
El-Sharkia	SHK	East Delta	499.394	2600.051
El-Salhia	SAL	East Delta	216.898	1187.633
Damietta	DMT	East Delta	104.539	756.636
East of Dakahlia	EDK	East Delta	427.163	3097.080
West of Dakahlia	WDK	Middle Delta	352.874	2558.457
Kafr El-Sheikh	KSH	Middle Delta	484.136	3621.481
El-Gharbia	GAR	Middle Delta	372.229	2144.754
El-Menofia	MIN	Middle Delta	379.748	2152.276
El-Behira	BHR	West Delta	338210	2024.251
West of El-Beheira	WBR	West Delta	375.183	2155.218
Alexandria	ALX	West Delta	728.149	4024.130

Table A.31: Annual MPWWR Budget

Year 1986

	Chapter 1	Chapter 2								Chapter 3		Chapter 4
Name	O	M1	M2	M3	M4	M5	M6	M7	M8	M	R	Loan
MPWWR	744814.00	2811281.00	2389.00	0.00	0.00	3413.00	13785.00	2903.00	8.00	2633759.00	3057498.00	
Delta Barrage	1663752.00	175047.00	11631.00	177.00	20384.00	7752.00	6123.00	118.00	8354.00	229588.00	683742.00	
Reservoirs	461634.00	0.00	1033.00	0.00	0.00	671.00	585.00	1315.00	0.00	3604.00	7176937.00	
Nile Monitoring	554790.00	0.00	700.00	0.00	0.00	1210.00	4069.00	214.00	0.00	6193.00	0.00	
Design Dept.	151007.00	0.00	0.00	1344.00	0.00	1572.00	3429.00	9.00	182.00	6536.00	7157.00	
Sudan	1631268.00	0.00	10052.00	251.00	0.00	13.00	3056.00	281.00	0.00	13653.00	0.00	
Aswan	1481483.00	1194604.00	5612.00	657.00	77059.00	2964.00	14150.00	504.00	0.00	1295550.00	0.00	1567831.00
Kena	2175669.00	2654973.00	2467.00	0.00	35339.00	4499.00	4603.00	52.00	0.00	2901933.00	0.00	2556899.00
Sohag	1793964.00	1211051.00	686.00	0.00	46348.00	2614.00	8071.00	313.00	0.00	1269083.00	0.00	1315033.00
Assuit	1227351.00	904740.00	1009.00	0.00	63830.00	3324.00	3805.00	78.00	0.00	976784.00	0.00	1955026.00
El-Menia	1545744.00	2441970.00	5782.00	86.00	14938.00	4806.00	14907.00	328.00	0.00	2482817.00	0.00	4460995.00
Beni-Suef	1506310.00	1494119.00	1534.00	0.00	29976.00	1468.00	3664.00	678.00	0.00	1531437.00	0.00	1872997.00
Fayoum	1091758.00	1050000.00	2295.00	0.00	7758.00	2928.00	4470.00	54.00	0.00	1067505.00	0.00	1635859.00
Giza	1603598.00	1341077.00	458.00	0.00	640.00	1498.00	3000.00	40.00	0.00	1347013.00	0.00	343575.00
El-Kalubia	1554429.00	1266040.00	4646.00	0.00	9399.00	2102.00	4510.00	102.00	0.00	1306799.00	0.00	924250.00
El-Ismailia	891282.00	1619247.00	1457.00	0.00	25147.00	1564.00	4241.00	50.00	0.00	1651706.00	0.00	977946.00
El-Sharkia	2167598.00	2014325.00	1469.00	0.00	20457.00	1354.00	4739.00	128.00	0.00	2042470.00	0.00	30369522.00
El-Dakahlia	3181698.00	3362998.00	2062.00	0.00	40544.00	2790.00	16114.00	418.00	0.00	3424928.00	0.00	12014052.00
Kafr El-Sheikh	1054443.00	1529508.00	3234.00	0.00	37095.00	1730.00	6206.00	100.00	0.00	1577871.00	0.00	2907073.00
El-Gharbia	1783218.00	1577963.00	1437.00	0.00	44666.00	1817.00	7533.00	387.00	0.00	1633803.00	0.00	3777535.00
El-Menofia	1674584.00	1569067.00	10268.00	0.00	68853.00	1115.00	4061.00	432.00	0.00	1653798.00	0.00	923903.00
El-Behera	1407648.00	4490909.00	3429.00	0.00	32938.00	2871.00	6158.00	140.00	0.00	4536445.00	0.00	4489886.00
Alexanderia	579844.00	1449992.00	16374.00	0.00	4461.00	1337.00	3362.00	10.00	0.00	1475538.00	0.00	4906328.00

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APPENDIX A 33

Year 1987

	Chapter 1	Chapter 2								Chapter 3		Chapter 4
Name	O	M1	M2	M3	M4	M5	M6	M7	M8	M	R	Loan
MPWWR	1049008.00	3878705.00	2349.00	0.00	0.00	1426.00	16998.00	5012.00	0.00	3902490.00		4520471.00
Delta Barrage	2253286.00	240188.00	7293.00	208.00	13190.00	11931.00	7074.00	100.00	6689.00	286673.00		518271.00
Reservoirs	249008.00	0.00	8512.00	0.00	0.00	393.00	222.00	147.00	0.00	10274.00		7321144.00
Nile Monitoring	641083.00	0.00	1092.00	0.00	0.00	1719.00	3356.00	364.00	0.00	6531.00		0.00
Design Dept.	208770.00	0.00	149.00	0.00	0.00	775.00	4108.00	275.00	295.00	5602.00		27056.00
Sudan	2002564.00	0.00	32182.00	11765.00	1986.00	6034.00	6026.00	1721.00	1563.00	61257.00		18435.00
Aswan	1709751.00	1499092.00	9493.00	0.00	60971.00	5377.00	10083.00	260.00	0.00	1585278.00	0.00	2960383.00
Kena	2714076.00	3618681.00	821.00	8918.00	13005.00	3774.00	4347.00	62.00	61.00	3649889.00	0.00	4836870.00
Sohag	2263755.00	1001550.00	772.00	0.00	40612.00	3465.00	7601.00	104.00	0.00	1054104.00	0.00	868506.00
Assult	1385081.00	1808274.00	1496.00	0.00	26514.00	1010.00	3372.00	83.00	250.00	1840999.00	0.00	2001867.00
El-Menia	1647089.00	4281376.00	3568.00	0.00	24895.00	3837.00	12214.00	304.00	0.00	4326194.00	0.00	4872944.00
Beni-Suef	1591385.00	2714472.00	992.00	0.00	29323.00	1535.00	4642.00	124.00	0.00	2751068.00	0.00	2134168.00
Fayoum	1137089.00	2675450.00	1744.00	0.00	0.00	4474.00	6343.00	57.00	0.00	2688068.00	0.00	1897754.00
Giza	1008001.00	1587740.00	3092.00	648.00	3998.00	1795.00	5023.00	326.00	0.00	1602822.00	0.00	215247.00
El-Kalubia	1950198.00	1791877.00	1036.00	0.00	10945.00	1478.00	3622.00	616.00	0.00	1809574.00	0.00	[illegible]
El-Ismailia	918033.00	1891586.00	2555.00	0.00	20779.00	1812.00	4248.00	99.00	0.00	1921079.00	0.00	[illegible]
El-Sharkia	2944009.00	3337656.00	2951.00	0.00	28737.00	3431.00	4158.00	143.00	0.00	3377078.00	0.00	22297412.00
El-Dakahlia	3739093.00	5700006.00	3658.00	1980.00	56274.00	2803.00	9505.00	259.00	0.00	5774485.00	0.00	12134822.00
Kafr El-Sheikh	1098709.00	2819867.00	2960.00	0.00	30045.00	947.00	5498.00	50.00	0.00	2859367.00	0.00	2541695.00
El-Gharbia	2082739.00	1624725.00	881.00	0.00	27870.00	1717.00	4104.00	144.00	0.00	1659241.00	0.00	3536673.00
El-Menofia	2088744.00	1356134.00	640.00	0.00	12963.00	1018.00	8675.00	236.00	0.00	1379668.00	0.00	481004.00
El-Behera	1647017.00	2937245.00	699.00	1395.00	24264.00	1621.00	6408.00	77.00	0.00	2971709.00	0.00	5085727.00
Alexanderia	681492.00	3401354.00	12691.00	0.00	0.00	1971.00	4515.00	0.00	0.00	3420531.00	0.00	9666750.00

Year 1988

	Chapter 1			Chapter 2						Chapter 3		Chapter 4
Name	O	M1	M2	M3	M4	M5	M6	M7	M8	M	R	Loan
MPWWR	1821002.00	5231219.00	13517.00	0.00	0.00	1894.00	21977.00	8017.00	0.00	5276624.00	8314497.00	
Delta Barrage	2561182.00	198913.00	21980.00	15.00	138789.00	11323.00	12757.00	85.00	7408.00	391280.00	424695.00	
Reservoirs	279711.00	0.00	3962.00	0.00	0.00	705.00	234.00	137.00	0.00	5038.00	14003481.00	
Nile Monitoring	707638.00	0.00	9868.00	0.00	0.00	1565.00	8275.00	165.00	0.00	19873.00	0.00	
Design Dept	231669.00	0.00	188.00	0.00	0.00	987.00	8639.00	0.00	1.00	9815.00	0.00	
Sudan	2547368.00	0.00	91141.00	4890.00	492.00	1669.00	5502.00	544.00	125.00	104363.00	50355.00	
Aswan	1868793.00	2008635.00	1553.00	0.00	34096.00	1889.00	12540.00	78.00	0.00	2058791.00	0.00	3988994.00
Kena	2992152.00	2439205.00	547.00	1408.00	44630.00	4085.00	8015.00	107.00	0.00	2497995.00	0.00	2543534.00
Sohag	2465561.00	1015631.00	1969.00	0.00	30128.00	5548.00	5268.00	153.00	0.00	1058717.00	0.00	983283.00
Assuit	1648032.00	1928399.00	2073.00	0.00	29999.00	1118.00	3373.00	140.00	82.00	1985184.00	0.00	2724651.00
El-Menia	2138861.00	5219516.00	1508.00	0.00	122422.00	4522.00	8730.00	205.00	0.00	5356803.00	0.00	6556140.00
Beni-Suef	1981554.00	3821032.00	897.00	0.00	18480.00	979.00	3850.00	219.00	0.00	3845457.00	0.00	4009677.00
Fayoum	1258744.00	5846726.00	2808.00	0.00	12084.00	3793.00	5689.00	57.00	0.00	587157.00	0.00	3986543.00
Giza	1124138.00	4076237.00	7390.00	0.00	10416.00	3329.00	9162.00	87.00	0.00	4106621.00	0.00	358589.00
El-Kalubia	2153593.00	2437459.00	697.00	0.00	7183.00	1436.00	7343.00	294.00	0.00	2364412.00	0.00	872618.00
El-Ismailia	1036120.00	2241962.00	2523.00	0.00	13769.00	2265.00	4753.00	88.00	0.00	2265360.00	0.00	1671408.00
El-Sharkia	2900475.00	5813455.00	1965.00	0.00	39805.00	1999.00	4536.00	1698.00	0.00	5863458.00	0.00	20700049.00
El-Dakahlia	4167320.00	8439363.00	1867.00	0.00	47718.00	3546.00	11383.00	571.00	0.00	8504446.00	0.00	13456421.00
Kafr El-Sheikh	1199285.00	3582978.00	999.00	0.00	97719.00	1042.00	6589.00	63.00	0.00	3689390.00	0.00	4202346.00
El-Gharbia	2269194.00	1810042.00	564.00	9448.00	13391.00	1692.00	5641.00	200.00	120.00	1841098.00	0.00	3561213.00
El-Menofia	2245258.00	1932601.00	433.00	0.00	11621.00	1840.00	7372.00	251.00	0.00	1953918.00	0.00	744637.00
El-Behera	1636578.00	5268217.00	1615.00	0.00	8689.00	1689.00	6037.00	117.00	0.00	5286364.00	0.00	4934562.00
Alexanderia	871072.00	3943330.00	13450.00	0.00	2580.00	2155.00	7404.00	10.00	0.00	3968929.00	0.00	13668518.00

Year 1989

	Chapter 1	Chapter 2								Chapter 3		Chapter 4
Name	O	M1	M2	M3	M4	M5	M6	M7	M8	M	R	Loan
MPWWR	1945821.00	10811373.00	382.00	0.00	0.00	208.00	29698.00	9945.00	0.00		10851608.00	10942151.00
Delta Barrage	2861874.00	203134.00	14386.00	199.00	14137.00	9807.00	12389.00	441.03	7077.00		261570.00	686969.00
Reservoirs	381040.00	0.00	16532.00	0.00	0.00	720.00	733.00	47.00	0.00		18032.00	20328637.00
Nile Monitoring	848549.00	0.00	4749.00	0.00	0.00	4008.00	7365.00	133.00	0.00		16273.00	0.00
Design Dept	258308.00	0.00	3.00	0.00	0.00	1095.00	5772.00	145.00	148.00		7164.00	0.00
Sudan	2384134.00	0.00	67281.00	1412.00	0.00	1467.00	21663.00	8196.00	485.00		100504.00	132868.00
Aswan	2065893.00	2311818.00	2234.00	0.00	64563.00	986.00	16815.00	9.00	0.00	2396425.00	0.00	2250604.00
Kena	3282722.00	3879362.00	2184.00	0.00	39950.00	7419.00	16793.00	349.00	0.00	3746057.00	0.00	3362407.00
Sohag	2729269.00	1498921.00	1387.00	1964.00	5035.00	3832.00	6693.00	1182.00	0.00	1517014.00	0.00	291364.00
Assuit	1840147.00	2736251.00	11448.00	0.00	59874.00	1509.00	4973.00	698.00	0.00	2814753.00	0.00	2623433.00
El-Menia	2728166.00	3855810.00	2321.00	1761.00	39245.00	4177.00	12068.00	3292.00	0.00	3918472.00	0.00	6658596.00
Beni-Suef	2185814.00	2514413.00	375.00	0.00	17050.00	2172.00	6838.00	68.00	0.00	2535916.00	0.00	3940511.00
Fayoum	1410874.00	5008028.00	1975.00	0.00	5130.00	7572.00	8083.00	78.00	0.00	5028864.00	0.00	2908744.00
Giza	1325517.00	3426807.00	8302.00	0.00	825.00	7616.00	10533.00	276.00	0.00	3454359.00	0.00	279175.00
El-Kalubia	2362257.00	1550444.00	1478.00	0.00	10072.00	962.00	5348.00	509.00	0.00	1568813.00	0.00	1253657.00
El-Ismailia	932871.00	1356840.00	2898.00	0.00	75200.00	999.00	8736.00	829.00	0.00	1443502.00	0.00	528168.00
El-Sharkia	3848429.00	4167618.00	3497.00	0.00	49918.00	1983.00	2835.00	2011.00	0.00	4227842.00	0.00	4691116.00
El-Dakahlia	4965718.00	7958660.00	1265.00	0.00	28250.00	2658.00	16849.00	258.00	0.00	8007938.00	0.00	12960547.00
Kafr El-Sheikh	1584533.00	2695172.00	1185.00	0.00	143454.00	2928.00	9540.00	78.00	0.00	2852357.00	0.00	3474393.00
El-Gharbia	2844843.00	2038918.00	155.00	119.00	21123.00	1661.00	7859.00	276.00	0.00	2070111.00	0.00	3025691.00
El-Menofia	2611370.00	1098002.00	501.00	0.00	14353.00	164.00	5467.00	104.00	0.00	1118591.00	0.00	779034.00
El-Behera	2163228.00	5101807.00	262.00	0.00	46193.00	3278.00	6821.00	182.00	0.00	5160521.00	0.00	5354343.00
Alexanderia	965767.00	6164122.00	720.00	0.00	58.00	607.00	9398.00	58.00	0.00	6174961.00	0.00	10772188.00

BEST AVAILABLE DOCUMENT

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Year 1990

	Chapter 1	Chapter 2								Chapter 3		Chapter 4
Name	O	M1	M2	M3	M4	M5	M6	M7	M8	M	R	Loan
MPWWR	2110525	765575	4037	0	0	0	41318	12115	0	7713285	1533434992	
Delta Barrage	3034450	216004	3552	534	15265	27660	39131	86	15694	317926	770347	
Tanks	361637	0	82	0	0	506	2979	145	0	3712	63302801	
Nile Monitoring	881090	0	6465	0	0	12449	22903	47	1230	43094	0	
Design Dept.	260881	0	0	0	0	2332	14624	10	0	16966	0	
Sudan	1423676	0	0	0	43696	0	0	0	0	43696	227708	
Aswan	2394029.00	1543692.00	4668.00	0.00	50838.00	979.00	25498.00	143.00	0.00	1825818.00	0.00	1678159.00
Kena	3784144.00	4394772.00	3989.00	0.00	27483.00	90897.00	46772.00	1228.00	0.00	4565139.00	0.00	1570697.00
Sohag	3178480.00	1509552.00	2783.00	0.00	3458.00	5650.00	18347.00	220.00	0.00	1540010.00	0.00	783843.00
Assuit	2179283.00	2025102.00	5888.00	0.00	48599.00	28027.00	[illegible]	318.00	0.00	2120200.00	0.00	2387626.00
El-Menia	3186229.00	6314871.00	2146.00	10153.00	9501.00	2733.00	[illegible]	5554.00	0.00	6406052.00	0.00	4668788.00
Beni-Suef	2393221.00	2893004.00	4287.00	0.00	17320.00	755.00	5998.00	1188.00	0.00	2722550.00	0.00	7381133.00
Fayoum	1592249.00	3199734.00	2854.00	0.00	41529.00	3027.00	8783.00	730.00	0.00	3258657.00	0.00	1704071.00
Giza	1004929.00	3282130.00	2355.00	25000.00	28344.00	4279.00	22230.00	68.00	0.00	3384408.00	0.00	327982.00
El-Kalubia	2710935.00	701055.00	650.00	2608.00	114691.00	1119.00	11934.00	387.00	0.00	832442.00	0.00	899814.00
El-Ismailia	1093141.00	3213499.00	5071.00	0.00	73255.00	1160.00	6185.00	424.00	0.00	3299594.00	0.00	4272184.00
El-Sharkia	3091958.00	6747238.00	1808.00	4862.00	212354.00	37784.00	47232.00	389.00	101.00	7051748.00	0.00	15038345.00
El-Dakahlia	5758840.00	3771836.00	3458.00	768.00	57920.00	5649.00	36608.00	168.00	0.00	3876203.00	0.00	11012063.00
Kafr El-Sheikh	1754624.00	5253187.00	1148.00	0.00	98181.00	902.00	14183.00	51.00	0.00	5387630.00	0.00	2204850.00
El-Gharbia	3250835.00	2369005.00	582.00	845.00	54208.00	2308.00	22563.00	914.00	0.00	2470425.00	0.00	2485819.00
El-Menofia	2184757.00	1587815.00	183.00	0.00	6777.00	1560.00	3925.00	1175.00	0.00	1581435.00	0.00	1309875.00
El-Behera	2757910.00	5123259.00	2328.00	20111.00	13748.00	8691.00	4752.00	62.00	0.00	5172951.00	0.00	6810162.00
Alexanderia	1030517.00	5240883.00	1803.00	0.00	2060.00	982.00	7909.00	0.00	0.00	5253417.00	0.00	17178357.00

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Annex II

COMPUTER IMPLEMENTATION OF THE COST ALLOCATION PROCESS FOR THE NILE RIVER BASIN, EGYPT

William J. Grenny

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INTRODUCTION

Task Objectives

The objective of this task was to develop a computer model for the cost allocation process and apply it to the Nile River Basin, Egypt. Specifically:

1) Write a stand-alone computer program in common "C" for the cost allocation process described in ISPAN (1992).

2) Test the model using data from ISPAN (1992) for four scenarios.

3) Install the model on the local hardware.

4) Prepare a report describing the model.

This report is composed of four chapters. This INTRODUCTION contains the objectives of the task and the definitions of the terms used in the cost allocation process. The COST ALLOCATION PROCESS chapter describes how the model was formulated for the Nile River Basin, Egypt. The COMPUTER MODEL DESCRIPTION chapter describes the organization of the computer program and the input file formats. The RESULTS chapter presents the results of model runs for the four scenarios. Appendices at the end of the report contain the complete input and output files for the four scenarios, a listing of the model header file declaring the variables and functions, and a listing of the main program and the function definitions.

During the study, the terms for the geographical regions were changed to provide greater specificity. Some of the original terms had already been coded into the model and so there are some slight inconsistencies between the terms in this report and the terms in the main report (ISPAN, 1992). In this report "old lands" and "existing lands" mean the same thing: the lands currently developed and available for cultivation. In the main report these terms are subdivided into "old lands" and "old new lands". In this report "new lands" refers to areas planned for development but not yet into production, and means the same as "new new lands" in the main report.

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Definition of Terms

Cost allocation is a process which provides information for distributing the costs of common works for a multi-purpose project to the beneficiaries of the project.. The commonly used terminology for describing the application of this process to water resources projects is somewhat imprecise. The purpose of the section is to provide a consistent set of terms for the remainder of the report.

The water users are classified into "use sectors"; for example, irrigated agriculture in the Upper Nile Region. The services provided by the multi-purpose project are classified into "service sectors"; for example, reservoir storage for agriculture. A service sector may provide water for several use sectors; for example, storage for agriculture in the High Aswan Dam provides water for irrigation in several regions (use sectors) down stream.

Figure 1 depicts the cost allocation process for a project with three service sectors: irrigated agriculture, hydropower, and navigation. The project cost at the top of the figure is distributed among the service sectors at the bottom of the figure. The "project cost" is the cost of a well defined infrastructure. It may include the investment costs of the physical works, operation and maintenance, rehabilitation, and management. A large water storage and delivery system may be composed of many projects; that is to say the overall system may be disaggregated into a set of well defined subsystems. In order to allocate costs among service sectors for the entire system the cost allocation process may be applied sequentially to each project in the system, and the costs accumulated.

The project cost is first divided into "common works cost" and "specific costs". The term "common works" refers to the project infrastructure needed to create and operate two or more service sectors. Normally it is a complex combination of structural and equipment components that are interdependent (i.e. they depend upon each other to provide full functionality of the project infrastructure for all of its service sectors). The High Aswan Dam is an obvious example of common works.

A "specific cost" is the cost for a facility that has the following characteristics:

1) Its cost is identifiable and part of the project cost.

2) It functions exclusively for a single service sector.

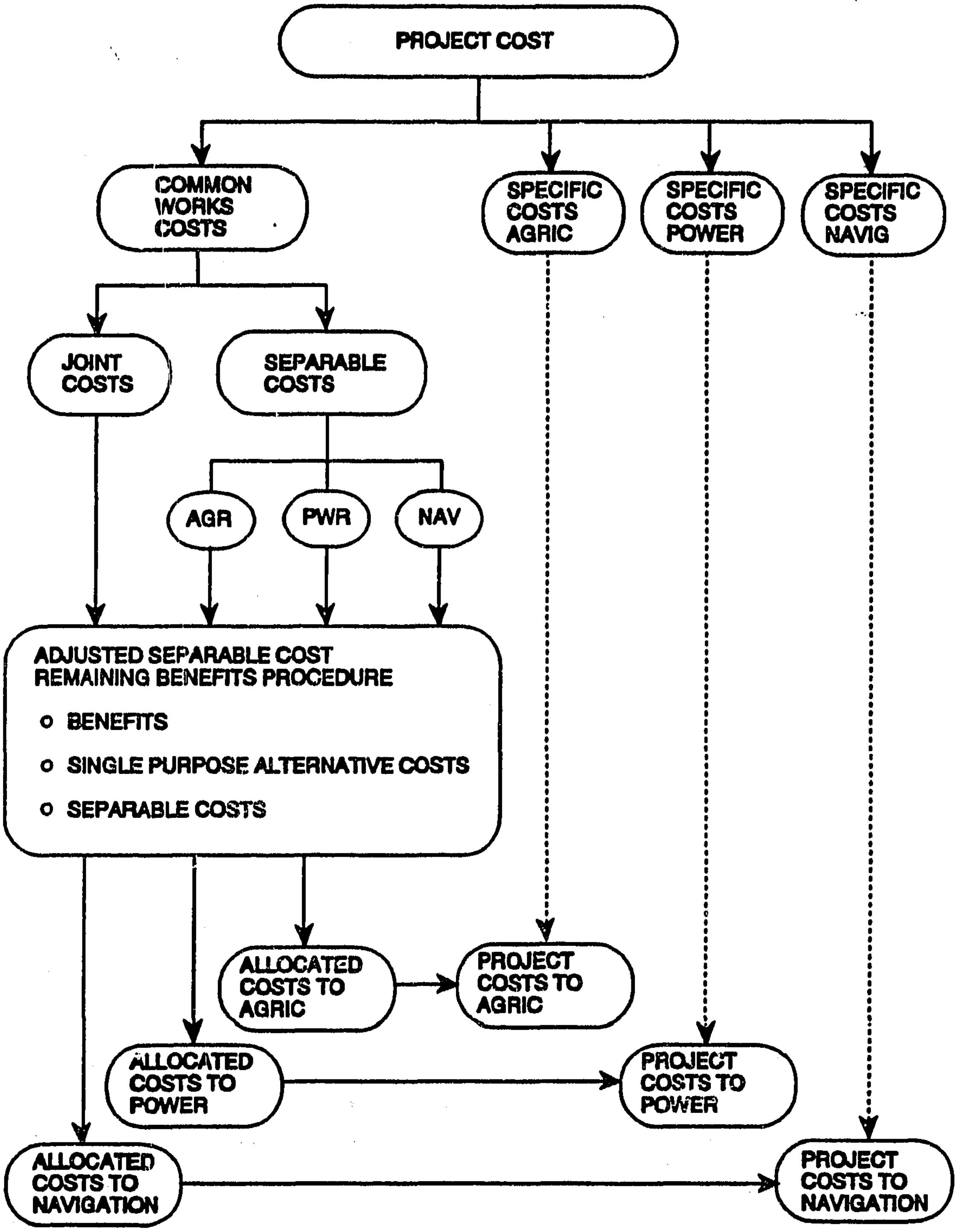

Figure 1. The Cost Allocation Process.

3) Other service sectors in the project would function as intended if this facility were missing.

4) It is not structurally integrated into the common works.

An example of a specific cost is the transmission line which carries energy from the dam to the load center. Specific costs are assigned directly to the appropriate service sector as indicated by the dash lines in Figure 1.

The common works are further divided into "separable costs" and "joint cost." A separable cost is something that is "part" of the common works, but can be associated with a single service sector. There are two types of separable costs which will be referred to as "separable cost of the common works (SCCW)" and "imputed cost." A separable cost of the common works is for an identifiable facility that exists in conjunction with the common works, but functions for a single service sector. The penstock for hydropower which is part of the dam is an example of a separable cost of the common works; it cannot exist without the presence of the common works.

An imputed cost is the incremental cost to the common works of adding a particular service to a project containing all other services. It is calculated for each service by determining the added cost of providing that service over and above the cost of providing the remaining services. To calculate the separable cost for a particular service, the cost of a structure which provides all of the remaining services is subtracted from the cost of a structure at the same site which provides all services planned for the project.

The joint cost is the common works cost less the separable costs as indicated in Figure 1.

The "Adjusted Separable Costs Remaining Benefits" (ASCRB) methodology (USU 1978, 1980, 1981, 1984, 1986, 1990) was adopted to allocate the common works cost as indicated in Figure 1. This methodology adheres to the two principal objectives of cost allocation: "economic efficiency" and "equity." The conditions of economic efficiency may be summarized as follows (USU 1986):

1) The separable cost of adding each service as the last increment should not exceed the benefits derived therefrom,

2) The sum of the total costs allocated to each service should not exceed the sum of the total benefits accruing from the use of each service, and

3) The total cost to each purpose should not exceed the cost of a single-purpose alternative providing equal benefits.

Equity refers to fairness in the distribution of total project costs among all of the users served by a multiple-purpose development. Specifically, an equitable cost allocation is one which permits all project users to share fairly in the savings from multiple-purpose as compared to single-purpose construction.

"Benefits" referred to in Figure 1 are the benefits attributed to each service sector as a result of the common works. Appendix B of the main report (ISPAN, 1992) describes four alternative procedures for calculating the values of project benefits. The selection of a particular benefit calculation method is limited by the availability of data necessary to make the calculations. The data requirements increase as the method becomes more sophisticated.

"Single Purpose Alternative Cost" referred to in Figure 1 is the cost of providing the same service by means of a single-purpose project in place of the multi-purpose project. For example, the single purpose cost for agriculture could be the cost of a dam constructed solely for agriculture.

All costs and benefits are represented as present values for the ASCRB methodology. The benefits are compared to single purpose alternative costs, and the lesser is termed the "justifiable cost." A service sector will not be assigned more than its justifiable cost. In other words, a particular service should not pay more for its share of the common works than the benefits it receives or its costs of "going it alone." If there are no separable costs identified for the common works, then the common works costs are allocated among the service sectors in direct proportion to their justifiable costs. For reasons described in ISPAN (1992) this is the case for all of the common works structures and service sectors in scenarios 1 through 4 of this study, except for flood control at the High Aswan Dam.

As might be expected, the classification of items into the mutually exclusive categories defined above requires a considerable amount of professional judgment. Consequently a great deal of care must be taken to provide a consistent set of benefits, common works costs, separable

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costs, specific costs, and alternative costs in order for the criteria of economic efficiency and equity to be met.

The allocated cost for each service sector is added to the specific cost for that sector to estimate the total sector cost, as indicated at the bottom of Figure 1.

After the total project cost has been distributed to the service sectors, it must be further distributed to the use sectors. A variety of methods have been used to make this distribution (USU 1990). In this study, irrigated area is used to distribute Nile main stem costs to agriculture, and population is used to distribute main stem costs to rural water supply.

COST ALLOCATION PROCESS FOR THE NILE RIVER

Introduction

This chapter describes how the cost allocation process was implemented for the Nile River Basin, Egypt. The general approach is to perform a sequence of cost allocations at three levels and sum the results. At the first level, allocations are conducted within each geographical region to distribute costs among agriculture, rural water supply and navigation. At the second level, cost allocations are conducted among services provided by the barrages on the main stem of the Nile. At the third level, cost allocations are conducted among services provided by the High Aswan Dam Complex.

Figure 2 is a diagram depicting the stages in the modeling procedure. Geographical discrimination is represented by the boxes in the left column. An "Old Land Region" is a geographical area representing a directorate or group of directorates that are currently operational in the basin. These are also called "existing regions". Five Old Land Regions were identified for the initial application of the model. A New Land Region may represent new land development within an existing directorate or outside the existing directorates. Six New Land Regions were identified for the initial application of the model: one within each of the five Old Land Regions plus one outside of these regions. The "Main Stem Nile" boxes in Figure 2 represent the barrages on the main stem of the Nile River and the High Aswan Dam. All benefits and costs are represented as 1991 present values.

The cost of the common works within each geographical category is represented by the boxes in the center column of Figure 2. The cost in each of these categories is allocated among the service sectors, represented by the boxes in the column on the right in Figure 2, using the Adjusted Separable Costs-Remaining Benefits (ASCRB) methodology. The cost of common works includes Operation, Maintenance and Replacement (OM&R) costs for the particular structure as described in the main report (ISPAN, 1992).

The model begins at the "Old Land Region" level shown at the bottom of Figure 2 and works up through the new lands and the main stem in the order shown from bottom to top. Costs allocated to each service sector are accumulated during the process.

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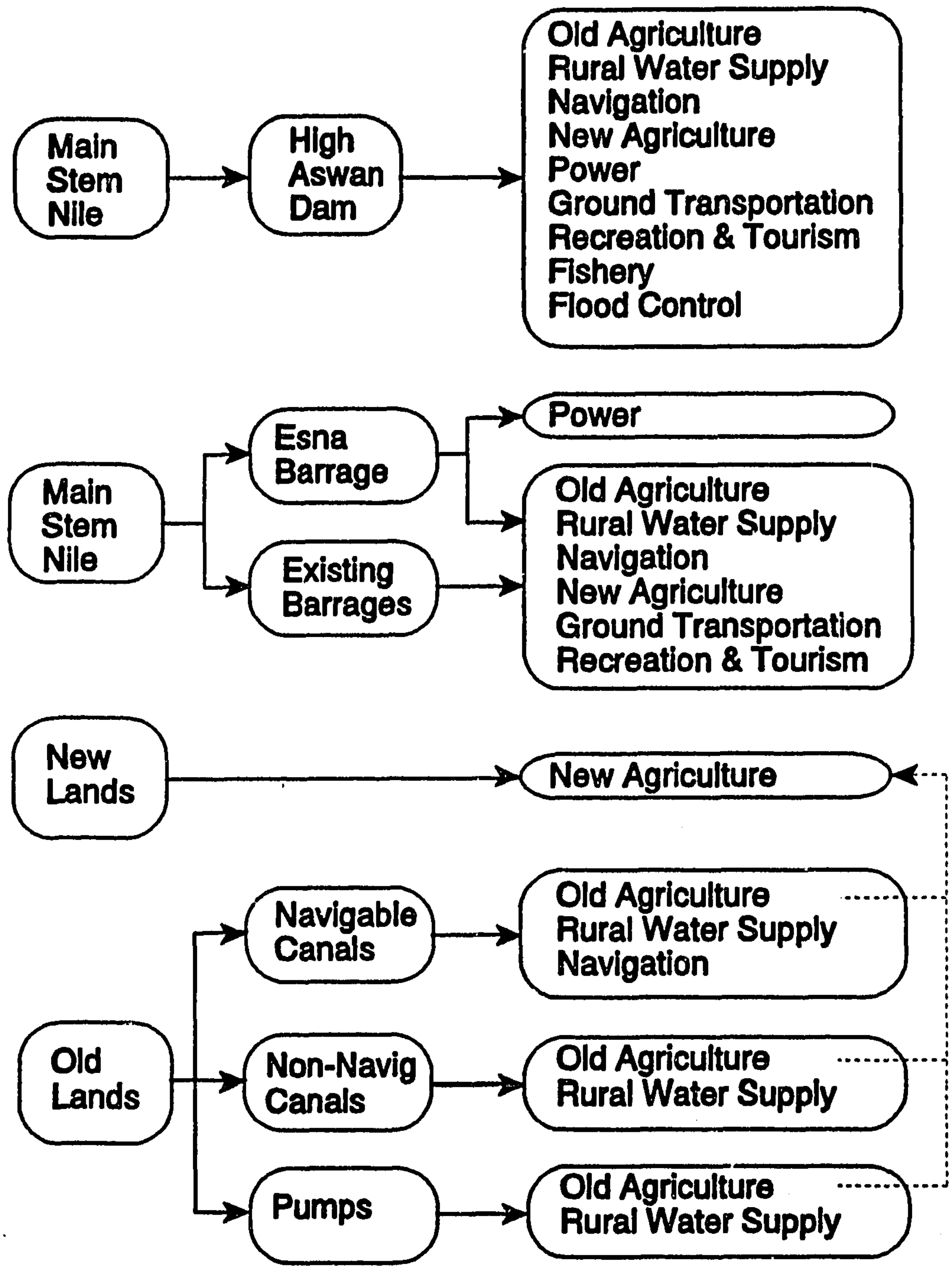

Figure 2. Cost Allocation Process for the Nile River.

Old Land Regions

Cost allocations are performed within each of the old land regions for 1) the irrigation and drainage pumps, 2) non-navigable canals, and 3) navigable canals. The parameters for these allocations are listed in Tables 1 through 3.

Table 1 contains the parameters for allocating pump costs within an existing region between agriculture and rural water supply, both of which benefit from the pumps.

Table 1. Allocation of OM&R Costs for Irrigation and Drainage Pumps

Cost:	OM&R for the existing irrigation and drainage pumps.
Old Agriculture	
Benefits:	Agricultural net primary returns for the region.
Alt Cost:	OM&R costs of the existing pumps.
Rural Water Supply	
Benefits:	Well and incremental pumping costs of a deep aquifer supply.
Alt Cost:	OM&R costs of a pumping system drawing water from a deep aquifer.

In Table 2, the fraction of non-navigable canals is determined by the ratio of the wetted area of the non-navigable canals to that of the total canals in the region. The ratio of population served is approximated by the same ratio. In Table 3, the fraction of navigable canals is determined by the ratio of the wetted area of the navigable canals to that of the total canals in the region. The population served is approximated by the same ratio.

This method of calculating benefits and alternative costs for the non-navigable and navigable canals was adopted in the model because it is conceptually consistent to treat all sectors in the same way throughout the model (i.e. to attempt to identify the actual benefactors and costs). The alternative would have been to use the region-wide benefits and alternative costs for both sub classifications within the region. A comparison of the two approaches is discussed in the RESULTS section of this report. The method can be easily modified in the model, or an option can be added to allow the user to make the choice at run time.

Table 2. Allocation of OM&R Costs for Non-Navigable Canals.	
Cost:	OM&R for all canals in the region multiplied by the fraction of non-navigable canals.
Old Agriculture	
Benefits:	Agricultural net primary returns for the region multiplied by the fraction of non-navigable canals.
Alt Cost:	OM&R and capital replacement costs for existing canals multiplied by the fraction of non-navigable canals.
Rural Water Supply	
Benefits:	Well and incremental pumping costs of a deep aquifer supply multiplied by the fraction of non-navigable canals.
Alt Cost:	OM&R costs of a pumping system drawing water from a deep aquifer multiplied by the fraction of non-navigable canals.

The costs resulting from each of the three allocations are accumulated for each use sector within the region. For example the costs to agriculture for pumps, non-navigable canals, and navigable canals are summed to provide the total cost to agriculture at the region level.

New Land Regions

After allocations have been conducted for all old land (existing land) regions, the model will reallocate some of the agriculture cost to a new land (new new land) region if an old land delivery system is shared by the new land. The dash line in Figure 2 is intended to indicate that the only cost allocated to a new land region is reassigned from an interfacing old land region. Table 4 lists the parameters for the allocation of cost from old land agriculture to new land agriculture.

The factor representing the fraction of the old canal system used by the new land region is a parameter supplied by the user based on wetted canal area.

The cost allocated to the new land region is added to that region's agricultural cost and subtracted from the old land region's agricultural cost. Any modifications to the existing water delivery systems which might be needed in order to accommodate delivery to the new lands are considered as specific costs to the new lands.

Table 3. Allocation of OM&R Costs for Navigable Canals.

Cost:	OM&R for all canals in the region multiplied by the fraction of navigable canals.
Old Agriculture	
Benefits:	Agricultural net primary returns for the region multiplied by the fraction of navigable canals.
Alt Cost:	OM&R costs for existing canals multiplied by the fraction of navigable canals.
Rural Water Supply	
Benefits:	Well and incremental pumping costs of a deep aquifer supply multiplied by the fraction of navigable canals.
Alt Cost:	OM&R costs of a pumping system drawing water from a deep aquifer multiplied by the fraction of navigable canals.
Navigation	
Benefits:	Cost savings over rail transport for the region.
Alt Cost:	OM&R costs for the canals multiplied by the fraction of navigable canals.

Main Stem Of The Nile

After all of the new land regions have been processed, two allocations are conducted for the main stem of the Nile as indicated in Figure 2: 1) the existing barrages excluding the new Esna, and 2) the new Esna barrage. The allocation parameters for the existing barrages are shown in Table 5. Benefits for Old Agriculture, Rural Water supply, and Navigation are the accumulation of respective benefits for these use sectors in the regions. Benefits for Ground Transportation and Recreation & Tourism are those for the main stem of the Nile.

Table 4. Reallocate Agricultural Costs from Existing Lands to New Lands (New New Lands).

Cost:	OM&R allocated to agriculture in an existing land region which is interfaced with this new land region, multiplied by a factor representing the fraction of the existing canal system delivering water to the new land.
Old Agriculture	
Benefits:	Agricultural net primary returns for the existing region.
Alt Cost:	OM&R and capital replacement costs for existing canals multiplied by the fraction delivering water to the new land region.
New Agriculture	
Benefits:	Agricultural net primary returns for the new region.
Alt Cost:	OM&R and capital replacement costs for existing canals multiplied by the fraction delivering water to the new land region..

The new Esna barrage, which is assumed to be in place for scenario 2, contains hydro-power generating facilities and thus is treated separately from the other barrages. Table 6 lists the parameters for the Esna Barrage cost allocations. Benefits for Old Agriculture, Rural Water supply, Navigation and New Agriculture are the accumulation of respective benefits in the regions (the same as those in Table 5) adjusted by a weighting factor. Benefits for Ground Transportation and Recreation & Tourism are those for the main stem of the Nile (the same as Table 5) adjusted by the weighting factor.

The weighting factor is used to assign a fraction of the basin wide benefits to Esna. This was done for three reasons:

1) To put benefits on a comparable basis with single purpose alternative costs for the Esna facility,

2) To put benefits for the other services on a comparable basis with Esna power, and

3) To provide consistency in the cost allocation process throughout the model.

Table 5. Allocation of OM&R Costs for Existing Barrages on the Main Stem Excluding the New Esna.

Cost: OM&R for existing barrages excluding Esna.

Old Agriculture

Benefits: Agricultural benefits accumulated for all existing land regions.

Alt Cost: OM&R costs for the existing barrages, excluding Esna, or substitute pumps.

Rural Water Supply (RWS)

Benefits: RWS benefits accumulated for all existing land regions.

Alt Cost: OM&R costs for the existing barrages, excluding Esna, or substitute pumps.

Navigation

Benefits: Navigation benefits accumulated for all existing regions.

Alt Cost: OM&R costs for the existing barrages excluding Esna.

New Agriculture

Benefits: Agricultural benefits accumulated for all new regions.

Alt Cost: OM&R costs for the existing barrages or substitute pumps jointly used to supply new lands.

Ground Transportation

Benefits: OM&R cost savings over bridge crossings at the barrage sites.

Alt Cost: OM&R costs for bridge crossings at the barrage sites.

Recreation & Tourism

Benefits: Net primary revenues from the Nile River Tourist Industry.

Alt Cost: OM&R costs for the existing barrages.

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Table 6. Allocation of OM&R Costs for the New Esna Barrage.

Cost: OM&R for Esna barrage.

Old Agriculture

Benefits: Table 5 multiplied by a factor for Esna.

Alt Cost: OM&R costs for Esna.

Rural Water Supply (RWS)

Benefits: Table 5 multiplied by a factor for Esna.

Alt Cost: OM&R costs for Esna or substitute pumps.

Navigation

Benefits: Table 5 multiplied by a factor for Esna.

Alt Cost: OM&R costs for Esna.

New Agriculture

Benefits: Table 5 multiplied by a factor for Esna.

Alt Cost: OM&R and capital replacement costs for Esna.

Power

Benefits: Cost saving over thermal energy as an alternative supply for the power at Esna.

Alt Cost: OM&R costs for Esna.

Ground Transportation

Benefits: Table 5 multiplied by a factor for Esna.

Alt Cost: Table 5 multiplied by a factor for Esna.

Recreation & Tourism

Benefits: Table 5 multiplied by a factor for Esna.

Alt Cost: OM&R costs for Esna.

As a first approximation, the weighting factor is calculated as the ratio of the cost for Esna to the cost for all barrages including Esna. This approximation for the weighting factor can be easily modified in the model, or an option can be added to allow the user to make the choice at run time. A discussion of the affects of the weighting factor is presented in the RESULTS section of this report.

The High Aswan Dam

After the main stem barrages have been processed, the allocation is conducted for the High Aswan Dam (HAD). The parameters for this allocation are listed in Table 7. Benefits for Old Agriculture (existing agriculture), Rural Water Supply, Navigation, New Agriculture, and Recreation & Tourism are the accumulated respective benefits from the regions and the main stem. Benefits for Power, Ground Transportation and Fishery are associated specifically with the HAD. Benefits for Flood Control at the HAD are calculated as a percentage of total basin benefits (excluding benefits for agriculture).

Single purpose alternative costs for all services except transportation and flood control are represented by the OM&R and capital replacement costs of a dam specifically for agriculture located at the HAD site. The single purpose alternative cost for transportation is the OM&R and capital replacement cost of a bridge crossing at the HAD site. The single purpose alternative for flood control is the OM&R and capital replacement cost of a dam specifically for flood control located at the HAD site.

The separable cost for flood control is the estimated cost for OM&R of the HAD with all services (existing situation) less the OM&R cost for a dam with all services except flood control at the HAD site.

Table 7. Allocation of OM&R Costs for the High Aswan Dam Complex.

Cost: OM&R for the High Aswan Dam Complex (HAD).

Old Agriculture

Benefits: Agricultural benefits accumulated for all existing land regions.

Alt Cost: Single purpose alternative dam for other purposes (1).

Rural Water Supply (RWS)

Benefits: RWS benefits accumulated for all existing land regions.

Alt Cost: OM&R costs of pumping systems for drawing water from deep aquifers summed for the existing land regions.

Navigation

Benefits: Navigation benefits accumulated for all existing regions.

Alt Cost: Single purpose alternative dam for other purposes (1).

New Agriculture

Benefits: Agricultural benefits accumulated for all new regions.

Alt Cost: Single purpose alternative dam for other purposes (1).

Power

Benefits: Cost savings over thermal energy as an alternative supply to the hydropower at the HAD.

Alt Cost: Single purpose alternative dam for other purposes (1).

Ground Transportation

Benefits: OM&R cost savings over a bridge crossing at the HAD.

Alt Cost: OM&R costs for a bridge crossing at the HAD.

Table 7 (continued). Allocation of OM&R Costs for High Aswan Dam Complex (HAD).

Recreation & Tourism

Benefits:	Net primary revenues from the Nile River Tourist Industry.
Alt Cost:	Single purpose alternative dam for other purposes (1).

Fishery

Benefits:	Value of direct output-market value of the fish harvest.
Alt Cost:	Single purpose alternative dam for other purposes (1).

Flood Control

Benefits:	Estimated percentage of the total basin wide benefits excluding benefits for agriculture.
Alt Cost:	Single purpose alternative dam for flood control (2).
Sep Cost:	Separable cost of the OM&R for the HAD.

Notes:

1) The single purpose alternative dam for other purposes is the OM&R costs of a dam for all services except flood control at the site of the HAD.

2) The single purpose alternative dam for flood control is the OM&R costs of a dam for flood control at the site of the HAD.

COMPUTER MODEL DESCRIPTION

Model Organization

The model is programmed in common "C" for the DOS operating system. Figure 3 is a diagram showing the principal program modules and indicating lines of control. Rounded boxes represent functions and circles represent ASCII files. When an arrow points from a file to a function, then the file is input. When an arrow points from a function to a file, then the file is output. All files for a specific run have the same file name and are distinguished only by their extensions. Looking across the bottom row in the figure, three output files are produced by the model and they are identified by their extensions: ".ECH", ".CAD", and ".RSU".

The data structures and the function prototypes are declared in the program header file which is listed in Appendix E. A complete listing of the main program and the function definitions is included in Appendix F. Comment statements in the listings provide detailed information about the technical aspects of the program.

Starting from the top left in Figure 3, four functions are called from the main program. Function "loadData" loads all of the data from the input files, "cAlloc" conducts the cost allocation procedures in accordance with the discussion in the previous section of this report, "irrControl" provides the capability for calculating internal rates of return, and "output" generates a summary of the results.

The functions "loadRxx", "loadNxx", "loadSTM", and "loadHAD" are called by loadData to input the ASCII files identified by the extensions: ".Rxx", ".Nxx", ".STM", and ".HAD". The "xx" characters in the file extensions represent a sequence number and indicate that more then one input file of this format may be required. For example: ".R01" is the file containing the parameters for Old Land Region #1, ".R02" for Old Land Region #2, etc. The files with extensions ".N01", ".N02", etc. contain the parameters for the New Land Regions. The files with the ".STM" and ".HAD" extensions contain the parameters for the main stem barrages and the High Aswan Dam respectively. Each of the load functions echo the input data and the calculated present values of cost and benefit streams to a file with the ".ECH" extension.

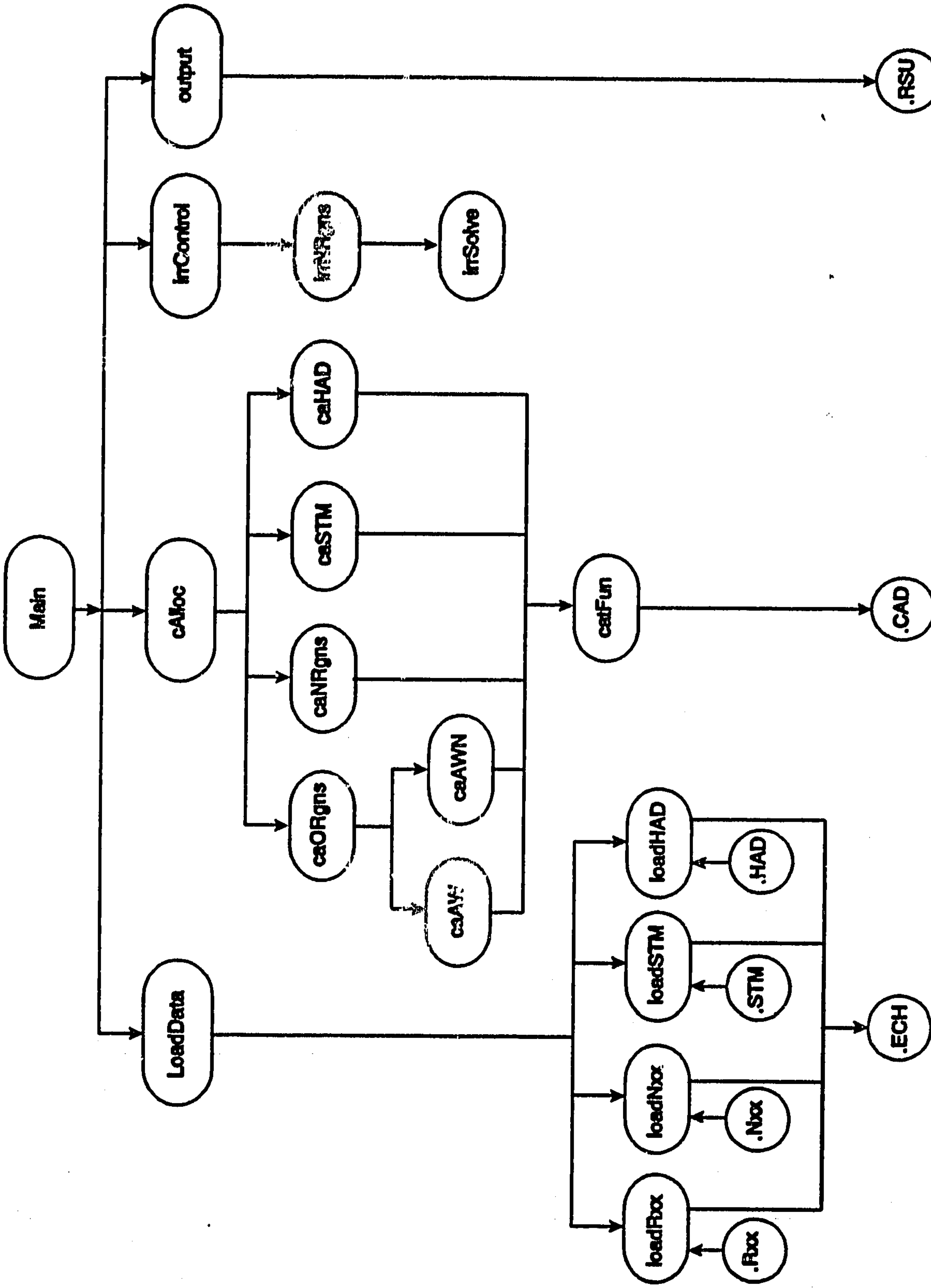

Figure 3. Principal Modules and Control Structure for the E-CAM Model.

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The cAlloc function calls "caORgns", "caNRgns", "caSTM", and "caHAD" functions which configure the input parameters for cost allocations on the Old Land Regions, the New Land Regions, the existing main stem barrages, Esna barrage, and the High Aswan Dam respectively in that order. The "caAW" and the "caAWN" functions configure the input parameters for cost allocations on the navigable canals and the non-navigable canals respectively within the Old Land Regions.

All cost allocations are performed by a single function "catFun" in order to provide consistency throughout the model. This function conducts the standard ASCRB allocation (USU 1986) using the following parameters for each service sector passed to it by the calling function:

1) project cost,

2) benefits,

3) single purpose alternative costs, and

4) separable costs.

The calling function outputs the results of each cost allocation to a file with the extension ".CAD".

The function irrControl can be used to calculate the internal rates of return for designated projects. As an example, it calls "irrNRgns" which could easily be configured to calculate the internal rate of return for New Land Regions. The "irrSolve" function is a generic algorithm for calculating the internal rate of return for any set of benefit-cost streams passed to it. It uses the method of false position to converge on the solution, and has been found to be very robust and reasonably fast.

The output function generates an ASCII file containing the results of a run. Currently this report is simply a summary of the present values of costs allocated to each service sector within each spatial element.

Input File Formats

Figures 4 through 7 contain images of the input file formats. Each data item is defined by a label. Detailed descriptions of each input variable are contained in the header file in Appendix E.

Figure 4 is the input file from Scenario 4 for the parameters for the Aswan High Dam Complex. This file is identified by the extension ".HAD". It includes a section at the top for parameters which apply to the run as a whole, including the discount rate, the planning horizon, the number of old regions, the number of new regions, and the annual cost for the basin-wide drainage system. In addition the file contains the data for the HAD, including the single-purpose alternatives (as a percentage of cost); separable costs (as a percentage of cost); benefits for Hydropower, Ground Transportation, and Fishery (as annual cost streams); single-purpose alternatives for Rural Water Supply, and Ground Transportation; the common works replacement cost (as an annual cost stream); and the annual O&M costs of the common works (as an annual cost stream).

Figure 5 is the input file from Scenario 4 for the parameters for the existing barrages on the main stem of the Nile and for Esna. This file is identified by the extension ".STM". The table provides columns for annual costs of benefits for Navigation, Esna Hydropower, and Recreation and Tourism; the single purpose alternative cost for Ground Transportation; the common works cost for stem barrages excluding the HAD and Esna; and the common works costs for Esna.

Figure 6 is the input file from Scenario 4 for the parameters for an Existing Land Region. One of these files is required for each Existing Land Region. These files are identified by the extension ".Rxx" where "xx" is the identification number for the region. The file contains an identification name and number for the region, the agricultural area, the water consumption, the population, the wetted perimeter of the canals, and the percent of the canals that are navigable. In addition columns are provided for annual values of benefits for Agriculture, Rural Water Supply, and Navigation; single purpose alternative costs for canal replacement and Rural Water Supply; costs for regional canal O&M; and costs for regional system pumps.

Figure 7 is the input file from Scenario 4 for the parameters for the New Land Regions. One of these files is required for each New Land Region. These files are identified by the extension ".Nxx" where "xx" is the identification number for the region. The file contains an identification name and number for the region; the identification number of the upstream Existing Land region sharing its water delivery system with this New Land; the fraction of Existing Land canals delivering water to this New Land; the potential agricultural area; and water consumption. In addition columns are provided for annual values of benefits for Agriculture; OM&R costs; irrigated area; and the cost of a new delivery system.

Preparation of the input files for the model was a major effort. For example, cost data needed for these files are distributed over 45 separate tables in Appendices C and D of the main report (ISPAN, 1992). Changing a value in one of these data tables could require considerable effort to make corresponding changes in the model input files. Consequently a set of linked spreadsheets was developed to automatically consolidate data from the individual data tables. As an example, Figure 8 shows the consolidating spreadsheet for calculating the costs for each of the existing regions. The fraction of the total irrigated area in each region is calculated at the top of the sheet. The column headings indicate the source of the data in the column, for example "D2_27" refers to Table D2.27 in Appendix D of the main report. The "TOTAL PUMP STATION" costs shown in the fifth column are the sum of the costs in columns two through four. Likewise, the "TOTAL CANAL" costs are the sum of the costs from the column headed "D2_22" to "D2_3".

In order to get the data from the consolidating spreadsheet into the proper format for the model, five additional spreadsheets were set up, one for each region. These five spreadsheets were linked to the consolidating spreadsheet. The "TOTAL PUMP STATION" and "TOTAL CANAL" costs are distributed to the regional spreadsheets in proportion to the irrigated areas. When a data value is changed in any one of the supporting spreadsheets "D2_27" through "D2_3", then the change will be automatically reflected in the consolidating spreadsheet and the regional spreadsheets. The input file format shown in Figure 6 is generated directly by each of the five regional spreadsheets.

INPUT FILE FOR THE HIGH ASWAN DAM (IMPHAD.WB1).
Costs and Benefits for Improved O&M.

BASIN DISCOUNT RATE (%):	12
BASIN PLANNING HORIZON (YRS):	30
NUMBER OF OLD REGIONS:	5
NUMBER OF NEW REGIONS:	6
ANNUAL COST FOR DRAINAGE (mil LE/Yr @ %):	96.422
HAD BENEFITS	
FLOOD CONTROL (% of total benefits):	4
SINGLE PURPOSE ALTERNATIVES	
AG, NAV, POWER, FISH (% of OM&R):	74.7
FLOOD CONTROL (% of OM&R):	44.4
SEPARABLE COSTS	
AGRICULTURE (% of O&M):	0
POWER (% of O&M):	0
FLOOD (% of O&M):	25.31

YEAR	------ HAD BENEFITS -----			--ALT. COST---			
	HYDRO POWER (m LE)	GROUND TRANSP (m LE)	FISHERY (m LE)	WATER SUPPLY (m LE)	GROUND TRANSP (m LE)	COMMON WORKS REPLACE (m LE)	ANNUAL COMMON WORKS O&M (m LE)
1	5625	35	60	1165	35	5600	78.45
2	5625	0.18	60	20.5	0.18	0	75.59
3	5625	0.18	60	20.5	0.18	0	89.73
4	5625	0.18	60	20.5	0.18	0	84.90
5	5625	0.18	60	20.5	0.18	0	80.19
6	5625	0.18	60	20.5	0.18	0	65.09
7	5625	0.18	60	20.5	0.18	0	67.68
8	5625	0.18	60	20.5	0.18	0	73.99
9	5625	0.18	60	20.5	0.18	0	78.54
10	5625	0.18	60	20.5	0.18	0	82.35
11	5625	0.18	60	20.5	0.18	0	88.46
12	5625	0.18	60	20.5	0.18	0	87.32
13	5625	0.18	60	20.5	0.18	0	87.76
14	5625	0.18	60	20.5	0.18	0	88.10
15	5625	0.18	60	20.5	0.18	0	88.85
16	5625	0.18	60	20.5	0.18	0	105.27
17	5625	0.18	60	20.5	0.18	0	104.30
18	5625	0.18	60	20.5	0.18	0	106.52
19	5625	0.18	60	20.5	0.18	0	105.55
20	5625	0.18	60	20.5	0.18	0	104.47
21	5625	0.18	60	20.5	0.18	0	102.86
22	5625	0.18	60	20.5	0.18	0	101.87
23	5625	0.18	60	20.5	0.18	0	101.69
24	5625	0.18	60	20.5	0.18	0	102.07
25	5625	0.18	60	20.5	0.18	0	100.55
26	5625	0.18	60	20.5	0.18	0	104.38
27	5625	0.18	60	20.5	0.18	0	101.99
28	5625	0.18	60	20.5	0.18	0	101.94
29	5625	0.18	60	20.5	0.18	0	102.59
30	5625	0.18	60	20.5	0.18	0	101.63

Figure 4. Input File Format for the High Aswan Dam (Scenario 4).

FILE INPUT FORMAT FOR MAIN STEM OF THE NILE (IMPSTM.WB1)
Costs and Benefits for Improved O&M

YEAR	BENEFITS NAVIG (m LE)	HYDRO POWER ESNA (m LE)	GROUND TRANSP (m LE)	RECREA & TOURISM (m LE)	SINGLE PURPOSE ALTERN COST TRANSP (m LE)	STEM COSTS EXCEPT HAD & ESNA (m LE)	ESNA COMMON WORKS COSTS (m LE)
1	36	300	220	920	220	114.35	147.98
2	36	300	1	920	1.1	134.83	156.01
3	36	300	1	920	1.1	159.86	14.08
4	36	300	1	920	1.1	146.75	38.30
5	36	300	1	920	1.1	114.34	17.53
6	36	300	1	920	1.1	83.80	1.71
7	36	300	1	920	1.1	115.97	2.35
8	36	300	1	920	1.1	132.14	3.75
9	36	300	1	920	1.1	201.33	4.12
10	36	300	1	920	1.1	237.80	3.99
11	36	300	1	920	1.1	211.76	4.09
12	36	300	1	920	1.1	214.37	4.14
13	36	300	1	920	1.1	188.31	4.15
14	36	300	1	920	1.1	145.47	4.17
15	36	300	1	920	1.1	106.91	4.77
16	36	300	1	920	1.1	103.94	4.57
17	36	300	1	920	1.1	101.71	4.17
18	36	300	1	920	1.1	98.91	4.17
19	36	300	1	920	1.1	97.02	4.17
20	36	300	1	920	1.1	96.36	4.17
21	36	300	1	920	1.1	107.20	4.17
22	36	300	1	920	1.1	109.22	4.77
23	36	300	1	920	1.1	106.46	4.57
24	36	300	1	920	1.1	102.61	4.17
25	36	300	1	920	1.1	99.59	4.17
26	36	300	1	920	1.1	114.17	44.77
27	36	300	1	920	1.1	115.58	52.17
28	36	300	1	920	1.1	120.84	8.77
29	36	300	1	920	1.1	114.29	20.57
30	36	300	1	920	1.1	104.86	10.61

Figure 5. Input Format for the Main Stem Barrages (Scenario 4).

INPUT FILE FORMAT FOR AN OLD LAND REGION (IMPRxx.WB1)
Costs and Benefits for Improved O&M.

REGION NAME:	UpperEgypt
REGION NUMBER:	1
AGRICULTURAL AREA (mil FED):	0.762
WATER CONSUMPTION (M3/FD):	8320.2
POPULATION (millions):	5.52
WETTED PERIMETER OF CANALS (meters):	61.7
PERCENT OF CANALS NAVIGABLE (%):	0

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI (m LE)	WATER SUPPLY (m LE)	NAVIG (m LE)	CANAL REPALCE (m LE)	WATER SUPPLY (m LE)	CANAL O&M (m LE)	SYSTEM PUMPS OM&R (m LE)
1	521	0.58	0	571.4	60	28.04	20.10
2	521	0.029	0	0	60	29.20	27.70
3	521	0.029	0	0	60	29.71	34.15
4	521	0.029	0	0	60	32.38	29.04
5	521	0.029	0	0	60	33.91	20.31
6	521	0.029	0	0	60	42.40	18.68
7	521	0.029	0	0	60	42.66	26.28
8	521	0.029	0	0	60	41.83	32.76
9	521	0.029	0	0	60	40.57	27.68
10	521	0.029	0	0	60	40.44	18.98
11	521	0.029	0	0	60	45.74	17.33
12	521	0.029	0	0	60	45.22	24.89
13	521	0.029	0	0	60	44.06	31.34
14	521	0.029	0	0	60	41.76	26.27
15	521	0.029	0	0	60	41.32	17.58
16	521	0.029	0	0	60	46.20	20.04
17	521	0.029	0	0	60	46.22	33.65
18	521	0.029	0	0	60	44.80	45.20
19	521	0.029	0	0	60	42.96	36.03
20	521	0.029	0	0	60	42.62	20.40
21	521	0.029	0	0	60	46.07	20.04
22	521	0.029	0	0	60	46.28	33.67
23	521	0.029	0	0	60	45.08	45.25
24	521	0.029	0	0	60	43.21	36.12
25	521	0.029	0	0	60	42.93	20.46
26	521	0.029	0	0	60	46.86	20.06
27	521	0.029	0	0	60	46.84	33.67
28	521	0.029	0	0	60	45.62	45.25
29	521	0.029	0	0	60	43.77	36.14
30	521	0.029	0	0	60	43.47	20.52

Figure 6. Input Format for an Existing Land Region (Scenario 4).

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INPUT FORMAT FOR NEW A LAND REGION (BASNxx.WB1).
Costs and Benefits for New Lands.

REGION NAME:	NewLand-1
NEW REGION NUMBER:	1
NUMBER OF UPSTREAM OLD REGION:	1
FACTOR OF OLD CANALS DELIVERING WATER:	0
POTENTIAL AGRICULTURAL AREA (mil FEDDANS):	0.195
WATER CONSUMPTION (M3/FD):	6454

YEAR	BENEFIT AGRICUL (m LE)	AN. COST OM&R (m LE)	IRRIG AREA (mil FD)	NEW DELIVERY SYSTEM (m LE)
1	12.50	28.80	0.007	386.37
2	25.00	28.81	0.013	0
3	37.50	16.92	0.020	0
4	50.00	9.17	0.026	0
5	62.50	0.78	0.033	0
6	75.00	1.95	0.039	0
7	87.50	1.74	0.046	0
8	100.00	1.56	0.052	0
9	112.50	1.39	0.059	0
10	125.00	1.24	0.065	0
11	137.50	1.11	0.072	0
12	150.00	0.99	0.078	0
13	162.50	0.88	0.085	0
14	175.00	0.79	0.091	0
15	187.50	0.70	0.098	0
16	200.00	1.73	0.104	0
17	212.50	2.26	0.111	0
18	225.00	1.79	0.117	0
19	237.50	1.16	0.124	0
20	250.00	0.46	0.130	0
21	262.50	0.36	0.137	0
22	275.00	0.32	0.143	0
23	287.50	0.28	0.150	0
24	300.00	0.25	0.156	0
25	312.50	0.23	0.163	0
26	325.00	0.20	0.169	0
27	337.50	0.18	0.176	0
28	350.00	0.16	0.182	0
29	362.50	0.15	0.189	0
30	375.00	0.13	0.195	0

Figure 7. Input Format for a New Land (New New Land) Region (Scenario 4).

BASIN WIDE COST SUMMARY OVER ALL REGIONS (1000 LE)

TOTAL BASIN AREA:	6.599
Fraction Upper	0.115472
Fraction Middle	0.230944
Fraction East Delta	0.239582
Fraction Middle Delta	0.218063
Fraction West Delta	0.195939
Fraction Sum	1

YEAR	D2_27	D2_37	D2_5 b24/1000	TOTAL PUMP STATION	D2_22	D2_23	D2_24	D2_25	D2_26	D2_31	D2_33	D2_3 c24/1000	TOTAL CANAL
1	42197	94552	37327	174075	14000	21875	5000	8000	0	134406	2970	56599	242851
2	107974	94552	37327	239852	19000	22092	5000	7000	0	140158	3024	56599	252872
3	163881	94552	37327	295759	20000	18808	5000	1500	0	152344	3077	56599	257328
4	119630	94552	37327	251508	23000	13740	5000	1500	0	177404	3130	56599	280374
5	43978	94552	37327	175856	24000	12995	5000	1200	0	190689	3184	56599	293667
6	42197	82286	37327	161809	41306	49304	669	587	22500	195330	890	56599	367184
7	107974	82286	37327	227586	41503	49783	669	587	22500	196952	890	56599	369483
8	164074	82286	37327	283686	40849	42513	719	587	22500	197580	890	56599	362236
9	120123	82286	37327	239735	40890	31291	719	587	22500	197849	890	56599	351324
10	44726	82286	37327	164338	41120	29641	719	587	22500	198130	890	56599	350185
11	42743	70020	37327	150089	39227	69972	719	587	30000	198130	890	56599	396123
12	108175	70020	37327	215521	34026	70637	719	587	30000	198130	890	56599	391587
13	164074	70020	37327	271420	34176	60552	669	587	30000	198130	890	56599	381603
14	120123	70020	37327	227469	29780	44986	669	587	30000	198130	890	56599	361640
15	44919	70020	37327	152265	28233	42698	719	587	30000	198130	890	56599	357855
16	76699	59506	37327	173531	27904	74195	1769	3087	37500	198130	890	56599	400073
17	194549	59506	37327	291381	27734	74876	1769	2775	37500	198130	890	56599	400272
18	294582	59506	37327	391414	27486	64556	1769	1056	37500	198130	890	56599	387985
19	215193	59506	37327	312025	27439	48628	1769	1056	37500	198130	890	56599	372010
20	79794	59506	37327	176626	27052	46286	1719	961	37500	198130	890	56599	369136
21	76699	59506	37327	173531	27692	76918	669	587	37500	198130	890	56599	398983
22	194741	59506	37327	291574	28803	77598	719	587	37500	198130	890	56599	400825
23	295074	59506	37327	391907	28672	67279	719	587	37500	198130	890	56599	390375
24	215941	59506	37327	312773	28440	51350	719	587	37500	198130	890	56599	374214
25	80340	59506	37327	177172	28337	49009	719	587	37500	198130	890	56599	371770
26	76900	59506	37327	173732	28364	79640	719	587	40875	198130	890	56599	405803
27	194741	59506	37327	291574	27549	80321	669	587	40875	198130	890	56599	405619
28	295074	59506	37327	391907	27352	70001	669	587	40875	198130	890	56599	395103
29	216134	59506	37327	312966	27183	54073	719	587	40875	198130	890	56599	379055
30	80833	59506	37327	177665	26956	51731	719	587	40875	198130	890	56599	376486

Figure 8 Consolidating Spreadsheet for Developing Regional Input Cost Data.

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RESULTS

Introduction

Four scenarios were processed for purposes of testing the model and providing information for the cost recovery project. Complete listings of input and output files are contained in Appendices A through D. Details regarding the sources of data for each scenario may be found in the Main Report (ISPAN, 1992). The scenarios are summarized briefly as follows:

1) Existing service sectors with current costs for OM&R,

2) Existing service sectors with upgraded costs for OM&R and the enhancement of Esna barrage,

3) The same as scenario 1 with the addition of six New (New New) Land Regions, and

4) The same as scenario 2 with the addition of six New (New New) Land Regions.

The model generates three report files. A file with the extension ".ECH" (ECHo) contains a summarized version of the input data. The data in this file can be used to verify that correct data were input to the model. The .ECH reports are included for each scenario in Appendices A through D.

A file with the extension ".CAD" (Cost Allocation Detail) contains the cost allocation table for each allocation performed during a model run. For Scenario 4, for example, this amounts to 24 tables: three for each of the five Old Land Regions, six New Land Regions, barrages on the main stem, Esna barrage, and the High Aswan Dam. The .CAD reports are included for each scenario in Appendices A through D.

A file with the extension ".RSU" (Result SUmmary) contains tables summarizing the results on a system-wide basis. The tables display costs allocated to each service sector and use sector. The costs for the main stem agriculture and water supply service sectors are distributed to the use sectors on the basis of irrigated area and population respectively. This file also contains annual cost figures for each of the regions, the main stem barrages, and the High Aswan Dam Complex. Annual costs are reported as total costs, costs per feddan, and costs per thousand cubic meters of water. The .RSU reports are included for each scenario in Appendices A through D.

Cost Allocation Tables

The examples used in this section have been selected from Scenario 4 because it contains data for all common works projects in the system: existing pumps and canals, existing barrages, Esna barrage, and the High Aswan Dam. Table 8 has been extracted from the .CAD file for scenario 4 and demonstrates how the cost allocation was performed on Old Land Region #5 (the West Delta) and New Land Region #5 (new development in the West Delta). Notice that rows 4 through 9 are missing in the tables. If separable costs are zero then these rows contain all zeros, and they are omitted from the output.

In accordance with the procedures described in the COST ALLOCATION PROCESS FOR THE NILE RIVER section of this report, an allocation of the 357.4 million LE (mLE) pump costs for the region is made between agriculture and rural water supply (R.W.S.). The benefits to the region from the two services are show in row 1, and the alternative costs are shown in row 2. As specified in Table 1, the alternative costs to agriculture is equal to the OM&R costs of the existing pumps, and the alternative cost to R.W.S. is the OM&R cost of a pumping system drawing water from a deep aquifer. The justifiable cost (row 3) to agriculture is equal to the alternative cost, 357.4 mLE, because its value is less than the benefits. The justifiable cost to rural water supply (RWS) is equal to the benefits, 800,000LE because its value is less than the alternative cost. There are no separable costs and, consequently, the project cost is allocated in proportion to the justifiable costs; 99.8% to agriculture and 0.2% to rural water supply.

The present value of the OM&R costs for canals in the region is 511.6 mLE. Of the total canals in the region, 7.3% are navigable (this parameter is based on the ratio of wetted area and is input by the user in the Old Region data file) and so 37.3 mLE (511.6 * 0.073) is attributed to navigable canals and 474.3 mLE to non-navigable canals. The cost of non-navigable canals is allocated to agriculture and rural water supply, and the cost of navigable canals is allocated to agriculture, rural water supply, and navigation as shown in Table 8. The alternative costs control for agriculture, and the benefits control for rural water supply and navigation.

At the bottom of Table 8 is the allocation of agricultural costs within the West Delta between the Old Land Region #5 and New Land Region #5. The accumulated cost allocated to agriculture in Old Land Region #5 by the previous allocations is 850.4 mLE (356.6 + 473.8 + 20.0). However, eight percent of the existing canals will deliver water to the new development (this parameter is input by the user in the data for the new region). Therefore, eight percent of

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850.4 (68.0 mLE) will be allocated between the old lands and the new lands. The allocation is controlled by the alternative costs as shown in Table 8, resulting in 50% of the 68.0 mLE (34.0 mLE) being allocated to each. The last step in the process for the West Delta is to subtract 34.0 mLE from the Old Land Region #5 and add it to the New Land Region #5.

Table 9 has been extracted from the .CAD file for scenario 4 and demonstrates how the cost allocations were performed on Esna barrage and the High Aswan Dam (HAD). All of the rows in the table for the HAD were output by the model because flood control has separable costs.

Two methods were considered for determining the benefits (row 1) for the Esna Barrage. The benefits shown in Figure 9 result from the method currently used by the model as described in the COST ALLOCATION PROCESS FOR THE NILE RIVER section of this report. The benefits for Old Agriculture, Rural Water Supply, Navigation and New Agriculture are calculated by taking the sum of the benefits for these sectors respectively over all old and new land regions, and multiplying each by a weighting factor, wE. The benefits for Ground Transportation and Recreation & Tourism are the benefits attributed to all barrages for the main stem of the Nile multiplied by wE. The purposes for using a weighting factor are:

1) To put benefits on a comparable basis with single purpose alternative costs for the Esna facility,

2) To put benefits for the other services on a comparable basis with Esna power, and

3) To provide consistency in the cost allocation process throughout the model.

As a first approximation, wE is calculated as the ratio of the costs for Esna to the costs for all barrages including Esna.

The other method considered for determining the benefits for Esna Barrage was to use the total sum of the benefits from old lands, new lands and all main stem barrages. This is the equivalent of using wE equal to 1. This method was evaluated during testing of the model. When compared to the previous method, this method resulted in an increase in costs to rural water supply, navigation, and ground transportation; and a corresponding decrease to old land agriculture, new land agriculture, power, and recreation & tourism. The justifiable cost for rural water supply changed from benefits to alternative cost. The service cost for navigation was effected the most. When Esna was assigned the benefits for all navigation, its allocated costs increased by 367%.

The approximation used for the weighting factor for Esna can be easily modified in the model, or an option can be added to allow the user to make the choice at run time.

In Table 9, the justifiable costs for the HAD are controlled by alternative costs for old agriculture, new agriculture, power and recreation & tourism. Justifiable costs are controlled by benefits for rural water supply, navigation, ground transportation, fishery, and flood control. In early model testing runs, the alternative cost for rural water supply was determined by the sum of the alternative costs to all regions. This value was greater than the replacement cost of the HAD and permitted an unreasonable cost allocation to rural water supply. The model was modified to accept this value as an input parameter in the data file for the HAD. For the set of runs described in this report, the single purpose alternative for water supply has been assigned values slightly less than the OM&R and capital replacement cost of the HAD.

Summary Tables

The summary of the results for Scenario 4 are presented in Tables 10 through 14. These results are taken from the output files identified with the extension ".RSU" (for Results SUmmary). Copies of the files for all scenarios are included in Appendices A through D.

Tables 10, 11 and 12 provide similar information in different units. The rows in the tables are for use sectors and the columns are for service sectors. Each of the tables is divided into two parts in order to fit onto a standard printer page. Part one shows the allocations to the old and new agricultural use sectors. Part two shows the allocations to the stem and HAD use sectors.

The values in the Table 10 are the present values of the costs from each service sector assigned to each regional use sector. For example within the West Delta use sector (R05) shown in part one, 816.3, 1.3 and 17.3 mLE are assigned to agriculture, rural water supply and navigation respectively. Also 74.3 and 0.3 mLE are assigned to the West Delta old lands agriculture and water supply from the main stem barrages based on irrigated area and population respectively. In addition, 21.4 mLE are assigned to old land agriculture from the HAD. New land in the West Delta (NO5) receives 34.0, 65.6, and 18.9 mLE shares of the costs from the associated old region (RO5), the main stem barrages, and the HAD respectively.

Part two of the tables shows the common works costs on the main stem for navigation, power, ground transportation, recreation & tourism, fishery and flood control that are not distributed back to the regional use sectors. Tables 11 and 12 show the same information as Table 10 except in units of annual costs and percentages respectively.

Table 13 summarizes the results by major category. For example existing agriculture (old land) is allocated 595.19 mLE per year of the joint costs. This is the sum of the costs across all five regions from all sources: within the region, main stem barrages, and the HAD (see Table 11). Results are also given in the table in terms of present values and percent of the total. The last two columns in Table 13 contain the total cost to existing agriculture. The is the sum of the joint costs reported in the previous columns and the cost of drainage which is input by the user in the ".HAD" file (see Figure 4).

Table 14 presents additional detail about the annual costs allocated to existing agriculture. The irrigated area and water consumption are shown for each region, and the respective sums are shown for the Stem and the HAD. The top half of the table shows the distribution of the joint costs across the regions, the Stem, and the HAD. Values are shown in terms of the annual cost, the cost per feddan, and the cost per 1000 cubic meters of water. Drainage costs are shown in the middle row of the table with the same units. The lower half of the table shows the total costs distributed across the five regions of existing agriculture. For example, the total annual cost to Upper Egypt (81.58 mLE) is calculated by the sum of the following:

1) Its share of costs within the region (63.45)

2) Its share of the HAD costs proportioned according to area (13.55 * 0.762 / 6.60 = 1.56)

3) Its share of the Stem costs proportioned according to area (47.05 * 0.762 / 6.60 = 5.43)

4) Its share of the drainage costs proportioned according to area (96.42 * 0.762 / 6.60 = 11.13)

Values are calculated for the last two columns in the table by dividing the annual cost to the region by the appropriate quantities for the region (e.g. 0.762 million feddans and 6340 million cubic meters of water).

The bottom line in Table 14 contains the flat unit rates that could be applied uniformly. These values are calculated by summing the costs for all of the regions and dividing by the total quantities. For example, the sum of the regional annual costs is 691.62 mLE and the sum of the regional areas is 6.60 million feddans. The flat rate is then 691.62 divided by 6.60 which gives 104.8.

Sensitivity to Discount Rate

The sensitivity of model results to the discount rate was also studied. Four additional runs were conducted for each scenario using discount rates of 6%, 9%, 15%, and 18%. Figure 9 shows the results for the existing agricultural sector. The present values (solid lines) and annual costs (dash lines) are shown for Scenarios 1 and 2. The present values decrease significantly with increasing discount rates and the annual costs decrease slightly. This result is reasonable. The present values are discounted cost streams and will always decrease with increasing discount rate. The annual costs are calculated from the present values by the following formula:

$$A = P(1+r)^n \left[\frac{r}{(1+r)^n - 1} \right]$$

where A is the annual cost, P is the present value, r is the discount rate, and n is the number of years. When r increases, P decreases and the tendency is to offset each other so that A changes less than either r or P. The amount that P changes will also depend upon the distribution of the values in the cost stream.

Figure 10 shows the relative changes in the annual cost allocations for four sectors under Scenario 2: fishery, existing agriculture, rural water supply, and ground transportation. These sectors were selected to demonstrate a range of sensitivities. The values in the figure are obtained by dividing the allocated annual cost for the specified discount rate by the allocated annual cost for the discount rate at 12%. Agriculture dominates the system and is insensitive to discount rate. The fishery sector decreases by about 50% while water supply and transportation increase by about 50% and 118% respectively over the range of discount rates used.

Table 8. Cost Allocation Tables for Region 5 (West Delta), Scenario 4.

Cost Allocation for Region #05 WestDelta, pump costs.
Cost to be allocated = 357.4

	AGRIC	R.W.S.	Totals
(1) Project benefits	5388.9	0.8	5389.7
(2) Alternative Costs	357.4	805.5	1162.9
(3) Justifiable Costs	357.4	0.8	358.1
(10) Joint Cost Propor	0.9978	0.0022	1.0000
(11) Allocated Joint Cost	356.6	0.8	357.4
(12) Total Service Cost	356.6	0.8	357.4
(13) Percentages	99.78	0.22	1.0000

Cost Allocation for Region #05 WestDelta, non-navigable canal.
Cost to be allocated = 474.3

	AGRIC	R.W.S.	Totals
(1) Project benefits	4995.5	0.7	4996.3
(2) Alternative Costs	733.8	746.7	1480.5
(3) Justifiable Costs	733.8	0.7	734.5
(10) Joint Cost Propor	0.9990	0.0010	1.0000
(11) Allocated Joint Cost	473.8	0.5	474.3
(12) Total Service Cost	473.8	0.5	474.3
(13) Percentages	99.90	0.10	1.0000

Cost Allocation for Region #05 WestDelta, navigable canal costs.
Cost to be allocated = 37.3

	AGRIC	R.W.S.	NAVIG	Totals
(1) Project benefits	393.4	0.1	49.9	443.4
(2) Alternative Costs	57.8	58.8	57.8	174.4
(3) Justifiable Costs	57.8	0.1	49.9	107.8
(10) Joint Cost Propor	0.5361	0.0005	0.4633	1.0000
(11) Allocated Joint Cost	20.0	0.0	17.3	37.3
(12) Total Service Cost	20.0	0.0	17.3	37.3
(13) Percentages	53.61	0.05	46.33	1.0000

Cost Allocation for New Land Region #05 NewLand-5
Share Ag costs with #05 WestDelta
Cost to be allocated = 68.0

	OLD AG	NEW AG	Totals
(1) Project benefits	5388.9	1131.8	6520.7
(2) Alternative Costs	63.3	63.3	126.7
(3) Justifiable Costs	63.3	63.3	126.7
(10) Joint Cost Propor	0.5000	0.5000	1.0000
(11) Allocated Joint Cost	34.0	34.0	68.0
(12) Total Service Cost	34.0	34.0	68.0
(13) Percentages	50.00	50.00	1.0000

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Table 9. Cost Allocation Tables for Esna Barrage and the High Aswan Dam.

Cost Allocation for Main Stem Esna Barrage.
Cost to be allocated = 322.7

	OLD AG	R.W.S.	NAVIG	NEW AG	POWER	TRANS	RECR&T	Totals
(1) Project benefits	11165.5	1.2	112.4	1466.6	2416.6	45.6	1661.1	16869.0
(2) Alternative Costs	322.7	322.7	322.7	322.7	322.7	45.8	322.7	1981.8
(3) Justifiable Costs	322.7	1.2	112.4	322.7	322.7	45.6	322.7	1449.9
(10) Joint Cost Propor	0.2225	0.0008	0.0775	0.2225	0.2225	0.0315	0.2225	1.0000
(11) Allocated Joint Cost	71.8	0.3	25.0	71.8	71.8	10.2	71.8	322.7
(12) Total Service Cost	71.8	0.3	25.0	71.8	71.8	10.2	71.8	322.7
(13) Percentages	22.25	0.08	7.75	22.25	22.25	3.15	22.25	1.0000

Cost Allocation for High Aswan Dam.
Cost to be allocated = 673.3

	OLD AG	R.W.S.	NAVIG	NEW AG	POWER	G.TRAN	RECR&T	FISH	FLOOD	Totals
(1) Project benefits	49813.3	5.4	501.4	6543.0	45310.4	32.5	7410.8	483.3	2254.6	112354.6
(2) Alternative Costs	4238.0	1187.0	4238.0	4238.0	4238.0	32.5	4238.0	4238.0	2513.9	29166.2
(3) Justifiable Costs	4238.0	5.4	501.4	4238.0	4238.0	32.5	4238.0	483.3	2254.6	20229.0
(4) Separable Costs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	170.4	170.4
(5) Cost Other Purposes	673.3	673.3	673.3	673.3	673.3	673.3	673.3	673.3	502.9	5889.3
(6) Just Cost Other Purp	673.3	673.3	673.3	673.3	673.3	673.3	673.3	673.3	502.9	5889.3
(7) Adjustment Factor	7.2943	1.0080	1.7446	7.2943	7.2943	1.0483	7.2943	1.7178	4.0954	
(8) Adj Separable Costs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	697.9	
(9) Remaining Benefits	4238.0	5.4	501.4	4238.0	4238.0	32.5	4238.0	483.3	1556.6	19531.1
(10) Joint Cost Propor	0.2170	0.0003	0.0257	0.2170	0.2170	0.0017	0.2170	0.0247	0.0797	1.0000
(11) Allocated Joint Cost	109.1	0.1	12.9	109.1	109.1	0.8	109.1	12.4	40.1	502.9
(12) Total Service Cost	109.1	0.1	12.9	109.1	109.1	0.8	109.1	12.4	210.5	673.3
(13) Percentages	16.21	0.02	1.92	16.21	16.21	0.12	16.21	1.85	31.26	1.0000

Table 10. Summary of Results for Scenario 4. Allocation as Present Values.

Allocation of Joint Costs as Present Values (mil LE) for File: scen04x.
Part One of Two

	---- AGRICULTURE ----			RURAL --- WATER SUPPLY ---			NAV	TOTAL
	Region	Stem	HAD	Region	Stem	HAD	Region	
Old R01	511.1	43.8	12.6	1.0	0.2	0.0	0.0	568.7
Old R02	989.0	87.5	25.2	2.3	0.5	0.0	2.3	1106.8
Old R03	1048.3	90.8	26.1	1.7	0.4	0.0	12.5	1179.8
Old R04	941.6	82.6	23.8	1.8	0.4	0.0	23.6	1073.9
Old R05	816.3	74.3	21.4	1.3	0.3	0.0	17.3	930.9
New N01	0.0	48.4	13.9					62.4
New N02	30.6	45.7	13.2					89.4
New N03	0.0	152.0	43.8					195.8
New N04	0.0	14.7	4.2					18.9
New N05	34.0	65.6	18.9					118.5
New N06	0.0	52.6	15.2					67.8
Totals	4370.9	758.0	218.2	8.1	1.8	0.1	55.7	5412.9

Allocation of Joint Costs as Present Values (mil LE) for File: scen04x.
Part Two of Two

	NAV	PWR	TRN	TOU	FIS	FLD	TOTAL	
Stem	162.9	71.8	66.1	379.0	0.0	0.0	679.8	
HAD	12.9	109.1	0.8	109.1	12.4	210.5	454.9	
Totals	175.8	180.9	67.0	488.1	12.4	210.5	1134.8	6547.6

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Table 11. Summary of Results for Scenario 4. Allocation as Annual Costs.

Allocation of Joint Costs as Annual Costs (mil LE/YR) for File: scen04x.
Part One of Two

	---- AGRICULTURE ----			RURAL --- WATER SUPPLY ---			NAV	TOTAL
	Region	Stem	HAD	Region	Stem	HAD	Region	
Old R01	63.45	5.43	1.56	0.12	0.03	0.00	0.00	70.60
Old R02	122.78	10.87	3.13	0.28	0.06	0.00	0.29	137.41
Old R03	130.13	11.27	3.25	0.22	0.05	0.00	1.55	146.47
Old R04	116.89	10.26	2.95	0.23	0.05	0.00	2.93	133.32
Old R05	101.34	9.22	2.65	0.16	0.03	0.00	2.15	115.56
New N01	0.00	6.01	1.73					7.74
New N02	3.80	5.67	1.63					11.10
New N03	0.00	18.87	5.43					24.30
New N04	0.00	1.82	0.52					2.34
New N05	4.22	8.14	2.34					14.71
New N06	0.00	6.54	1.88					8.42
Totals	542.62	94.10	27.09	1.01	0.22	0.02	6.92	671.97

Allocation of Joint Costs as Annual Costs (mil LE/Yr for File: scen04x.
Part Two of Two

	NAV	PWR	TRN	TOU	FIS	FLD	TOTAL	
Stem	20.22	8.91	8.21	47.05	0.00	0.00	84.40	
HAD	1.60	13.55	0.10	13.55	1.54	26.13	56.48	
Totals	21.82	22.46	8.32	60.59	1.54	26.13	140.87	812.84

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Table 12. Summary of Results for Scenario 4. Allocation as Percentages.

Allocation of Joint Costs as Percentages of the Total for File: scen04x.
Part One of Two

	AGRICULTURE Region	AGRICULTURE Stem	AGRICULTURE HAD	RURAL WATER SUPPLY Region	RURAL WATER SUPPLY Stem	RURAL WATER SUPPLY HAD	NAV Region	TOTAL
Old R01	7.806	0.668	0.192	0.015	0.004	0.000	0.000	8.686
Old R02	15.105	1.337	0.385	0.035	0.008	0.001	0.035	16.905
Old R03	16.010	1.387	0.399	0.027	0.006	0.000	0.191	18.019
Old R04	14.381	1.262	0.363	0.028	0.006	0.000	0.361	16.402
Old R05	12.468	1.134	0.327	0.020	0.004	0.000	0.264	14.217
New N01	0.000	0.740	0.213					0.953
New N02	0.467	0.698	0.201					1.366
New N03	0.000	2.321	0.668					2.990
New N04	0.000	0.224	0.064					0.288
New N05	0.519	1.001	0.288					1.809
New N06	0.000	0.804	0.232					1.036
Totals	66.756	11.576	3.333	0.124	0.027	0.002	0.851	82.669

Allocation of Joint Costs as Percentages of the Total for File: scen04x.
Part Two of Two

	NAV	PWR	TRN	TOU	FIS	FLD	TOTAL	
Stem	2.488	1.097	1.010	5.788	0.000	0.000	10.383	
HAD	0.197	1.667	0.013	1.667	0.190	3.215	6.948	
Totals	2.685	2.763	1.023	7.455	0.190	3.215	17.331	100.000

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Table 13. Summary of Results for Scenario 4. Allocation by Major Categories.

Allocation of Costs by Major Categories for File: scen04x.
Present Value (P.V.) and Annual Cost (A.C.).

CATEGORY	JOINT COST			TOTAL COST	
	P.V. m LE	A.C. m LE/YR	%	P.V. m LE	A.C. m LE/YR
Existing Ag	4794.4	595.19	73.22	5571.1	691.62
New New Land	552.7	68.61	8.44		
Water Supply	10.0	1.24	0.15		
Navigation	231.5	28.75	3.54		
Power	180.9	22.46	2.76		
Transport	67.0	8.32	1.02		
Tourism	488.1	60.59	7.45		
Fishery	12.4	1.54	0.19		
Flood Cntrl	210.5	26.13	3.21		
TOTALS	6547.6	812.84	100.00	5571.1	691.62

Table 14. Annual Costs Allocated to Existing Agriculture.

Allocation of Annual Costs (A.C.) by Hierarchy for File: scen04x.
Annual Costs Allocated to Existing Agriculture

	Area mil FD	Water mil M3	Annual Cost	A.C./FD LE/FD	A.C./1000M3 LE/1000M3
JOINT COSTS					
HAD	6.599	46569.9	13.546	2.053	0.291
Stem	6.599	46569.9	47.048	7.130	1.010
Upper Egypt	0.762	6340.0	63.450	83.268	10.008
Middle Egypt	1.524	11263.0	122.778	80.563	10.901
East Delta	1.581	10154.0	130.134	82.311	12.816
Middle Delta	1.439	10609.0	116.893	81.232	11.018
West Delta	1.293	8204.0	101.344	78.379	12.353
DRAIN COSTS	6.599	46569.9	96.422	14.612	2.070
TOTAL COSTS					
Upper Egypt	0.762	6340.0	81.581	107.062	12.868
Middle Egypt	1.524	11263.0	159.040	104.357	14.121
East Delta	1.581	10154.0	167.752	106.105	16.521
Middle Delta	1.439	10609.0	151.132	105.026	14.246
West Delta	1.293	8204.0	132.110	102.173	16.103
FLAT RATE				104.806	14.851

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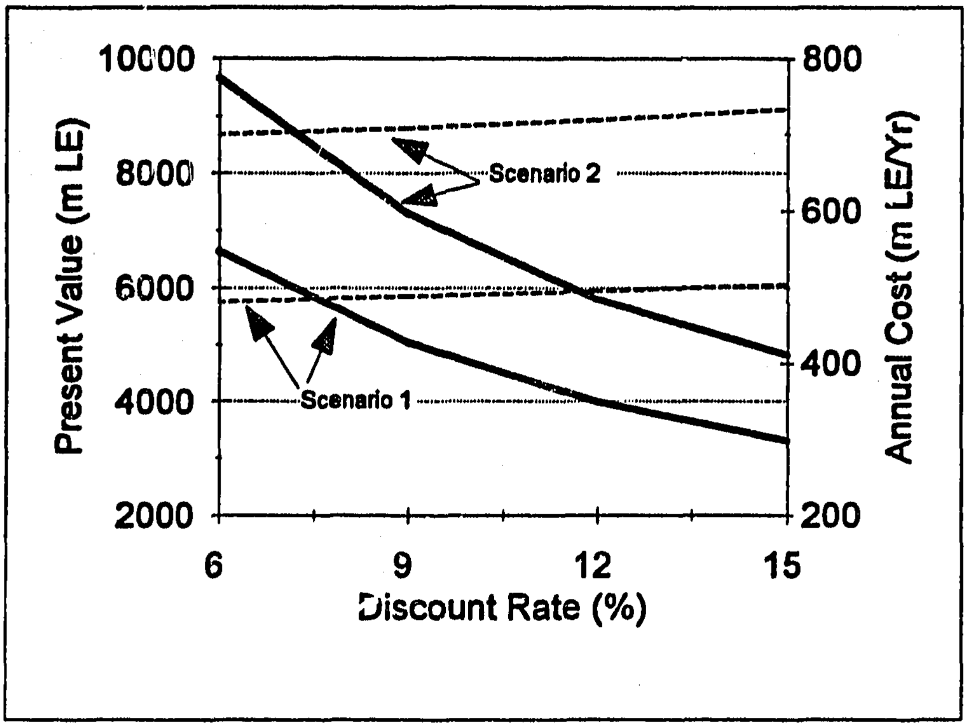

Figure 9. Sensitivity Analysis for Discount Rate on Existing Agriculture.

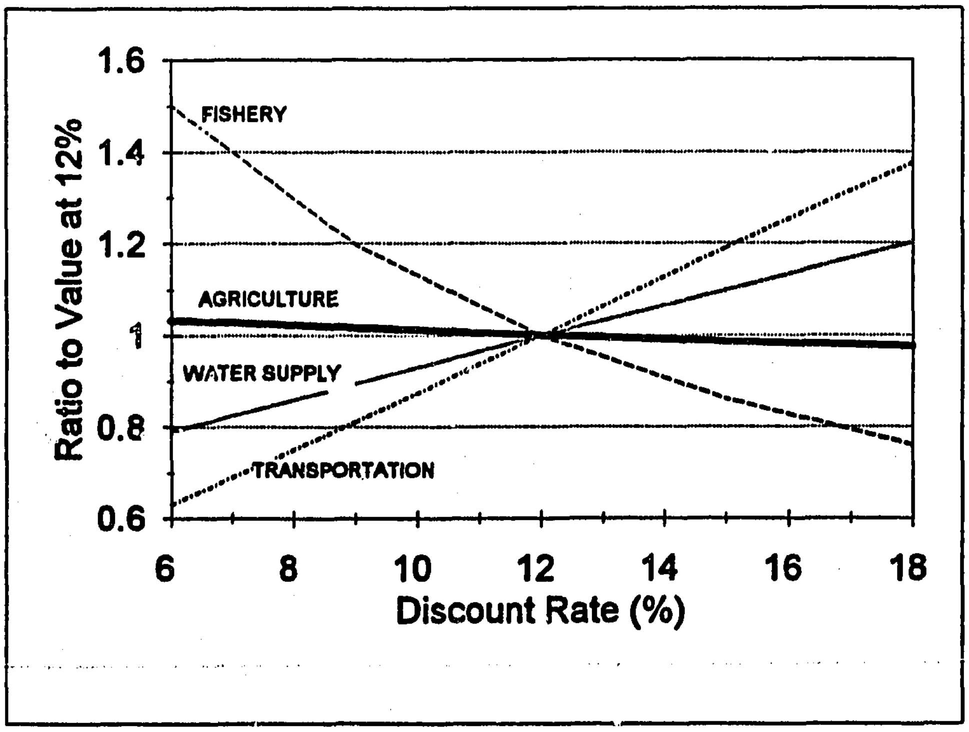

Figure 10. Sensitivity Analysis for Discount Rate on Several Sectors.

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APPENDIX A
INPUT/OUPUT FILES FOR SCENARIO 1

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Allocation of Joint Costs as Present Values (mil LE) for File: scen01x.
Part One of Two

	---- AGRICULTURE ----			RURAL --- WATER SUPPLY ---			NAV	TOTAL
	Region	Stem	HAD	Region	Stem	HAD	Region	
Old R01	440.2	29.7	9.2	1.0	0.2	0.0	0.0	480.4
Old R02	924.4	59.5	18.5	2.3	0.5	0.0	2.3	1007.5
Old R03	780.6	61.7	19.2	1.6	0.4	0.0	8.8	872.3
Old R04	671.3	56.2	17.5	1.7	0.4	0.0	15.3	762.3
Old R05	561.5	50.5	15.7	1.2	0.3	0.0	10.4	639.6
Totals	3378.1	257.5	80.1	7.8	1.8	0.1	36.7	3762.1

Allocation of Joint Costs as Present Values (mil LE) for File: scen01x.
Part Two of Two

	NAV	PWR	TRN	TOU	FIS	FLD	TOTAL	
Stem	170.6	0.0	69.3	257.5	0.0	0.0	497.4	
HAD	10.0	80.1	0.6	80.1	9.6	129.2	309.6	
Totals	180.6	80.1	69.9	337.6	9.6	129.2	807.0	4569.1

Allocation of Joint Costs as Annual Costs (mil LE/YR) for File: scen01x.
Part One of Two

	---- AGRICULTURE ----			RURAL --- WATER SUPPLY ---			NAV	TOTAL
	Region	Stem	HAD	Region	Stem	HAD	Region	
Old R01	54.64	3.69	1.15	0.12	0.03	0.00	0.00	59.64
Old R02	114.76	7.38	2.30	0.28	0.06	0.00	0.28	125.07
Old R03	96.91	7.66	2.38	0.20	0.05	0.00	1.09	108.29
Old R04	83.34	6.97	2.17	0.21	0.05	0.00	1.89	94.64
Old R05	69.71	6.26	1.95	0.15	0.03	0.00	1.29	79.40
Totals	419.37	31.97	9.94	0.96	0.23	0.01	4.56	467.04

Allocation of Joint Costs as Annual Costs (mil LE/Yr for File: scen01x.
Part Two of Two

	NAV	PWR	TRN	TOU	FIS	FLD	TOTAL	
Stem	21.18	0.00	8.60	31.97	0.00	0.00	61.75	
HAD	1.24	9.94	0.08	9.94	1.19	16.04	38.44	
Totals	22.42	9.94	8.68	41.91	1.19	16.04	100.18	567.22

Allocation of Joint Costs as Percentages of the Total for File: scen01x.
Part One of Two

	---- AGRICULTURE ----			RURAL --- WATER SUPPLY ---			NAV	TOTAL
	Region	Stem	HAD	Region	Stem	HAD	Region	
Old R01	9.634	0.651	0.202	0.021	0.005	0.000	0.000	10.514
Old R02	20.233	1.302	0.405	0.049	0.011	0.001	0.050	22.050
Old R03	17.084	1.350	0.420	0.036	0.008	0.000	0.192	19.091
Old R04	14.693	1.229	0.382	0.038	0.009	0.001	0.334	16.685
Old R05	12.290	1.104	0.343	0.026	0.006	0.000	0.228	13.998
Totals	73.934	5.636	1.752	0.170	0.040	0.002	0.804	82.338

Allocation of Joint Costs as Percentages of the Total for File: scen01x.
Part Two of Two

	NAV	PWR	TRN	TOU	FIS	FLD	TOTAL	
Stem	3.734	0.000	1.516	5.636	0.000	0.000	10.886	
HAD	0.218	1.752	0.014	1.752	0.210	2.829	6.776	
Totals	3.952	1.752	1.530	7.388	0.210	2.829	17.662	100.000

Allocation of Costs by Major Categories for File: scen01x.
Present Value (P.V.) and Annual Cost (A.C.).

CATEGORY	---------JOINT COST---------			---TOTAL COST---	
	P.V. m LE	A.C. m LE/YR	%	P.V. m LE	A.C. m LE/YR
Existing Ag	3715.6	461.27	81.32	3998.3	496.36
New New Land	0.0	0.00	0.00		
Water Supply	9.7	1.21	0.21		
Navigation	217.3	26.97	4.76		
Power	80.1	9.94	1.75		
Transport	69.9	8.68	1.53		
Tourism	337.6	41.91	7.39		
Fishery	9.6	1.19	0.21		
Flood Cntrl	129.2	16.04	2.83		
TOTALS	4569.1	567.22	100.00	3998.3	496.36

Allocation of Annual Costs (A.C.) by Hierarchy for File: scen01x.
Annual Costs Allocated to Existing Agriculture

	Area mil FD	Water mil M3	Annual Cost	A.C./FD LE/FD	A.C./1000M3 LE/1000M3
JOINT COSTS					
HAD	6.599	46569.9	9.940	1.506	0.213
Stem	6.599	46569.9	31.967	4.844	0.686
Upper Egypt	0.762	6340.0	54.644	71.711	8.619
Middle Egypt	1.524	11263.0	114.764	75.304	10.189
East Delta	1.581	10154.0	96.906	61.294	9.544
Middle Delta	1.439	10609.0	83.340	57.915	7.856
West Delta	1.293	8204.0	69.713	53.916	8.497
DRAIN COSTS	6.599	46569.9	35.088	5.317	0.753
TOTAL COSTS					
Upper Egypt	0.762	6340.0	63.535	83.379	10.021
Middle Egypt	1.524	11263.0	132.545	86.972	11.768
East Delta	1.581	10154.0	115.352	72.962	11.360
Middle Delta	1.439	10609.0	100.130	69.583	9.438
West Delta	1.293	8204.0	84.799	65.583	10.336
FLAT RATE				75.218	10.658

Cost Allocation for Region #01 UpperEgypt, pump costs.
Cost to be allocated = 169.5

	AGRIC	R.W.S.	Totals
(1) Project benefits	3214.0	0.7	3214.7
(2) Alternative Costs	169.5	483.3	652.8
(3) Justifiable Costs	169.5	0.7	170.3
(10) Joint Cost Propor	0.9957	0.0043	1.0000
(11) Allocated Joint Cost	168.8	0.7	169.5
(12) Total Service Cost	168.8	0.7	169.5
(13) Percentages	99.57	0.43	1.0000

Cost Allocation for Region #01 UpperEgypt, non-navigable canal.
Cost to be allocated = 271.6

	AGRIC	R.W.S.	Totals
(1) Project benefits	3214.0	0.7	3214.7
(2) Alternative Costs	781.8	483.3	1265.1
(3) Justifiable Costs	781.8	0.7	782.5
(10) Joint Cost Propor	0.9991	0.0009	1.0000
(11) Allocated Joint Cost	271.4	0.3	271.6
(12) Total Service Cost	271.4	0.3	271.6
(13) Percentages	99.91	0.09	1.0000

Cost Allocation for Region #02 Middle, pump costs.
Cost to be allocated = 339.2

	AGRIC	R.W.S.	Totals
(1) Project benefits	13339.4	1.5	13340.9
(2) Alternative Costs	339.2	725.0	1064.1
(3) Justifiable Costs	339.2	1.5	340.7
(10) Joint Cost Propor	0.9955	0.0045	1.0000
(11) Allocated Joint Cost	337.6	1.5	339.2
(12) Total Service Cost	337.6	1.5	339.2
(13) Percentages	99.55	0.45	1.0000

Cost Allocation for Region #02 Middle, non-navigable canal.
Cost to be allocated = 585.3

	AGRIC	R.W.S.	Totals
(1) Project benefits	13236.7	1.5	13238.2
(2) Alternative Costs	1194.8	719.4	1914.2
(3) Justifiable Costs	1194.8	1.5	1196.3
(10) Joint Cost Propor	0.9987	0.0013	1.0000
(11) Allocated Joint Cost	584.5	0.7	585.3
(12) Total Service Cost	584.5	0.7	585.3
(13) Percentages	99.87	0.13	1.0000

Cost Allocation for Region #02 Middle, navigable canal costs.
Cost to be allocated = 4.5

	AGRIC	R.W.S.	NAVIG	Totals
(1) Project benefits	102.7	0.0	11.4	114.2
(2) Alternative Costs	9.3	5.6	9.3	24.1
(3) Justifiable Costs	9.3	0.0	9.3	18.6
(10) Joint Cost Propor	0.4997	0.0006	0.4997	1.0000
(11) Allocated Joint Cost	2.3	0.0	2.3	4.5
(12) Total Service Cost	2.3	0.0	2.3	4.5
(13) Percentages	49.97	0.06	49.97	1.0000

Cost Allocation for Region #03 EastDelta, pump costs.
Cost to be allocated = 351.8

	AGRIC	R.W.S.	Totals
(1) Project benefits	12477.5	1.2	12478.6
(2) Alternative Costs	351.8	1611.0	1962.8
(3) Justifiable Costs	351.8	1.2	353.0
(10) Joint Cost Propor	0.9967	0.0033	1.0000
(11) Allocated Joint Cost	350.7	1.2	351.8
(12) Total Service Cost	350.7	1.2	351.8
(13) Percentages	99.67	0.33	1.0000

Cost Allocation for Region #03 EastDelta, non-navigable canal.
Cost to be allocated = 421.6

	AGRIC	R.W.S.	Totals
(1) Project benefits	11978.4	1.1	11979.5
(2) Alternative Costs	996.7	1546.6	2543.3
(3) Justifiable Costs	996.7	1.1	997.8
(10) Joint Cost Propor	0.9989	0.0011	1.0000
(11) Allocated Joint Cost	421.2	0.5	421.6
(12) Total Service Cost	421.2	0.5	421.6
(13) Percentages	99.89	0.11	1.0000

Cost Allocation for Region #03 EastDelta, navigable canal costs.
Cost to be allocated = 17.6

	AGRIC	R.W.S.	NAVIG	Totals
(1) Project benefits	499.1	0.0	58.3	557.5
(2) Alternative Costs	41.5	64.4	41.5	147.5
(3) Justifiable Costs	41.5	0.0	41.5	83.1
(10) Joint Cost Propor	0.4997	0.0006	0.4997	1.0000
(11) Allocated Joint Cost	8.8	0.0	8.8	17.6
(12) Total Service Cost	8.8	0.0	8.8	17.6
(13) Percentages	49.97	0.06	49.97	1.0000

Cost Allocation for Region #04 MiddleDelta, pump costs.
Cost to be allocated = 320.3

	AGRIC	R.W.S.	Totals
(1) Project benefits	7483.3	1.2	7484.5
(2) Alternative Costs	320.3	805.5	1125.8
(3) Justifiable Costs	320.3	1.2	321.5
(10) Joint Cost Propor	0.9962	0.0038	1.0000
(11) Allocated Joint Cost	319.1	1.2	320.3
(12) Total Service Cost	319.1	1.2	320.3
(13) Percentages	99.62	0.38	1.0000

Cost Allocation for Region #04 MiddleDelta, non-navigable canal.
Cost to be allocated = 337.4

	AGRIC	R.W.S.	Totals
(1) Project benefits	6862.2	1.1	6863.3
(2) Alternative Costs	754.7	738.7	1493.3
(3) Justifiable Costs	754.7	1.1	755.8
(10) Joint Cost Propor	0.9985	0.0015	1.0000
(11) Allocated Joint Cost	336.9	0.5	337.4
(12) Total Service Cost	336.9	0.5	337.4
(13) Percentages	99.85	0.15	1.0000

Cost Allocation for Region #04 MiddleDelta, navigable canal costs.
Cost to be allocated = 30.5

	AGRIC	R.W.S.	NAVIG	Totals
(1) Project benefits	621.1	0.1	91.7	712.9
(2) Alternative Costs	68.3	66.9	68.3	203.5
(3) Justifiable Costs	68.3	0.1	68.3	136.7
(10) Joint Cost Propor	0.4996	0.0007	0.4996	1.0000
(11) Allocated Joint Cost	15.3	0.0	15.3	30.5
(12) Total Service Cost	15.3	0.0	15.3	30.5
(13) Percentages	49.96	0.07	49.96	1.0000

Cost Allocation for Region #05 WestDelta, pump costs.
Cost to be allocated = 287.9

	AGRIC	R.W.S.	Totals
(1) Project benefits	4591.5	0.8	4592.3
(2) Alternative Costs	287.9	805.5	1093.4
(3) Justifiable Costs	287.9	0.8	288.6
(10) Joint Cost Propor	0.9972	0.0028	1.0000
(11) Allocated Joint Cost	287.1	0.8	287.9
(12) Total Service Cost	287.1	0.8	287.9
(13) Percentages	99.72	0.28	1.0000

Cost Allocation for Region #05 WestDelta, non-navigable canal.
Cost to be allocated = 264.5

	AGRIC	R.W.S.	Totals
(1) Project benefits	4256.3	0.7	4257.0
(2) Alternative Costs	524.0	746.7	1270.7
(3) Justifiable Costs	524.0	0.7	524.7
(10) Joint Cost Propor	0.9986	0.0014	1.0000
(11) Allocated Joint Cost	264.1	0.4	264.5
(12) Total Service Cost	264.1	0.4	264.5
(13) Percentages	99.86	0.14	1.0000

Cost Allocation for Region #05 WestDelta, navigable canal costs.
Cost to be allocated = 20.8

	AGRIC	R.W.S.	NAVIG	Totals
(1) Project benefits	335.2	0.1	49.9	385.2
(2) Alternative Costs	41.3	58.8	41.3	141.3
(3) Justifiable Costs	41.3	0.1	41.3	82.6
(10) Joint Cost Propor	0.4996	0.0007	0.4996	1.0000
(11) Allocated Joint Cost	10.4	0.0	10.4	20.8
(12) Total Service Cost	10.4	0.0	10.4	20.8
(13) Percentages	49.96	0.07	49.96	1.0000

Cost Allocation for Main Stem Barrages Excluding Esna.
Cost to be allocated = 756.7

	OLD AG	R.W.S.	NAVIG	NEW AG	POWER	TRANS	RECR&T	Totals
(1) Project benefits	41105.6	5.4	501.4	0.0	0.0	203.6	7410.8	49226.7
(2) Alternative Costs	756.7	756.7	756.7	756.7	0.0	204.3	756.7	3987.9
(3) Justifiable Costs	756.7	5.4	501.4	0.0	0.0	203.6	756.7	2223.8
(10) Joint Cost Propor	0.3403	0.0024	0.2254	0.0000	0.0000	0.0916	0.3403	1.0000
(11) Allocated Joint Cost	257.5	1.3	170.6	0.0	0.0	69.3	257.5	756.7
(12) Total Service Cost	257.5	1.8	170.6	0.0	0.0	69.3	257.5	756.7
(13) Percentages	34.03	0.24	22.54	0.00	0.00	9.16	34.03	1.0000

Cost Allocation for Main Stem Esna Barrage.
Cost to be allocated = 0.0

OLD AG	R.W.S.	NAVIG	NEW AG	POWER	TRANS	RECR&T	Totals

Cost for allocation is zero, skip this analysis.

Cost Allocation for High Aswan Dam.
Cost to be allocated = 389.8

	OLD AG	R.W.S.	NAVIG	NEW AG	POWER	G.TRAN	RECR&T	FISH	FLOOD	Totals
(1) Project benefits	41105.6	5.4	501.4	0.0	45310.4	32.5	7410.8	483.3	2157.9	97007.3
(2) Alternative Costs	4026.2	1187.0	4026.2	4026.2	4026.2	32.5	4026.2	4026.2	2393.1	27769.7
(3) Justifiable Costs	4026.2	5.4	501.4	0.0	4026.2	32.5	4026.2	483.3	2157.9	15259.0
(4) Separable Costs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	98.7	98.7
(5) Cost Other Purposes	389.8	389.8	389.8	389.8	389.8	389.8	389.8	389.8	291.1	3409.5
(6) Just Cost Other Purp	389.8	389.8	389.8	389.8	389.8	389.8	389.8	389.8	291.1	3409.5
(7) Adjustment Factor	11.3291	1.0139	2.2862	1.0000	11.3291	1.0835	11.3291	2.2399	6.2829	
(8) Adj Separable Costs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	619.8	
(9) Remaining Benefits	4026.2	5.4	501.4	0.0	4026.2	32.5	4026.2	483.3	1538.0	14639.2
(10) Joint Cost Propor	0.2750	0.0004	0.0342	0.0000	0.2750	0.0022	0.2750	0.0330	0.1051	1.0000
(11) Allocated Joint Cost	80.1	0.1	10.0	0.0	80.1	0.6	80.1	9.6	30.6	291.1
(12) Total Service Cost	80.1	0.1	10.0	0.0	80.1	0.6	80.1	9.6	129.2	389.8
(13) Percentages	20.54	0.03	2.56	0.00	20.54	0.17	20.54	2.47	33.16	1.0000

File name: scen01x.ECH
TABLE 1. THE HIGH ASWAN DAM (BASHAD.WB1).
Costs and Benefits for Basic O&M

BASIN DISCOUNT RATE (%):	12.0		
BASIN PLANNING HORIZON (YRS):	30		
NUMBER OF OLD REGIONS:	5		
NUMBER OF NEW REGIONS:	0		
ANNUAL COST FOR DRAINAGE (m LE/Yr @	35.088	282.64	35.088
HAD BENEFITS			
FLOOD CONTROL (% of total benefit	4.0		
SINGLE PURPOSE ALTERNATIVES			
AG, NAV, POWER, FISH (% of OM&R):	74.700		
FLOOD CONTROL (% of OM&R):	44.400		
SEPARABLE COSTS			
AGRICULTURE (% of O&M):	0.00		
POWER (% of O&M):	0.00		
FLOOD (% of O&M):	25.31		

YEAR		HAD BENEFIT		SINGLE PUPROSE ALTERN			ANNUAL
	HYDRO POWER	GROUND TRANSP	FISHERY	WATER SUPPLY	GROUND TRANSP	COMMON WORKS REPLACE	COMMON WORKS O&M
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
p. val	45310.42	32.54	483.31	1187.01	32.54	5000.00	389.79

Present value SPA Other	4026.2
Present value SPA Flood	2393.1
Pres. val. separable Agri.	0.0
Pres. val. separable Power	0.0
Pres. val. separable Flood	98.7

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File name: scen01x.STM
TABLE 2: MAIN STEM OF THE NILE (BASSTM.WB1).
Costs and Benefits for Basic O&M

YEAR				BEN	SINGLE	STEM	ESNA
	NAVIG	HYDRO POWER ESNA	GROUND TRANSP	RECREA & TOURISM	PURPOSE ALTERN COST TRANSP	COSTS EXCEPT HAD & ESNA	COMMON WORKS COSTS
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
p. val	289.99	0.00	203.59	7410.77	204.31	756.73	0.00

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File name: scen01x.R01

TABLE 3. INPUT FOR OLD REGION (BASRxx.WB1).

Costs and Benefits for Basic O&M

REGION NAME:	UpperEgypt
REGION NUMBER:	1

AGRICULTURAL AREA (mil FED):	0.762	
WATER CONSUMPTION (M3/FD):	8320.200,	= 6340.0 (mil M3).
POPULATION (millions):	5.520	
WETTED PERIMETER OF CANALS (meters)	61.7	
PERCENT OF CANALS NAVIGABLE (%):	0.0	

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI (m LE)	WATER SUPPLY (m LE)	NAVIG (m LE)	CANAL REPALCE (m LE)	WATER SUPPLY (m LE)	CANAL O&M (m LE)	SYSTEM PUMPS OM&R (m LE)
p. val	3214.02	0.73	0.00	510.18	483.31	271.60	169.54

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File name: scen01x.R02

TABLE 3. INPUT FOR OLD REGION. (BASRxx.WB1)

Costs and Benefits for Basic O&M

REGION NAME:	Middle
REGION NUMBER:	2

AGRICULTURAL AREA (mil FED):	1.524	
WATER CONSUMPTION (M3/FD):	7390.400,	= 11263.0 (mil M3).
POPULATION (millions):	11.590	
WETTED PERIMETER OF CANALS (meters)	71.8	
PERCENT OF CANALS NAVIGABLE (%):	0.8	

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI (m LE)	WATER SUPPLY (m LE)	NAVIG (m LE)	CANAL REPALCE (m LE)	WATER SUPPLY (m LE)	CANAL O&M (m LE)	SYSTEM PUMPS OM&R (m LE)
p. val	13339.38	1.52	11.44	614.30	724.97	589.81	339.16

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File name: scen01x.R03

TABLE 3. INPUT FOR OLD REGION. (BASRxx.WB1)

Costs and Benefits for Basic O&M.

REGION NAME: EastDelta
REGION NUMBER: 3

AGRICULTURAL AREA (mil FED): 1.581
WATER CONSUMPTION (M3/FD): 6422.500, = 10154.0 (mil M3).
POPULATION (millions): 8.570
WETTED PERIMETER OF CANALS (meters) 72.5
PERCENT OF CANALS NAVIGABLE (%): 4.0

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
p. val	12477.48	1.16	58.32	599.02	1611.04	439.20	351.81

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File name: scen01x.R04

TABLE 3. INPUT FOR OLD REGION. (BASRxx.WB1)

Costs and Benefits for Basic O&M

REGION NAME: MiddleDelta
REGION NUMBER: 4

AGRICULTURAL AREA (mil FED): 1.439
WATER CONSUMPTION (M3/FD): 7372.500, = 10609.0 (mil M3).
POPULATION (millions): 9.050
WETTED PERIMETER OF CANALS (meters) 55.1
PERCENT OF CANALS NAVIGABLE (%): 8.3

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
p. val	7483.27	1.21	91.67	454.98	805.52	367.99	320.31

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File name: scen01x.R05
TABLE 3. INPUT FOR OLD REGION. (BASRxx.WB1)
Costs and Benefits for Basic O&M

REGION NAME: WestDelta
REGION NUMBER: 5

AGRICULTURAL AREA (mil FED): 1.293
WATER CONSUMPTION (M3/FD): 6344.900, = 8204.0 (mil M3).
POPULATION (millions): 6.180
WETTED PERIMETER OF CANALS (meters) 37.0
PERCENT OF CANALS NAVIGABLE (%): 7.3

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
p. val	4591.46	0.80	49.94	279.98	805.52	285.28	287.85

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TABLE 1. THE HIGH ASWAN DAM (BASHAD.WB1).
Costs and Benefits for Basic O&M

BASIN DISCOUNT RATE (%):	12	
BASIN PLANNING HORIZON (YRS):	30	
NUMBER OF OLD REGIONS:	5	
NUMBER OF NEW REGIONS:	0	
ANNUAL COST FOR DRAINAGE (m LE/Yr @ 12%):	35.088	12

HAD BENEFITS

FLOOD CONTROL (% of total benefits):	4

SINGLE PURPOSE ALTERNATIVES

AG, NAV, POWER, FISH (% of OM&R):	74.7
FLOOD CONTROL (% of OM&R):	44.4

SEPARABLE COSTS

AGRICULTURE (% of O&M):	0
POWER (% of O&M):	0
FLOOD (% of O&M):	25.31

YEAR	HAD BENEFIT HYDRO POWER (m LE)	HAD BENEFIT GROUND TRANSP (m LE)	HAD BENEFIT FISHERY (m LE)	SINGLE PUPROSE WATER SUPPLY (m LE)	SINGLE PUPROSE GROUND TRANSP (m LE)	ALTERN COMMON WORKS REPLACE (m LE)	ANNUAL COMMON WORKS O&M (m LE)
1	5625	35	60	1165	35	5600	48.39
2	5625	0.18	60	20.5	0.18	0	48.39
3	5625	0.18	60	20.5	0.18	0	48.39
4	5625	0.18	60	20.5	0.18	0	48.39
5	5625	0.18	60	20.5	0.18	0	48.39
6	5625	0.18	60	20.5	0.18	0	48.39
7	5625	0.18	60	20.5	0.18	0	48.39
8	5625	0.18	60	20.5	0.18	0	48.39
9	5625	0.18	60	20.5	0.18	0	48.39
10	5625	0.18	60	20.5	0.18	0	48.39
11	5625	0.18	60	20.5	0.18	0	48.39
12	5625	0.18	60	20.5	0.18	0	48.39
13	5625	0.18	60	20.5	0.18	0	48.39
14	5625	0.18	60	20.5	0.18	0	48.39
15	5625	0.18	60	20.5	0.18	0	48.39
16	5625	0.18	60	20.5	0.18	0	48.39
17	5625	0.18	60	20.5	0.18	0	48.39
18	5625	0.18	60	20.5	0.18	0	48.39
19	5625	0.18	60	20.5	0.18	0	48.39
20	5625	0.18	60	20.5	0.18	0	48.39
21	5625	0.18	60	20.5	0.18	0	48.39
22	5625	0.18	60	20.5	0.18	0	48.39
23	5625	0.18	60	20.5	0.18	0	48.39
24	5625	0.18	60	20.5	0.18	0	48.39
25	5625	0.18	60	20.5	0.18	0	48.39
26	5625	0.18	60	20.5	0.18	0	48.39
27	5625	0.18	60	20.5	0.18	0	48.39
28	5625	0.18	60	20.5	0.18	0	48.39
29	5625	0.18	60	20.5	0.18	0	48.39
30	5625	0.18	60	20.5	0.18	0	48.39

TABLE 2: MAIN STEM OF THE NILE (BASSTM.WB1).
Costs and Benefits for Basic O&M

YEAR	NAVIG (m LE)	HYDRO POWER ESNA (m LE)	GROUND TRANSP (m LE)	BEN RECREA & TOURISM (m LE)	SINGLE PURPOSE ALTERN COST TRANSP (m LE)	STEM COSTS EXCEPT HAD & ESNA (m LE)	ESNA COMMON WORKS COSTS (m LE)
1	36	0	220	920	220	93.943	0
2	36	0	1	920	1.1	93.943	0
3	36	0	1	920	1.1	93.943	0
4	36	0	1	920	1.1	93.943	0
5	36	0	1	920	1.1	93.943	0
6	36	0	1	920	1.1	93.943	0
7	36	0	1	920	1.1	93.943	0
8	36	0	1	920	1.1	93.943	0
9	36	0	1	920	1.1	93.943	0
10	36	0	1	920	1.1	93.943	0
11	36	0	1	920	1.1	93.943	0
12	36	0	1	920	1.1	93.943	0
13	36	0	1	920	1.1	93.943	0
14	36	0	1	920	1.1	93.943	0
15	36	0	1	920	1.1	93.943	0
16	36	0	1	920	1.1	93.943	0
17	36	0	1	920	1.1	93.943	0
18	36	0	1	920	1.1	93.943	0
19	36	0	1	920	1.1	93.943	0
20	36	0	1	920	1.1	93.943	0
21	36	0	1	920	1.1	93.943	0
22	36	0	1	920	1.1	93.943	0
23	36	0	1	920	1.1	93.943	0
24	36	0	1	920	1.1	93.943	0
25	36	0	1	920	1.1	93.943	0
26	36	0	1	920	1.1	93.943	0
27	36	0	1	920	1.1	93.943	0
28	36	0	1	920	1.1	93.943	0
29	36	0	1	920	1.1	93.943	0
30	36	0	1	920	1.1	93.943	0

TABLE 3. INPUT FOR OLD REGION (BASRxx.WB1).
Costs and Benefits for Basic O&M

REGION NAME:	UpperEgypt
REGION NUMBER:	1
AGRICULTURAL AREA (mil FED):	0.762
WATER CONSUMPTION (M3/FD):	8320.2
POPULATION (millions):	5.52
WETTED PERIMETER OF CANALS (meters):	61.7
PERCENT OF CANALS NAVIGABLE (%):	0

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
1	399	0.58	0	571.4	60	33.718	21.047
2	399	0.029	0	0	60	33.718	21.047
3	399	0.029	0	0	60	33.718	21.047
4	399	0.029	0	0	60	33.718	21.047
5	399	0.029	0	0	60	33.718	21.047
6	399	0.029	0	0	60	33.718	21.047
7	399	0.029	0	0	60	33.718	21.047
8	399	0.029	0	0	60	33.718	21.047
9	399	0.029	0	0	60	33.718	21.047
10	399	0.029	0	0	60	33.718	21.047
11	399	0.029	0	0	60	33.718	21.047
12	399	0.029	0	0	60	33.718	21.047
13	399	0.029	0	0	60	33.718	21.047
14	399	0.029	0	0	60	33.718	21.047
15	399	0.029	0	0	60	33.718	21.047
16	399	0.029	0	0	60	33.718	21.047
17	399	0.029	0	0	60	33.718	21.047
18	399	0.029	0	0	60	33.718	21.047
19	399	0.029	0	0	60	33.718	21.047
20	399	0.029	0	0	60	33.718	21.047
21	399	0.029	0	0	60	33.718	21.047
22	399	0.029	0	0	60	33.718	21.047
23	399	0.029	0	0	60	33.718	21.047
24	399	0.029	0	0	60	33.718	21.047
25	399	0.029	0	0	60	33.718	21.047
26	399	0.029	0	0	60	33.718	21.047
27	399	0.029	0	0	60	33.718	21.047
28	399	0.029	0	0	60	33.718	21.047
29	399	0.029	0	0	60	33.718	21.047
30	399	0.029	0	0	60	33.718	21.047

TABLE 3. INPUT FOR OLD REGION. (BASRxx.WB1)
Costs and Benefits for Basic O&M

REGION NAME:	Middle Egypt
REGION NUMBER:	2
AGRICULTURAL AREA (mil FED):	1.524
WATER CONSUMPTION (M3/FD):	7390.4
POPULATION (millions):	11.59
WETTED PERIMETER OF CANALS (meters):	71.8
PERCENT OF CANALS NAVIGABLE (%):	0.77

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
1	1656	1.22	1.42	688.02	90	73.221	42.104
2	1656	0.06	1.42	0.00	90	73.221	42.104
3	1656	0.06	1.42	0.00	90	73.221	42.104
4	1656	0.06	1.42	0.00	90	73.221	42.104
5	1656	0.06	1.42	0.00	90	73.221	42.104
6	1656	0.06	1.42	0.00	90	73.221	42.104
7	1656	0.06	1.42	0.00	90	73.221	42.104
8	1656	0.06	1.42	0.00	90	73.221	42.104
9	1656	0.06	1.42	0.00	90	73.221	42.104
10	1656	0.06	1.42	0.00	90	73.221	42.104
11	1656	0.06	1.42	0.00	90	73.221	42.104
12	1656	0.06	1.42	0.00	90	73.221	42.104
13	1656	0.06	1.42	0.00	90	73.221	42.104
14	1656	0.06	1.42	0.00	90	73.221	42.104
15	1656	0.06	1.42	0.00	90	73.221	42.104
16	1656	0.06	1.42	0.00	90	73.221	42.104
17	1656	0.06	1.42	0.00	90	73.221	42.104
18	1656	0.06	1.42	0.00	90	73.221	42.104
19	1656	0.06	1.42	0.00	90	73.221	42.104
20	1656	0.06	1.42	0.00	90	73.221	42.104
21	1656	0.06	1.42	0.00	90	73.221	42.104
22	1656	0.06	1.42	0.00	90	73.221	42.104
23	1656	0.06	1.42	0.00	90	73.221	42.104
24	1656	0.06	1.42	0.00	90	73.221	42.104
25	1656	0.06	1.42	0.00	90	73.221	42.104
26	1656	0.06	1.42	0.00	90	73.221	42.104
27	1656	0.06	1.42	0.00	90	73.221	42.104
28	1656	0.06	1.42	0.00	90	73.221	42.104
29	1656	0.06	1.42	0.00	90	73.221	42.104
30	1656	0.06	1.42	0.00	90	73.221	42.104

TABLE 3. INPUT FOR OLD REGION. (BASRxx.WB1)
Costs and Benefits for Basic O&M.

REGION NAME: EastDelta
REGION NUMBER: 3

AGRICULTURAL AREA (mil FED): 1.581
WATER CONSUMPTION (M3/FD): 6422.5
POPULATION (millions): 8.57
WETTED PERIMETER OF CANALS (meters): 72.5
PERCENT OF CANALS NAVIGABLE (%): 4

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
1	1549	0.9	7.24	670.90	200	54.524	43.675
2	1549	0.05	7.24	0.00	200	54.524	43.675
3	1549	0.05	7.24	0.00	200	54.524	43.675
4	1549	0.05	7.24	0.00	200	54.524	43.675
5	1549	0.05	7.24	0.00	200	54.524	43.675
6	1549	0.05	7.24	0.00	200	54.524	43.675
7	1549	0.05	7.24	0.00	200	54.524	43.675
8	1549	0.05	7.24	0.00	200	54.524	43.675
9	1549	0.05	7.24	0.00	200	54.524	43.675
10	1549	0.05	7.24	0.00	200	54.524	43.675
11	1549	0.05	7.24	0.00	200	54.524	43.675
12	1549	0.05	7.24	0.00	200	54.524	43.675
13	1549	0.05	7.24	0.00	200	54.524	43.675
14	1549	0.05	7.24	0.00	200	54.524	43.675
15	1549	0.05	7.24	0.00	200	54.524	43.675
16	1549	0.05	7.24	0.00	200	54.524	43.675
17	1549	0.05	7.24	0.00	200	54.524	43.675
18	1549	0.05	7.24	0.00	200	54.524	43.675
19	1549	0.05	7.24	0.00	200	54.524	43.675
20	1549	0.05	7.24	0.00	200	54.524	43.675
21	1549	0.05	7.24	0.00	200	54.524	43.675
22	1549	0.05	7.24	0.00	200	54.524	43.675
23	1549	0.05	7.24	0.00	200	54.524	43.675
24	1549	0.05	7.24	0.00	200	54.524	43.675
25	1549	0.05	7.24	0.00	200	54.524	43.675
26	1549	0.05	7.24	0.00	200	54.524	43.675
27	1549	0.05	7.24	0.00	200	54.524	43.675
28	1549	0.05	7.24	0.00	200	54.524	43.675
29	1549	0.05	7.24	0.00	200	54.524	43.675
30	1549	0.05	7.24	0.00	200	54.524	43.675

TABLE 3. INPUT FOR OLD REGION. (BASRxx.WB1)
Costs and Benefits for Basic O&M

REGION NAME:	MiddleDelta
REGION NUMBER:	4
AGRICULTURAL AREA (mil FED):	1.439
WATER CONSUMPTION (M3/FD):	7372.5
POPULATION (millions):	9.05
WETTED PERIMETER OF CANALS (meters):	55.1
PERCENT OF CANALS NAVIGABLE (%):	8.3

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
1	929	0.95	11.38	509.58	100	45.683	39.765
2	929	0.05	11.38	0.00	100	45.683	39.765
3	929	0.05	11.38	0.00	100	45.683	39.765
4	929	0.05	11.38	0.00	100	45.683	39.765
5	929	0.05	11.38	0.00	100	45.683	39.765
6	929	0.05	11.38	0.00	100	45.683	39.765
7	929	0.05	11.38	0.00	100	45.683	39.765
8	929	0.05	11.38	0.00	100	45.683	39.765
9	929	0.05	11.38	0.00	100	45.683	39.765
10	929	0.05	11.38	0.00	100	45.683	39.765
11	929	0.05	11.38	0.00	100	45.683	39.765
12	929	0.05	11.38	0.00	100	45.683	39.765
13	929	0.05	11.38	0.00	100	45.683	39.765
14	929	0.05	11.38	0.00	100	45.683	39.765
15	929	0.05	11.38	0.00	100	45.683	39.765
16	929	0.05	11.38	0.00	100	45.683	39.765
17	929	0.05	11.38	0.00	100	45.683	39.765
18	929	0.05	11.38	0.00	100	45.683	39.765
19	929	0.05	11.38	0.00	100	45.683	39.765
20	929	0.05	11.38	0.00	100	45.683	39.765
21	929	0.05	11.38	0.00	100	45.683	39.765
22	929	0.05	11.38	0.00	100	45.683	39.765
23	929	0.05	11.38	0.00	100	45.683	39.765
24	929	0.05	11.38	0.00	100	45.683	39.765
25	929	0.05	11.38	0.00	100	45.683	39.765
26	929	0.05	11.38	0.00	100	45.683	39.765
27	929	0.05	11.38	0.00	100	45.683	39.765
28	929	0.05	11.38	0.00	100	45.683	39.765
29	929	0.05	11.38	0.00	100	45.683	39.765
30	929	0.05	11.38	0.00	100	45.683	39.765

TABLE 3. INPUT FOR OLD REGION. (BASRxx.WB1)
Costs and Benefits for Basic O&M

REGION NAME: WestDelta
REGION NUMBER: 5

AGRICULTURAL AREA (mil FED): 1.293
WATER CONSUMPTION (M3/FD): 6344.9
POPULATION (millions): 6.18
WETTED PERIMETER OF CANALS (meters): 37
PERCENT OF CANALS NAVIGABLE (%): 7.3

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
1	570	0.65	6.2	313.58	100	35.416	35.735
2	570	0.03	6.2	0	100	35.416	35.735
3	570	0.03	6.2	0	100	35.416	35.735
4	570	0.03	6.2	0	100	35.416	35.735
5	570	0.03	6.2	0	100	35.416	35.735
6	570	0.03	6.2	0	100	35.416	35.735
7	570	0.03	6.2	0	100	35.416	35.735
8	570	0.03	6.2	0	100	35.416	35.735
9	570	0.03	6.2	0	100	35.416	35.735
10	570	0.03	6.2	0	100	35.416	35.735
11	570	0.03	6.2	0	100	35.416	35.735
12	570	0.03	6.2	0	100	35.416	35.735
13	570	0.03	6.2	0	100	35.416	35.735
14	570	0.03	6.2	0	100	35.416	35.735
15	570	0.03	6.2	0	100	35.416	35.735
16	570	0.03	6.2	0	100	35.416	35.735
17	570	0.03	6.2	0	100	35.416	35.735
18	570	0.03	6.2	0	100	35.416	35.735
19	570	0.03	6.2	0	100	35.416	35.735
20	570	0.03	6.2	0	100	35.416	35.735
21	570	0.03	6.2	0	100	35.416	35.735
22	570	0.03	6.2	0	100	35.416	35.735
23	570	0.03	6.2	0	100	35.416	35.735
24	570	0.03	6.2	0	100	35.416	35.735
25	570	0.03	6.2	0	100	35.416	35.735
26	570	0.03	6.2	0	100	35.416	35.735
27	570	0.03	6.2	0	100	35.416	35.735
28	570	0.03	6.2	0	100	35.416	35.735
29	570	0.03	6.2	0	100	35.416	35.735
30	570	0.03	6.2	0	100	35.416	35.735

APPENDIX B

INPUT / OUTPUT FILES FOR SCENARIO 2

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Allocation of Joint Costs as Present Values (mil LE) for File: scen02x.
Part One of Two

	---- AGRICULTURE ----			RURAL --- WATER SUPPLY ---			NAV	TOTAL
	Region	Stem	HAD	Region	Stem	HAD	Region	
Old R01	511.1	59.6	16.1	1.0	0.3	0.0	0.0	588.1
Old R02	1019.6	119.2	32.2	2.3	0.7	0.1	2.3	1176.3
Old R03	1048.3	123.6	33.4	1.7	0.5	0.0	12.5	1220.1
Old R04	941.6	112.5	30.4	1.8	0.5	0.0	23.6	1110.5
Old R05	850.4	101.1	27.3	1.3	0.4	0.0	17.3	997.8
Totals	4370.9	516.1	139.4	8.1	2.4	0.2	55.7	5092.8

Allocation of Joint Costs as Present Values (mil LE) for File: scen02x.
Part Two of Two

	NAV	PWR	TRN	TOU	FIS	FLD	TOTAL	
Stem	222.4	92.4	90.3	516.1	0.0	0.0	921.1	
HAD	16.5	139.4	1.1	139.4	15.9	221.6	533.8	
Totals	238.8	231.7	91.4	655.4	15.9	221.6	1454.8	6547.6

Allocation of Joint Costs as Annual Costs (mil LE/YR) for File: scen02x.
Part One of Two

	---- AGRICULTURE ----			RURAL --- WATER SUPPLY ---			NAV	TOTAL
	Region	Stem	HAD	Region	Stem	HAD	Region	
Old R01	63.45	7.40	2.00	0.12	0.04	0.00	0.00	73.01
Old R02	126.58	14.80	4.00	0.28	0.08	0.01	0.29	146.03
Old R03	130.13	15.35	4.14	0.22	0.06	0.00	1.55	151.46
Old R04	116.89	13.97	3.77	0.23	0.07	0.00	2.93	137.87
Old R05	105.57	12.55	3.39	0.16	0.04	0.00	2.15	123.87
Totals	542.62	64.07	17.30	1.01	0.30	0.02	6.92	632.23

Allocation of Joint Costs as Annual Costs (mil LE/Yr for File: scen02x.
Part Two of Two

	NAV	PWR	TRN	TOU	FIS	FLD	TOTAL	
Stem	27.60	11.47	11.21	64.07	0.00	0.00	114.35	
HAD	2.05	17.30	0.13	17.30	1.97	27.51	66.26	
Totals	29.65	28.77	11.34	81.37	1.97	27.51	180.61	812.84

Allocation of Joint Costs as Percentages of the Total for File: scen02x.
Part One of Two

	---- AGRICULTURE ----			RURAL			NAV	
TOTAL				--- WATER SUPPLY ---				
	Region	Stem	HAD	Region	Stem	HAD	Region	
Old R01	7.806	0.910	0.246	0.015	0.005	0.000	0.000	8.982
Old R02	15.572	1.820	0.492	0.035	0.010	0.001	0.035	17.965
Old R03	16.010	1.888	0.510	0.027	0.008	0.001	0.191	18.634
Old R04	14.381	1.719	0.464	0.028	0.008	0.001	0.361	16.961
Old R05	12.987	1.544	0.417	0.020	0.006	0.000	0.264	15.239
Totals	66.756	7.882	2.128	0.124	0.037	0.003	0.851	77.781

Allocation of Joint Costs as Percentages of the Total for File: scen02x.
Part Two of Two

	NAV	PWR	TRN	TOU	FIS	FLD	TOTAL	
Stem	3.396	1.411	1.379	7.882	0.000	0.000	14.067	
HAD	0.252	2.128	0.016	2.128	0.243	3.384	8.152	
Totals	3.648	3.539	1.395	10.010	0.243	3.384	22.219	100.000

Allocation of Costs by Major Categories for File: scen02x.
Present Value (P.V.) and Annual Cost (A.C.).

CATEGORY	---------JOINT COST---------			---TOTAL COST---	
	P.V. m LE	A.C. m LE/YR	%	P.V. m LE	A.C. m LE/YR
Existing Ag	5026.3	623.98	76.77	5803.0	720.41
New New Land	0.0	0.00	0.00		
Water Supply	10.7	1.33	0.16		
Navigation	294.6	36.57	4.50		
Power	231.7	28.77	3.54		
Transport	91.4	11.34	1.40		
Tourism	655.4	81.37	10.01		
Fishery	15.9	1.97	0.24		
Flood Cntrl	221.6	27.51	3.38		
TOTALS	6547.6	812.84	100.00	5803.0	720.41

Allocation of Annual Costs (A.C.) by Hierarchy for File: scen02x.
Annual Costs Allocated to Existing Agriculture

	Area mil FD	Water mil M3	Annual Cost	A.C./FD LE/FD	A.C./1000M3 LE/1000M3
JOINT COSTS					
HAD	6.599	46569.9	17.300	2.622	0.371
Stem	6.599	46569.9	64.066	9.708	1.376
Upper Egypt	0.762	6340.0	63.450	83.268	10.008
Middle Egypt	1.524	11263.0	126.575	83.055	11.238
East Delta	1.581	10154.0	130.134	82.311	12.816
Middle Delta	1.439	10609.0	116.893	81.232	11.018
West Delta	1.293	8204.0	105.567	81.645	12.868
DRAIN COSTS	6.599	46569.9	96.422	14.612	2.070
TOTAL COSTS					
Upper Egypt	0.762	6340.0	83.979	110.209	13.246
Middle Egypt	1.524	11263.0	167.634	109.996	14.884
East Delta	1.581	10154.0	172.729	109.253	17.011
Middle Delta	1.439	10609.0	155.662	108.174	14.673
West Delta	1.293	8204.0	140.402	108.586	17.114
FLAT RATE				109.169	15.469

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Cost Allocation for Region #01 UpperEgypt, pump costs.
Cost to be allocated = 210.6

	AGRIC	R.W.S.	Totals
(1) Project benefits	4196.8	0.7	4197.5
(2) Alternative Costs	210.6	483.3	693.9
(3) Justifiable Costs	210.6	0.7	211.3
(10) Joint Cost Propor	0.9966	0.0034	1.0000
(11) Allocated Joint Cost	209.9	0.7	210.6
(12) Total Service Cost	209.9	0.7	210.6
(13) Percentages	99.66	0.34	1.0000

Cost Allocation for Region #01 UpperEgypt, non-navigable canal.
Cost to be allocated = 301.5

	AGRIC	R.W.S.	Totals
(1) Project benefits	4196.8	0.7	4197.5
(2) Alternative Costs	811.7	483.3	1295.0
(3) Justifiable Costs	811.7	0.7	812.4
(10) Joint Cost Propor	0.9991	0.0009	1.0000
(11) Allocated Joint Cost	301.2	0.3	301.5
(12) Total Service Cost	301.2	0.3	301.5
(13) Percentages	99.91	0.09	1.0000

Cost Allocation for Region #02 Middle, pump costs.
Cost to be allocated = 421.2

	AGRIC	R.W.S.	Totals
(1) Project benefits	15981.5	1.5	15983.0
(2) Alternative Costs	421.2	725.0	1146.2
(3) Justifiable Costs	421.2	1.5	422.7
(10) Joint Cost Propor	0.9964	0.0036	1.0000
(11) Allocated Joint Cost	419.7	1.5	421.2
(12) Total Service Cost	419.7	1.5	421.2
(13) Percentages	99.64	0.36	1.0000

Cost Allocation for Region #02 Middle, non-navigable canal.
Cost to be allocated = 598.3

	AGRIC	R.W.S.	Totals
(1) Project benefits	15858.4	1.5	15859.9
(2) Alternative Costs	1207.9	719.4	1927.3
(3) Justifiable Costs	1207.9	1.5	1209.4
(10) Joint Cost Propor	0.9988	0.0012	1.0000
(11) Allocated Joint Cost	597.6	0.7	598.3
(12) Total Service Cost	597.6	0.7	598.3
(13) Percentages	99.88	0.12	1.0000

Cost Allocation for Region #02 Middle, navigable canal costs.
Cost to be allocated = 4.6

	AGRIC	R.W.S.	NAVIG	Totals
(1) Project benefits	123.1	0.0	11.4	134.5
(2) Alternative Costs	9.4	5.6	9.4	24.3
(3) Justifiable Costs	9.4	0.0	9.4	18.8
(10) Joint Cost Propor	0.4997	0.0006	0.4997	1.0000
(11) Allocated Joint Cost	2.3	0.0	2.3	4.6
(12) Total Service Cost	2.3	0.0	2.3	4.6
(13) Percentages	49.97	0.06	49.97	1.0000

Cost Allocation for Region #03 EastDelta, pump costs.
Cost to be allocated = 437.0

	AGRIC	R.W.S.	Totals
(1) Project benefits	14579.9	1.2	14581.0
(2) Alternative Costs	437.0	1611.0	2048.0
(3) Justifiable Costs	437.0	1.2	438.1
(10) Joint Cost Propor	0.9973	0.0027	1.0000
(11) Allocated Joint Cost	435.8	1.2	437.0
(12) Total Service Cost	435.8	1.2	437.0
(13) Percentages	99.73	0.27	1.0000

Cost Allocation for Region #03 EastDelta, non-navigable canal.
Cost to be allocated = 600.5

	AGRIC	R.W.S.	Totals
(1) Project benefits	13996.7	1.1	13997.8
(2) Alternative Costs	1175.6	1546.6	2722.2
(3) Justifiable Costs	1175.6	1.1	1176.7
(10) Joint Cost Propor	0.9991	0.0009	1.0000
(11) Allocated Joint Cost	600.0	0.6	600.5
(12) Total Service Cost	600.0	0.6	600.5
(13) Percentages	99.91	0.09	1.0000

Cost Allocation for Region #03 EastDelta, navigable canal costs.
Cost to be allocated = 25.0

	AGRIC	R.W.S.	NAVIG	Totals
(1) Project benefits	583.2	0.0	58.3	641.6
(2) Alternative Costs	49.0	64.4	49.0	162.4
(3) Justifiable Costs	49.0	0.0	49.0	98.0
(10) Joint Cost Propor	0.4998	0.0005	0.4998	1.0000
(11) Allocated Joint Cost	12.5	0.0	12.5	25.0
(12) Total Service Cost	12.5	0.0	12.5	25.0
(13) Percentages	49.98	0.05	49.98	1.0000

Cost Allocation for Region #04 MiddleDelta, pump costs.
Cost to be allocated = 397.7

	AGRIC	R.W.S.	Totals
(1) Project benefits	9666.2	1.2	9667.4
(2) Alternative Costs	397.7	805.5	1203.2
(3) Justifiable Costs	397.7	1.2	398.9
(10) Joint Cost Propor	0.9970	0.0030	1.0000
(11) Allocated Joint Cost	396.5	1.2	397.7
(12) Total Service Cost	396.5	1.2	397.7
(13) Percentages	99.70	0.30	1.0000

Cost Allocation for Region #04 MiddleDelta, non-navigable canal.
Cost to be allocated = 522.1

	AGRIC	R.W.S.	Totals
(1) Project benefits	8863.9	1.1	8865.0
(2) Alternative Costs	938.8	738.7	1677.5
(3) Justifiable Costs	938.8	1.1	940.0
(10) Joint Cost Propor	0.9988	0.0012	1.0000
(11) Allocated Joint Cost	521.5	0.6	522.1
(12) Total Service Cost	521.5	0.6	522.1
(13) Percentages	99.88	0.12	1.0000

Cost Allocation for Region #04 MiddleDelta, navigable canal costs.
Cost to be allocated = 47.3

	AGRIC	R.W.S.	NAVIG	Totals
(1) Project benefits	802.3	0.1	91.7	894.1
(2) Alternative Costs	85.0	66.9	85.0	236.8
(3) Justifiable Costs	85.0	0.1	85.0	170.1
(10) Joint Cost Propor	0.4997	0.0006	0.4997	1.0000
(11) Allocated Joint Cost	23.6	0.0	23.6	47.3
(12) Total Service Cost	23.6	0.0	23.6	47.3
(13) Percentages	49.97	0.06	49.97	1.0000

Cost Allocation for Region #05 WestDelta, pump costs.
Cost to be allocated = 357.4

	AGRIC	R.W.S.	Totals
(1) Project benefits	5388.9	0.8	5389.7
(2) Alternative Costs	357.4	805.5	1162.9
(3) Justifiable Costs	357.4	0.8	358.1
(10) Joint Cost Propor	0.9978	0.0022	1.0000
(11) Allocated Joint Cost	356.6	0.8	357.4
(12) Total Service Cost	356.6	0.8	357.4
(13) Percentages	99.78	0.22	1.0000

2

Cost Allocation for Region #05 WestDelta, non-navigable canal.
Cost to be allocated = 474.3

	AGRIC	R.W.S.	Totals
(1) Project benefits	4995.5	0.7	4996.3
(2) Alternative Costs	733.8	746.7	1480.5
(3) Justifiable Costs	733.8	0.7	734.5
(10) Joint Cost Propor	0.9990	0.0010	1.0000
(11) Allocated Joint Cost	473.8	0.5	474.3
(12) Total Service Cost	473.8	0.5	474.3
(13) Percentages	99.90	0.10	1.0000

Cost Allocation for Region #05 WestDelta, navigable canal costs.
Cost to be allocated = 37.3

	AGRIC	R.W.S.	NAVIG	Totals
(1) Project benefits	393.4	0.1	49.9	443.4
(2) Alternative Costs	57.8	58.8	57.8	174.4
(3) Justifiable Costs	57.8	0.1	49.9	107.8
(10) Joint Cost Propor	0.5361	0.0005	0.4633	1.0000
(11) Allocated Joint Cost	20.0	0.0	17.3	37.3
(12) Total Service Cost	20.0	0.0	17.3	37.3
(13) Percentages	53.61	0.05	46.33	1.0000

Cost Allocation for Main Stem Barrages Excluding Esna.
Cost to be allocated = 1116.9

	OLD AG	R.W.S.	NAVIG	NEW AG	POWER	TRANS	RECR&T	Totals
(1) Project benefits	49813.3	5.4	501.4	0.0	0.0	203.6	7410.8	57934.4
(2) Alternative Costs	1116.9	1116.9	1116.9	1116.9	0.0	204.3	1116.9	5788.7
(3) Justifiable Costs	1116.9	5.4	501.4	0.0	0.0	203.6	1116.9	2944.1
(10) Joint Cost Propor	0.3794	0.0018	0.1703	0.0000	0.0000	0.0692	0.3794	1.0000
(11) Allocated Joint Cost	423.7	2.1	190.2	0.0	0.0	77.2	423.7	1116.9
(12) Total Service Cost	423.7	2.1	190.2	0.0	0.0	77.2	423.7	1116.9
(13) Percentages	37.94	0.18	17.03	0.00	0.00	6.92	37.94	1.0000

Cost Allocation for Main Stem Esna Barrage.
Cost to be allocated = 322.7

	OLD AG	R.W.S.	NAVIG	NEW AG	POWER	TRANS	RECR&T	Totals
(1) Project benefits	11165.5	1.2	112.4	0.0	2416.6	45.6	1661.1	15402.4
(2) Alternative Costs	322.7	322.7	322.7	322.7	322.7	45.8	322.7	1981.8
(3) Justifiable Costs	322.7	1.2	112.4	0.0	322.7	45.6	322.7	1127.2
(10) Joint Cost Propor	0.2862	0.0011	0.0997	0.0000	0.2862	0.0405	0.2862	1.0000
(11) Allocated Joint Cost	92.4	0.3	32.2	0.0	92.4	13.1	92.4	322.7
(12) Total Service Cost	92.4	0.3	32.2	0.0	92.4	13.1	92.4	322.7
(13) Percentages	28.62	0.11	9.97	0.00	28.62	4.05	28.62	1.0000

Cost Allocation for High Aswan Dam.
Cost to be allocated = 673.3

	OLD AG	R.W.S.	NAVIG	NEW AG	POWER	G.TRAN	RECR&T	FISH	FLOOD	Totals
(1) Project benefits	49813.3	5.4	501.4	0.0	45310.4	32.5	7410.8	483.3	2254.6	105811.6
(2) Alternative Costs	4238.0	1187.0	4238.0	4238.0	4238.0	32.5	4238.0	4238.0	2518.9	29166.2
(3) Justifiable Costs	4238.0	5.4	501.4	0.0	4238.0	32.5	4238.0	483.3	2254.6	15991.0
(4) Separable Costs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	170.4	170.4
(5) Cost Other Purposes	673.3	673.3	673.3	673.3	673.3	673.3	673.3	673.3	502.9	5889.3
(6) Just Cost Other Purp	673.3	673.3	673.3	673.3	673.3	673.3	673.3	673.3	502.9	5889.3
(7) Adjustment Factor	7.2943	1.0080	1.7446	1.0000	7.2943	1.0483	7.2943	1.7178	4.0954	
(8) Adj Separable Costs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	697.9	
(9) Remaining Benefits	4238.0	5.4	501.4	0.0	4238.0	32.5	4238.0	483.3	1556.6	15293.1
(10) Joint Cost Propor	0.2771	0.0004	0.0328	0.0000	0.2771	0.0021	0.2771	0.0316	0.1018	1.0000
(11) Allocated Joint Cost	139.4	0.2	16.5	0.0	139.4	1.1	139.4	15.9	51.2	502.9
(12) Total Service Cost	139.4	0.2	16.5	0.0	139.4	1.1	139.4	15.9	221.6	673.3
(13) Percentages	20.70	0.03	2.45	0.00	20.70	0.16	20.70	2.36	32.91	1.0000

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File name: scen02x.ECH
TABLE 1. THE HIGH ASWAN DAM (IMPHAD.WB1).
Costs and Benefits for Improved O&M.

BASIN DISCOUNT RATE (%):	12.0		
BASIN PLANNING HORIZON (YRS):	30		
NUMBER OF OLD REGIONS:	5		
NUMBER OF NEW REGIONS:	0		
ANNUAL COST FOR DRAINAGE (mil LE/Yr	96.422	776.70	96.422
HAD BENEFITS			
FLOOD CONTROL (% of total benefit	4.0		
SINGLE PURPOSE ALTERNATIVES			
AG, NAV, POWER, FISH (% of OM&R):	74.700		
FLOOD CONTROL (% of OM&R):	44.400		
SEPARABLE COSTS			
AGRICULTURE (% of O&M):	0.00		
POWER (% of O&M):	0.00		
FLOOD (% of O&M):	25.31		

YEAR	------ HAD BENEFITS -----			-SINGLE PURPOSE ALTERN-			ANNUAL
	HYDRO POWER	GROUND TRANSP	FISHERY	WATER SUPPLY	GROUND TRANSP	COMMON WORKS REPLACE	COMMON WORKS O&M
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
p. val	45310.42	32.54	483.31	1187.01	32.54	5000.00	673.30

Present value SPA Other	4238.0
Present value SPA Flood	2518.9
Pres. val. separable Agri.	0.0
Pres. val. separable Power	0.0
Pres. val. separable Flood	170.[illegible]

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File name: scen02x.STM
TABLE 2: MAIN STEM OF THE NILE (IMPSTM.WB1)
Costs and Benefits for Improved O&M

YEAR				BEN	SINGLE	STEM	ESNA
	NAVIG	HYDRO POWER ESNA	GROUND TRANSP	RECREA & TOURISM	PURPOSE ALTERN COST TRANSP	COSTS EXCEPT HAD & ESNA	COMMON WORKS COSTS
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
p. val	289.99	2416.56	203.59	7410.77	204.31	1116.87	322.67

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File name: scen02x.R01
TABLE 3. INPUT FOR OLD REGION (IMPRxx.WB1)
Costs and Benefits for Improved O&M.

REGION NAME:	UpperEgypt		
REGION NUMBER:	1		
AGRICULTURAL AREA (mil FED):	0.762		
WATER CONSUMPTION (M3/FD):	8320.200,	=	6340.0 (mil M3).
POPULATION (millions):	5.520		
WETTED PERIMETER OF CANALS (meters)	61.7		
PERCENT OF CANALS NAVIGABLE (%):	0.0		

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
p. val	4196.75	0.73	0.00	510.18	483.31	301.49	210.60

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File name: scen02x.R02
TABLE 3. INPUT FOR OLD REGION (IMPRxx.WB1).
Costs and Benefits for Improved O&M.

REGION NAME:	Middle		
REGION NUMBER:	2		
AGRICULTURAL AREA (mil FED):	1.524		
WATER CONSUMPTION (M3/FD):	7390.400,	=	11263.0 (mil M3).
POPULATION (millions):	11.590		
WETTED PERIMETER OF CANALS (meters)	71.8		
PERCENT OF CANALS NAVIGABLE (%):	0.8		

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
p. val	15981.49	1.52	11.44	614.29	724.97	602.99	421.18

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File name: scen02x.R03
TABLE 3. INPUT FOR OLD REGION (IMPRxx.WB1)
Costs and Benefits for Improved O&M.

REGION NAME: EastDelta
REGION NUMBER: 3

AGRICULTURAL AREA (mil FED): 1.581
WATER CONSUMPTION (M3/FD): 6422.500, = 10154.0 (mil M3).
POPULATION (millions): 8.570
WETTED PERIMETER OF CANALS (meters) 72.5
PERCENT OF CANALS NAVIGABLE (%): 4.0

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
p. val	14579.88	1.16	58.32	599.02	1611.04	625.54	436.96

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File name: scen02x.R04
TABLE 3. INPUT FOR OLD REGION (IMPRxx.WB1).
Costs and Benefits for Improved O&M

REGION NAME: MiddleDelta
REGION NUMBER: 4

AGRICULTURAL AREA (mil FED): 1.439
WATER CONSUMPTION (M3/FD): 7372.500, = 10609.0 (mil M3).
POPULATION (millions): 9.050
WETTED PERIMETER OF CANALS (meters) 55.1
PERCENT OF CANALS NAVIGABLE (%): 8.3

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
p. val	9666.22	1.21	91.67	454.46	805.52	569.36	397.69

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File name: scen02x.R05
TABLE 3. INPUT FOR OLD REGION (IMPRxx.WB1).
Costs and Benefits for Improved O&M.

REGION NAME: WestDelta
REGION NUMBER: 5

AGRICULTURAL AREA (mil FED): 1.293
WATER CONSUMPTION (M3/FD): 6344.900, = 8204.0 (mil M3).
POPULATION (millions): 6.180
WETTED PERIMETER OF CANALS (meters) 37.0
PERCENT OF CANALS NAVIGABLE (%): 7.3

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
p. val	5388.92	0.80	49.94	279.98	805.52	511.60	357.35

TABLE 1. THE HIGH ASWAN DAM (IMPHAD.WB1).
Costs and Benefits for Improved O&M.

BASIN DISCOUNT RATE (%):	12	
BASIN PLANNING HORIZON (YRS):	30	
NUMBER OF OLD REGIONS:	5	
NUMBER OF NEW REGIONS:	0	
ANNUAL COST FOR DRAINAGE (mil LE/Yr @ %):	96.422	12

HAD BENEFITS

FLOOD CONTROL (% of total benefits):	4

SINGLE PURPOSE ALTERNATIVES

AG, NAV, POWER, FISH (% of OM&R):	74.7
FLOOD CONTROL (% of OM&R):	44.4

SEPARABLE COSTS

AGRICULTURE (% of O&M):	0
POWER (% of O&M):	0
FLOOD (% of O&M):	25.31

YEAR	------ HAD BENEFITS -----			-SINGLE PURPOSE ALTERN-			ANNUAL
	HYDRO POWER	GROUND TRANSP	FISHERY	WATER SUPPLY	GROUND TRANSP	COMMON WORKS REPLACE	COMMON WORKS O&M
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
1	5625	35	60	1165	35	5600	78.45
2	5625	0.18	60	20.5	0.18	0	75.59
3	5625	0.18	60	20.5	0.18	0	89.73
4	5625	0.18	60	20.5	0.18	0	84.90
5	5625	0.18	60	20.5	0.18	0	80.19
6	5625	0.18	60	20.5	0.18	0	65.09
7	5625	0.18	60	20.5	0.18	0	67.68
8	5625	0.18	60	20.5	0.18	0	73.99
9	5625	0.18	60	20.5	0.18	0	78.54
10	5625	0.18	60	20.5	0.18	0	82.35
11	5625	0.18	60	20.5	0.18	0	88.46
12	5625	0.18	60	20.5	0.18	0	87.32
13	5625	0.18	60	20.5	0.18	0	87.76
14	5625	0.18	60	20.5	0.18	0	88.10
15	5625	0.18	60	20.5	0.18	0	88.85
16	5625	0.18	60	20.5	0.18	0	105.27
17	5625	0.18	60	20.5	0.18	0	104.30
18	5625	0.18	60	20.5	0.18	0	106.52
19	5625	0.18	60	20.5	0.18	0	105.55
20	5625	0.18	60	20.5	0.18	0	104.47
21	5625	0.18	60	20.5	0.18	0	102.86
22	5625	0.18	60	20.5	0.18	0	101.87
23	5625	0.18	60	20.5	0.18	0	101.69
24	5625	0.18	60	20.5	0.18	0	102.07
25	5625	0.18	60	20.5	0.18	0	100.55
26	5625	0.18	60	20.5	0.18	0	104.38
27	5625	0.18	60	20.5	0.18	0	101.99
28	5625	0.18	60	20.5	0.18	0	101.94
29	5625	0.18	60	20.5	0.18	0	102.59
30	5625	0.18	60	20.5	0.18	0	101.63

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TABLE 2: MAIN STEM OF THE NILE (IMPSTM.WB1)
Costs and Benefits for Improved O&M

YEAR	NAVIG (m LE)	HYDRO POWER ESNA (m LE)	GROUND TRANSP (m LE)	BEN RECREA & TOURISM (m LE)	SINGLE PURPOSE ALTERN COST TRANSP (m LE)	STEM COSTS EXCEPT HAD & ESNA (m LE)	ESNA COMMON WORKS COSTS (m LE)
1	36	300	220	920	220	114.35	147.98
2	36	300	1	920	1.1	134.83	156.01
3	36	300	1	920	1.1	159.86	14.08
4	36	300	1	920	1.1	146.75	38.30
5	36	300	1	920	1.1	114.34	17.53
6	36	300	1	920	1.1	83.80	1.71
7	36	300	1	920	1.1	115.97	2.35
8	36	300	1	920	1.1	132.14	3.75
9	36	300	1	920	1.1	201.33	4.12
10	36	300	1	920	1.1	237.80	3.99
11	36	300	1	920	1.1	211.76	4.09
12	36	300	1	920	1.1	214.37	4.14
13	36	300	1	920	1.1	188.31	4.15
14	36	300	1	920	1.1	145.47	4.17
15	36	300	1	920	1.1	106.91	4.77
16	36	300	1	920	1.1	103.94	4.57
17	36	300	1	920	1.1	101.71	4.17
18	36	300	1	920	1.1	98.91	4.17
19	36	300	1	920	1.1	97.02	4.17
20	36	300	1	920	1.1	96.36	4.17
21	36	300	1	920	1.1	107.20	4.17
22	36	300	1	920	1.1	109.22	4.77
23	36	300	1	920	1.1	106.46	4.57
24	36	300	1	920	1.1	102.61	4.17
25	36	300	1	920	1.1	99.59	4.17
26	36	300	1	920	1.1	114.17	44.77
27	36	300	1	920	1.1	115.58	52.17
28	36	300	1	920	1.1	120.84	8.77
29	36	300	1	920	1.1	114.29	20.57
30	36	300	1	920	1.1	104.86	10.61

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TABLE 3. INPUT FOR OLD REGION (IMPRxx.WB1)
Costs and Benefits for Improved O&M.

REGION NAME:	UpperEgypt
REGION NUMBER:	1
AGRICULTURAL AREA (mil FED):	0.762
WATER CONSUMPTION (M3/FD):	8320.2
POPULATION (millions):	5.52
WETTED PERIMETER OF CANALS (meters):	61.7
PERCENT OF CANALS NAVIGABLE (%):	0

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES			COSTS
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
1	521	0.58	0	571.4	60	28.04	20.10
2	521	0.029	0	0	60	29.20	27.70
3	521	0.029	0	0	60	29.71	34.15
4	521	0.029	0	0	60	32.38	29.04
5	521	0.029	0	0	60	33.91	20.31
6	521	0.029	0	0	60	42.40	18.68
7	521	0.029	0	0	60	42.66	26.28
8	521	0.029	0	0	60	41.83	32.76
9	521	0.029	0	0	60	40.57	27.68
10	521	0.029	0	0	60	40.44	18.98
11	521	0.029	0	0	60	45.74	17.33
12	521	0.029	0	0	60	45.22	24.89
13	521	0.029	0	0	60	44.06	31.34
14	521	0.029	0	0	60	41.76	26.27
15	521	0.029	0	0	60	41.32	17.58
16	521	0.029	0	0	60	46.20	20.04
17	521	0.029	0	0	60	46.22	33.65
18	521	0.029	0	0	60	44.80	45.20
19	521	0.029	0	0	60	42.96	36.03
20	521	0.029	0	0	60	42.62	20.40
21	521	0.029	0	0	60	46.07	20.04
22	521	0.029	0	0	60	46.28	33.67
23	521	0.029	0	0	60	45.08	45.25
24	521	0.029	0	0	60	43.21	36.12
25	521	0.029	0	0	60	42.93	20.46
26	521	0.029	0	0	60	46.86	20.06
27	521	0.029	0	0	60	46.84	33.67
28	521	0.029	0	0	60	45.62	45.25
29	521	0.029	0	0	60	43.77	36.14
30	521	0.029	0	0	60	43.47	20.52

TABLE 3. INPUT FOR OLD REGION (IMPRxx.WB1).
Costs and Benefits for Improved O&M.

REGION NAME: Middle Egypt
REGION NUMBER: 2

AGRICULTURAL AREA (mil FED): 1.524
WATER CONSUMPTION (M3/FD): 7390.4
POPULATION (millions): 11.59
WETTED PERIMETER OF CANALS (meters): 71.8
PERCENT OF CANALS NAVIGABLE (%): 0.77

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
1	1984	1.22	1.42	688	90	56.08	40.20
2	1984	0.06	1.42	0	90	58.40	55.39
3	1984	0.06	1.42	0	90	59.43	68.30
4	1984	0.06	1.42	0	90	64.75	58.08
5	1984	0.06	1.42	0	90	67.82	40.61
6	1984	0.06	1.42	0	90	84.80	37.37
7	1984	0.06	1.42	0	90	85.33	52.56
8	1984	0.06	1.42	0	90	83.66	65.52
9	1984	0.06	1.42	0	90	81.14	55.37
10	1984	0.06	1.42	0	90	80.87	37.95
11	1984	0.06	1.42	0	90	91.48	34.66
12	1984	0.06	1.42	0	90	90.43	49.77
13	1984	0.06	1.42	0	90	88.13	62.68
14	1984	0.06	1.42	0	90	83.52	52.53
15	1984	0.06	1.42	0	90	82.64	35.16
16	1984	0.06	1.42	0	90	92.39	40.08
17	1984	0.06	1.42	0	90	92.44	67.29
18	1984	0.06	1.42	0	90	89.60	90.39
19	1984	0.06	1.42	0	90	85.91	72.06
20	1984	0.06	1.42	0	90	85.25	40.79
21	1984	0.06	1.42	0	90	92.14	40.08
22	1984	0.06	1.42	0	90	92.57	67.34
23	1984	0.06	1.42	0	90	90.15	90.51
24	1984	0.06	1.42	0	90	86.42	72.23
25	1984	0.06	1.42	0	90	85.86	40.92
26	1984	0.06	1.42	0	90	93.72	40.12
27	1984	0.06	1.42	0	90	93.68	67.34
28	1984	0.06	1.42	0	90	91.25	90.51
29	1984	0.06	1.42	0	90	87.54	72.28
30	1984	0.06	1.42	0	90	86.95	41.03

TABLE 3. INPUT FOR OLD REGION (IMPRxx.WB1)
Costs and Benefits for Improved O&M.

REGION NAME: EastDelta
REGION NUMBER: 3

AGRICULTURAL AREA (mil FED): 1.581
WATER CONSUMPTION (M3/FD): 6422.5
POPULATION (millions): 8.57
WETTED PERIMETER OF CANALS (meters): 72.5
PERCENT OF CANALS NAVIGABLE (%): 4

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
1	1810	0.9	7.24	670.9	200	58.18	41.71
2	1810	0.05	7.24	0	200	60.58	57.46
3	1810	0.05	7.24	0	200	61.65	70.86
4	1810	0.05	7.24	0	200	67.17	60.26
5	1810	0.05	7.24	0	200	70.36	42.13
6	1810	0.05	7.24	0	200	87.97	38.77
7	1810	0.05	7.24	0	200	88.52	54.53
8	1810	0.05	7.24	0	200	86.79	67.97
9	1810	0.05	7.24	0	200	84.17	57.44
10	1810	0.05	7.24	0	200	83.90	39.37
11	1810	0.05	7.24	0	200	94.90	35.96
12	1810	0.05	7.24	0	200	93.82	51.63
13	1810	0.05	7.24	0	200	91.43	65.03
14	1810	0.05	7.24	0	200	86.64	54.50
15	1810	0.05	7.24	0	200	85.74	36.48
16	1810	0.05	7.24	0	200	95.85	41.57
17	1810	0.05	7.24	0	200	95.90	69.81
18	1810	0.05	7.24	0	200	92.95	93.78
19	1810	0.05	7.24	0	200	89.13	74.76
20	1810	0.05	7.24	0	200	88.44	42.32
21	1810	0.05	7.24	0	200	95.59	41.57
22	1810	0.05	7.24	0	200	96.03	69.86
23	1810	0.05	7.24	0	200	93.53	93.89
24	1810	0.05	7.24	0	200	89.65	74.93
25	1810	0.05	7.24	0	200	89.07	42.45
26	1810	0.05	7.24	0	200	97.22	41.62
27	1810	0.05	7.24	0	200	97.18	69.86
28	1810	0.05	7.24	0	200	94.66	93.89
29	1810	0.05	7.24	0	200	90.81	74.98
30	1810	0.05	7.24	0	200	90.20	42.57

TABLE 3. INPUT FOR OLD REGION (IMPRxx.WB1).
Costs and Benefits for Improved O&M

REGION NAME: MiddleDelta
REGION NUMBER: 4

AGRICULTURAL AREA (mil FED): 1.439
WATER CONSUMPTION (M3/FD): 7372.5
POPULATION (millions): 9.05
WETTED PERIMETER OF CANALS (meters): 55.1
PERCENT OF CANALS NAVIGABLE (%): 8.3

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
1	1200	0.95	11.38	509	100	52.96	37.96
2	1200	0.05	11.38	0	100	55.14	52.30
3	1200	0.05	11.38	0	100	56.11	64.49
4	1200	0.05	11.38	0	100	61.14	54.84
5	1200	0.05	11.38	0	100	64.04	38.35
6	1200	0.05	11.38	0	100	80.07	35.28
7	1200	0.05	11.38	0	100	80.57	49.63
8	1200	0.05	11.38	0	100	78.99	61.86
9	1200	0.05	11.38	0	100	76.61	52.28
10	1200	0.05	11.38	0	100	76.36	35.84
11	1200	0.05	11.38	0	100	86.38	32.73
12	1200	0.05	11.38	0	100	85.39	47.00
13	1200	0.05	11.38	0	100	83.21	59.19
14	1200	0.05	11.38	0	100	78.86	49.60
15	1200	0.05	11.38	0	100	78.04	33.20
16	1200	0.05	11.38	0	100	87.24	37.84
17	1200	0.05	11.38	0	100	87.28	63.54
18	1200	0.05	11.38	0	100	84.61	85.35
19	1200	0.05	11.38	0	100	81.12	68.04
20	1200	0.05	11.38	0	100	80.50	38.52
21	1200	0.05	11.38	0	100	87.00	37.84
22	1200	0.05	11.38	0	100	87.41	63.58
23	1200	0.05	11.38	0	100	85.13	85.46
24	1200	0.05	11.38	0	100	81.60	68.20
25	1200	0.05	11.38	0	100	81.07	38.63
26	1200	0.05	11.38	0	100	88.49	37.88
27	1200	0.05	11.38	0	100	88.45	63.58
28	1200	0.05	11.38	0	100	86.16	85.46
29	1200	0.05	11.38	0	100	82.66	68.25
30	1200	0.05	11.38	0	100	82.10	38.74

TABLE 3. INPUT FOR OLD REGION (IMPRxx.WB1).
Costs and Benefits for Improved O&M.

REGION NAME:	WestDelta
REGION NUMBER:	5
AGRICULTURAL AREA (mil FED):	1.293
WATER CONSUMPTION (M3/FD):	6344.9
POPULATION (millions):	6.18
WETTED PERIMETER OF CANALS (meters):	37
PERCENT OF CANALS NAVIGABLE (%):	7.3

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
1	669	0.65	6.2	313.58	100	47.58	34.11
2	669	0.03	6.2	0	100	49.55	47.00
3	669	0.03	6.2	0	100	50.42	57.95
4	669	0.03	6.2	0	100	54.94	49.28
5	669	0.03	6.2	0	100	57.54	34.46
6	669	0.03	6.2	0	100	71.95	31.70
7	669	0.03	6.2	0	100	72.40	44.59
8	669	0.03	6.2	0	100	70.98	55.59
9	669	0.03	6.2	0	100	68.84	46.97
10	669	0.03	6.2	0	100	68.61	32.20
11	669	0.03	6.2	0	100	77.62	29.41
12	669	0.03	6.2	0	100	76.73	42.23
13	669	0.03	6.2	0	100	74.77	53.18
14	669	0.03	6.2	0	100	70.86	44.57
15	669	0.03	6.2	0	100	70.12	29.83
16	669	0.03	6.2	0	100	78.39	34.00
17	669	0.03	6.2	0	100	78.43	57.09
18	669	0.03	6.2	0	100	76.02	76.69
19	669	0.03	6.2	0	100	72.89	61.14
20	669	0.03	6.2	0	100	72.33	34.61
21	669	0.03	6.2	0	100	78.18	34.00
22	669	0.03	6.2	0	100	78.54	57.13
23	669	0.03	6.2	0	100	76.49	76.79
24	669	0.03	6.2	0	100	73.32	61.28
25	669	0.03	6.2	0	100	72.84	34.71
26	669	0.03	6.2	0	100	79.51	34.04
27	669	0.03	6.2	0	100	79.48	57.13
28	669	0.03	6.2	0	100	77.42	76.79
29	669	0.03	6.2	0	100	74.27	61.32
30	669	0.03	6.2	0	100	73.77	34.81

APPENDIX C
INPUT / OUPUT FILES FOR SCENARIO 3

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Allocation of Joint Costs as Present Values (mil LE) for File: scen03x.
Part One of Two

	---- AGRICULTURE ----			RURAL --- WATER SUPPLY ---			NAV	TOTAL
	Region	Stem	HAD	Region	Stem	HAD	Region	
Old R01	440.2	22.2	7.3	1.0	0.2	0.0	0.0	470.8
Old R02	896.7	44.4	14.5	2.3	0.4	0.0	2.3	960.5
Old R03	780.6	46.0	15.0	1.6	0.3	0.0	8.8	852.4
Old R04	671.3	41.9	13.7	1.7	0.3	0.0	15.3	744.2
Old R05	539.1	37.6	12.3	1.2	0.2	0.0	10.4	600.8
New N01	0.0	24.6	8.0					32.6
New N02	27.7	23.2	7.6					58.5
New N03	0.0	77.1	25.2					102.2
New N04	0.0	7.4	2.4					9.9
New N05	22.5	33.2	10.9					66.6
New N06	0.0	26.7	8.7					35.4
Totals	3378.1	384.3	125.6	7.8	1.4	0.1	36.7	3933.9

Allocation of Joint Costs as Present Values (mil LE) for File: scen03x.
Part Two of Two

	NAV	PWR	TRN	TOU	FIS	FLD	TOTAL	
Stem	127.3	0.0	51.7	192.1	0.0	0.0	371.1	
HAD	7.8	62.8	0.5	62.8	7.5	122.6	264.1	
Totals	135.1	62.8	52.2	254.9	7.5	122.6	635.2	4569.1

Allocation of Joint Costs as Annual Costs (mil LE/YR) for File: scen03x.
Part One of Two

	---- AGRICULTURE ----			RURAL --- WATER SUPPLY ---			NAV	TOTAL
	Region	Stem	HAD	Region	Stem	HAD	Region	
Old R01	54.64	2.75	0.90	0.12	0.02	0.00	0.00	58.44
Old R02	111.32	5.51	1.80	0.28	0.05	0.00	0.28	119.24
Old R03	96.91	5.71	1.87	0.20	0.04	0.00	1.09	105.82
Old R04	83.34	5.20	1.70	0.21	0.04	0.00	1.89	92.39
Old R05	66.92	4.67	1.53	0.15	0.03	0.00	1.29	74.59
New N01	0.00	3.05	1.00					4.04
New N02	3.44	2.88	0.94					7.26
New N03	0.00	9.57	3.13					12.69
New N04	0.00	0.92	0.30					1.22
New N05	2.79	4.13	1.35					8.26
New N06	0.00	3.31	1.08					4.40
Totals	419.37	47.70	15.59	0.96	0.17	0.01	4.56	488.36

Allocation of Joint Costs as Annual Costs (mil LE/Yr for File: scen03x.
Part Two of Two

	NAV	PWR	TRN	TOU	FIS	FLD	TOTAL	
Stem	15.80	0.00	6.42	23.85	0.00	0.00	46.07	
HAD	0.97	7.80	0.06	7.80	0.94	15.23	32.79	
Totals	16.77	7.80	6.48	31.65	0.94	15.23	78.86	567.22

Allocation of Joint Costs as Percentages of the Total for File: scen03x.
Part One of Two

	---- AGRICULTURE ----			RURAL --- WATER SUPPLY ---			NAV	TOTAL
	Region	Stem	HAD	Region	Stem	HAD	Region	
Old R01	9.634	0.486	0.159	0.021	0.004	0.000	0.000	10.304
Old R02	19.626	0.971	0.317	0.049	0.009	0.001	0.050	21.022
Old R03	17.084	1.007	0.329	0.036	0.006	0.000	0.192	18.656
Old R04	14.693	0.917	0.300	0.038	0.007	0.000	0.334	16.288
Old R05	11.799	0.824	0.269	0.026	0.005	0.000	0.228	13.150
New N01	0.000	0.537	0.176					0.713
New N02	0.607	0.507	0.166					1.280
New N03	0.000	1.686	0.551					2.238
New N04	0.000	0.163	0.053					0.216
New N05	0.492	0.727	0.238					1.457
New N06	0.000	0.584	0.191					0.775
Totals	73.934	8.410	2.749	0.170	0.030	0.002	0.804	86.098

Allocation of Joint Costs as Percentages of the Total for File: scen03x.
Part Two of Two

	NAV	PWR	TRN	TOU	FIS	FLD	TOTAL	
Stem	2.786	0.000	1.131	4.205	0.000	0.000	8.122	
HAD	0.171	1.374	0.011	1.374	0.165	2.684	5.780	
Totals	2.957	1.374	1.142	5.579	0.165	2.684	13.902	100.000

Allocation of Costs by Major Categories for File: scen03x.
Present Value (P.V.) and Annual Cost (A.C.).

CATEGORY	--------JOINT COST--------			---TOTAL COST---	
	P.V. m LE	A.C. m LE/YR	%	P.V. m LE	A.C. m LE/YR
Existing Ag	3582.8	444.78	78.41	3865.4	479.87
New New Land	305.1	37.88	6.68		
Water Supply	9.2	1.14	0.20		
Navigation	171.8	21.33	3.76		
Power	62.8	7.80	1.37		
Transport	52.2	6.48	1.14		
Tourism	254.9	31.65	5.58		
Fishery	7.5	0.94	0.16		
Flood Cntrl	122.6	15.23	2.68		
TOTALS	4569.1	567.22	100.00	3865.4	479.87

Allocation of Annual Costs (A.C.) by Hierarchy for File: scen03x.
Annual Costs Allocated to Existing Agriculture

	Area mil FD	Water mil M3	Annual Cost	A.C./FD LE/FD	A.C./1000M3 LE/1000M3
JOINT COSTS					
HAD	6.599	46569.9	7.796	1.181	0.167
Stem	6.599	46569.9	23.851	3.614	0.512
Upper Egypt	0.762	6340.0	54.644	71.711	8.619
Middle Egypt	1.524	11263.0	111.321	73.045	9.884
East Delta	1.581	10154.0	96.906	61.294	9.544
Middle Delta	1.439	10609.0	83.340	57.915	7.856
West Delta	1.293	8204.0	66.924	51.759	8.158
DRAIN COSTS	6.599	46569.9	35.088	5.317	0.753
TOTAL COSTS					
Upper Egypt	0.762	6340.0	62.350	81.824	9.834
Middle Egypt	1.524	11263.0	126.733	83.158	11.252
East Delta	1.581	10154.0	112.894	71.407	11.118
Middle Delta	1.439	10609.0	97.893	68.028	9.227
West Delta	1.293	8204.0	80.000	61.872	9.751
FLAT RATE				72.719	10.304

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Cost Allocation for Region #01 UpperEgypt, pump costs.
Cost to be allocated = 169.5

	AGRIC	R.W.S.	Totals
(1) Project benefits	3214.0	0.7	3214.7
(2) Alternative Costs	169.5	483.3	652.8
(3) Justifiable Costs	169.5	0.7	170.3
(10) Joint Cost Propor	0.9957	0.0043	1.0000
(11) Allocated Joint Cost	168.8	0.7	169.5
(12) Total Service Cost	168.8	0.7	169.5
(13) Percentages	99.57	0.43	1.0000

Cost Allocation for Region #01 UpperEgypt, non-navigable canal.
Cost to be allocated = 271.6

	AGRIC	R.W.S.	Totals
(1) Project benefits	3214.0	0.7	3214.7
(2) Alternative Costs	781.8	483.3	1265.1
(3) Justifiable Costs	781.8	0.7	782.5
(10) Joint Cost Propor	0.9991	0.0009	1.0000
(11) Allocated Joint Cost	271.4	0.3	271.6
(12) Total Service Cost	271.4	0.3	271.6
(13) Percentages	99.91	0.09	1.0000

Cost Allocation for Region #02 Middle, pump costs.
Cost to be allocated = 339.2

	AGRIC	R.W.S.	Totals
(1) Project benefits	13339.4	1.5	13340.9
(2) Alternative Costs	339.2	725.0	1064.1
(3) Justifiable Costs	339.2	1.5	340.7
(10) Joint Cost Propor	0.9955	0.0045	1.0000
(11) Allocated Joint Cost	337.6	1.5	339.2
(12) Total Service Cost	337.6	1.5	339.2
(13) Percentages	99.55	0.45	1.0000

Cost Allocation for Region #02 Middle, non-navigable canal.
Cost to be allocated = 585.3

	AGRIC	R.W.S.	Totals
(1) Project benefits	13236.7	1.5	13238.2
(2) Alternative Costs	1194.8	719.4	1914.2
(3) Justifiable Costs	1194.8	1.5	1196.3
(10) Joint Cost Propor	0.9987	0.0013	1.0000
(11) Allocated Joint Cost	584.5	0.7	585.3
(12) Total Service Cost	584.5	0.7	585.3
(13) Percentages	99.87	0.13	1.0000

Cost Allocation for Region #02 Middle, navigable canal costs.
Cost to be allocated = 4.5

	AGRIC	R.W.S.	NAVIG	Totals
(1) Project benefits	102.7	0.0	11.4	114.2
(2) Alternative Costs	9.3	5.6	9.3	24.1
(3) Justifiable Costs	9.3	0.0	9.3	18.6
(10) Joint Cost Propor	0.4997	0.0006	0.4997	1.0000
(11) Allocated Joint Cost	2.3	0.0	2.3	4.5
(12) Total Service Cost	2.3	0.0	2.3	4.5
(13) Percentages	49.97	0.06	49.97	1.0000

Cost Allocation for Region #03 EastDelta, pump costs.
Cost to be allocated = 351.8

	AGRIC	R.W.S.	Totals
(1) Project benefits	12477.5	1.2	12478.6
(2) Alternative Costs	351.8	1611.0	1962.8
(3) Justifiable Costs	351.8	1.2	353.0
(10) Joint Cost Propor	0.9967	0.0033	1.0000
(11) Allocated Joint Cost	350.7	1.2	351.8
(12) Total Service Cost	350.7	1.2	351.8
(13) Percentages	99.67	0.33	1.0000

Cost Allocation for Region #03 EastDelta, non-navigable canal.
Cost to be allocated = 421.6

	AGRIC	R.W.S.	Totals
(1) Project benefits	11978.4	1.1	11979.5
(2) Alternative Costs	996.7	1546.6	2543.3
(3) Justifiable Costs	996.7	1.1	997.8
(10) Joint Cost Propor	0.9989	0.0011	1.0000
(11) Allocated Joint Cost	421.2	0.5	421.6
(12) Total Service Cost	421.2	0.5	421.6
(13) Percentages	99.89	0.11	1.0000

Cost Allocation for Region #03 EastDelta, navigable canal costs.
Cost to be allocated = 17.6

	AGRIC	R.W.S.	NAVIG	Totals
(1) Project benefits	499.1	0.0	58.3	557.5
(2) Alternative Costs	41.5	64.4	41.5	147.5
(3) Justifiable Costs	41.5	0.0	41.5	83.1
(10) Joint Cost Propor	0.4997	0.0006	0.4997	1.0000
(11) Allocated Joint Cost	8.8	0.0	8.8	17.6
(12) Total Service Cost	8.8	0.0	8.8	17.6
(13) Percentages	49.97	0.06	49.97	1.0000

Cost Allocation for Region #04 MiddleDelta, pump costs.
Cost to be allocated = 320.3

	AGRIC	R.W.S.	Totals
(1) Project benefits	7483.3	1.2	7484.5
(2) Alternative Costs	320.3	805.5	1125.8
(3) Justifiable Costs	320.3	1.2	321.5
(10) Joint Cost Propor	0.9962	0.0038	1.0000
(11) Allocated Joint Cost	319.1	1.2	320.3
(12) Total Service Cost	319.1	1.2	320.3
(13) Percentages	99.62	0.38	1.0000

Cost Allocation for Region #04 MiddleDelta, non-navigable canal.
Cost to be allocated = 337.4

	AGRIC	R.W.S.	Totals
(1) Project benefits	6862.2	1.1	6863.3
(2) Alternative Costs	754.7	738.7	1493.3
(3) Justifiable Costs	754.7	1.1	755.8
(10) Joint Cost Propor	0.9985	0.0015	1.0000
(11) Allocated Joint Cost	336.9	0.5	337.4
(12) Total Service Cost	336.9	0.5	337.4
(13) Percentages	99.85	0.15	1.0000

Cost Allocation for Region #04 MiddleDelta, navigable canal costs.
Cost to be allocated = 30.5

	AGRIC	R.W.S.	NAVIG	Totals
(1) Project benefits	621.1	0.1	91.7	712.9
(2) Alternative Costs	68.3	66.9	68.3	203.5
(3) Justifiable Costs	68.3	0.1	68.3	136.7
(10) Joint Cost Propor	0.4996	0.0007	0.4996	1.0000
(11) Allocated Joint Cost	15.3	0.0	15.3	30.5
(12) Total Service Cost	15.3	0.0	15.3	30.5
(13) Percentages	49.96	0.07	49.96	1.0000

Cost Allocation for Region #05 WestDelta, pump costs.
Cost to be allocated = 287.9

	AGRIC	R.W.S.	Totals
(1) Project benefits	4591.5	0.8	4592.3
(2) Alternative Costs	287.9	805.5	1093.4
(3) Justifiable Costs	287.9	0.8	288.6
(10) Joint Cost Propor	0.9972	0.0028	1.0000
(11) Allocated Joint Cost	287.1	0.8	287.9
(12) Total Service Cost	287.1	0.8	287.9
(13) Percentages	99.72	0.28	1.0000

Cost Allocation for Region #05 WestDelta, non-navigable canal.
Cost to be allocated = 264.5

	AGRIC	R.W.S.	Totals
(1) Project benefits	4256.3	0.7	4257.0
(2) Alternative Costs	524.0	746.7	1270.7
(3) Justifiable Costs	524.0	0.7	524.7
(10) Joint Cost Propor	0.9986	0.0014	1.0000
(11) Allocated Joint Cost	264.1	0.4	264.5
(12) Total Service Cost	264.1	0.4	264.5
(13) Percentages	99.86	0.14	1.0000

Cost Allocation for Region #05 WestDelta, navigable canal costs.
Cost to be allocated = 20.8

	AGRIC	R.W.S.	NAVIG	Totals
(1) Project benefits	335.2	0.1	49.9	385.2
(2) Alternative Costs	41.3	58.8	41.3	141.3
(3) Justifiable Costs	41.3	0.1	41.3	82.6
(10) Joint Cost Propor	0.4996	0.0007	0.4996	1.0000
(11) Allocated Joint Cost	10.4	0.0	10.4	20.8
(12) Total Service Cost	10.4	0.0	10.4	20.8
(13) Percentages	49.96	0.07	49.96	1.0000

Cost Allocation for New Land Region #01 NewLand-1
Share Ag costs with #01 UpperEgypt
Cost to be allocated = 0.0

OLD AG	NEW AG	Totals

Cost for allocation is zero, skip this analysis.

Cost Allocation for New Land Region #02 NewLand-2
Share Ag costs with #02 Middle
Cost to be allocated = 55.5

	OLD AG	NEW AG	Totals
(1) Project benefits	13339.4	788.4	14127.8
(2) Alternative Costs	72.2	72.2	144.5
(3) Justifiable Costs	72.2	72.2	144.5
(10) Joint Cost Propor	0.5000	0.5000	1.0000
(11) Allocated Joint Cost	27.7	27.7	55.5
(12) Total Service Cost	27.7	27.7	55.5
(13) Percentages	50.00	50.00	1.0000

Cost Allocation for New Land Region #03 NewLand-3
Share Ag costs with #03 EastDelta
Cost to be allocated = 0.0

OLD AG	NEW AG	Totals

Cost for allocation is zero, skip this analysis.

Cost Allocation for New Land Region #04 NewLand-4
Share Ag costs with #04 MiddleDelta
Cost to be allocated = 0.0

OLD AG	NEW AG	Totals

Cost for allocation is zero, skip this analysis.

Cost Allocation for New Land Region #05 NewLand-5
Share Ag costs with #05 WestDelta
Cost to be allocated = 44.9

	OLD AG	NEW AG	Totals
(1) Project benefits	4591.5	1131.8	5723.2
(2) Alternative Costs	45.2	45.2	90.4
(3) Justifiable Costs	45.2	45.2	90.4
(10) Joint Cost Propor	0.5000	0.5000	1.0000
(11) Allocated Joint Cost	22.5	22.5	44.9
(12) Total Service Cost	22.5	22.5	44.9
(13) Percentages	50.00	50.00	1.0000

Cost Allocation for New Land Region #06 NewLand-6
Share Ag costs with #03 EastDelta
Cost to be allocated = 0.0

OLD AG	NEW AG	Totals

Cost for allocation is zero, skip this analysis.

Cost Allocation for Main Stem Barrages Excluding Esna.
Cost to be allocated = 756.7

	OLD AG	R.W.S.	NAVIG	NEW AG	POWER	TRANS	RECR&T	Totals
(1) Project benefits	41105.6	5.4	501.4	6543.0	0.0	203.6	7410.8	55769.7
(2) Alternative Costs	756.7	756.7	756.7	756.7	0.0	204.3	756.7	3987.9
(3) Justifiable Costs	756.7	5.4	501.4	756.7	0.0	203.6	756.7	2980.5
(10) Joint Cost Propor	0.2539	0.0018	0.1682	0.2539	0.0000	0.0683	0.2539	1.0000
(11) Allocated Joint Cost	192.1	1.4	127.3	192.1	0.0	51.7	192.1	756.7
(12) Total Service Cost	192.1	1.4	127.3	192.1	0.0	51.7	192.1	756.7
(13) Percentages	25.39	0.18	16.82	25.39	0.00	6.83	25.39	1.0000

Cost Allocation for Main Stem Esna Barrage.
Cost to be allocated = 0.0

OLD AG	R.W.S.	NAVIG	NEW AG	POWER	TRANS	RECR&T	Totals

Cost for allocation is zero, skip this analysis.

Cost Allocation for High Aswan Dam.
Cost to be allocated = 389.8

	OLD AG	R.W.S.	NAVIG	NEW AG	POWER	G.TRAN	RECR&T	FISH	FLOOD	Totals
(1) Project benefits	41105.6	5.4	501.4	6543.0	45310.4	32.5	7410.8	483.3	2157.9	103550.3
(2) Alternative Costs	4026.2	1187.0	4026.2	4026.2	4026.2	32.5	4026.2	4026.2	2393.1	27769.7
(3) Justifiable Costs	4026.2	5.4	501.4	4026.2	4026.2	32.5	4026.2	483.3	2157.9	19285.2
(4) Separable Costs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	98.7	98.7
(5) Cost Other Purposes	389.8	389.8	389.8	389.8	389.8	389.8	389.8	389.8	291.1	3409.5
(6) Just Cost Other Purp	389.8	389.8	389.8	389.8	389.8	389.8	389.8	389.8	291.1	3409.5
(7) Adjustment Factor	11.3291	1.0139	2.2862	11.3291	11.3291	1.0835	11.3291	2.2399	6.2829	
(8) Adj Separable Costs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	619.8	
(9) Remaining Benefits	4026.2	5.4	501.4	4026.2	4026.2	32.5	4026.2	483.3	1538.0	18665.4
(10) Joint Cost Propor	0.2157	0.0003	0.0269	0.2157	0.2157	0.0017	0.2157	0.0259	0.0824	1.0000
(11) Allocated Joint Cost	62.8	0.1	7.8	62.8	62.8	0.5	62.8	7.5	24.0	291.1
(12) Total Service Cost	62.8	0.1	7.8	62.8	62.8	0.5	62.8	7.5	122.6	389.8
(13) Percentages	16.11	0.02	2.01	16.11	16.11	0.13	16.11	1.93	31.46	1.0000

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File name: scen03x.ECH
TABLE 1. THE HIGH ASWAN DAM (BASHAD.WB1).
Costs and Benefits for Basic O&M

BASIN DISCOUNT RATE (%):	12.0		
BASIN PLANNING HORIZON (YRS):	30		
NUMBER OF OLD REGIONS:	5		
NUMBER OF NEW REGIONS:	6		
ANNUAL COST FOR DRAINAGE (m LE/Yr @	35.088	282.64	35.088
HAD BENEFITS			
FLOOD CONTROL (% of total benefit	4.0		
SINGLE PURPOSE ALTERNATIVES			
AG, NAV, POWER, FISH (% of OM&R):	74.700		
FLOOD CONTROL (% of OM&R):	44.400		
SEPARABLE COSTS			
AGRICULTURE (% of O&M):	0.00		
POWER (% of O&M):	0.00		
FLOOD (% of O&M):	25.31		

YEAR	HAD BENEFIT HYDRO POWER (m LE)	GROUND TRANSP (m LE)	FISHERY (m LE)	SINGLE PUPROSE WATER SUPPLY (m LE)	GROUND TRANSP (m LE)	ALTERN COMMON WORKS REPLACE (m LE)	ANNUAL COMMON WORKS O&M (m LE)
p. val	45310.42	32.54	483.31	1187.01	32.54	5000.00	389.79

Present value SPA Other	4026.2
Present value SPA Flood	2393.1
Pres. val. separable Agri.	0.0
Pres. val. separable Power	0.0
Pres. val. separable Flood	98.7

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File name: scen03x.STM
TABLE 2: MAIN STEM OF THE NILE (BASSTM.WB1).
Costs and Benefits for Basic O&M

YEAR	NAVIG (m LE)	HYDRO POWER ESNA (m LE)	GROUND TRANSP (m LE)	BEN RECREA & TOURISM (m LE)	SINGLE PURPOSE ALTERN COST TRANSP (m LE)	STEM COSTS EXCEPT HAD & ESNA (m LE)	ESNA COMMON WORKS COSTS (m LE)
p. val	289.99	0.00	203.59	7410.77	204.31	756.73	0.00

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File name: scen03x.R01
TABLE 3. INPUT FOR OLD REGION (BASRxx.WB1).
Costs and Benefits for Basic O&M

REGION NAME: UpperEgypt
REGION NUMBER: 1

AGRICULTURAL AREA (mil FED): 0.762
WATER CONSUMPTION (M3/FD): 8320.200, = 6340.0 (mil M3).
POPULATION (millions): 5.520
WETTED PERIMETER OF CANALS (meters) 61.7
PERCENT OF CANALS NAVIGABLE (%): 0.0

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
p. val	3214.02	0.73	0.00	510.18	483.31	271.60	169.54

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File name: scen03x.R02
TABLE 3. INPUT FOR OLD REGION. (BASRxx.WB1)
Costs and Benefits for Basic O&M

REGION NAME: Middle
REGION NUMBER: 2

AGRICULTURAL AREA (mil FED): 1.524
WATER CONSUMPTION (M3/FD): 7390.400, = 11263.0 (mil M3).
POPULATION (millions): 11.590
WETTED PERIMETER OF CANALS (meters) 71.8
PERCENT OF CANALS NAVIGABLE (%): 0.8

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
p. val	13339.38	1.52	11.44	614.30	724.97	589.81	339.16

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File name: scen03x.R03

TABLE 3. INPUT FOR OLD REGION. (BASRxx.WB1)

Costs and Benefits for Basic O&M.

REGION NAME: EastDelta
REGION NUMBER: 3

AGRICULTURAL AREA (mil FED): 1.581
WATER CONSUMPTION (M3/FD): 6422.500, = 10154.0 (mil M3).
POPULATION (millions): 8.570
WETTED PERIMETER OF CANALS (meters) 72.5
PERCENT OF CANALS NAVIGABLE (%): 4.0

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
p. val	12477.48	1.16	58.32	599.02	1611.04	439.20	351.81

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File name: scen03x.R04

TABLE 3. INPUT FOR OLD REGION. (BASRxx.WB1)

Costs and Benefits for Basic O&M

REGION NAME: MiddleDelta
REGION NUMBER: 4

AGRICULTURAL AREA (mil FED): 1.439
WATER CONSUMPTION (M3/FD): 7372.500, = 10609.0 (mil M3).
POPULATION (millions): 9.050
WETTED PERIMETER OF CANALS (meters) 55.1
PERCENT OF CANALS NAVIGABLE (%): 8.3

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
p. val	7483.27	1.21	91.67	454.98	805.52	367.99	320.31

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File name: scen03x.R05
TABLE 3. INPUT FOR OLD REGION. (BASRxx.WB1)
Costs and Benefits for Basic O&M

REGION NAME:	WestDelta		
REGION NUMBER:	5		
AGRICULTURAL AREA (mil FED):	1.293		
WATER CONSUMPTION (M3/FD):	6344.900,	=	8204.0 (mil M3).
POPULATION (millions):	6.180		
WETTED PERIMETER OF CANALS (meters)	37.0		
PERCENT OF CANALS NAVIGABLE (%):	7.3		

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
p. val	4591.46	0.80	49.94	279.98	805.52	285.28	287.85

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File name: scen03x.N01
TABLE 4. INPUT FOR NEW LAND REGIONS (BASNxx.WB1).
Costs and Benefits for New Lands.

REGION NAME:	NewLand-1		
NEW REGION NUMBER:	1		
NUMBER OF UPSTREAM OLD REGION:	1		
FACTOR OF OLD CANALS DELIVERING WAT	0.000		
POTENTIAL AGRICULTURAL AREA (mil FE	0.2		
WATER CONSUMPTION (M3/FD):	6454.000,	=	1258.5299 (mil M3).

YEAR	BENEFIT AGRICUL	AN. COST CAP, O&M	IRRIG AREA	NEW DELIVERY SYSTEMS
	(m LE)	(m LE)	(mil FD)	(m LE)
p. val	835.5	72.5		345.0

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File name: scen03x.N02
TABLE 4. INPUT FOR NEW LAND REGIONS (BASNxx.WB1).
Costs and Benefits for New Lands.

REGION NAME:	NewLand-2		
NEW REGION NUMBER:	2		
NUMBER OF UPSTREAM OLD REGION:	2		
FACTOR OF OLD CANALS DELIVERING WAT	0.060		
POTENTIAL AGRICULTURAL AREA (mil FE	0.2		
WATER CONSUMPTION (M3/FD):	6454.000,	=	1187.5360 (mil M3).

YEAR	BENEFITAN. AGRICULCAP,	COST O&M	IRRIG AREA	NEW DELIVERY SYSTEMS
	(m LE)	(m LE)	(mil FD)	(m LE)
p. val	788.4	71.2		7.6

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File name: scen03x.N03
TABLE 4. INPUT FOR NEW LAND REGIONS (BASNxx.WB1).
Costs and Benefits for New Lands.

REGION NAME: NewLand-3
NEW REGION NUMBER: 3
NUMBER OF UPSTREAM OLD REGION: 3
FACTOR OF OLD CANALS DELIVERING WAT 0.000
POTENTIAL AGRICULTURAL AREA (mil FE 0.6
WATER CONSUMPTION (M3/FD): 6454.000, = 3949.8479 (mil M3).

YEAR	BENEFIT AGRICUL (m LE)	AN. COST CAP, O&M (m LE)	IRRIG AREA (mil FD)	NEW DELIVERY SYSTEMS (m LE)
p. val	2624.4	237.2		427.7

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File name: scen03x.N04
TABLE 4. INPUT FOR NEW LAND REGIONS (BASNxx.WB1).
Costs and Benefits for New Lands.

REGION NAME: NewLand-4
NEW REGION NUMBER: 4
NUMBER OF UPSTREAM OLD REGION: 4
FACTOR OF OLD CANALS DELIVERING WAT 0.000
POTENTIAL AGRICULTURAL AREA (mil FE 0.1
WATER CONSUMPTION (M3/FD): 6454.000, = 380.7860 (mil M3).

YEAR	BENEFIT AGRICUL (m LE)	AN. COST CAP, O&M (m LE)	IRRIG AREA (mil FD)	NEW DELIVERY SYSTEMS (m LE)
p. val	254.0	22.7		71.1

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File name: scen03x.N05
TABLE 4. INPUT FOR NEW LAND REGION (BASNxx.WB1).
Costs and Benefits for New Lands.

REGION NAME: NewLand-5
NEW REGION NUMBER: 5
NUMBER OF UPSTREAM OLD REGION: 5
FACTOR OF OLD CANALS DELIVERING WAT 0.080
POTENTIAL AGRICULTURAL AREA (mil FE 0.3
WATER CONSUMPTION (M3/FD): 6454.000, = 1703.8560 (mil M3).

YEAR	BENEFIT AGRICUL (m LE)	AN. COST CAP, O&M (m LE)	IRRIG AREA (mil FD)	NEW DELIVERY SYSTEMS (m LE)
p. val	1131.8	102.2		156.5

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File name: scen03x.N06
TABLE 4. INPUT FOR NEW LAND REGIONS (BASNxx.WQ1).
Costs and Benefits for New Lands.

REGION NAME: NewLand-6
NEW REGION NUMBER: 6
NUMBER OF UPSTREAM OLD REGION: 3
FACTOR OF OLD CANALS DELIVERING WAT 0.000
POTENTIAL AGRICULTURAL AREA (mil FE 0.2
WATER CONSUMPTION (M3/FD): 6454.000, = 1368.2479 (mil M3).

YEAR	BENEFIT AGRICUL (mil LE)	AN. COST CAP, O&M (mil LE)	IRRIG AREA (mil FD)	NEW DELIVERY SYSTEMS (m LE)
p. val	909.0	82.0		4463.3

TABLE 1. THE HIGH ASWAN DAM (BASHAD.WB1).
Costs and Benefits for Basic O&M

BASIN DISCOUNT RATE (%):	12	
BASIN PLANNING HORIZON (YRS):	30	
NUMBER OF OLD REGIONS:	5	
NUMBER OF NEW REGIONS:	6	
ANNUAL COST FOR DRAINAGE (m LE/Yr @ 12%):	35.088	12
HAD BENEFITS		
FLOOD CONTROL (% of total benefits):	4	
SINGLE PURPOSE ALTERNATIVES		
AG, NAV, POWER, FISH (% of OM&R):	74.7	
FLOOD CONTROL (% of OM&R):	44.4	
SEPARABLE COSTS		
AGRICULTURE (% of O&M):	0	
POWER (% of O&M):	0	
FLOOD (% of O&M):	25.31	

YEAR	HAD BENEFIT HYDRO POWER (m LE)	HAD BENEFIT GROUND TRANSP (m LE)	HAD BENEFIT FISHERY (m LE)	SINGLE PUPROSE ALTERN WATER SUPPLY (m LE)	SINGLE PUPROSE ALTERN GROUND TRANSP (m LE)	COMMON WORKS REPLACE (m LE)	ANNUAL COMMON WORKS O&M (m LE)
1	5625	35	60	1165	35	5600	48.39
2	5625	0.18	60	20.5	0.18	0	48.39
3	5625	0.18	60	20.5	0.18	0	48.39
4	5625	0.18	60	20.5	0.18	0	48.39
5	5625	0.18	60	20.5	0.18	0	48.39
6	5625	0.18	60	20.5	0.18	0	48.39
7	5625	0.18	60	20.5	0.18	0	48.39
8	5625	0.18	60	20.5	0.18	0	48.39
9	5625	0.18	60	20.5	0.18	0	48.39
10	5625	0.18	60	20.5	0.18	0	48.39
11	5625	0.18	60	20.5	0.18	0	48.39
12	5625	0.18	60	20.5	0.18	0	48.39
13	5625	0.18	60	20.5	0.18	0	48.39
14	5625	0.18	60	20.5	0.18	0	48.39
15	5625	0.18	60	20.5	0.18	0	48.39
16	5625	0.18	60	20.5	0.18	0	48.39
17	5625	0.18	60	20.5	0.18	0	48.39
18	5625	0.18	60	20.5	0.18	0	48.39
19	5625	0.18	60	20.5	0.18	0	48.39
20	5625	0.18	60	20.5	0.18	0	48.39
21	5625	0.18	60	20.5	0.18	0	48.39
22	5625	0.18	60	20.5	0.18	0	48.39
23	5625	0.18	60	20.5	0.18	0	48.39
24	5625	0.18	60	20.5	0.18	0	48.39
25	5625	0.18	60	20.5	0.18	0	48.39
26	5625	0.18	60	20.5	0.18	0	48.39
27	5625	0.18	60	20.5	0.18	0	48.39
28	5625	0.18	60	20.5	0.18	0	48.39
29	5625	0.18	60	20.5	0.18	0	48.39
30	5625	0.18	60	20.5	0.18	0	48.39

TABLE 2: MAIN STEM OF THE NILE (BASSTM.WB1).
Costs and Benefits for Basic O&M

YEAR	NAVIG (m LE)	HYDRO POWER ESNA (m LE)	GROUND TRANSP (m LE)	BEN RECREA & TOURISM (m LE)	SINGLE PURPOSE ALTERN COST TRANSP (m LE)	STEM COSTS EXCEPT HAD & ESNA (m LE)	ESNA COMMON WORKS COSTS (m LE)
1	36	0	220	920	220	93.943	0
2	36	0	1	920	1.1	93.943	0
3	36	0	1	920	1.1	93.943	0
4	36	0	1	920	1.1	93.943	0
5	36	0	1	920	1.1	93.943	0
6	36	0	1	920	1.1	93.943	0
7	36	0	1	920	1.1	93.943	0
8	36	0	1	920	1.1	93.943	0
9	36	0	1	920	1.1	93.943	0
10	36	0	1	920	1.1	93.943	0
11	36	0	1	920	1.1	93.943	0
12	36	0	1	920	1.1	93.943	0
13	36	0	1	920	1.1	93.943	0
14	36	0	1	920	1.1	93.943	0
15	36	0	1	920	1.1	93.943	0
16	36	0	1	920	1.1	93.943	0
17	36	0	1	920	1.1	93.943	0
18	36	0	1	920	1.1	93.943	0
19	36	0	1	920	1.1	93.943	0
20	36	0	1	920	1.1	93.943	0
21	36	0	1	920	1.1	93.943	0
22	36	0	1	920	1.1	93.943	0
23	36	0	1	920	1.1	93.943	0
24	36	0	1	920	1.1	93.943	0
25	36	0	1	920	1.1	93.943	0
26	36	0	1	920	1.1	93.943	0
27	36	0	1	920	1.1	93.943	0
28	36	0	1	920	1.1	93.943	0
29	36	0	1	920	1.1	93.943	0
30	36	0	1	920	1.1	93.943	0

TABLE 3. INPUT FOR OLD REGION (BASRxx.WB1).
Costs and Benefits for Basic O&M

REGION NAME:	UpperEgypt
REGION NUMBER:	1
AGRICULTURAL AREA (mil FED):	0.762
WATER CONSUMPTION (M3/FD):	8320.2
POPULATION (millions):	5.52
WETTED PERIMETER OF CANALS (meters):	61.7
PERCENT OF CANALS NAVIGABLE (%):	0

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES			COSTS
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
1	399	0.58	0	571.4	60	33.718	21.047
2	399	0.029	0	0	60	33.718	21.047
3	399	0.029	0	0	60	33.718	21.047
4	399	0.029	0	0	60	33.718	21.047
5	399	0.029	0	0	60	33.718	21.047
6	399	0.029	0	0	60	33.718	21.047
7	399	0.029	0	0	60	33.718	21.047
8	399	0.029	0	0	60	33.718	21.047
9	399	0.029	0	0	60	33.718	21.047
10	399	0.029	0	0	60	33.718	21.047
11	399	0.029	0	0	60	33.718	21.047
12	399	0.029	0	0	60	33.718	21.047
13	399	0.029	0	0	60	33.718	21.047
14	399	0.029	0	0	60	33.718	21.047
15	399	0.029	0	0	60	33.718	21.047
16	399	0.029	0	0	60	33.718	21.047
17	399	0.029	0	0	60	33.718	21.047
18	399	0.029	0	0	60	33.718	21.047
19	399	0.029	0	0	60	33.718	21.047
20	399	0.029	0	0	60	33.718	21.047
21	399	0.029	0	0	60	33.718	21.047
22	399	0.029	0	0	60	33.718	21.047
23	399	0.029	0	0	60	33.718	21.047
24	399	0.029	0	0	60	33.718	21.047
25	399	0.029	0	0	60	33.718	21.047
26	399	0.029	0	0	60	33.718	21.047
27	399	0.029	0	0	60	33.718	21.047
28	399	0.029	0	0	60	33.718	21.047
29	399	0.029	0	0	60	33.718	21.047
30	399	0.029	0	0	60	33.718	21.047

TABLE 3. INPUT FOR OLD REGION. (BASRxx.WB1)
Costs and Benefits for Basic O&M

REGION NAME:	Middle Egypt
REGION NUMBER:	2
AGRICULTURAL AREA (mil FED):	1.524
WATER CONSUMPTION (M3/FD):	7390.4
POPULATION (millions):	11.59
WETTED PERIMETER OF CANALS (meters):	71.8
PERCENT OF CANALS NAVIGABLE (%):	0.77

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
1	1656	1.22	1.42	688.02	90	73.221	42.104
2	1656	0.06	1.42	0.00	90	73.221	42.104
3	1656	0.06	1.42	0.00	90	73.221	42.104
4	1656	0.06	1.42	0.00	90	73.221	42.104
5	1656	0.06	1.42	0.00	90	73.221	42.104
6	1656	0.06	1.42	0.00	90	73.221	42.104
7	1656	0.06	1.42	0.00	90	73.221	42.104
8	1656	0.06	1.42	0.00	90	73.221	42.104
9	1656	0.06	1.42	0.00	90	73.221	42.104
10	1656	0.06	1.42	0.00	90	73.221	42.104
11	1656	0.06	1.42	0.00	90	73.221	42.104
12	1656	0.06	1.42	0.00	90	73.221	42.104
13	1656	0.06	1.42	0.00	90	73.221	42.104
14	1656	0.06	1.42	0.00	90	73.221	42.104
15	1656	0.06	1.42	0.00	90	73.221	42.104
16	1656	0.06	1.42	0.00	90	73.221	42.104
17	1656	0.06	1.42	0.00	90	73.221	42.104
18	1656	0.06	1.42	0.00	90	73.221	42.104
19	1656	0.06	1.42	0.00	90	73.221	42.104
20	1656	0.06	1.42	0.00	90	73.221	42.104
21	1656	0.06	1.42	0.00	90	73.221	42.104
22	1656	0.06	1.42	0.00	90	73.221	42.104
23	1656	0.06	1.42	0.00	90	73.221	42.104
24	1656	0.06	1.42	0.00	90	73.221	42.104
25	1656	0.06	1.42	0.00	90	73.221	42.104
26	1656	0.06	1.42	0.00	90	73.221	42.104
27	1656	0.06	1.42	0.00	90	73.221	42.104
28	1656	0.06	1.42	0.00	90	73.221	42.104
29	1656	0.06	1.42	0.00	90	73.221	42.104
30	1656	0.06	1.42	0.00	90	73.221	42.104

TABLE 3. INPUT FOR OLD REGION. (BASRxx.WB1)
Costs and Benefits for Basic O&M.

REGION NAME:	EastDelta
REGION NUMBER:	3
AGRICULTURAL AREA (mil FED):	1.581
WATER CONSUMPTION (M3/FD):	6422.5
POPULATION (millions):	8.57
WETTED PERIMETER OF CANALS (meters):	72.5
PERCENT OF CANALS NAVIGABLE (%):	4

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
1	1549	0.9	7.24	670.90	200	54.524	43.675
2	1549	0.05	7.24	0.00	200	54.524	43.675
3	1549	0.05	7.24	0.00	200	54.524	43.675
4	1549	0.05	7.24	0.00	200	54.524	43.675
5	1549	0.05	7.24	0.00	200	54.524	43.675
6	1549	0.05	7.24	0.00	200	54.524	43.675
7	1549	0.05	7.24	0.00	200	54.524	43.675
8	1549	0.05	7.24	0.00	200	54.524	43.675
9	1549	0.05	7.24	0.00	200	54.524	43.675
10	1549	0.05	7.24	0.00	200	54.524	43.675
11	1549	0.05	7.24	0.00	200	54.524	43.675
12	1549	0.05	7.24	0.00	200	54.524	43.675
13	1549	0.05	7.24	0.00	200	54.524	43.675
14	1549	0.05	7.24	0.00	200	54.524	43.675
15	1549	0.05	7.24	0.00	200	54.524	43.675
16	1549	0.05	7.24	0.00	200	54.524	43.675
17	1549	0.05	7.24	0.00	200	54.524	43.675
18	1549	0.05	7.24	0.00	200	54.524	43.675
19	1549	0.05	7.24	0.00	200	54.524	43.675
20	1549	0.05	7.24	0.00	200	54.524	43.675
21	1549	0.05	7.24	0.00	200	54.524	43.675
22	1549	0.05	7.24	0.00	200	54.524	43.675
23	1549	0.05	7.24	0.00	200	54.524	43.675
24	1549	0.05	7.24	0.00	200	54.524	43.675
25	1549	0.05	7.24	0.00	200	54.524	43.675
26	1549	0.05	7.24	0.00	200	54.524	43.675
27	1549	0.05	7.24	0.00	200	54.524	43.675
28	1549	0.05	7.24	0.00	200	54.524	43.675
29	1549	0.05	7.24	0.00	200	54.524	43.675
30	1549	0.05	7.24	0.00	200	54.524	43.675

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TABLE 3. INPUT FOR OLD REGION. (BASRxx.WB1)
Costs and Benefits for Basic O&M

REGION NAME:	MiddleDelta
REGION NUMBER:	4
AGRICULTURAL AREA (mil FED):	1.439
WATER CONSUMPTION (M3/FD):	7372.5
POPULATION (millions):	9.05
WETTED PERIMETER OF CANALS (meters):	55.1
PERCENT OF CANALS NAVIGABLE (%):	8.3

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
1	929	0.95	11.38	509.58	100	45.683	39.765
2	929	0.05	11.38	0.00	100	45.683	39.765
3	929	0.05	11.38	0.00	100	45.683	39.765
4	929	0.05	11.38	0.00	100	45.683	39.765
5	929	0.05	11.38	0.00	100	45.683	39.765
6	929	0.05	11.38	0.00	100	45.683	39.765
7	929	0.05	11.38	0.00	100	45.683	39.765
8	929	0.05	11.38	0.00	100	45.683	39.765
9	929	0.05	11.38	0.00	100	45.683	39.765
10	929	0.05	11.38	0.00	100	45.683	39.765
11	929	0.05	11.38	0.00	100	45.683	39.765
12	929	0.05	11.38	0.00	100	45.683	39.765
13	929	0.05	11.38	0.00	100	45.683	39.765
14	929	0.05	11.38	0.00	100	45.683	39.765
15	929	0.05	11.38	0.00	100	45.683	39.765
16	929	0.05	11.38	0.00	100	45.683	39.765
17	929	0.05	11.38	0.00	100	45.683	39.765
18	929	0.05	11.38	0.00	100	45.683	39.765
19	929	0.05	11.38	0.00	100	45.683	39.765
20	929	0.05	11.38	0.00	100	45.683	39.765
21	929	0.05	11.38	0.00	100	45.683	39.765
22	929	0.05	11.38	0.00	100	45.683	39.765
23	929	0.05	11.38	0.00	100	45.683	39.765
24	929	0.05	11.38	0.00	100	45.683	39.765
25	929	0.05	11.38	0.00	100	45.683	39.765
26	929	0.05	11.38	0.00	100	45.683	39.765
27	929	0.05	11.38	0.00	100	45.683	39.765
28	929	0.05	11.38	0.00	100	45.683	39.765
29	929	0.05	11.38	0.00	100	45.683	39.765
30	929	0.05	11.38	0.00	100	45.683	39.765

TABLE 3. INPUT FOR OLD REGION. (BASRxx.WB1)
Costs and Benefits for Basic O&M

REGION NAME:	WestDelta
REGION NUMBER:	5
AGRICULTURAL AREA (mil FED):	1.293
WATER CONSUMPTION (M3/FD):	6344.9
POPULATION (millions):	6.18
WETTED PERIMETER OF CANALS (meters):	37
PERCENT OF CANALS NAVIGABLE (%):	7.3

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES			COSTS
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
1	570	0.65	6.2	313.58	100	35.416	35.735
2	570	0.03	6.2	0	100	35.416	35.735
3	570	0.03	6.2	0	100	35.416	35.735
4	570	0.03	6.2	0	100	35.416	35.735
5	570	0.03	6.2	0	100	35.416	35.735
6	570	0.03	6.2	0	100	35.416	35.735
7	570	0.03	6.2	0	100	35.416	35.735
8	570	0.03	6.2	0	100	35.416	35.735
9	570	0.03	6.2	0	100	35.416	35.735
10	570	0.03	6.2	0	100	35.416	35.735
11	570	0.03	6.2	0	100	35.416	35.735
12	570	0.03	6.2	0	100	35.416	35.735
13	570	0.03	6.2	0	100	35.416	35.735
14	570	0.03	6.2	0	100	35.416	35.735
15	570	0.03	6.2	0	100	35.416	35.735
16	570	0.03	6.2	0	100	35.416	35.735
17	570	0.03	6.2	0	100	35.416	35.735
18	570	0.03	6.2	0	100	35.416	35.735
19	570	0.03	6.2	0	100	35.416	35.735
20	570	0.03	6.2	0	100	35.416	35.735
21	570	0.03	6.2	0	100	35.416	35.735
22	570	0.03	6.2	0	100	35.416	35.735
23	570	0.03	6.2	0	100	35.416	35.735
24	570	0.03	6.2	0	100	35.416	35.735
25	570	0.03	6.2	0	100	35.416	35.735
26	570	0.03	6.2	0	100	35.416	35.735
27	570	0.03	6.2	0	100	35.416	35.735
28	570	0.03	6.2	0	100	35.416	35.735
29	570	0.03	6.2	0	100	35.416	35.735
30	570	0.03	6.2	0	100	35.416	35.735

TABLE 4. INPUT FOR NEW LAND REGIONS (BASNxx.WB1).
Costs and Benefits for New Lands.

REGION NAME:	NewLand-1
NEW REGION NUMBER:	1
NUMBER OF UPSTREAM OLD REGION:	1
FACTOR OF OLD CANALS DELIVERING WATER:	0
POTENTIAL AGRICULTURAL AREA (mil FEDDANS):	0.195
WATER CONSUMPTION (M3/FD):	6454

YEAR	BENEFIT AGRICUL (m LE)	AN. COST CAP, O&M (m LE)	IRRIG AREA (mil FD)	NEW DELIVERY SYSTEMS (m LE)
1	12.50	28.80	0.007	386.37
2	25.00	28.81	0.013	0
3	37.50	16.92	0.020	0
4	50.00	9.17	0.026	0
5	62.50	0.78	0.033	0
6	75.00	1.95	0.039	0
7	87.50	1.74	0.046	0
8	100.00	1.56	0.052	0
9	112.50	1.39	0.059	0
10	125.00	1.24	0.065	0
11	137.50	1.11	0.072	0
12	150.00	0.99	0.078	0
13	162.50	0.88	0.085	0
14	175.00	0.79	0.091	0
15	187.50	0.70	0.098	0
16	200.00	1.73	0.104	0
17	212.50	2.26	0.111	0
18	225.00	1.79	0.117	0
19	237.50	1.16	0.124	0
20	250.00	0.46	0.130	0
21	262.50	0.36	0.137	0
22	275.00	0.32	0.143	0
23	287.50	0.28	0.150	0
24	300.00	0.25	0.156	0
25	312.50	0.23	0.163	0
26	325.00	0.20	0.169	0
27	337.50	0.18	0.176	0
28	350.00	0.16	0.182	0
29	362.50	0.15	0.189	0
30	375.00	0.13	0.195	0

TABLE 4. INPUT FOR NEW LAND REGIONS (BASNxx.WB1).
Costs and Benefits for New Lands.

REGION NAME:	NewLand-2
NEW REGION NUMBER:	2
NUMBER OF UPSTREAM OLD REGION:	2
FACTOR OF OLD CANALS DELIVERING WATER:	0.06
POTENTIAL AGRICULTURAL AREA (mil FEDDANS):	0.184
WATER CONSUMPTION (M3/FD):	6454

YEAR	BENEFIT AGRICUL (m LE)	AN. COST CAP, O&M (m LE)	IRRIG AREA (mil FD)	NEW DELIVERY SYSTEMS (m LE)
1	11.80	28.19	0.006	8.52
2	23.59	27.85	0.012	0
3	35.39	17.28	0.018	0
4	47.18	9.08	0.025	0
5	58.98	0.78	0.031	0
6	70.77	1.88	0.037	0
7	82.57	1.68	0.043	0
8	94.36	1.49	0.049	0
9	106.16	1.33	0.055	0
10	117.95	1.19	0.061	0
11	129.75	1.06	0.067	0
12	141.54	0.94	0.074	0
13	153.34	0.84	0.080	0
14	165.13	0.76	0.086	0
15	176.93	0.67	0.092	0
16	188.72	1.64	0.098	0
17	200.52	2.15	0.104	0
18	212.31	1.70	0.110	0
19	224.11	1.10	0.117	0
20	235.90	0.45	0.123	0
21	247.70	0.35	0.129	0
22	259.49	0.31	0.135	0
23	271.29	0.27	0.141	0
24	283.08	0.25	0.147	0
25	294.88	0.22	0.153	0
26	306.67	0.20	0.159	0
27	318.47	0.16	0.166	0
28	330.26	0.16	0.172	0
29	342.06	0.14	0.178	0
30	353.85	0.12	0.184	0

TABLE 4. INPUT FOR NEW LAND REGIONS (BASNxx.WB1).
Costs and Benefits for New Lands.

REGION NAME:	NewLand-3
NEW REGION NUMBER:	3
NUMBER OF UPSTREAM OLD REGION:	3
FACTOR OF OLD CANALS DELIVERING WATER:	0
POTENTIAL AGRICULTURAL AREA (mil FEDDANS):	0.612
WATER CONSUMPTION (M3/FD):	6454

YEAR	BENEFIT AGRICUL (m LE)	AN. COST CAP, O&M (m LE)	IRRIG AREA (mil FD)	NEW DELIVERY SYSTEMS (m LE)
1	39.27	93.76	0.020	479
2	78.53	92.60	0.041	0
3	117.80	57.41	0.061	0
4	157.06	30.23	0.082	0
5	196.33	2.63	0.102	0
6	235.60	6.24	0.122	0
7	274.86	5.57	0.143	0
8	314.13	4.96	0.163	0
9	353.39	4.47	0.184	0
10	392.66	5.20	0.204	0
11	431.93	3.55	0.224	0
12	471.19	3.18	0.245	0
13	510.46	2.82	0.265	0
14	549.72	2.51	0.286	0
15	588.99	2.26	0.306	0
16	628.25	5.45	0.326	0
17	667.52	7.10	0.347	0
18	706.79	5.63	0.367	0
19	746.05	3.67	0.388	0
20	785.32	1.47	0.408	0
21	824.58	1.16	0.428	0
22	863.85	1.04	0.449	0
23	903.12	0.92	0.469	0
24	942.38	0.80	0.490	0
25	981.65	0.73	0.510	0
26	1020.91	0.67	0.530	0
27	1060.18	0.55	0.551	0
28	1099.45	0.49	0.571	0
29	1138.71	0.49	0.592	0
30	1177.98	0.49	0.612	0

TABLE 4. INPUT FOR NEW LAND REGIONS (BASNxx.WB1).
Costs and Benefits for New Lands.

REGION NAME:	NewLand-4
NEW REGION NUMBER:	4
NUMBER OF UPSTREAM OLD REGION:	4
FACTOR OF OLD CANALS DELIVERING WATER:	0
POTENTIAL AGRICULTURAL AREA (mil FEDDANS):	0.059
WATER CONSUMPTION (M3/FD):	6454

YEAR	BENEFIT AGRICUL (m LE)	AN. COST CAP, O&M (m LE)	IRRIG AREA (mil FD)	NEW DELIVERY SYSTEMS (m LE)
1	3.80	9.04	0.002	79.65
2	7.60	8.93	0.004	0
3	11.40	5.54	0.006	0
4	15.20	2.91	0.008	0
5	19.00	0.25	0.010	0
6	22.80	0.60	0.012	0
7	26.60	0.54	0.014	0
8	30.40	0.48	0.016	0
9	34.20	0.43	0.018	0
10	38.00	0.38	0.020	0
11	41.80	0.34	0.022	0
12	45.60	0.30	0.024	0
13	49.40	0.27	0.026	0
14	53.20	0.24	0.028	0
15	57.00	0.22	0.029	0
16	60.80	0.34	0.031	0
17	64.60	0.43	0.033	0
18	68.40	0.35	0.035	0
19	72.20	0.24	0.037	0
20	76.00	0.13	0.039	0
21	79.80	0.11	0.041	0
22	83.60	0.10	0.043	0
23	87.40	0.09	0.045	0
24	91.20	0.08	0.047	0
25	95.00	0.07	0.049	0
26	98.80	0.06	0.051	0
27	102.60	0.06	0.053	0
28	106.40	0.05	0.055	0
29	110.20	0.04	0.057	0
30	114.00	0.04	0.059	0

TABLE 4. INPUT FOR NEW LAND REGION (BASNxx.WB1).
Costs and Benefits for New Lands.

REGION NAME:	NewLand-5
NEW REGION NUMBER:	5
NUMBER OF UPSTREAM OLD REGION:	5
FACTOR OF OLD CANALS DELIVERING WATER:	0.08
POTENTIAL AGRICULTURAL AREA (mil FEDDANS):	0.264
WATER CONSUMPTION (M3/FD):	6454

YEAR	BENEFIT AGRICUL (m LE)	AN. COST CAP, O&M (m LE)	IRRIG AREA (mil FD)	NEW DELIVERY SYSTEMS (m LE)
1	16.93	40.47	0.009	175.27
2	33.87	39.94	0.018	0
3	50.80	24.78	0.026	0
4	67.73	13.05	0.035	0
5	84.67	1.13	0.044	0
6	101.60	2.68	0.053	0
7	118.53	2.41	0.062	0
8	135.47	2.15	0.070	0
9	152.40	1.92	0.079	0
10	169.33	1.70	0.088	0
11	186.27	1.51	0.097	0
12	203.20	1.36	0.106	0
13	220.13	1.21	0.114	0
14	237.07	1.09	0.123	0
15	254.00	0.98	0.132	0
16	270.93	2.38	0.141	0
17	287.87	3.05	0.150	0
18	304.80	2.45	0.158	0
19	321.73	1.58	0.167	0
20	338.67	0.64	0.176	0
21	355.60	0.43	0.185	0
22	372.53	0.45	0.194	0
23	389.47	0.38	0.202	0
24	406.40	0.34	0.211	0
25	423.33	0.30	0.220	0
26	440.27	0.26	0.229	0
27	457.20	0.26	0.238	0
28	474.13	0.23	0.246	0
29	491.07	0.19	0.255	0
30	508.00	0.19	0.264	0

TABLE 4. INPUT FOR NEW LAND REGIONS (BASNxx.WQ1).
Costs and Benefits for New Lands.

REGION NAME:	NewLand-6
NEW REGION NUMBER:	6
NUMBER OF UPSTREAM OLD REGION:	3
FACTOR OF OLD CANALS DELIVERING WATER:	0
POTENTIAL AGRICULTURAL AREA (mil FEDDANS):	0.212
WATER CONSUMPTION (M3/FD):	6454

YEAR	BENEFIT AGRICUL (mil LE)	AN. COST CAP, O&M (mil LE)	IRRIG AREA (mil FD)	NEW DELIVERY SYSTEMS (m LE)
1	13.60	32.48	0.007	4998.9
2	27.20	32.08	0.014	0
3	40.80	19.89	0.021	0
4	54.40	10.47	0.028	0
5	68.00	0.91	0.035	0
6	81.60	2.16	0.042	0
7	95.20	1.93	0.049	0
8	108.80	1.72	0.057	0
9	122.40	1.55	0.064	0
10	136.00	1.38	0.071	0
11	149.60	1.23	0.078	0
12	163.20	1.10	0.085	0
13	176.80	0.98	0.092	0
14	190.40	0.87	0.099	0
15	204.00	0.78	0.106	0
16	217.60	1.89	0.113	0
17	231.20	2.46	0.120	0
18	244.80	1.95	0.127	0
19	258.40	1.27	0.134	0
20	272.00	0.51	0.141	0
21	285.60	0.40	0.148	0
22	299.20	0.36	0.155	0
23	312.80	0.32	0.163	0
24	326.40	0.28	0.170	0
25	340.00	0.25	0.177	0
26	353.60	0.23	0.184	0
27	367.20	0.19	0.191	0
28	380.80	0.17	0.198	0
29	394.40	0.17	0.205	0
30	408.00	0.15	0.212	0

APPENDIX D
INPUT / OUPUT FILES FOR SCENARIO 4

429

Sat Nov 07 13:00:12 1992

Allocation of Joint Costs as Present Values (mil LE) for File: scen04x.
Part One of Two

	---- AGRICULTURE ----			RURAL --- WATER SUPPLY ---			NAV	TOTAL
	Region	Stem	HAD	Region	Stem	HAD	Region	
Old R01	511.1	43.8	12.6	1.0	0.2	0.0	0.0	568.7
Old R02	989.0	87.5	25.2	2.3	0.5	0.0	2.3	1106.8
Old R03	1048.3	90.8	26.1	1.7	0.4	0.0	12.5	1179.8
Old R04	941.6	82.6	23.8	1.8	0.4	0.0	23.6	1073.9
Old R05	816.3	74.3	21.4	1.3	0.3	0.0	17.3	930.9
New N01	0.0	48.4	13.9					62.4
New N02	30.6	45.7	13.2					89.4
New N03	0.0	152.0	43.8					195.8
New N04	0.0	14.7	4.2					18.9
New N05	34.0	65.6	18.9					118.5
New N06	0.0	52.6	15.2					67.8
Totals	4370.9	758.0	218.2	8.1	1.8	0.1	55.7	5412.9

Allocation of Joint Costs as Present Values (mil LE) for File: scen04x.
Part Two of Two

	NAV	PWR	TRN	TOU	FIS	FLD	TOTAL	
Stem	162.9	71.8	66.1	379.0	0.0	0.0	679.8	
HAD	12.9	109.1	0.8	109.1	12.4	210.5	454.9	
Totals	175.8	180.9	67.0	488.1	12.4	210.5	1134.8	6547.6

Allocation of Joint Costs as Annual Costs (mil LE/YR) for File: scen04x.
Part One of Two

	---- AGRICULTURE ----			RURAL --- WATER SUPPLY ---			NAV	TOTAL
	Region	Stem	HAD	Region	Stem	HAD	Region	
Old R01	63.45	5.43	1.56	0.12	0.03	0.00	0.00	70.60
Old R02	122.78	10.87	3.13	0.28	0.06	0.00	0.29	137.41
Old R03	130.13	11.27	3.25	0.22	0.05	0.00	1.55	146.47
Old R04	116.89	10.26	2.95	0.23	0.05	0.00	2.93	133.32
Old R05	101.34	9.22	2.65	0.16	0.03	0.00	2.15	115.56
New N01	0.00	6.01	1.73					7.74
New N02	3.80	5.67	1.63					11.10
New N03	0.00	18.87	5.43					24.30
New N04	0.00	1.82	0.52					2.34
New N05	4.22	8.14	2.34					14.71
New N06	0.00	6.54	1.88					8.42
Totals	542.62	94.10	27.09	1.01	0.22	0.02	6.92	671.97

Allocation of Joint Costs as Annual Costs (mil LE/Yr for File: scen04x.
Part Two of Two

	NAV	PWR	TRN	TOU	FIS	FLD	TOTAL	
Stem	20.22	8.91	8.21	47.05	0.00	0.00	84.40	
HAD	1.60	13.55	0.10	13.55	1.54	26.13	56.48	
Totals	21.82	22.46	8.32	60.59	1.54	26.13	140.87	812.84

Allocation of Joint Costs as Percentages of the Total for File: scen04x.
Part One of Two

	---- AGRICULTURE ----			RURAL --- WATER SUPPLY ---			NAV	TOTAL
	Region	Stem	HAD	Region	Stem	HAD	Region	
Old R01	7.806	0.668	0.192	0.015	0.004	0.000	0.000	8.686
Old R02	15.105	1.337	0.385	0.035	0.008	0.001	0.035	16.905
Old R03	16.010	1.387	0.399	0.027	0.006	0.000	0.191	18.019
Old R04	14.381	1.262	0.363	0.028	0.006	0.000	0.361	16.402
Old R05	12.468	1.134	0.327	0.020	0.004	0.000	0.264	14.217
New N01	0.000	0.740	0.213					0.953
New N02	0.467	0.698	0.201					1.366
New N03	0.000	2.321	0.668					2.990
New N04	0.000	0.224	0.064					0.288
New N05	0.519	1.001	0.288					1.809
New N06	0.000	0.804	0.232					1.036
Totals	66.756	11.576	3.333	0.124	0.027	0.002	0.851	82.669

Allocation of Joint Costs as Percentages of the Total for File: scen04x.
Part Two of Two

	NAV	PWR	TRN	TOU	FIS	FLD	TOTAL	
Stem	2.488	1.097	1.010	5.788	0.000	0.000	10.383	
HAD	0.197	1.667	0.013	1.667	0.190	3.215	6.948	
Totals	2.685	2.763	1.023	7.455	0.190	3.215	17.331	100.000

Allocation of Costs by Major Categories for File: scen04x.
Present Value (P.V.) and Annual Cost (A.C.).

CATEGORY	--------JOINT COST--------			---TOTAL COST---	
	P.V. m LE	A.C. m LE/YR	%	P.V. m LE	A.C. m LE/YR
Existing Ag	4794.4	595.19	73.22	5571.1	691.62
New New Land	552.7	68.61	8.44		
Water Supply	10.0	1.24	0.15		
Navigation	231.5	28.75	3.54		
Power	180.9	22.46	2.76		
Transport	67.0	8.32	1.02		
Tourism	488.1	60.59	7.45		
Fishery	12.4	1.54	0.19		
Flood Cntrl	210.5	26.13	3.21		
TOTALS	6547.6	812.84	100.00	5571.1	691.62

Allocation of Annual Costs (A.C.) by Hierarchy for File: scen04x.
Annual Costs Allocated to Existing Agriculture

	Area mil FD	Water mil M3	Annual Cost	A.C./FD LE/FD	A.C./1000M3 LE/1000M3
JOINT COSTS					
HAD	6.599	46569.9	13.546	2.053	0.291
Stem	6.599	46569.9	47.048	7.130	1.010
Upper Egypt	0.762	6340.0	63.450	83.268	10.008
Middle Egypt	1.524	11263.0	122.778	80.563	10.901
East Delta	1.581	10154.0	130.134	82.311	12.816
Middle Delta	1.439	10609.0	116.893	81.232	11.018
West Delta	1.293	8204.0	101.344	78.379	12.353
DRAIN COSTS	6.599	46569.9	96.422	14.612	2.070
TOTAL COSTS					
Upper Egypt	0.762	6340.0	81.581	107.062	12.868
Middle Egypt	1.524	11263.0	159.040	104.357	14.121
East Delta	1.581	10154.0	167.752	106.105	16.521
Middle Delta	1.439	10609.0	151.132	105.026	14.246
West Delta	1.293	8204.0	132.110	102.173	16.103
FLAT RATE				104.806	14.851

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Cost Allocation for Region #01 UpperEgypt, pump costs.
Cost to be allocated = 210.6

	AGRIC	R.W.S.	Totals
(1) Project benefits	4196.8	0.7	4197.5
(2) Alternative Costs	210.6	483.3	693.9
(3) Justifiable Costs	210.6	0.7	211.3
(10) Joint Cost Propor	0.9966	0.0034	1.0000
(11) Allocated Joint Cost	209.9	0.7	210.6
(12) Total Service Cost	209.9	0.7	210.6
(13) Percentages	99.66	0.34	1.0000

Cost Allocation for Region #01 UpperEgypt, non-navigable canal.
Cost to be allocated = 301.5

	AGRIC	R.W.S.	Totals
(1) Project benefits	4196.8	0.7	4197.5
(2) Alternative Costs	811.7	483.3	1295.0
(3) Justifiable Costs	811.7	0.7	812.4
(10) Joint Cost Propor	0.9991	0.0009	1.0000
(11) Allocated Joint Cost	301.2	0.3	301.5
(12) Total Service Cost	301.2	0.3	301.5
(13) Percentages	99.91	0.09	1.0000

Cost Allocation for Region #02 Middle, pump costs.
Cost to be allocated = 421.2

	AGRIC	R.W.S.	Totals
(1) Project benefits	15981.5	1.5	15983.0
(2) Alternative Costs	421.2	725.0	1146.2
(3) Justifiable Costs	421.2	1.5	422.7
(10) Joint Cost Propor	0.9964	0.0036	1.0000
(11) Allocated Joint Cost	419.7	1.5	421.2
(12) Total Service Cost	419.7	1.5	421.2
(13) Percentages	99.64	0.36	1.0000

Cost Allocation for Region #02 Middle, non-navigable canal.
Cost to be allocated = 598.3

	AGRIC	R.W.S.	Totals
(1) Project benefits	15858.4	1.5	15859.9
(2) Alternative Costs	1207.9	719.4	1927.3
(3) Justifiable Costs	1207.9	1.5	1209.4
(10) Joint Cost Propor	0.9988	0.0012	1.0000
(11) Allocated Joint Cost	597.6	0.7	598.3
(12) Total Service Cost	597.6	0.7	598.3
(13) Percentages	99.88	0.12	1.0000

Cost Allocation for Region #02 Middle, navigable canal costs.
Cost to be allocated = 4.6

	AGRIC	R.W.S.	NAVIG	Totals
(1) Project benefits	123.1	0.0	11.4	134.5
(2) Alternative Costs	9.4	5.6	9.4	24.3
(3) Justifiable Costs	9.4	0.0	9.4	18.8
(10) Joint Cost Propor	0.4997	0.0006	0.4997	1.0000
(11) Allocated Joint Cost	2.3	0.0	2.3	4.6
(12) Total Service Cost	2.3	0.0	2.3	4.6
(13) Percentages	49.97	0.06	49.97	1.0000

Cost Allocation for Region #03 EastDelta, pump costs.
Cost to be allocated = 437.0

	AGRIC	R.W.S.	Totals
(1) Project benefits	14579.9	1.2	14581.0
(2) Alternative Costs	437.0	1611.0	2048.0
(3) Justifiable Costs	437.0	1.2	438.1
(10) Joint Cost Propor	0.9973	0.0027	1.0000
(11) Allocated Joint Cost	435.8	1.2	437.0
(12) Total Service Cost	435.8	1.2	437.0
(13) Percentages	99.73	0.27	1.0000

Cost Allocation for Region #03 EastDelta, non-navigable canal.
Cost to be allocated = 600.5

	AGRIC	R.W.S.	Totals
(1) Project benefits	13996.7	1.1	13997.8
(2) Alternative Costs	1175.6	1546.6	2722.2
(3) Justifiable Costs	1175.6	1.1	1176.7
(10) Joint Cost Propor	0.9991	0.0009	1.0000
(11) Allocated Joint Cost	600.0	0.6	600.5
(12) Total Service Cost	600.0	0.6	600.5
(13) Percentages	99.91	0.09	1.0000

Cost Allocation for Region #03 EastDelta, navigable canal costs.
Cost to be allocated = 25.0

	AGRIC	R.W.S.	NAVIG	Totals
(1) Project benefits	583.2	0.0	58.3	641.6
(2) Alternative Costs	49.0	64.4	49.0	162.4
(3) Justifiable Costs	49.0	0.0	49.0	98.0
(10) Joint Cost Propor	0.4998	0.0005	0.4998	1.0000
(11) Allocated Joint Cost	12.5	0.0	12.5	25.0
(12) Total Service Cost	12.5	0.0	12.5	25.0
(13) Percentages	49.98	0.05	49.98	1.0000

Cost Allocation for Region #04 MiddleDelta, pump costs.
Cost to be allocated = 397.7

	AGRIC	R.W.S.	Totals
(1) Project benefits	9666.2	1.2	9667.4
(2) Alternative Costs	397.7	805.5	1203.2
(3) Justifiable Costs	397.7	1.2	398.9
(10) Joint Cost Propor	0.9970	0.0030	1.0000
(11) Allocated Joint Cost	396.5	1.2	397.7
(12) Total Service Cost	396.5	1.2	397.7
(13) Percentages	99.70	0.30	1.0000

Cost Allocation for Region #04 MiddleDelta, non-navigable canal.
Cost to be allocated = 522.1

	AGRIC	R.W.S.	Totals
(1) Project benefits	8863.9	1.1	8865.0
(2) Alternative Costs	938.8	738.7	1677.5
(3) Justifiable Costs	938.8	1.1	940.0
(10) Joint Cost Propor	0.9988	0.0012	1.0000
(11) Allocated Joint Cost	521.5	0.6	522.1
(12) Total Service Cost	521.5	0.6	522.1
(13) Percentages	99.88	0.12	1.0000

Cost Allocation for Region #04 MiddleDelta, navigable canal costs.
Cost to be allocated = 47.3

	AGRIC	R.W.S.	NAVIG	Totals
(1) Project benefits	802.3	0.1	91.7	894.1
(2) Alternative Costs	85.0	66.9	85.0	236.8
(3) Justifiable Costs	85.0	0.1	85.0	170.1
(10) Joint Cost Propor	0.4997	0.0006	0.4997	1.0000
(11) Allocated Joint Cost	23.6	0.0	23.6	47.3
(12) Total Service Cost	23.6	0.0	23.6	47.3
(13) Percentages	49.97	0.06	49.97	1.0000

Cost Allocation for Region #05 WestDelta, pump costs.
Cost to be allocated = 357.4

	AGRIC	R.W.S.	Totals
(1) Project benefits	5388.9	0.8	5389.7
(2) Alternative Costs	357.4	805.5	1162.9
(3) Justifiable Costs	357.4	0.8	358.1
(10) Joint Cost Propor	0.9978	0.0022	1.0000
(11) Allocated Joint Cost	356.6	0.8	357.4
(12) Total Service Cost	356.6	0.8	357.4
(13) Percentages	99.78	0.22	1.0000

Cost Allocation for Region #05 WestDelta, non-navigable canal.
Cost to be allocated = 474.3

	AGRIC	R.W.S.	Totals
(1) Project benefits	4995.5	0.7	4996.3
(2) Alternative Costs	733.8	746.7	1480.5
(3) Justifiable Costs	733.8	0.7	734.5
(10) Joint Cost Propor	0.9990	0.0010	1.0000
(11) Allocated Joint Cost	473.8	0.5	474.3
(12) Total Service Cost	473.8	0.5	474.3
(13) Percentages	99.90	0.10	1.0000

Cost Allocation for Region #05 WestDelta, navigable canal costs.
Cost to be allocated = 37.3

	AGRIC	R.W.S.	NAVIG	Totals
(1) Project benefits	393.4	0.1	49.9	443.4
(2) Alternative Costs	57.8	58.8	57.8	174.4
(3) Justifiable Costs	57.8	0.1	49.9	107.8
(10) Joint Cost Propor	0.5361	0.0005	0.4633	1.0000
(11) Allocated Joint Cost	20.0	0.0	17.3	37.3
(12) Total Service Cost	20.0	0.0	17.3	37.3
(13) Percentages	53.61	0.05	46.33	1.0000

Cost Allocation for New Land Region #01 NewLand-1
Share Ag costs with #01 UpperEgypt
Cost to be allocated = 0.0

OLD AG NEW AG Totals

Cost for allocation is zero, skip this analysis.

Cost Allocation for New Land Region #02 NewLand-2
Share Ag costs with #02 Middle
Cost to be allocated = 61.2

	OLD AG	NEW AG	Totals
(1) Project benefits	15981.5	788.4	16769.9
(2) Alternative Costs	73.0	73.0	146.1
(3) Justifiable Costs	73.0	73.0	146.1
(10) Joint Cost Propor	0.5000	0.5000	1.0000
(11) Allocated Joint Cost	30.6	30.6	61.2
(12) Total Service Cost	30.6	30.6	61.2
(13) Percentages	50.00	50.00	1.0000

Cost Allocation for New Land Region #03 NewLand-3
Share Ag costs with #03 EastDelta
Cost to be allocated = 0.0

OLD AG NEW AG Totals

Cost for allocation is zero, skip this analysis.

Cost Allocation for New Land Region #04 NewLand-4
Share Ag costs with #04 MiddleDelta
Cost to be allocated = 0.0

OLD AG NEW AG Totals

Cost for allocation is zero, skip this analysis.

Cost Allocation for New Land Region #05 NewLand-5
Share Ag costs with #05 WestDelta
Cost to be allocated = 68.0

	OLD AG	NEW AG	Totals
(1) Project benefits	5388.9	1131.8	6520.7
(2) Alternative Costs	63.3	63.3	126.7
(3) Justifiable Costs	63.3	63.3	126.7
(10) Joint Cost Propor	0.5000	0.5000	1.0000
(11) Allocated Joint Cost	34.0	34.0	68.0
(12) Total Service Cost	34.0	34.0	68.0
(13) Percentages	50.00	50.00	1.0000

Cost Allocation for New Land Region #06 NewLand-6
Share Ag costs with #03 EastDelta
Cost to be allocated = 0.0

	OLD AG	NEW AG	Totals

Cost for allocation is zero, skip this analysis.

Cost Allocation for Main Stem Barrages Excluding Esna.
Cost to be allocated = 1116.9

	OLD AG	R.W.S.	NAVIG	NEW AG	POWER	TRANS	RECR&T	Totals
(1) Project benefits	49813.3	5.4	501.4	6543.0	0.0	203.6	7410.8	64477.4
(2) Alternative Costs	1116.9	1116.9	1116.9	1116.9	0.0	204.3	1116.9	5788.7
(3) Justifiable Costs	1116.9	5.4	501.4	1116.9	0.0	203.6	1116.9	4061.0
(10) Joint Cost Propor	0.2750	0.0013	0.1235	0.2750	0.0000	0.0501	0.2750	1.0000
(11) Allocated Joint Cost	307.2	1.5	137.9	307.2	0.0	56.0	307.2	1116.9
(12) Total Service Cost	307.2	1.5	137.9	307.2	0.0	56.0	307.2	1116.9
(13) Percentages	27.50	0.13	12.35	27.50	0.00	5.01	27.50	1.0000

Cost Allocation for Main Stem Esna Barrage.
Cost to be allocated = 322.7

	OLD AG	R.W.S.	NAVIG	NEW AG	POWER	TRANS	RECR&T	Totals
(1) Project benefits	11165.5	1.2	112.4	1466.6	2416.6	45.6	1661.1	16869.0
(2) Alternative Costs	322.7	322.7	322.7	322.7	322.7	45.8	322.7	1981.8
(3) Justifiable Costs	322.7	1.2	112.4	322.7	322.7	45.6	322.7	1449.9
(10) Joint Cost Propor	0.2225	0.0008	0.0775	0.2225	0.2225	0.0315	0.2225	1.0000
(11) Allocated Joint Cost	71.8	0.3	25.0	71.8	71.8	10.2	71.8	322.7
(12) Total Service Cost	71.8	0.3	25.0	71.8	71.8	10.2	71.8	322.7
(13) Percentages	22.25	0.08	7.75	22.25	22.25	3.15	22.25	1.0000

Cost Allocation for High Aswan Dam.
Cost to be allocated = 673.3

	OLD AG	R.W.S.	NAVIG	NEW AG	POWER	G.TRAN	RECR&T	FISH	FLOOD	Totals
(1) Project benefits	49813.3	5.4	501.4	6543.0	45310.4	32.5	7410.8	483.3	2254.6	112354.6
(2) Alternative Costs	4238.0	1187.0	4238.0	4238.0	4238.0	32.5	4238.0	4238.0	2518.9	29166.2
(3) Justifiable Costs	4238.0	5.4	501.4	4238.0	4238.0	32.5	4238.0	483.3	2254.6	20229.0
(4) Separable Costs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	170.4	170.4
(5) Cost Other Purposes	673.3	673.3	673.3	673.3	673.3	673.3	673.3	673.3	502.9	5889.3
(6) Just Cost Other Purp	673.3	673.3	673.3	673.3	673.3	673.3	673.3	673.3	502.9	5889.3
(7) Adjustment Factor	7.2943	1.0080	1.7446	7.2943	7.2943	1.0483	7.2943	1.7178	4.0954	
(8) Adj Separable Costs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	697.9	
(9) Remaining Benefits	4238.0	5.4	501.4	4238.0	4238.0	32.5	4238.0	483.3	1556.6	19531.1
(10) Joint Cost Propor	0.2170	0.0003	0.0257	0.2170	0.2170	0.0017	0.2170	0.0247	0.0797	1.0000
(11) Allocated Joint Cost	109.1	0.1	12.9	109.1	109.1	0.8	109.1	12.4	40.1	502.9
(12) Total Service Cost	109.1	0.1	12.9	109.1	109.1	0.8	109.1	12.4	210.5	673.3
(13) Percentages	16.21	0.02	1.92	16.21	16.21	0.12	16.21	1.85	31.26	1.0000

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File name: scen04x.ECH
TABLE 1. THE HIGH ASWAN DAM (IMPHAD.WB1).
Costs and Benefits for Improved O&M.

BASIN DISCOUNT RATE (%):	12.0		
BASIN PLANNING HORIZON (YRS):	30		
NUMBER OF OLD REGIONS:	5		
NUMBER OF NEW REGIONS:	6		
ANNUAL COST FOR DRAINAGE (mil LE/Yr	96.422	776.70	96.422
HAD BENEFITS			
FLOOD CONTROL (% of total benefit	4.0		
SINGLE PURPOSE ALTERNATIVES			
AG, NAV, POWER, FISH (% of OM&R):	74.700		
FLOOD CONTROL (% of OM&R):	44.400		
SEPARABLE COSTS			
AGRICULTURE (% of O&M):	0.00		
POWER (% of O&M):	0.00		
FLOOD (% of O&M):	25.31		

YEAR	------ HAD BENEFITS -----			-SINGLE PURPOSE ALTERN-			ANNUAL
	HYDRO POWER	GROUND TRANSP	FISHERY	WATER SUPPLY	GROUND TRANSP	COMMON WORKS REPLACE	COMMON WORKS O&M
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
p. val	45310.42	32.54	483.31	1187.01	32.54	5000.00	673.30

Present value SPA Other	4238.0
Present value SPA Flood	2518.9
Pres. val. separable Agri.	0.0
Pres. val. separable Power	0.0
Pres. val. separable Flood	170.4

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File name: scen04x.STM
TABLE 2: MAIN STEM OF THE NILE (IMPSTM.WB1)
Costs and Benefits for Improved O&M

YEAR				BEN	SINGLE	STEM	ESNA
	NAVIG	HYDRO POWER ESNA	GROUND TRANSP	RECREA & TOURISM	PURPOSE ALTERN COST TRANSP	COSTS EXCEPT HAD & ESNA	COMMON WORKS COSTS
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
p. val	289.99	2416.56	203.59	7410.77	204.31	1116.87	322.67

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File name: scen04x.R01
TABLE 3. INPUT FOR OLD REGION (IMPRxx.WB1)
Costs and Benefits for Improved O&M.

REGION NAME:	UpperEgypt
REGION NUMBER:	1
AGRICULTURAL AREA (mil FED):	0.762
WATER CONSUMPTION (M3/FD):	8320.200, = 6340.0 (mil M3).
POPULATION (millions):	5.520
WETTED PERIMETER OF CANALS (meters)	61.7
PERCENT OF CANALS NAVIGABLE (%):	0.0

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
p. val	4196.75	0.73	0.00	510.18	483.31	301.49	210.60

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File name: scen04x.R02
TABLE 3. INPUT FOR OLD REGION (IMPRxx.WB1).
Costs and Benefits for Improved O&M.

REGION NAME:	Middle
REGION NUMBER:	2
AGRICULTURAL AREA (mil FED):	1.524
WATER CONSUMPTION (M3/FD):	7390.400, = 11263.0 (mil M3).
POPULATION (millions):	11.590
WETTED PERIMETER OF CANALS (meters)	71.8
PERCENT OF CANALS NAVIGABLE (%):	0.8

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
p. val	15981.49	1.52	11.44	614.29	724.97	602.99	421.18

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File name: scen04x.R03
TABLE 3. INPUT FOR OLD REGION (IMPRxx.WB1)
Costs and Benefits for Improved O&M.

REGION NAME: EastDelta
REGION NUMBER: 3

AGRICULTURAL AREA (mil FED): 1.581
WATER CONSUMPTION (M3/FD): 6422.500, = 10154.0 (mil M3).
POPULATION (millions): 8.570
WETTED PERIMETER OF CANALS (meters) 72.5
PERCENT OF CANALS NAVIGABLE (%): 4.0

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES			COSTS
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
p. val	14579.88	1.16	58.32	599.02	1611.04	625.54	436.96

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File name: scen04x.R04
TABLE 3. INPUT FOR OLD REGION (IMPRxx.WB1).
Costs and Benefits for Improved O&M

REGION NAME: MiddleDelta
REGION NUMBER: 4

AGRICULTURAL AREA (mil FED): 1.439
WATER CONSUMPTION (M3/FD): 7372.500, = 10609.0 (mil M3).
POPULATION (millions): 9.050
WETTED PERIMETER OF CANALS (meters) 55.1
PERCENT OF CANALS NAVIGABLE (%): 8.3

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES			COSTS
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
p. val	9666.22	1.21	91.67	454.46	805.52	569.36	397.69

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File name: scen04x.R05

TABLE 3. INPUT FOR OLD REGION (IMPRxx.WB1).

Costs and Benefits for Improved O&M.

REGION NAME: WestDelta

REGION NUMBER: 5

AGRICULTURAL AREA (mil FED): 1.293

WATER CONSUMPTION (M3/FD): 6344.900, = 8204.0 (mil M3).

POPULATION (millions): 6.180

WETTED PERIMETER OF CANALS (meters) 37.0

PERCENT OF CANALS NAVIGABLE (%): 7.3

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
p. val	5388.92	0.80	49.94	279.98	805.52	511.60	357.35

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File name: scen04x.N01

TABLE 4. INPUT FOR NEW LAND REGIONS (BASNxx.WB1).

Costs and Benefits for New Lands.

REGION NAME: NewLand-1

NEW REGION NUMBER: 1

NUMBER OF UPSTREAM OLD REGION: 1

FACTOR OF OLD CANALS DELIVERING WAT 0.000

POTENTIAL AGRICULTURAL AREA (mil FE 0.2

WATER CONSUMPTION (M3/FD): 6454.000, = 1258.5299 (mil M3).

YEAR	BENEFIT AGRICUL	AN. COST CAP, O&M	IRRIG AREA	NEW DELIVERY SYSTEMS
	(m LE)	(m LE)	(mil FD)	(m LE)
p. val	835.5	72.5		345.0

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File name: scen04x.N02

TABLE 4. INPUT FOR NEW LAND REGIONS (BASNxx.WB1).

Costs and Benefits for New Lands.

REGION NAME: NewLand-2

NEW REGION NUMBER: 2

NUMBER OF UPSTREAM OLD REGION: 2

FACTOR OF OLD CANALS DELIVERING WAT 0.060

POTENTIAL AGRICULTURAL AREA (mil FE 0.2

WATER CONSUMPTION (M3/FD): 6454.000, = 1187.5360 (mil M3).

YEAR	BENEFITAN. COST AGRICULCAP, O&M		IRRIG AREA	NEW DELIVERY SYSTEMS
	(m LE)	(m LE)	(mil FD)	(m LE)
p. val	788.4	71.2		7.6

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File name: scen04x.N03
TABLE 4. INPUT FOR NEW LAND REGIONS (BASNxx.WB1).
Costs and Benefits for New Lands.

REGION NAME:                                  NewLand-3
NEW REGION NUMBER:                             3
NUMBER OF UPSTREAM OLD REGION:                 3
FACTOR OF OLD CANALS DELIVERING WAT        0.000
POTENTIAL AGRICULTURAL AREA (mil FE       0.6
WATER CONSUMPTION (M3/FD):              6454.000,  =  3949.8479 (mil M3).

           BENEFIT AN. COST  IRRIG     NEW
  YEAR     AGRICULCAP, O&M   AREA    DELIVERY
                                     SYSTEMS
          (m LE)   (m LE)   (mil FD) (m LE)

p. val   2624.4    237.2             427.7
/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/
File name: scen04x.N04
TABLE 4. INPUT FOR NEW LAND REGIONS (BASNxx.WB1).
Costs and Benefits for New Lands.

REGION NAME:                                  NewLand-4
NEW REGION NUMBER:                             4
NUMBER OF UPSTREAM OLD REGION:                 4
FACTOR OF OLD CANALS DELIVERING WAT        0.000
POTENTIAL AGRICULTURAL AREA (mil FE       0.1
WATER CONSUMPTION (M3/FD):              6454.000,  =   380.7860 (mil M3).

           BENEFIT AN. COST  IRRIG     NEW
  YEAR     AGRICULCAP, O&M   AREA    DELIVERY
                                     SYSTEMS
          (m LE)   (m LE)   (mil FD) (m LE)

p. val    254.0     22.7              71.1
/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/
File name: scen04x.N05
TABLE 4. INPUT FOR NEW LAND REGION (BASNxx.WB1).
Costs and Benefits for New Lands.

REGION NAME:                                  NewLand-5
NEW REGION NUMBER:                             5
NUMBER OF UPSTREAM OLD REGION:                 5
FACTOR OF OLD CANALS DELIVERING WAT        0.080
POTENTIAL AGRICULTURAL AREA (mil FE       0.3
WATER CONSUMPTION (M3/FD):              6454.000,  =  1703.8560 (mil M3).

           BENEFIT AN. COST  IRRIG     NEW
  YEAR     AGRICULCAP, O&M   AREA    DELIVERY
                                     SYSTEMS
          (m LE)   (m LE)  (mil  FD) (m LE)

p. val   1131.8    102.2             156.5
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File name: scen04x.N06
TABLE 4. INPUT FOR NEW LAND REGIONS (BASNxx.WQ1).
Costs and Benefits for New Lands.

REGION NAME: NewLand-6
NEW REGION NUMBER: 6
NUMBER OF UPSTREAM OLD REGION: 3
FACTOR OF OLD CANALS DELIVERING WAT 0.000
POTENTIAL AGRICULTURAL AREA (mil FE 0.2
WATER CONSUMPTION (M3/FD): 6454.000, = 1368.2479 (mil M3).

YEAR	BENEFIT AGRICUL (mil LE)	AN. COST CAP, O&M (mil LE)	IRRIG AREA (mil FD)	NEW DELIVERY SYSTEMS (m LE)
p. val	909.0	82.0		4463.3

TABLE 1. THE HIGH ASWAN DAM (IMPHAD.WB1).
Costs and Benefits for Improved O&M.

BASIN DISCOUNT RATE (%):	12	
BASIN PLANNING HORIZON (YRS):	30	
NUMBER OF OLD REGIONS:	5	
NUMBER OF NEW REGIONS:	6	
ANNUAL COST FOR DRAINAGE (mil LE/Yr @ %):	96.422	12
HAD BENEFITS		
FLOOD CONTROL (% of total benefits):	4	
SINGLE PURPOSE ALTERNATIVES		
AG, NAV, POWER, FISH (% of OM&R):	74.7	
FLOOD CONTROL (% of OM&R):	44.4	
SEPARABLE COSTS		
AGRICULTURE (% of O&M):	0	
POWER (% of O&M):	0	
FLOOD (% of O&M):	25.31	

YEAR	------ HAD BENEFITS -----			-SINGLE PURPOSE ALTERN-			ANNUAL COMMON WORKS O&M (m LE)
	HYDRO POWER (m LE)	GROUND TRANSP (m LE)	FISHERY (m LE)	WATER SUPPLY (m LE)	GROUND TRANSP (m LE)	COMMON WORKS REPLACE (m LE)	
1	5625	35	60	1165	35	5600	78.45
2	5625	0.18	60	20.5	0.18	0	75.59
3	5625	0.18	60	20.5	0.18	0	89.73
4	5625	0.18	60	20.5	0.18	0	84.90
5	5625	0.18	60	20.5	0.18	0	80.19
6	5625	0.18	60	20.5	0.18	0	65.09
7	5625	0.18	60	20.5	0.18	0	67.68
8	5625	0.18	60	20.5	0.18	0	73.99
9	5625	0.18	60	20.5	0.18	0	78.54
10	5625	0.18	60	20.5	0.18	0	82.35
11	5625	0.18	60	20.5	0.18	0	88.46
12	5625	0.18	60	20.5	0.18	0	87.32
13	5625	0.18	60	20.5	0.18	0	87.76
14	5625	0.18	60	20.5	0.18	0	88.10
15	5625	0.18	60	20.5	0.18	0	88.85
16	5625	0.18	60	20.5	0.18	0	105.27
17	5625	0.18	60	20.5	0.18	0	104.30
18	5625	0.18	60	20.5	0.18	0	106.52
19	5625	0.18	60	20.5	0.18	0	105.55
20	5625	0.18	60	20.5	0.18	0	104.47
21	5625	0.18	60	20.5	0.18	0	102.86
22	5625	0.18	60	20.5	0.18	0	101.87
23	5625	0.18	60	20.5	0.18	0	101.69
24	5625	0.18	60	20.5	0.18	0	102.07
25	5625	0.18	60	20.5	0.18	0	100.55
26	5625	0.18	60	20.5	0.18	0	104.38
27	5625	0.18	60	20.5	0.18	0	101.99
28	5625	0.18	60	20.5	0.18	0	101.94
29	5625	0.18	60	20.5	0.18	0	102.59
30	5625	0.18	60	20.5	0.18	0	101.63

TABLE 2: MAIN STEM OF THE NILE (IMPSTM.WB1)
Costs and Benefits for Improved O&M

YEAR	NAVIG (m LE)	HYDRO POWER ESNA (m LE)	GROUND TRANSP (m LE)	BEN RECREA & TOURISM (m LE)	SINGLE PURPOSE ALTERN COST TRANSP (m LE)	STEM COSTS EXCEPT HAD & ESNA (m LE)	ESNA COMMON WORKS COSTS (m LE)
1	36	300	220	920	220	114.35	147.98
2	36	300	1	920	1.1	134.83	156.01
3	36	300	1	920	1.1	159.86	14.08
4	36	300	1	920	1.1	146.75	38.30
5	36	300	1	920	1.1	114.34	17.53
6	36	300	1	920	1.1	83.80	1.71
7	36	300	1	920	1.1	115.97	2.35
8	36	300	1	920	1.1	132.14	3.75
9	36	300	1	920	1.1	201.33	4.12
10	36	300	1	920	1.1	237.80	3.99
11	36	300	1	920	1.1	211.76	4.09
12	36	300	1	920	1.1	214.37	4.14
13	36	300	1	920	1.1	188.31	4.15
14	36	300	1	920	1.1	145.47	4.17
15	36	300	1	920	1.1	106.91	4.77
16	36	300	1	920	1.1	103.94	4.57
17	36	300	1	920	1.1	101.71	4.17
18	36	300	1	920	1.1	98.91	4.17
19	36	300	1	920	1.1	97.02	4.17
20	36	300	1	920	1.1	96.36	4.17
21	36	300	1	920	1.1	107.20	4.17
22	36	300	1	920	1.1	109.22	4.77
23	36	300	1	920	1.1	106.46	4.57
24	36	300	1	920	1.1	102.61	4.17
25	36	300	1	920	1.1	99.59	4.17
26	36	300	1	920	1.1	114.17	44.77
27	36	300	1	920	1.1	115.58	52.17
28	36	300	1	920	1.1	120.84	8.77
29	36	300	1	920	1.1	114.29	20.57
30	36	300	1	920	1.1	104.86	10.61

TABLE 3. INPUT FOR OLD REGION (IMPRxx.WB1)
Costs and Benefits for Improved O&M.

REGION NAME: UpperEgypt
REGION NUMBER: 1

AGRICULTURAL AREA (mil FED): 0.762
WATER CONSUMPTION (M3/FD): 8320.2
POPULATION (millions): 5.52
WETTED PERIMETER OF CANALS (meters): 61.7
PERCENT OF CANALS NAVIGABLE (%): 0

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
1	521	0.58	0	571.4	60	28.04	20.10
2	521	0.029	0	0	60	29.20	27.70
3	521	0.029	0	0	60	29.71	34.15
4	521	0.029	0	0	60	32.38	29.04
5	521	0.029	0	0	60	33.91	20.31
6	521	0.029	0	0	60	42.40	18.68
7	521	0.029	0	0	60	42.66	26.28
8	521	0.029	0	0	60	41.83	32.76
9	521	0.029	0	0	60	40.57	27.68
10	521	0.029	0	0	60	40.44	18.98
11	521	0.029	0	0	60	45.74	17.33
12	521	0.029	0	0	60	45.22	24.89
13	521	0.029	0	0	60	44.06	31.34
14	521	0.029	0	0	60	41.76	26.27
15	521	0.029	0	0	60	41.32	17.58
16	521	0.029	0	0	60	46.20	20.04
17	521	0.029	0	0	60	46.22	33.65
18	521	0.029	0	0	60	44.80	45.20
19	521	0.029	0	0	60	42.96	36.03
20	521	0.029	0	0	60	42.62	20.40
21	521	0.029	0	0	60	46.07	20.04
22	521	0.029	0	0	60	46.28	33.67
23	521	0.029	0	0	60	45.08	45.25
24	521	0.029	0	0	60	43.21	36.12
25	521	0.029	0	0	60	42.93	20.46
26	521	0.029	0	0	60	46.86	20.06
27	521	0.029	0	0	60	46.84	33.67
28	521	0.029	0	0	60	45.62	45.25
29	521	0.029	0	0	60	43.77	36.14
30	521	0.029	0	0	60	43.47	20.52

TABLE 3. INPUT FOR OLD REGION (IMPRxx.WB1).
Costs and Benefits for Improved O&M.

REGION NAME: Middle Egypt
REGION NUMBER: 2

AGRICULTURAL AREA (mil FED): 1.524
WATER CONSUMPTION (M3/FD): 7390.4
POPULATION (millions): 11.59
WETTED PERIMETER OF CANALS (meters): 71.8
PERCENT OF CANALS NAVIGABLE (%): 0.77

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
1	1984	1.22	1.42	688	90	56.08	40.20
2	1984	0.06	1.42	0	90	58.40	55.39
3	1984	0.06	1.42	0	90	59.43	68.30
4	1984	0.06	1.42	0	90	64.75	58.08
5	1984	0.06	1.42	0	90	67.82	40.61
6	1984	0.06	1.42	0	90	84.80	37.37
7	1984	0.06	1.42	0	90	85.33	52.56
8	1984	0.06	1.42	0	90	83.66	65.52
9	1984	0.06	1.42	0	90	81.14	55.37
10	1984	0.06	1.42	0	90	80.87	37.95
11	1984	0.06	1.42	0	90	91.48	34.66
12	1984	0.06	1.42	0	90	90.43	49.77
13	1984	0.06	1.42	0	90	88.13	62.66
14	1984	0.06	1.42	0	90	83.52	52.53
15	1984	0.06	1.42	0	90	82.64	35.16
16	1984	0.06	1.42	0	90	92.39	40.08
17	1984	0.06	1.42	0	90	92.44	67.29
18	1984	0.06	1.42	0	90	89.60	90.39
19	1984	0.06	1.42	0	90	85.91	72.06
20	1984	0.06	1.42	0	90	85.25	40.79
21	1984	0.06	1.42	0	90	92.14	40.08
22	1984	0.06	1.42	0	90	92.57	67.34
23	1984	0.06	1.42	0	90	90.15	90.51
24	1984	0.06	1.42	0	90	86.42	72.23
25	1984	0.06	1.42	0	90	85.86	40.92
26	1984	0.06	1.42	0	90	93.72	40.12
27	1984	0.06	1.42	0	90	93.68	67.34
28	1984	0.06	1.42	0	90	91.25	90.51
29	1984	0.06	1.42	0	90	87.54	72.28
30	1984	0.06	1.42	0	90	86.95	41.03

TABLE 3. INPUT FOR OLD REGION (IMPRxx.WB1)
Costs and Benefits for Improved O&M.

.REGION NAME: EastDelta
REGION NUMBER: 3

AGRICULTURAL AREA (mil FED): 1.581
WATER CONSUMPTION (M3/FD): 6422.5
POPULATION (millions): 8.57
WETTED PERIMETER OF CANALS (meters): 72.5
PERCENT OF CANALS NAVIGABLE (%): 4

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
1	1810	0.9	7.24	670.9	200	58.18	41.71
2	1810	0.05	7.24	0	200	60.58	57.46
3	1810	0.05	7.24	0	200	61.65	70.86
4	1810	0.05	7.24	0	200	67.17	60.26
5	1810	0.05	7.24	0	200	70.36	42.13
6	1810	0.05	7.24	0	200	87.97	38.77
7	1810	0.05	7.24	0	200	88.52	54.53
8	1810	0.05	7.24	0	200	86.79	67.97
9	1810	0.05	7.24	0	200	84.17	57.44
10	1810	0.05	7.24	0	200	83.90	39.37
11	1810	0.05	7.24	0	200	94.90	35.96
12	1810	0.05	7.24	0	200	93.82	51.63
13	1810	0.05	7.24	0	200	91.43	65.03
14	1810	0.05	7.24	0	200	86.64	54.50
15	1810	0.05	7.24	0	200	85.74	36.48
16	1810	0.05	7.24	0	200	95.85	41.57
17	1810	0.05	7.24	0	200	95.90	69.81
18	1810	0.05	7.24	0	200	92.95	93.78
19	1810	0.05	7.24	0	200	89.13	74.76
20	1810	0.05	7.24	0	200	88.44	42.32
21	1810	0.05	7.24	0	200	95.59	41.57
22	1810	0.05	7.24	0	200	96.03	69.86
23	1810	0.05	7.24	0	200	93.53	93.89
24	1810	0.05	7.24	0	200	89.65	74.93
25	1810	0.05	7.24	0	200	89.07	42.45
26	1810	0.05	7.24	0	200	97.22	41.62
27	1810	0.05	7.24	0	200	97.18	69.86
28	1810	0.05	7.24	0	200	94.66	93.89
29	1810	0.05	7.24	0	200	90.81	74.98
30	1810	0.05	7.24	0	200	90.20	42.57

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TABLE 3. INPUT FOR OLD REGION (IMPRxx.WB1).
Costs and Benefits for Improved O&M

REGION NAME:	MiddleDelta
REGION NUMBER:	4
AGRICULTURAL AREA (mil FED):	1.439
WATER CONSUMPTION (M3/FD):	7372.5
POPULATION (millions):	9.05
WETTED PERIMETER OF CANALS (meters):	55.1
PERCENT OF CANALS NAVIGABLE (%):	8.3

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES		COSTS	
	AGRI	WATER SUPPLY	NAVIG	CANAL REPALCE	WATER SUPPLY	CANAL O&M	SYSTEM PUMPS OM&R
	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)	(m LE)
1	1200	0.95	11.38	509	100	52.96	37.96
2	1200	0.05	11.38	0	100	55.14	52.30
3	1200	0.05	11.38	0	100	56.11	64.49
4	1200	0.05	11.38	0	100	61.14	54.84
5	1200	0.05	11.38	0	100	64.04	38.35
6	1200	0.05	11.38	0	100	80.07	35.28
7	1200	0.05	11.38	0	100	80.57	49.63
8	1200	0.05	11.38	0	100	78.99	61.86
9	1200	0.05	11.38	0	100	76.61	52.28
10	1200	0.05	11.38	0	100	76.36	35.84
11	1200	0.05	11.38	0	100	86.38	32.73
12	1200	0.05	11.38	0	100	85.39	47.00
13	1200	0.05	11.38	0	100	83.21	59.19
14	1200	0.05	11.38	0	100	78.86	49.60
15	1200	0.05	11.38	0	100	78.04	33.20
16	1200	0.05	11.38	0	100	87.24	37.84
17	1200	0.05	11.38	0	100	87.28	63.54
18	1200	0.05	11.38	0	100	84.61	85.35
19	1200	0.05	11.38	0	100	81.12	68.04
20	1200	0.05	11.38	0	100	80.50	38.52
21	1200	0.05	11.38	0	100	87.00	37.84
22	1200	0.05	11.38	0	100	87.41	63.58
23	1200	0.05	11.38	0	100	85.13	85.46
24	1200	0.05	11.38	0	100	81.60	68.20
25	1200	0.05	11.38	0	100	81.07	38.63
26	1200	0.05	11.38	0	100	88.49	37.88
27	1200	0.05	11.38	0	100	88.45	63.58
28	1200	0.05	11.38	0	100	86.16	85.46
29	1200	0.05	11.38	0	100	82.66	68.25
30	1200	0.05	11.38	0	100	82.10	38.74

TABLE 3. INPUT FOR OLD REGION (IMPRxx.WB1).
Costs and Benefits for Improved O&M.

REGION NAME:	WestDelta
REGION NUMBER:	5
AGRICULTURAL AREA (mil FED):	1.293
WATER CONSUMPTION (M3/FD):	6344.9
POPULATION (millions):	6.18
WETTED PERIMETER OF CANALS (meters):	37
PERCENT OF CANALS NAVIGABLE (%):	7.3

YEAR	BENEFITS			SINGLE PURPOSE ALTERNATIVES			COSTS
	AGRI (m LE)	WATER SUPPLY (m LE)	NAVIG (m LE)	CANAL REPALCE (m LE)	WATER SUPPLY (m LE)	CANAL O&M (m LE)	SYSTEM PUMPS OM&R (m LE)
1	669	0.65	6.2	313.58	100	47.58	34.11
2	669	0.03	6.2	0	100	49.55	47.00
3	669	0.03	6.2	0	100	50.42	57.95
4	669	0.03	6.2	0	100	54.94	49.28
5	669	0.03	6.2	0	100	57.54	34.46
6	669	0.03	6.2	0	100	71.95	31.70
7	669	0.03	6.2	0	100	72.40	44.59
8	669	0.03	6.2	0	100	70.98	55.59
9	669	0.03	6.2	0	100	68.84	46.97
10	669	0.03	6.2	0	100	68.61	32.20
11	669	0.03	6.2	0	100	77.62	29.41
12	669	0.03	6.2	0	100	76.73	42.23
13	669	0.03	6.2	0	100	74.77	53.18
14	669	0.03	.2	0	100	70.86	44.57
15	669	0.03	6.2	0	100	70.12	29.83
16	669	0.03	6.2	0	100	78.39	34.00
17	669	0.03	6.2	0	100	78.43	57.09
18	669	0.03	6.2	0	100	76.02	76.69
19	669	0.03	6.2	0	100	72.89	61.14
20	669	0.03	6.2	0	100	72.33	34.61
21	669	0.03	6.2	0	100	78.18	34.00
22	669	0.03	6.2	0	100	78.54	57.13
23	669	0.03	6.2	0	100	76.49	76.79
24	669	0.03	6.2	0	100	73.32	61.28
25	669	0.03	6.2	0	100	72.84	34.71
26	669	0.03	6.2	0	100	79.51	34.04
27	669	0.03	6.2	0	100	79.48	57.13
28	669	0.03	6.2	0	100	77.42	76.79
29	669	0.03	6.2	0	100	74.27	61.32
30	669	0.03	6.2	0	100	73.77	34.81

TABLE 4. INPUT FOR NEW LAND REGIONS (BASNxx.WB1).
Costs and Benefits for New Lands.

REGION NAME:	NewLand-1
NEW REGION NUMBER:	1
NUMBER OF UPSTREAM OLD REGION:	1
FACTOR OF OLD CANALS DELIVERING WATER:	0
POTENTIAL AGRICULTURAL AREA (mil FEDDANS):	0.195
WATER CONSUMPTION (M3/FD):	6454

YEAR	BENEFIT AGRICUL (m LE)	AN. COST CAP, O&M (m LE)	IRRIG AREA (mil FD)	NEW DELIVERY SYSTEMS (m LE)
1	12.50	28.80	0.007	386.37
2	25.00	28.81	0.013	0
3	37.50	16.92	0.020	0
4	50.00	9.17	0.026	0
5	62.50	0.78	0.033	0
6	75.00	1.95	0.039	0
7	87.50	1.74	0.046	0
8	100.00	1.56	0.052	0
9	112.50	1.39	0.059	0
10	125.00	1.24	0.065	0
11	137.50	1.11	0.072	0
12	150.00	0.99	0.078	0
13	162.50	0.88	0.085	0
14	175.00	0.79	0.091	0
15	187.50	0.70	0.098	0
16	200.00	1.73	0.104	0
17	212.50	2.26	0.111	0
18	225.00	1.79	0.117	0
19	237.50	1.16	0.124	0
20	250.00	0.46	0.130	0
21	262.50	0.36	0.137	0
22	275.00	0.32	0.143	0
23	287.50	0.28	0.150	0
24	300.00	0.25	0.156	0
25	312.50	0.23	0.163	0
26	325.00	0.20	0.169	0
27	337.50	0.18	0.176	0
28	350.00	0.16	0.182	0
29	362.50	0.15	0.189	0
30	375.00	0.13	0.195	0

TABLE 4. INPUT FOR NEW LAND REGIONS (BASNxx.WB1).
Costs and Benefits for New Lands.

REGION NAME:	NewLand-2
NEW REGION NUMBER:	2
NUMBER OF UPSTREAM OLD REGION:	2
FACTOR OF OLD CANALS DELIVERING WATER:	0.06
POTENTIAL AGRICULTURAL AREA (mil FEDDANS):	0.184
WATER CONSUMPTION (M3/FD):	6454

YEAR	BENEFIT AGRICUL (m LE)	AN. COST CAP, O&M (m LE)	IRRIG AREA (mil FD)	NEW DELIVERY SYSTEMS (m LE)
1	11.80	28.19	0.006	8.52
2	23.59	27.85	0.012	0
3	35.39	17.28	0.018	0
4	47.18	9.08	0.025	0
5	58.98	0.78	0.031	0
6	70.77	1.88	0.037	0
7	82.57	1.68	0.043	0
8	94.36	1.49	0.049	0
9	106.16	1.33	0.055	0
10	117.95	1.19	0.061	0
11	129.75	1.06	0.067	0
12	141.54	0.94	0.074	0
13	153.34	0.84	0.080	0
14	165.13	0.76	0.086	0
15	176.93	0.67	0.092	0
16	188.72	1.64	0.098	0
17	200.52	2.15	0.104	0
18	212.31	1.70	0.110	0
19	224.11	1.10	0.117	0
20	235.90	0.45	0.123	0
21	247.70	0.35	0.129	0
22	259.49	0.31	0.135	0
23	271.29	0.27	0.141	0
24	283.08	0.25	0.147	0
25	294.88	0.22	0.153	0
26	306.67	0.20	0.159	0
27	318.47	0.16	0.166	0
28	330.26	0.16	0.172	0
29	342.06	0.14	0.178	0
30	353.85	0.12	0.184	0

TABLE 4. INPUT FOR NEW LAND REGIONS (BASNxx.WB1).
Costs and Benefits for New Lands.

REGION NAME:	NewLand-3
NEW REGION NUMBER:	3
NUMBER OF UPSTREAM OLD REGION:	3
FACTOR OF OLD CANALS DELIVERING WATER:	0
POTENTIAL AGRICULTURAL AREA (mil FEDDANS):	0.612
WATER CONSUMPTION (M3/FD):	6454

YEAR	BENEFIT AGRICUL (m LE)	AN. COST CAP, O&M (m LE)	IRRIG AREA (mil FD)	NEW DELIVERY SYSTEMS (m LE)
1	39.27	93.76	0.020	479
2	78.53	92.60	0.041	0
3	117.80	57.41	0.061	0
4	157.06	30.23	0.082	0
5	196.33	2.63	0.102	0
6	235.60	6.24	0.122	0
7	274.86	5.57	0.143	0
8	314.13	4.96	0.163	0
9	353.39	4.47	0.184	0
10	392.66	5.20	0.204	0
11	431.93	3.55	0.224	0
12	471.19	3.18	0.245	0
13	510.46	2.82	0.265	0
14	549.72	2.51	0.286	0
15	588.99	2.26	0.306	0
16	628.25	5.45	0.326	0
17	667.52	7.10	0.347	0
18	706.79	5.63	0.367	0
19	746.05	3.67	0.388	0
20	785.32	1.47	0.408	0
21	824.58	1.16	0.428	0
22	863.85	1.04	0.449	0
23	903.12	0.92	0.469	0
24	942.38	0.80	0.490	0
25	981.65	0.73	0.510	0
26	1020.91	0.67	0.530	0
27	1060.18	0.55	0.551	0
28	1099.45	0.49	0.571	0
29	1138.71	0.49	0.592	0
30	1177.98	0.49	0.612	0

TABLE 4. INPUT FOR NEW LAND REGIONS (BASNxx.WB1).
Costs and Benefits for New Lands.

REGION NAME:	NewLand-4
NEW REGION NUMBER:	4
NUMBER OF UPSTREAM OLD REGION:	4
FACTOR OF OLD CANALS DELIVERING WATER:	0
POTENTIAL AGRICULTURAL AREA (mil FEDDANS):	0.059
WATER CONSUMPTION (M3/FD):	6454

YEAR	BENEFIT AGRICUL (m LE)	AN. COST CAP, O&M (m LE)	IRRIG AREA (mil FD)	NEW DELIVERY SYSTEMS (m LE)
1	3.80	9.04	0.002	79.65
2	7.60	8.93	0.004	0
3	11.40	5.54	0.006	0
4	15.20	2.91	0.008	0
5	19.00	0.25	0.010	0
6	22.80	0.60	0.012	0
7	26.60	0.54	0.014	0
8	30.40	0.48	0.016	0
9	34.20	0.43	0.018	0
10	38.00	0.38	0.020	0
11	41.80	0.34	0.022	0
12	45.60	0.30	0.024	0
13	49.40	0.27	0.026	0
14	53.20	0.24	0.028	0
15	57.00	0.22	0.029	0
16	60.80	0.34	0.031	0
17	64.60	0.43	0.033	0
18	68.40	0.35	0.035	0
19	72.20	0.24	0.037	0
20	76.00	0.13	0.039	0
21	79.80	0.11	0.041	0
22	83.60	0.10	0.043	0
23	87.40	0.09	0.045	0
24	91.20	0.08	0.047	0
25	95.00	0.07	0.049	0
26	98.80	0.06	0.051	0
27	102.60	0.06	0.053	0
28	106.40	0.05	0.055	0
29	110.20	0.04	0.057	0
30	114.00	0.04	0.059	0

TABLE 4. INPUT FOR NEW LAND REGION (BASNxx.WB1).
Costs and Benefits for New Lands.

REGION NAME:	NewLand-5
NEW REGION NUMBER:	5
NUMBER OF UPSTREAM OLD REGION:	5
FACTOR OF OLD CANALS DELIVERING WATER:	0.08
POTENTIAL AGRICULTURAL AREA (mil FEDDANS):	0.264
WATER CONSUMPTION (M3/FD):	6454

YEAR	BENEFIT AGRICUL (m LE)	AN. COST CAP, O&M (m LE)	IRRIG AREA (mil FD)	NEW DELIVERY SYSTEMS (m LE)
1	16.93	40.47	0.009	175.27
2	33.87	39.94	0.018	0
3	50.80	24.78	0.026	0
4	67.73	13.05	0.035	0
5	84.67	1.13	0.044	0
6	101.60	2.68	0.053	0
7	118.53	2.41	0.062	0
8	135.47	2.15	0.070	0
9	152.40	1.92	0.079	0
10	169.33	1.70	0.088	0
11	186.27	1.51	0.097	0
12	203.20	1.36	0.106	0
13	220.13	1.21	0.114	0
14	237.07	1.09	0.123	0
15	254.00	0.98	0.132	0
16	270.93	2.38	0.141	0
17	287.87	3.05	0.150	0
18	304.80	2.45	0.158	0
19	321.73	1.58	0.167	0
20	338.67	0.64	0.176	0
21	355.60	0.43	0.185	0
22	372.53	0.45	0.194	0
23	389.47	0.38	0.202	0
24	406.40	0.34	0.211	0
25	423.33	0.30	0.220	0
26	440.27	0.26	0.229	0
27	457.20	0.26	0.238	0
28	474.13	0.23	0.246	0
29	491.07	0.19	0.255	0
30	508.00	0.19	0.264	0

TABLE 4. INPUT FOR NEW LAND REGIONS (BASNxx.WQ1).
Costs and Benefits for New Lands.

REGION NAME:	NewLand-6
NEW REGION NUMBER:	6
NUMBER OF UPSTREAM OLD REGION:	3
FACTOR OF OLD CANALS DELIVERING WATER:	0
POTENTIAL AGRICULTURAL AREA (mil FEDDANS):	0.212
WATER CONSUMPTION (M3/FD):	6454

YEAR	BENEFIT AGRICUL (mil LE)	AN. COST CAP, O&M (mil LE)	IRRIG AREA (mil FD)	NEW DELIVERY SYSTEMS (m LE)
1	13.60	32.48	0.007	4998.9
2	27.20	32.08	0.014	0
3	40.80	19.89	0.021	0
4	54.40	10.47	0.028	0
5	68.00	0.91	0.035	0
6	81.60	2.16	0.042	0
7	95.20	1.93	0.049	0
8	108.80	1.72	0.057	0
9	122.40	1.55	0.064	0
10	136.00	1.38	0.071	0
11	149.60	1.23	0.078	0
12	163.20	1.10	0.085	0
13	176.80	0.98	0.092	0
14	190.40	0.87	0.099	0
15	204.00	0.78	0.106	0
16	217.60	1.89	0.113	0
17	231.20	2.46	0.120	0
18	244.80	1.95	0.127	0
19	258.40	1.27	0.134	0
20	272.00	0.51	0.141	0
21	285.60	0.40	0.148	0
22	299.20	0.36	0.155	0
23	312.80	0.32	0.163	0
24	326.40	0.28	0.170	0
25	340.00	0.25	0.177	0
26	353.60	0.23	0.184	0
27	367.20	0.19	0.191	0
28	380.80	0.17	0.198	0
29	394.40	0.17	0.205	0
30	408.00	0.15	0.212	0

APPENDIX E
HEADER FILE CAM-4.H

DECLARATION OF DATA STRUCTURES
DECLARATION OF FUNCTION PROTOTYPES

```
  /***********************************************************************/
/**********************************************************************/
/*  Cost Allocation Model for ISPAN, Nile River Cost Recovery Project */
/*  First version: W. J. Grenney and J. P. Riley, January 1992       */
/*  Revisions by: W. J. Grenney, September 1992
/*  Header file CAM7.H for program CAM7.C                            */

#include    <stdio.h>    /* sscanf(), sprintf(), */
#include    <string.h>   /* strchr(), strcat(), */
#include    <stdlib.h>   /* exit(), */
#include    <math.h>     /* sscanf() bug, fabs(), */
#include    <time.h>     /* time, ctime(),  */

#ifndef     CAM-5_H
#define     CAM-5_H

#define     MAX_YRS       51  /* maximum number of years planning horizon*/
#define     MAX_RGNS       7  /* maximum number of regions of old lands */
#define     MAX_NEWL       7  /* maximum number of regions of new lands */
#define     ECHO           1  /* echo input if 1, don't if 0 */
#define     MAX_TBL_COL   12  /* maximum number of columns in a table */
#define     CBUF_W       120  /* input character buffer width */
#define     MAX_CAT_COL   12  /* max number of columns in cost alloc table*/
/**********************************************************************/
/*  Data Structures                                                   */

/*----- structure for the cost allocation table -----*/
struct CATable
{
float    projCst;               /* project cost to be allocated */
float    ben[MAX_CAT_COL];      /* (1)benefits (mil LE) */
float    spaCst[MAX_CAT_COL]; /* (2)single purpose alt cost (mil LE) */
float    jstCst[MAX_CAT_COL]; /* (3)justifiable costs */
float    sepCst[MAX_CAT_COL]; /* (4)separable costs (mil LE) */
float    cop[MAX_CAT_COL];     /* (5)costs for other purposes */
float    jcop[MAX_CAT_COL];    /* (6)justifiable costs for other purposes*/
float    adjF[MAX_CAT_COL];    /* (7)adjustment factor */
float    asCst[MAX_CAT_COL];   /* (8)adjusted separable costs */
float    rBen[MAX_CAT_COL];    /* (9)remaining benefits */
float    jcp[MAX_CAT_COL];     /* (10)joint cost propostion */
float    ajc[MAX_CAT_COL];     /* (11)allocated joint costs */
float    sectCst[MAX_CAT_COL]; /*(12)total sector costs */
float    percnt[MAX_CAT_COL];  /*(13)percentages */
float    pvTotJCst;             /* Grand total joint cost */
float    acTotJCst;             /* Grand total annual cost */
};

/*----- Structure for model control data -----*/
struct CntrlDat
  {
  char   inptFName[81]; /* input file name */
  int    inptFLen;      /* number of characters in name including "." */
  FILE  *pInptHand;     /* input file handel */
  FILE  *pOtptHand;     /* echo output file handle */
  float  dscnt;         /* discount rate */
  int    nbrYrs;        /* number of years in this run */
  int    nbrRgns;       /* number of old regions in this run */
  int    nbrRgnNew;     /* number of new regions in this run */
  int    firstYr;       /* first year in the series  */
  };

/*----- Structure for Basin Wide Data -----*/
struct BasinData
{
float   sumORgAgAr; /* sum of Ag area in old regions (mil FD)*/
float   sumNRgAgAr; /* sum of Ag area in new regions (mil FD)*/
float   sumORgAgW;  /* sum of water consumption in old regions (mil M3)*/
```

```
float    sumNRgAgW;  /* sum of water consumption in new regions (mil M3)*/
float    sumORgPop;  /* sum of population in old regions */
float    sumORgNWP;  /* sum of navigable wetted perimeter in old regions*/
float    sumBOA;  /* sum of benefits, old lands, agri */
float    sumBNA;  /* sum of benefits, new lands, agri */
float    sumBW;   /* sum of benefits, water supply (old lands only) */
float    sumBN;   /* sum of benefits, navig, old lands and main stem */
float    sumBP;   /*  power */
float    sumBT;   /*  G. Transportation */
float    sumBF;   /*  Fish */
float    sumBR;   /*  Recreation & tourism */
float    sumBQ;   /*  Flood control */
float    pvDrain; /* present value drains existing ag (mil LE) */
float    acDrain;  /* annual cost drains (mil LE/YR) */
};

/*----- Structure for High Aswan Dam data -----*/
struct HighAD
{
                             /* single purpose alternative coefficients */
float     spaXO;             /* fraction all other O&M to total O&M */
float     spaXQ;             /* fraction flood O&M to total O&M */
                             /* benefit coefficients and data */
float     benXQ;             /* fraction of total benefits attrib to flood cntr*/
float     sepCXA;            /* separable cost Ag (fraction of O&M) */
float     sepCXP;            /* separable cost Pw (fraction of O&M) */
float     sepCXQ;            /* separable cost Flood (fraction of O&M) */
float     pvBP;              /* present value of power benefit stream (mil LE)*/
float     pvBT;              /* present value of transp benefit stream (mil LE)*/
float     pvBF;              /* present value of fish benefit stream (mil LE)*/
float     pvBQ;              /* present value flood control (% of total ben)*/
float     pvCOM;             /* present value cost of common works (mil LE)*/
float     pvSPACO;           /* p v Other purposes (AG, NAV, POWER, FISH) */
float     pvSPACW;           /* p v Rural Water Supply (mil LE) */
float     pvSPACT;           /* present value single purpose alt G. TRANS */
float     pvSPACQ;           /* p v single purpose alt flood control (mil LE)*/
float     pvSPACR;           /* p v SPAC replacement cost of dam (mil LE)*/
float     pvSepCA;           /* p v separable cost Ag.  (mil LE)*/
float     pvSepCP;           /* p v separable cost Pw  (mil LE)*/
float     pvSepCQ;           /* p v separable cost flood (mil LE) */
float    alJCOA;  /* HAD costs to old ag */
float    alJCNA;  /* HAD costs to new ag */
float    alJCW;   /* HAD costs to rural water supply */
float    alJCN;   /* HAD costs to Navig */
float    alJCP;   /* HAD costs to Power */
float    alJCT;   /* HAD costs to G.TRANS */
float    alJCF;   /* HAD costs to Fish */
float    alJCR;   /* HAD costs to Recreation and Tourism */
float    alJCQ;   /* HAD costs to Flood Control */

};

/*----- Structure for Main Stem data -----*/
struct MainStem
{
float     pvBN;              /* present value nav benefit stream (mil LE) */
float     pvBT;              /* present value trans benefit stream (mil LE) */
float     pvBR;              /* present value rec & touir benefit stream */
float     pvSPACT;           /* present value single purpose alt cost G.TRANS*/
float     pvCOM;             /* present value O&M cost stream */
float    alJCOA;  /* stem costs to old agriculture */
float    alJCNA;  /* stem costs to new agriculture */
float    alJCW;   /* stem costs to rural water supply */
float    alJCN;   /* stem costs to Navig */
float    alJCP;   /* stem costs to Power */
float    alJCT;   /* stem costs to G.TRANS */
float    alJCF;   /* stem costs to Fish */
```

```
float    alJCR;   /* stem costs to Recreation and Tourism */
float    alJCQ;   /* AHW costs to Flood Control */
};

/*----- Sturcture for Esna on the Main Stem -----*/
struct Esna
{
float     pvBP;           /* present value power Esna (mil LE)*/
float     pvCCp;          /* present value capital and O&M Esna (mil LE)*/
};

/*----- Structure for Regional Data Old Lands -----*/
struct Region
{
char      name[21];      /* region identification name */
int       id;            /* region ident number */
float     agArea;        /* irrigated area in the region (mil FD) */
float     agWater;       /* ag water consumption in region (mil M3) */
float     popul;         /* population in the region (mil) */
float     wpCanal;       /* total wetted perimeter of canals in region (M)*/
float     fCanalN;       /* fraction of canals navigable in region */
float     pvBA;          /* present value ag benefit stream (mil LE)*/
float     pvBW;          /* present value rural water sup. benefit strm. */
float     pvBN;          /* present value navigation benefit strm. (mil LE)*/
float     pvCOM;         /* p. v. O&M cost stream (mil LE)*/
float     pvPump;        /* p. v. pumps cost stream (mil LE)*/
float     pvSPACW;       /* p. v. sing purpose alt water(mil LE)*/
float     pvSPACCR;      /* replacement cost of canals (mil LE)*/
float     alJCA;         /* joint cost allocated to agri (mil LE)*/
float     alJCW;         /* joint cost allocated to water (mil LE)*/
float     alJCN;         /* joint cost allocated to navigation (mil LE)*/
};

/*------ Structure for the Regions of New Land -----*/
struct  RegnNewL
{
char    name[21];       /* Region identification name */
int     id;             /* region identification number */
float   agArea;         /* irrigated area in the region (mil FD) */
float   agWater;        /* ag water consumption (mil M3) */
int     upS;            /* id number of the old region upstream */
float   fOldToNew;      /* factor of canals in upstream old land */
                        /* serving theis new land region  */
float   cstDelivery;    /* cost new water delivery system (lump sum)*/
float   pvBA;           /* present value benefits to agriculture */
float   pvCCpOM;        /* p. v. capital costs and O&M canals */
float   alJCA;          /* allocated joint cost to Ag from upstream  /
                        /* old land region */
};


/*************************************************************************/
/*  Declare function prototypes                                          */

void   loadData(void);     /* open files and load input data */
void   loadHAD(void);      /* load data from the .HAD file */
void   loadSTM(void);      /* load data from the .STM file */
void   loadRxx(int iR);    /* load data from .RiR for region iR */
void   loadNxx(int iN);    /* load data from .NiN for new regn iN */
char  *skipTxt(char cBuf[], char c);  /* skip text in a buffer to c */
void   quit(int code);     /* flush streams and exit */
void   parseRowF(char *cBuf, float fVal[], int nbrFld); /*parse a buffer */
float  fField(char cBuf[], int *cPos, int *eOL);  /* next field to float */
float  pvFactor(int   iYr,   /* present value factor for year iYr */
               float rate); /* and rate rate */
void   cAlloc(void);     /* cost allocation top level function */
void   caORgns(void);    /* allocate costs to old regions  */
```

```
void    caAWN(int iR);    /* allocate subregion navigable canal costs */
void    caAW(int iR);     /* allocate subregion non-nav canal costs */
void    caNRgns(void);    /* allocate costs to new land regions */
void    caSTM(void);      /* allocate costs of the Nile main stem */
void    caHAD(void);      /* allocate costs of the High Aswan Dam */
void    catFun(char  cBuf[],   /* cost allocation uses CATable */
               char *headers[],/* Arguments: identification string, */
               int   nbrSer);  /* array of 6 char headers, number services*/
void    irrControl(void);      /* control calc of internal rates of return */
void    irrRgns(void);         /* calculate the irr for all regions */
float   irrSolve(float benStrm[],  /* solve for irr by the method of */
                 float cstStrm[],  /* false position */
                 float guess);
float   pvSolve(float datStrm[],   /* calculate the present value of a */
                int   nbrEle,      /* data stream */
                float rate);
float   pvSolCA(float cap,    /* calculate the present value of a first */
                float annual, /* year capital investment followed by an */
                int   nYr,    /* annual O&M charge */
                float rate);
void    output(void);           /* output the results */
void    initialize(void);       /* initialize data to zero */
void    inptStAF(float *v1,     /* input a string and one or two floats*/
                 float *v2,     /* and take the present value */
                 int   nbrFlds,
                 float *vpV);
int     lastLine( char cBuf[] );
int     blankLine(char cBuf[]);      /* Is this a blank line? 1=TRUE, 0=F */
float   annCst(float presentValue); /* Calculate annual payment from p. v.*/

#endif
```

APPENDIX F

LISTING OF CAM-4.CPP

MAIN PROGRAM
FUNCTION DEFINITIONS

```
/*****************************************************************************/
/*************************************************************************/
/*  Cost Allocation Model for ISPAN, Nile River Cost Recovery Project */
/*  First version W. J. Grenney & J. P. Riley,  January 1992         */
/*  Revisions by W. J. Grenney, September 1992.                      */
/*  Main module CAM7.C                                                */

#include "CAM7.H"

/*************************************************************************/
/*  Declare global variables                                          */

/* Structures for input data */
struct HighAD      had;
struct MainStem    stm;
struct Region      rgn[MAX_RGNS];
struct RegnNewL    rnl[MAX_NEWL];

/* Structures for program control and algorithms */
struct CntrlDat    ctr;
struct BasinData   bwd;
struct Esna        esn;
struct CATable     caT;

/*************************************************************************/
/*************************************************************************/
/* main program                                                       */
/*************************************************************************/

int main(void)
{
ctr.pInptHand = ctr.pOtptHand = NULL;

initialize();  /* set some initial values to zero in the global data */

/*----- load data from the input files -----*/
loadData();

/*----- conduct the cost allocation -----*/
cAlloc();

/*----- calculate internal rates of return -----*/
irrControl();

/*--- output summary of results ---*/
output();

/*----- insure that the output file has been closed -----*/
fclose(ctr.pOtptHand);
ctr.pOtptHand = NULL;
printf("\n\nNormal Termination!\n");
return 0;
}

/*************************************************************************/
/*************************************************************************/
/* Define The Functions                                               */
/*************************************************************************/

/*************************************************************************/
/*  loadHAD(void)                                                     */

void loadHAD(void)
{
char    cBuf[CBUF_W+2];
char   *pC;
int     i, iYr;
```

```
float  fVal[MAX_TBL_COL], pvF;
char  *format[4]  = {"%10.1f\n", "%10.0f\n", "%10.0f\n", "%10.0f\n"};

if( ctr.pOtptHand )
  fprintf(ctr.pOtptHand,"File name: %s\n",ctr.inptFName);

for(i = 0; i < 3; i++)  /* three lines of headings */
   {
  fgets(cBuf, CBUF_W, ctr.pInptHand);
  if(ctr.pInptHand) fputs(cBuf, ctr.pOtptHand );
   }
/*--- four basin-wide coefficients for ctr. ---*/
for( i = 0; i < 4; i++)
   {
  fgets(cBuf, CBUF_W, ctr.pInptHand);
  pC = skipTxt(cBuf, ':');
  if( ! pC )
     {
    printf("\n\nERROR loadHAD(): Expect a \":\" in record \n<%s>\n",cBuf);
    quit(1);
     }
  sscanf(pC,"%f",&fVal[i]);
  if( ctr.pOtptHand) fprintf(ctr.pOtptHand, format[i], fVal[i]);
   }

ctr.dscnt    = fVal[0]/100.;
ctr.nbrYrs   = (int)(fVal[1]+.01);
if( ctr.nbrYrs > MAX_YRS )
   {
  printf("\n\nERROR loadHAD(): Planning Horizon = %d",ctr.nbrYrs);
  printf(", exceeds maximum = MAX_YRS\n");
  quit(1);
   }
ctr.nbrRgns = (int)(fVal[2]+.01);
if( ctr.nbrRgns > MAX_RGNS )
   {
  printf("\n\nERROR loadHAD(): Number of Regions = %d",ctr.nbrRgns);
  printf(", exceeds maximum = MAX_RGNS\n");
  quit(1);
   }

ctr.nbrRgnNew = (int)(fVal[3]+.01);
if( ctr.nbrRgnNew > MAX_NEWL )
   {
  printf("\n\nERROR loadHAD(): Number of New Regions = %d",ctr.nbrRgnNew);
  printf(", exceeds maximum = MAX_NEWL\n");
  quit(1);
   }

/* --- Drainage annual cost  ---*/
fgets(cBuf, CBUF_W, ctr.pInptHand);
pC = skipTxt(cBuf, ':');
  if( ! pC )
     {
    printf("\n\nERROR loadHAD(): Expect a \":\" in record \n<%s>\n",cBuf);
    quit(1);
     }
sscanf(pC,"%f",&fVal[0]);

bwd.pvDrain   = pvSolCA( fVal[0], fVal[0], ctr.nbrYrs, ctr.dscnt );
bwd.acDrain   = annCst(bwd.pvDrain);

if(ctr.pOtptHand) fprintf(ctr.pOtptHand,"%10.3f%8.2f%9.3f",
                         fVal[0], bwd.pvDrain, bwd.acDrain);

/*--- Input Benefit Coefficients ---*/
for(i = 0; i < 2; i++)  /* skip two lines */
```

```
    {
    fgets(cBuf, CBUF_W, ctr.pInptHand);
    if(ctr.pOtptHand) fputs(cBuf, ctr.pOtptHand);
    }
  fgets(cBuf, CBUF_W, ctr.pInptHand);
  pC = skipTxt(cBuf, ':');
  if( ! pC )
    {
    printf("\n\nERROR loadHAD(): Expect a \":\" in record \n<%s>\n",cBuf);
    quit(1);
    }
  sscanf(pC,"%f",&had.benXQ);
  if( ctr.pOtptHand) fprintf(ctr.pOtptHand,"%10.1f\n", had.benXQ);

  had.benXQ /= 100.;

  /*---  Input Single Purpose Alternative Coefficients ---*/
  for( i = 0; i < 2; i++)          /* skip headings */
    {
    fgets(cBuf, CBUF_W, ctr.pInptHand);
    if( ctr.pOtptHand ) fputs(cBuf, ctr.pOtptHand);
    }
  for( i = 0; i < 2; i++)
    {
    fgets(cBuf, CBUF_W, ctr.pInptHand);
    pC = skipTxt(cBuf, ':');
    sscanf(pC,"%f",&fVal[i]);
    if( ctr.pOtptHand) fprintf(ctr.pOtptHand,"%10.3f\n", fVal[i]);
    }
  had.spaXO     = fVal[0]/100;
  had.spaXQ     = fVal[1]/100.;

  /*--- Separable Cost Data ---*/
  for( i = 0; i < 2; i++)          /* skip headings */
    {
    fgets(cBuf, CBUF_W, ctr.pInptHand);
    if( ctr.pOtptHand ) fputs(cBuf, ctr.pOtptHand);
    }

  fgets(cBuf, CBUF_W, ctr.pInptHand);
  pC = skipTxt(cBuf, ':');
  sscanf(pC,"%f", &had.sepCXA);
  if(ctr.pOtptHand) fprintf(ctr.pOtptHand,"%10.2f\n", had.sepCXA);
  had.sepCXA /= 100;

  fgets(cBuf, CBUF_W, ctr.pInptHand);
  pC = skipTxt(cBuf, ':');
  sscanf(pC,"%f", &had.sepCXP);
  if(ctr.pOtptHand) fprintf(ctr.pOtptHand,"%10.2f\n", had.sepCXP);
  had.sepCXP /= 100;

  fgets(cBuf, CBUF_W, ctr.pInptHand);
  pC = skipTxt(cBuf, ':');
  sscanf(pC,"%f", &had.sepCXQ);
  if(ctr.pOtptHand) fprintf(ctr.pOtptHand,"%10.2f\n", had.sepCXQ);
  had.sepCXQ /= 100;

  /*--- Input High Aswan Dam Annual Data ---*/
  /* skip headings */
   for(i = 0; i < 7; i++)
    {
    fgets(cBuf, CBUF_W, ctr.pInptHand);
    if( ctr.pOtptHand ) fputs(cBuf, ctr.pOtptHand);
    }
  /* input 8 columns of data and calculate present values */
  had.pvBP = had.pvBT = had.pvBF = had.pvSPACW = had.pvSPACR = had.pvCOM = 0.0;
  for (iYr = 0; iYr < MAX_YRS; iYr++)
```

```
  {
  pC = fgets(cBuf, CBUF_W, ctr.pInptHand);
  if( ! pC ) break;
  if( blankLine(cBuf) ) /* probably a blank line at the end of the table */
    break;

  parseRowF(cBuf, fVal, 8);

  pvF = pvFactor(iYr, ctr.dscnt);  /* note: iYr starts at zero, not one */
  had.pvBP    += fVal[1] / pvF; /* benefit power */
  had.pvBT    += fVal[2] / pvF; /* benefit ground transportation */
  had.pvBF    += fVal[3] / pvF; /* benefit fishery */
  had.pvSPACW += fVal[4] / pvF; /* SPAC water supply */
  had.pvSPACT += fVal[5] / pvF; /* SPAC ground transportation */
  had.pvSPACR += fVal[6] / pvF; /* SPAC common works replacement */
  had.pvCOM   += fVal[7] / pvF; /* common works O&M cost */
  }
if(iYr != ctr.nbrYrs)
  {
  printf("ERROR loadHAD(): The number of records in the file does\n");
  printf("not match the specified number of years = %d\n", ctr.nbrYrs);
  quit(1);
  }

/* output the present values for each column */
if(ctr.pOtptHand)
  {
  fprintf(ctr.pOtptHand,"\np. val ");
  fprintf(ctr.pOtptHand,"%9.2f", had.pvBP);
  fprintf(ctr.pOtptHand,"%9.2f", had.pvBT);
  fprintf(ctr.pOtptHand,"%9.2f", had.pvBF);
  fprintf(ctr.pOtptHand,"%9.2f", had.pvSPACW);
  fprintf(ctr.pOtptHand,"%9.2f", had.pvSPACT);
  fprintf(ctr.pOtptHand,"%9.2f", had.pvSPACR);
  fprintf(ctr.pOtptHand,"%9.2f\n\n", had.pvCOM);
  }

/*--- calculate present value for other variables---*/

had.pvSPACO = (had.pvCOM + had.pvSPACR) * had.spaXO;
if(ctr.pOtptHand)
  fprintf(ctr.pOtptHand,"Present value SPA Other      %10.1f\n",had.pvSPACO);

had.pvSPACQ = (had.pvCOM + had.pvSPACR) * had.spaXQ;
if(ctr.pOtptHand)
  fprintf(ctr.pOtptHand,"Present value SPA Flood      %10.1f\n",had.pvSPACQ);

had.pvSepCA = had.pvCOM * had.sepCXA;
if(ctr.pOtptHand)
  fprintf(ctr.pOtptHand,"Pres. val. separable Agri.   %10.1f\n",had.pvSepCA);

had.pvSepCP = had.pvCOM * had.sepCXP;
if(ctr.pOtptHand)
  fprintf(ctr.pOtptHand,"Pres. val. separable Power   %10.1f\n",had.pvSepCP);

had.pvSepCQ = had.pvCOM * had.sepCXQ;
if(ctr.pOtptHand)
  fprintf(ctr.pOtptHand,"Pres. val. separable Flood   %10.1f\n",had.pvSepCQ);
}

/***********************************************************************/
/*  loadSTM(void)                                                      */

void loadSTM(void)
{
char   cBuf[CBUF_W+2];
char   *pC;
```

```
int    i, iYr;
float  fVal[MAX_TBL_COL];
float  pvF;

if( ctr.pOtptHand )
  {
  fprintf(ctr.pOtptHand,"\n/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/");
  fprintf(ctr.pOtptHand,"-/-/-/-/-/-/-/-/-/-/-/-/-/-/\n");
  fprintf(ctr.pOtptHand,"File name: %s\n",ctr.inptFName);
  }
for(i = 0; i < 9; i++)  /* nine lines of headings */
  {
  fgets(cBuf, CBUF_W, ctr.pInptHand);
  if(ctr.pInptHand) fputs(cBuf, ctr.pOtptHand );
  }
stm.pvBN  = esn.pvBP  = stm.pvBT = stm.pvBR = stm.pvSPACT = 0.0;
stm.pvCOM = esn.pvCCp = 0.0;

for(iYr = 0; iYr < MAX_YRS; iYr++)
  {
  pC = fgets(cBuf, CBUF_W, ctr.pInptHand);
  if( ! pC ) break;
  if( blankLine(cBuf) ) /* probably a blank line at the end of the table */
    break;

  parseRowF(cBuf, fVal, 8);
  pvF = pvFactor(iYr, ctr.dscnt);  /* note: iYr starts at zero, not one */

  stm.pvBN     += fVal[1] / pvF;
  esn.pvBP     += fVal[2] / pvF;
  stm.pvBT     += fVal[3] / pvF;
  stm.pvBR     += fVal[4] / pvF;
  stm.pvSPACT += fVal[5] / pvF;
  stm.pvCOM    += fVal[6] / pvF;
  esn.pvCCp    += fVal[7] / pvF;

  }   /* end of the iYr (year) loop */

if(iYr != ctr.nbrYrs)
  {
  printf("ERROR loadSTM(): The number of records in the file does\n");
  printf("not match the specified number of years = %d\n", ctr.nbrYrs);
  quit(1);
  }
if(ctr.pOtptHand)
  {
  fprintf(ctr.pOtptHand,"\np. val ");
  fprintf(ctr.pOtptHand,"%9.2f", stm.pvBN);
  fprintf(ctr.pOtptHand,"%9.2f", esn.pvBP);
  fprintf(ctr.pOtptHand,"%9.2f", stm.pvBT);
  fprintf(ctr.pOtptHand,"%9.2f", stm.pvBR);
  fprintf(ctr.pOtptHand,"%9.2f", stm.pvSPACT);
  fprintf(ctr.pOtptHand,"%9.2f", stm.pvCOM);
  fprintf(ctr.pOtptHand,"%9.2f\n\n", esn.pvCCp);
  }
}

/**********************************************************************/
/*  loadRxx(int iR) load data for region iR                           */

void loadRxx(int iR)
{
char   cBuf[CBUF_W+2];
char   *pC;
int    i, iYr;
float  fVal[MAX_TBL_COL], pvF;
```

```
if( ctr.pOtptHand )
  {
  fprintf(ctr.pOtptHand,"/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/");
  fprintf(ctr.pOtptHand,"-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/\n");
  fprintf(ctr.pOtptHand,"File name: %s\n",ctr.inptFName);
  }

for(i = 0; i < 3; i++)  /* two lines of headings */
  {
  fgets(cBuf, CBUF_W, ctr.pInptHand);
  if(ctr.pInptHand) fputs(cBuf, ctr.pOtptHand );
  }

/*---  Name, identification, navigable canals ---*/
fgets(cBuf, CBUF_W, ctr.pInptHand);
pC = skipTxt(cBuf, ':');
sscanf(pC,"%s", rgn[iR].name);
if(ctr.pOtptHand) fprintf(ctr.pOtptHand,"%20s\n", rgn[iR].name);

fgets(cBuf, CBUF_W, ctr.pInptHand);
pC = skipTxt(cBuf, ':');
sscanf(pC,"%d", &rgn[iR].id);
if(ctr.pOtptHand) fprintf(ctr.pOtptHand,"%13d\n", rgn[iR].id);

fgets(cBuf, CBUF_W, ctr.pInptHand);
if(ctr.pOtptHand) fputs(cBuf, ctr.pOtptHand);

fgets(cBuf, CBUF_W, ctr.pInptHand);
pC = skipTxt(cBuf, ':');
sscanf(pC,"%f", &rgn[iR].agArea); /* Million FD (1 FD = 4,200 M2)*/
if(ctr.pOtptHand) fprintf(ctr.pOtptHand,"%13.3f\n", rgn[iR].agArea);

fgets(cBuf, CBUF_W, ctr.pInptHand);
pC = skipTxt(cBuf, ':');
sscanf(pC,"%f", &rgn[iR].agWater);  /* M3/FD */
if(ctr.pOtptHand) fprintf(ctr.pOtptHand,"%13.3f, ", rgn[iR].agWater);
rgn[iR].agWater *= rgn[iR].agArea;  /* (M3/FD) * (mil FD) = (mil M3) */
if(ctr.pOtptHand) fprintf(ctr.pOtptHand," = %10.1f (mil M3).\n",
                              rgn[iR].agWater);

fgets(cBuf, CBUF_W, ctr.pInptHand);
pC = skipTxt(cBuf, ':');
sscanf(pC,"%f", &rgn[iR].popul);
if(ctr.pOtptHand) fprintf(ctr.pOtptHand,"%13.3f\n", rgn[iR].popul);

fgets(cBuf, CBUF_W, ctr.pInptHand);
pC = skipTxt(cBuf, ':');
sscanf(pC,"%f", &rgn[iR].wpCanal);
if(ctr.pOtptHand) fprintf(ctr.pOtptHand,"%13.1f\n", rgn[iR].wpCanal);

fgets(cBuf, CBUF_W, ctr.pInptHand);
pC = skipTxt(cBuf, ':');
sscanf(pC,"%f", &rgn[iR].fCanalN);
if(ctr.pOtptHand) fprintf(ctr.pOtptHand,"%13.1f\n", rgn[iR].fCanalN );
rgn[iR].fCanalN /= 100.;

for(i = 0; i < 7; i++)  /* skip headings */
  {
  fgets(cBuf, CBUF_W, ctr.pInptHand);
  if(ctr.pOtptHand) fputs(cBuf, ctr.pOtptHand);
  }
/*--- Input Annual Data --- */
rgn[iR].pvBA    = rgn[iR].pvBW  = rgn[iR].pvBN   = rgn[iR].pvSPACCR = 0.0;
rgn[iR].pvSPACW = rgn[iR].pvCOM = rgn[iR].pvPump = 0.0;

for(iYr = 0; iYr < MAX_YRS; iYr++)
  {
```

```
    pC = fgets(cBuf, CBUF_W, ctr.pInptHand);
    if( !pC ) break;
    if( blankLine(cBuf) ) /* probably a blank line at the end of the table */
      break;

    parseRowF(cBuf, fVal, 8);
    pvF = pvFactor(iYr, ctr.dscnt);

    rgn[iR].pvBA  += fVal[1] / pvF;
    rgn[iR].pvBW  += fVal[2] / pvF;
    rgn[iR].pvBN  += fVal[3] / pvF;
    rgn[iR].pvSPACCR += fVal[4] / pvF;
    rgn[iR].pvSPACW  += fVal[5] / pvF;
    rgn[iR].pvCOM    += fVal[6] / pvF;
    rgn[iR].pvPump   += fVal[7] / pvF;
    }
  if(iYr != ctr.nbrYrs)
    {
    printf("ERROR loadRxx(): The number of records in the file does\n");
    printf("not match the specified number of years = %d\n", ctr.nbrYrs);
    quit(1);
    }
  if(ctr.pOtptHand)
    {
    fprintf(ctr.pOtptHand,"\np. val ");
    fprintf(ctr.pOtptHand,"%9.2f", rgn[iR].pvBA);
    fprintf(ctr.pOtptHand,"%9.2f", rgn[iR].pvBW);
    fprintf(ctr.pOtptHand,"%9.2f", rgn[iR].pvBN);
    fprintf(ctr.pOtptHand,"%9.2f", rgn[iR].pvSPACCR);
    fprintf(ctr.pOtptHand,"%9.2f", rgn[iR].pvSPACW);
    fprintf(ctr.pOtptHand,"%9.2f", rgn[iR].pvCOM);
    fprintf(ctr.pOtptHand,"%9.2f\n\n", rgn[iR].pvPump);
    }
  }

/**********************************************************************/
/*  loadNxx(int iN)                                                   */

void loadNxx(int iN)
{
char   cBuf[CBUF_W+2];
char  *pC;
int    i, iYr;
float  pvF, fVal[MAX_TBL_COL];

if( ctr.pOtptHand )
  {
  fprintf(ctr.pOtptHand,"/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/");
  fprintf(ctr.pOtptHand,"-/-/-/-/-/-/-/-/-/-/-/-/-/-/-/\n");
  fprintf(ctr.pOtptHand,"File name: %s\n",ctr.inptFName);
  }

for(i = 0; i < 3; i++)  /* three lines of headings */
  {
  fgets(cBuf, CBUF_W, ctr.pInptHand);
  if(ctr.pInptHand) fputs(cBuf, ctr.pOtptHand );
  }

/*---  Name, identification, old region upstream ---*/
fgets(cBuf, CBUF_W, ctr.pInptHand);
pC = skipTxt(cBuf, ':');
sscanf(pC,"%s", rnl[iN].name);
if(ctr.pOtptHand) fprintf(ctr.pOtptHand,"%20s\n", rnl[iN].name);

fgets(cBuf, CBUF_W, ctr.pInptHand);
pC = skipTxt(cBuf, ':');
sscanf(pC,"%d", &rnl[iN].id);
```

```
if(ctr.pOtptHand) fprintf(ctr.pOtptHand,"%13d\n", rnl[iN].id);

fgets(cBuf, CBUF_W, ctr.pInptHand);
pC = skipTxt(cBuf, ':');
sscanf(pC,"%d", &rnl[iN].upS);
if(ctr.pOtptHand) fprintf(ctr.pOtptHand,"%13d\n", rnl[iN].upS);

fgets(cBuf, CBUF_W, ctr.pInptHand);
pC = skipTxt(cBuf, ':');
sscanf(pC,"%f", &rnl[iN].fOldToNew);
if(ctr.pOtptHand) fprintf(ctr.pOtptHand,"%13.3f\n", rnl[iN].fOldToNew);

fgets(cBuf, CBUF_W, ctr.pInptHand);
pC = skipTxt(cBuf, ':');
sscanf(pC,"%f", &rnl[iN].agArea);
if(ctr.pOtptHand) fprintf(ctr.pOtptHand,"%10.1f\n", rnl[iN].agArea);

fgets(cBuf, CBUF_W, ctr.pInptHand);
pC = skipTxt(cBuf, ':');
sscanf(pC,"%f", &rnl[iN].agWater);  /* M3/FD */
if(ctr.pOtptHand) fprintf(ctr.pOtptHand,"%13.3f, ", rnl[iN].agWater);
rnl[iN].agWater *= rnl[iN].agArea;  /* (M3/FD) * (mil FD) = (mil M3) */
if(ctr.pOtptHand) fprintf(ctr.pOtptHand," = %10.4f (mil M3).\n",
                          rnl[iN].agWater);

for(i = 0; i < 5; i++)  /* skip headings */
  {
  fgets(cBuf, CBUF_W, ctr.pInptHand);
  if(ctr.pOtptHand) fputs(cBuf, ctr.pOtptHand);
  }

rnl[iN].pvBA = rnl[iN].pvCCpOM = rnl[iN].cstDelivery = 0.0;

for(iYr = 0; iYr < MAX_YRS; iYr++)
  {
  pC = fgets(cBuf, CBUF_W, ctr.pInptHand);
  if( ! pC ) break;
  if( blankLine(cBuf) ) /* probably a blank line at the end of the table */
    break;

  parseRowF(cBuf, fVal, 5);
  pvF = pvFactor(iYr, ctr.dscnt);  /* note: iYr starts at zero, not one */

  rnl[iN].pvBA        += fVal[1] / pvF;
  rnl[iN].pvCCpOM     += fVal[2] / pvF;
  rnl[iN].cstDelivery += fVal[4] / pvF;
  }

if(iYr != ctr.nbrYrs)
  {
  printf("ERROR loadSTM(): The number of records in the file does\n");
  printf("not match the specified number of years = %d\n", ctr.nbrYrs);
  quit(1);
  }
if(ctr.pOtptHand)
  {
  fprintf(ctr.pOtptHand,"\np. val");
  fprintf(ctr.pOtptHand,"%9.1f", rnl[iN].pvBA);
  fprintf(ctr.pOtptHand,"%9.1f          ", rnl[iN].pvCCpOM);
  fprintf(ctr.pOtptHand,"%9.1f\n\n", rnl[iN].cstDelivery);
  }
}

/**************************************************************************/
/*  caHAD()  allocate costs for the High Aswan Dam                        */

void caHAD()
```

```
{
char   cBuf[CBUF_W + 2];
char   *headers[9] = (" OLD AG", "R.W.S.", " NAVIG", "NEW AG",
                      " POWER", " G.TRAN", "RECR&T", " FISH ",
                      " FLOOD" );

/*----- Cost allocation for the High Aswan Dam -----*/
/*--- assign benefits ---*/
caT.ben[0] = bwd.sumBOA;  /* Ag benefits totaled for old regions*/

caT.ben[1] = bwd.sumBW;   /* RWS benefits totaled for old regions*/

caT.ben[2] = bwd.sumBN;   /* Nav benefits totaled for old regions */
                          /* plus main stem navigation benefits */

caT.ben[3] = bwd.sumBNA;  /* Ag benefits totaled for new regions */

caT.ben[4] = had.pvBP;    /* benefits for HAD power */

caT.ben[5] = had.pvBT;    /* benefits for ground transportation */

caT.ben[6] = stm.pvBR;    /* benefits for recreation & tourism */

caT.ben[7] = had.pvBF;    /* benefits for fish */

caT.ben[8] = had.pvBQ;    /* benefits for flood control */

/*--- assign single purpose alternative costs ---*/
caT.spaCst[0] = had.pvSPACO;      /* old agric */
caT.spaCst[1] = had.pvSPACW;      /* rural water supply */
caT.spaCst[2] = had.pvSPACO;      /* navigation */
caT.spaCst[3] = had.pvSPACO;      /* new agric */
caT.spaCst[4] = had.pvSPACO;      /* power */
caT.spaCst[5] = had.pvSPACT;      /* G. Transp */
caT.spaCst[6] = had.pvSPACO;      /* Recr & tourism */
caT.spaCst[7] = had.pvSPACO;      /* Fish */
caT.spaCst[8] = had.pvSPACQ;      /* Flood Control */

/*--- assign separable costs ---*/
caT.sepCst[0] =  0.0;                /* old ag */
caT.sepCst[1] =  0.0;                /* rural water supply */
caT.sepCst[2] =  0.0;                /* navigation */
caT.sepCst[3] =  0.0;                /* new agric */
caT.sepCst[4] =  had.pvSepCP;        /* power */
caT.sepCst[5] =  0.0;                /* G. Transp */
caT.sepCst[6] =  0.0;                /* Recr & tourism */
caT.sepCst[7] =  0.0;                /* Fish */
caT.sepCst[8] =  had.pvSepCQ;        /* Flood Control */

/*--- total cost to be allocated ---*/
caT.projCst = had.pvCOM;

/*--- perform cost allocation ---*/
sprintf(cBuf,"High Aswan Dam.");
catFun(cBuf, headers, 9);

/*--- assign allocated costs ---*/
had.alJCOA = caT.sectCst[0];
had.alJCW  = caT.sectCst[1];
had.alJCN  = caT.sectCst[2];
had.alJCNA = caT.sectCst[3];
had.alJCP  = caT.sectCst[4];
had.alJCT  = caT.sectCst[5];
had.alJCR  = caT.sectCst[6];
had.alJCF  = caT.sectCst[7];
had.alJCQ  = caT.sectCst[8];
}
```

```
/**************************************************************************/
/*  caSTM()  allocate cost for the main stem of the Nile                 */

void caSTM(void)
{
int     i;
float  wE;
char    cBuf[CBUF_W + 2];
char   *headers[7] = {" OLD AG", "R.W.S.", " NAVIG", "NEW AG",
                      " POWER", " TRANS", "RECR&T" };

/*----- Cost allocation for main stem barrages except Etan -----*/
if( (stm.pvCOM + esn.pvCCp) < 1.0E-10 )
  {
  printf("\n\nERROR caSTM(): Costs cannot be zero on the main stem\n");
  quit(1);
  }

/*--- assign benefits ---*/
caT.ben[0] = bwd.sumBOA;  /* Ag benefits totaled for old regions*/

caT.ben[1] = bwd.sumBW;   /* RWS benefits totaled for old regions*/

caT.ben[2] = bwd.sumBN;   /* Nav benefits totaled for old regions */
                          /* plus main stem navigation benefits */
caT.ben[3] = bwd.sumBNA;  /* Ag benefits totaled for new regions */

caT.ben[4] =  0;          /* benefits for power */

caT.ben[5] = stm.pvBT;    /* benefits for ground transportation */

caT.ben[6] = stm.pvBR;    /* benefits for recreation & tourism */

/*--- assign single purpose alternative costs ---*/
caT.spaCst[0] = stm.pvCOM;          /* old agric */
caT.spaCst[1] = stm.pvCOM;          /* rural water supply */
caT.spaCst[2] = stm.pvCOM;          /* navigation */
caT.spaCst[3] = stm.pvCOM;          /* new agric */
caT.spaCst[4] = 0.0;                /* power */
caT.spaCst[5] = stm.pvSPACT;        /* G. Transp */
caT.spaCst[6] = stm.pvCOM;          /* Recr & tourism */

/*--- assign separable costs ---*/
for(i = 0; i < 7; i++)  caT.sepCst[i] = 0.0;

/*--- total cost to be allocated ---*/
caT.projCst = stm.pvCOM;

/*--- perform cost allocation ---*/
sprintf(cBuf,"Main Stem Barrages Excluding Esna.");
catFun(cBuf, headers, 7);

/*--- assign allocated costs ---*/
stm.alJCOA = caT.sectCst[0];
stm.alJCW  = caT.sectCst[1];
stm.alJCN  = caT.sectCst[2];
stm.alJCNA = caT.sectCst[3];
stm.alJCP  = caT.sectCst[4];
stm.alJCT  = caT.sectCst[5];
stm.alJCR  = caT.sectCst[6];

/*----- Cost Allocation for Esna Barrage ------*/
wE = esn.pvCCp/(esn.pvCCp + stm.pvCOM);  /* weighting factor for Esna */

/*--- assign benefits ---*/
caT.ben[0] = bwd.sumBOA * wE;  /* Ag benefits totaled for old regions*/
```

```
caT.ben[1] = bwd.sumBW * wE;   /* RWS benefits totaled for old regions*/

caT.ben[2] = bwd.sumBN * wE;   /* Nav benefits totaled for old regions */
                               /* including main stem navigation ben */
caT.ben[3] = bwd.sumBNA * wE;  /* Ag benefits totaled for new regions */

caT.ben[4] =  esn.pvBP;        /* benefits for power */

caT.ben[5] =  stm.pvBT * wE;   /* benefits for ground transportation */

caT.ben[6] =  stm.pvBR * wE;   /* benefits for recreation & tourism */

/*--- assign single purpose alternative costs ---*/
caT.spaCst[0] = esn.pvCCp;          /* old agric */
caT.spaCst[1] = esn.pvCCp;          /* rural water supply */
caT.spaCst[2] = esn.pvCCp;          /* navigation */
caT.spaCst[3] = esn.pvCCp;          /* new agric */
caT.spaCst[4] = esn.pvCCp;          /* power */
caT.spaCst[5] = stm.pvSPACT * wE;   /* G. Transp */
caT.spaCst[6] = esn.pvCCp;          /* Recr & tourism */

/*--- assign separable costs ---*/
for(i = 0; i < 7; i++)  caT.sepCst[i] = 0.0;

/*--- total cost to be allocated ---*/
caT.projCst = esn.pvCCp;

/*--- perform cost allocation ---*/
sprintf(cBuf,"Main Stem Esna Barrage.");
catFun(cBuf, headers, 7);

/*--- assign allocated costs ---*/
stm.alJCOA += caT.sectCst[0];
stm.alJCW  += caT.sectCst[1];
stm.alJCN  += caT.sectCst[2];
stm.alJCNA += caT.sectCst[3];
stm.alJCP  += caT.sectCst[4];
stm.alJCT  += caT.sectCst[5];
stm.alJCR  += caT.sectCst[6];
}

/**********************************************************************/
/*  caNRgns()  Allocate part of Ag. joint cost from upstream old      */
/*  region to this region                                             */

void  caNRgns(void)
{
char   cBuf[CBUF_W + 2];
char  *headers[2] = {"OLD AG", "NEW AG"};
int    i, iN, upS;

/*----- Conduct Cost Allocation for all New Regions -----*/

if( ctr.nbrRgnNew < 1 ) return;  /* no new regions in scenario */

for(iN = 0; iN < ctr.nbrRgnNew; iN++)
  {
  upS = rnl[iN].upS - 1;       /* index of upstream old region */
  /*--- check that data for old region upS has been input this run*/
  for( i = 0; i < ctr.nbrRgns; i++)
    {
    if( ( (upS + 1) == rgn[i].id) || ((upS +1) == 0) ) break;
    }
  if( i >= ctr.nbrRgns )
    {
    printf("\n\nERROR caNRgns(): The upstream old region id number <");
```

```
        printf("%d>\nused in new region id number <%d>\n",
               upS, rnl[iN].id);
        printf("is not in the input data set.\n");
        quit(1);
        }

      /*--- assign benefits ---*/
      caT.ben[0] = rgn[upS].pvBA;
      caT.ben[1] = rnl[iN].pvBA;

      /*--- assign single purpose alternative costs ---*/
      caT.spaCst[0] = (rgn[upS].pvCOM + rgn[upS].pvSPACCR) * rnl[iN].fOldToNew;
      caT.spaCst[1] = (rgn[upS].pvCOM + rgn[upS].pvSPACCR) * rnl[iN].fOldToNew;

      /*--- assign separable costs to Ag, RWS, and Nav ---*/
      caT.sepCst[0] = 0.0;
      caT.sepCst[1] = 0.0;

      /*--- total cost of delivery canals ---*/
      caT.projCst = rgn[upS].alJCA * rnl[iN].fOldToNew;

      sprintf(cBuf,"New Land Region #%02d %s\n Share Ag costs with #%02d %s",
                  iN+1, rnl[iN].name, upS + 1, rgn[upS].name);

      catFun(cBuf, headers, 2);

      /*--- store allocated costs for the new region and adjust allocated */
      /*--- cost for the upstream old region. */
      rnl[iN].alJCA  =  caT.sectCst[1];
      rgn[upS].alJCA -= rnl[iN].alJCA;
      }
    }

/************************************************************************/
/*  caAW() allocate costs to Ag and Water Supply for non-navigable     */
/*  canals and all pumps                                               */

void caAW(int iR)
{
char   cBuf[CBUF_W + 2];
char  *headers[2] = {" AGRIC", "R.W.S." };

/*----- allocate pump costs to region wide Ag and R.W.S. ------*/
/*--- assign benefits for Ag and Water ---*/
caT.ben[0] = rgn[iR].pvBA;
caT.ben[1] = rgn[iR].pvBW;

/*--- assign single purpose alternative cost for Ag and RWS ---*/
caT.spaCst[0] = rgn[iR].pvPump;
caT.spaCst[1] = rgn[iR].pvSPACW;

/*--- assign separable costs to Ag and RWS ---*/
caT.sepCst[0] = 0.0;
caT.sepCst[1] = 0.0;

/*--- total cost of pumps ---*/
caT.projCst = rgn[iR].pvPump;

sprintf(cBuf,"Region #%02d  %s, pump costs.",
            iR+1, rgn[iR].name);
catFun(cBuf, headers, 2);

rgn[iR].alJCA = caT.sectCst[0];
rgn[iR].alJCW = caT.sectCst[1];

/*----- allocate non-navigable canal costs to Ag & RWS -----*/
/*--- assign benefits for Ag and Water ---*/
```

```
caT.ben[0] = rgn[iR].pvBA * (1.0 - rgn[iR].fCanalN);
caT.ben[1] = rgn[iR].pvBW * (1.0 - rgn[iR].fCanalN);

/*--- assign single purpose alternative cost for Ag and RWS ---*/
caT.spaCst[0] = (rgn[iR].pvCOM + rgn[iR].pvSPACCR)
                * (1.0 - rgn[iR].fCanalN);
caT.spaCst[1] = rgn[iR].pvSPACW * (1.0 - rgn[iR].fCanalN);

/*--- assign separable costs to Ag and RWS ---*/
caT.sepCst[0] = 0.0;
caT.sepCst[1] = 0.0;

/*--- total cost of non-navigable canals ---*/
caT.projCst = (rgn[iR].pvCOM) * (1.0-rgn[iR].fCanalN);

sprintf(cBuf,"Region #%02d  %s, non-navigable canal.",
              iR+1, rgn[iR].name);
catFun(cBuf, headers, 2);

rgn[iR].alJCA += caT.sectCst[0];
rgn[iR].alJCW += caT.sectCst[1];

}

/************************************************************************/
/*  caAWN() allocate costs to sub-region served by navigable canals   */

void caAWN(int iR)
{
char   cBuf[CBUF_W + 2];
char  *headers[3] = {" AGRIC", "R.W.S.", " NAVIG" };

/*--- assign benefits for Ag, RWS, and Nav ---*/
caT.ben[0] = rgn[iR].pvBA * rgn[iR].fCanalN;

caT.ben[1] = rgn[iR].pvBW * rgn[iR].fCanalN;

caT.ben[2] = rgn[iR].pvBN;

/*--- assign single purpose alternative cost for Ag, Water & Nav ---*/
caT.spaCst[0] = (rgn[iR].pvCOM + rgn[iR].pvSPACCR) * rgn[iR].fCanalN;

caT.spaCst[1] = rgn[iR].pvSPACW * rgn[iR].fCanalN;

caT.spaCst[2] = (rgn[iR].pvCOM + rgn[iR].pvSPACCR) * rgn[iR].fCanalN;

/*--- assign separable costs to Ag, RWS, and Nav ---*/
caT.sepCst[0] = 0.0;
caT.sepCst[1] = 0.0;
caT.sepCst[2] = 0.0;

/*--- total cost of navigable canals ---*/
caT.projCst = (rgn[iR].pvCOM) * rgn[iR].fCanalN;

sprintf(cBuf,"Region #%02d  %s, navigable canal costs.",
              iR+1, rgn[iR].name);
catFun(cBuf, headers, 3);

/*--- assign allocated costs to the region ---*/
rgn[iR].alJCA += caT.sectCst[0];
rgn[iR].alJCW += caT.sectCst[1];
rgn[iR].alJCN += caT.sectCst[2];

}

/************************************************************************/
/*  caORgns() allocate the costs for the old regions                   */
```

```
/*  note: allocated costs are stored in rgn[iR].alJCA, alJCW           */
/*         and alJCN as appropriate inside functions caAW and caAWN     */

void caORgns(void)
{
int  iR;

for(iR = 0; iR < ctr.nbrRgns; iR++)
  {
  rgn[iR].alJCA = rgn[iR].alJCW = rgn[iR].alJCN = 0.0;
  /*--- allocate costs of pumps and non-navigable canals to Ag & RWS*/

  caAW(iR);

  /*--- if present, allocate navigable canals to Ag, RWS, & Nav ---*/

  if(rgn[iR].fCanalN > .001)  caAWN(iR);

  }

}

/**********************************************************************/
/*  irrControl(): control the calculation of internal rates of return */
/*  for different components in the basin                             */

void irrControl(void)
{
irrRgns();
}

/**********************************************************************/
/*  irrRgns()  calculate the internal rates of return for all regions  */

void  irrRgns(void)
{
float benStrm[MAX_YRS], cstStrm[MAX_YRS];
float irrRgn[MAX_RGNS];
float xW;
int   iR, iYr;

for(iR = 0; iR < ctr.nbrRgns; iR++)   /* for each region */
  {
  for(iYr = 0; iYr < ctr.nbrYrs; iYr++)
    {
    /*--- Note: this is where the benefit stream (benStrm) ---*/
    /*---       and the cost stream (cstStrm) are assigned ---*/
    /*---       from the data                            ---*/
    }
  /*--- calculate the internal rate of return for region iR ---*/
  /* irrRgn[iR] = irrSolve( benStrm, cstStrm, ctr.dscnt); */
  }
}

/**********************************************************************/
/*  irrSolve(): calculate the internal rate of return for the benefit */
/*  and cost streams using the method of false position               */

float  irrSolve(float benStrm[], float cstStrm[], float guess)
{
double  epsilonX = .001, delX = .01;
double  x0, x1, x2, y0, y1, denom;
int     i, j;

x0 = guess;
y0 = pvSolve(benStrm, ctr.nbrYrs, x0) - pvSolve(cstStrm, ctr.nbrYrs, x0);
x1 = x0;
```

```
/*--- insure the gradient is not negligible ---*/
for(j = 0; j < 6; j++)
  {
  x1 += delX;
  y1 = pvSolve(benStrm, ctr.nbrYrs, x1) - pvSolve(cstStrm, ctr.nbrYrs, x1);
  if( fabs(y1 - y0) > 1.0E-15 ) break;
  }

/*--- stop if no convergence after 50 iterations ---*/
for(i = 0; i < 50; i++)
  {
  if( fabs(denom = y1 - y0) < 1.0E-15 )
    {
    printf("\n\nERROR in irrSolve(): gradient is less than 1.0E-15\n");
    quit(1);
    }
  x2 = x1 - y1 * (x1 - x0)/(denom);
  if( fabs(x1 - x2) < epsilonX ) break;  /* we have a solution */
  x0 = x1;  x1 = x2; y0 = y1;
  y1 = pvSolve(benStrm, ctr.nbrYrs, x1) - pvSolve(cstStrm, ctr.nbrYrs, x1);
  }

if(i > 49)
  {
  printf("\n\nFAILURE in irrSolve(): does not converge after ");
  printf("50 iterations\n");
  quit(1);
  }

return (float)x2;
}

/*********************************************************************/
/*  pvSolve()  calculate the present value of a data stream          */

float  pvSolve(float datStrm[], int nbrEle, float rate)
{
int   iYr;
float fVal = 0;

for(iYr = 0; iYr < nbrEle; iYr++)
  fVal += datStrm[iYr] / pvFactor(iYr, rate); /* note, iYr starts */
                                              /* at zero */

return fVal;
}
/*********************************************************************/
/*  cAlloc()                                                         */

void cAlloc(void)
{
int    iR, iN;
time_t t;

/*----- open output file (.CAD) for cost allocation detail -----*/
fclose(ctr.pOtptHand); /* extra precaution */
ctr.pOtptHand = NULL;
ctr.inptFName[ctr.inptFLen] = '\0';
strcat(ctr.inptFName, "CAD");
ctr.pOtptHand = fopen(ctr.inptFName, "w");
if( ! ctr.pOtptHand )
  {
  printf("\n\nERROR in cAlloc(): Cannot open cost allocation ");
  printf("detail file <%s>\n", ctr.inptFName);
  quit(1);
  }
```

```
/*--- Date/time stamp ---*/
t = time(NULL);
fprintf(ctr.pOtptHand,"%s\n", ctime(&t));

/*--- cost allocation for the old regions ---*/
caORgns();

/*--- update basin wide benefits ---*/
bwd.sumBOA = bwd.sumBW = bwd.sumBN = 0.0;
bwd.sumORgAgAr = bwd.sumORgPop = bwd.sumORgNWP = 0.0;
bwd.sumORgAgW  =  0.0;
for(iR = 0; iR < ctr.nbrRgns; iR++)
  {
  bwd.sumBOA    += rgn[iR].pvBA;
  bwd.sumBW     += rgn[iR].pvBW;
  bwd.sumBN     += rgn[iR].pvBN;
  bwd.sumORgAgAr += rgn[iR].agArea;
  bwd.sumORgAgW  += rgn[iR].agWater;
  bwd.sumORgPop  += rgn[iR].popul;
  bwd.sumORgNWP  += rgn[iR].wpCanal * rgn[iR].fCanalN;
  }

/*--- cost allocation for the new regions ---*/
bwd.sumBNA = 0.0;
if(ctr.nbrRgnNew > 0 )
  {
  caNRgns();

  /*--- update basin wide benefits ---*/
  bwd.sumBNA = bwd.sumNRgAgAr = bwd.sumNRgAgW = 0.0;
  for(iN = 0; iN < ctr.nbrRgnNew; iN++)
    {
    bwd.sumBNA     += rnl[iN].pvBA;
    bwd.sumNRgAgAr += rnl[iN].agArea;
    bwd.sumNRgAgW  += rnl[iN].agWater;
    }
  }

/*----- cost allocation for the main stem ---*/
/*--- UpDate basin wide benefits ---*/
bwd.sumBN += stm.pvBN;
bwd.sumBT += stm.pvBT;
bwd.sumBR += stm.pvBR;
bwd.sumBP += esn.pvBP;
caSTM();

/*----- cost allocation for the high Aswan dam ---*/
/*--- UpDate basin wide benefits ---*/
bwd.sumBP += had.pvBP;
bwd.sumBT += had.pvBT;
bwd.sumBF += had.pvBF;
/*----- Calculate benefits of Flood Control for the HAD -----*/
had.pvBQ = (bwd.sumBW  + bwd.sumBN
         +  bwd.sumBP  + bwd.sumBT + bwd.sumBF + bwd.sumBR)
         *  had.benXQ;

bwd.sumBQ += had.pvBQ;

caHAD();

fclose(ctr.pOtptHand);
ctr.pOtptHand = NULL;

}

/************************************************************************/
/*  caFun(int nbrSer)  perform cost allocation for nbrSer services    */
```

```
/*  using the global data in struct caT                                    */

void catFun(char cBuf[], char *headers[], int nbrSer)
{
int   iVal, iC, nbrCol, endCol;
float fVal;

/*----- print table headings, 25 char for row desc, 6 char for col ---*/
fprintf(ctr.pOtptHand,"\n\nCost Allocation for %s\n", cBuf);
fprintf(ctr.pOtptHand,"Cost to be allocated = %10.1f\n",caT.projCst);
fprintf(ctr.pOtptHand,"                                       %s",headers[0]);
for(iC = 1; iC < nbrSer; iC++)
  fprintf(ctr.pOtptHand,"   %s",headers[iC]);
fprintf(ctr.pOtptHand,"  Totals\n");

if(nbrSer > MAX_CAT_COL - 1)
  {
  iVal = MAX_CAT_COL -1;
  printf("\n\nERROR caFun(): Number of services exceeds maximum number ");
  printf("of columns in table.\n<%d> <%d>",nbrSer, iVal);
  quit(1);
  }

/*--- prepare table with new entries ---*/
nbrCol = nbrSer + 1;
endCol = nbrSer;
for(iC = 0; iC < nbrCol; iC++)
  {
  caT.jstCst[iC] = caT.cop[iC]     = caT.jcop[iC]     = caT.adjF[iC]    = 0;
  caT.asCst[iC]  = caT.rBen[iC]    = caT.jcp[iC]      = 0;
  caT.ajc[iC]    = caT.sectCst[iC] = caT.percnt[iC] = 0;
  }
if( caT.projCst < 0.001 )
  {
  fprintf(ctr.pOtptHand,"\nCost for allocation is zero,");
  fprintf(ctr.pOtptHand," skip this analysis.\n");
  return;
  }

caT.ben[endCol] = caT.spaCst[endCol] = caT.sepCst[endCol] = 0.0;

/* row 1 contains project benefits by service caT.ben[iC] */
for(iC = 0; iC < nbrSer; iC++)
  {
  caT.ben[endCol] += caT.ben[iC];
  }
fprintf(ctr.pOtptHand,"( 1) Project benefits     ");
for(iC = 0; iC < nbrSer; iC++)
  fprintf(ctr.pOtptHand,"%9.1f",caT.ben[iC]);
fprintf(ctr.pOtptHand,"%9.1f\n", caT.ben[endCol]);

/* row 2 contains single purpose alternative caT.spaCst[iC] */
for(iC = 0; iC < nbrSer; iC++)
  {
  caT.spaCst[endCol] += caT.spaCst[iC];
  }
fprintf(ctr.pOtptHand,"( 2) Alternative Costs    ");
for(iC = 0; iC < nbrSer; iC++)
  fprintf(ctr.pOtptHand,"%9.1f", caT.spaCst[iC]);
fprintf(ctr.pOtptHand,"%9.1f\n", caT.spaCst[endCol]);

/* row 3 justifiable costs = lesser of row 1 and row 2 */
for(iC = 0; iC < nbrSer; iC++)
  {
  if( caT.spaCst[iC] < caT.ben[iC] ) caT.jstCst[iC] = caT.spaCst[iC];
  else                               caT.jstCst[iC] = caT.ben[iC];
  caT.jstCst[endCol] += caT.jstCst[iC];
```

```
    }
  fprintf(ctr.pOtptHand,"( 3) Justifiable Costs    ");
  for(iC = 0; iC < nbrSer; iC++)
    fprintf(ctr.pOtptHand,"%9.1f",caT.jstCst[iC]);
  fprintf(ctr.pOtptHand,"%9.1f\n", caT.jstCst[endCol]);

  /* row 4 Separable costs = caT.sepCst[iC] */
  for(iC = 0; iC < nbrSer; iC++)
    {
    caT.sepCst[endCol] += caT.sepCst[iC];
    }
  if( caT.sepCst[endCol] > .00001 )
    {
    fprintf(ctr.pOtptHand,"( 4) Separable Costs      ");
    for(iC = 0; iC < nbrSer; iC++)
      fprintf(ctr.pOtptHand,"%9.1f",caT.sepCst[iC]);
    fprintf(ctr.pOtptHand,"%9.1f\n", caT.sepCst[endCol]);
    }

  /* row 5 costs for other purposes = total project cost less the */
  /*       separable costs for that service (row 4) */
  for(iC = 0; iC < nbrSer; iC++)
    {
    caT.cop[iC] = caT.projCst - caT.sepCst[iC];
    caT.cop[endCol] += caT.cop[iC];
    }
  if( caT.sepCst[endCol] > .00001 )
    {
    fprintf(ctr.pOtptHand,"( 5) Cost Other Purposes ");
    for(iC = 0; iC < nbrSer; iC++)
      fprintf(ctr.pOtptHand,"%9.1f",caT.cop[iC]);
    fprintf(ctr.pOtptHand,"%9.1f\n", caT.cop[endCol]);
    }

  /* row 6 justifiable cost for other purposes = the lesser of row 5 */
  /*       or (sum of row 3 minus row 3 for that service).           */
  for(iC = 0; iC < nbrSer; iC++)
    {
    fVal = caT.jstCst[endCol] - caT.jstCst[iC];
    if( fVal < caT.cop[iC] ) caT.jcop[iC] = fVal;
    else                     caT.jcop[iC] = caT.cop[iC];
    caT.jcop[endCol] += caT.jcop[iC];
    }
  if( caT.sepCst[endCol] > .00001)
    {
    fprintf(ctr.pOtptHand,"( 6) Just Cost Other Purp");
    for(iC = 0; iC < nbrSer; iC++)
      fprintf(ctr.pOtptHand,"%9.1f",caT.jcop[iC]);
    fprintf(ctr.pOtptHand,"%9.1f\n", caT.jcop[endCol]);
    }
  /* row 7 adjustment factor = (row 3 + row 6)/(total project cost) */
  if(caT.projCst < .001)
    {
    printf("\n\nERROR catFun(): total project cost is less than 0.001\n");
    quit(1);
    }
  for(iC = 0; iC < nbrSer; iC++)
    caT.adjF[iC] = (caT.jstCst[iC] + caT.jcop[iC]) / caT.projCst;

  if( caT.sepCst[endCol] > .0001)
    {
    fprintf(ctr.pOtptHand,"( 7) Adjustment Factor    ");
    for(iC = 0; iC < nbrSer; iC++)
      fprintf(ctr.pOtptHand,"%9.4f", caT.adjF[iC]);
    fprintf(ctr.pOtptHand,"\n");
    }
```

```
/* row 8 adjusted separable cost = (row 4) * (row 7) */
for(iC = 0; iC < nbrSer; iC++)
  {
  caT.asCst[iC] = caT.sepCst[iC] * caT.adjF[iC];
  }
if( caT.sepCst[endCol] > .0001 )
  {
  fprintf(ctr.pOtptHand,"( 8) Adj Separable Costs ");
  for(iC = 0; iC < nbrSer; iC++)
    fprintf(ctr.pOtptHand,"%9.1f",caT.asCst[iC]);
  fprintf(ctr.pOtptHand,"\n");
  }

/* row 9 remaining benefits = (row 3) - (row 8) */
for(iC = 0; iC < nbrSer; iC++)
  {
  caT.rBen[iC] = caT.jstCst[iC] - caT.asCst[iC];
  caT.rBen[endCol] += caT.rBen[iC];
  }
if(caT.sepCst[endCol] > .00001)
  {
  fprintf(ctr.pOtptHand,"( 9) Remaining Benefits  ");
  for(iC = 0; iC < nbrSer; iC++)
    fprintf(ctr.pOtptHand,"%9.1f",caT.rBen[iC]);
  fprintf(ctr.pOtptHand,"%9.1f\n", caT.rBen[endCol]);
  }

/* row 10 Joint cost proportion = (row 9)/(sum of row 9) */
if( caT.rBen[endCol]  < 0.001 )
  {
  printf("\n\nERROR catFun(): sum of remaining benefits (row 9) ");
  printf("is less than 0.001\n");
  quit(1);
  }
for(iC = 0; iC < nbrSer; iC++)
  {
  caT.jcp[iC] = caT.rBen[iC] / caT.rBen[endCol];
  caT.jcp[endCol] += caT.jcp[iC];
  }
/*if( caT.jcp[endCol] > .00001 )*/
  {
  fprintf(ctr.pOtptHand,"(10) Joint Cost Propor   ");
  for(iC = 0; iC < nbrSer; iC++)
    fprintf(ctr.pOtptHand,"%9.4f", caT.jcp[iC]);
  fprintf(ctr.pOtptHand,"%9.4f\n", caT.jcp[endCol]);
  }

/* row 11 allocated joint costs = [(total cost)-(sum row 4)]*(row 10) */
fprintf(ctr.pOtptHand,"(11) Allocated Joint Cost");
for(iC = 0; iC < nbrSer; iC++)
  {
  caT.ajc[iC] = (caT.projCst - caT.sepCst[endCol]) * caT.jcp[iC];
  caT.ajc[endCol] += caT.ajc[iC];
  fprintf(ctr.pOtptHand,"%9.1f", caT.ajc[iC]);
  }
fprintf(ctr.pOtptHand,"%9.1f\n", caT.ajc[endCol]);

/* row 12 Total service sector cost = (row 4) + (row 11)  */
fprintf(ctr.pOtptHand,"(12) Total Service Cost  ");
for(iC = 0; iC < nbrSer; iC++)
  {
  caT.sectCst[iC] = caT.sepCst[iC] + caT.ajc[iC];
  caT.sectCst[endCol] += caT.sectCst[iC];
  fprintf(ctr.pOtptHand,"%9.1f", caT.sectCst[iC]);
  }
fprintf(ctr.pOtptHand,"%9.1f\n", caT.sectCst[iC]);
```

```
/* row 13 percentage of total cost = (row 12)/(total cost) */
fprintf(ctr.pOtptHand,"(13) Percentages          ");
for(iC = 0; iC < nbrSer; iC++)
  {
  caT.percnt[iC] = caT.sectCst[iC] / caT.projCst;
  caT.percnt[endCol] += caT.percnt[iC];
  fprintf(ctr.pOtptHand,"%9.2f", caT.percnt[iC]*100);
  }
fprintf(ctr.pOtptHand, "%9.4f\n\n", caT.percnt[endCol]);
}


/**********************************************************************/
/*  loadData(void)                                                    */

void  loadData(void)
{
char   cBuf[CBUF_W+2];
int    iR, iN;
time_t t;

/*--- open input (.HAD) file ---*/
printf("\n\nEnter file name: ");
gets(ctr.inptFName);
/*pC = strchr(ctr.inptFName, '.');*/  /* strip extension if included */
/*if( pC ) *pC = '\0'; */
strcat(ctr.inptFName, ".");
ctr.inptFLen = strlen(ctr.inptFName);
ctr.inptFName[ctr.inptFLen] = '\0';
strcat(ctr.inptFName, "HAD");
ctr.pInptHand = fopen(ctr.inptFName, "r");
if( ! ctr.pInptHand )
  {
  printf("\n\nERROR in loadData(): Cannot open file <%s>\n",
         ctr.inptFName);
  quit(1);
  }
/*--- open output echo (.ECH) file ---*/
if( ECHO )
  {
  ctr.inptFName[ctr.inptFLen] = '\0';
  strcat(ctr.inptFName, "ECH");
  ctr.pOtptHand = fopen(ctr.inptFName, "w");
  if( ! ctr.pOtptHand )
    {
    printf("\n\nERROR in loadData(): Cannot open echo file <%s>\n",
           ctr.inptFName);
    quit(1);
    }
  }
else
  ctr.pOtptHand = NULL;

/*--- Date/Time Stamp ---*/
t = time(NULL);
if(ctr.pOtptHand)
  fprintf(ctr.pOtptHand,"%s\n", ctime(&t) );

loadHAD();
fclose(ctr.pInptHand);
ctr.pInptHand = NULL;

/*--- open input (.STM) file ---*/
ctr.inptFName[ctr.inptFLen] = '\0';
strcat(ctr.inptFName, "STM");
ctr.pInptHand = fopen(ctr.inptFName, "r");
if( ! ctr.pInptHand )
```

```
  {
  printf("\n\nERROR in loadData(): Cannot open file <%s>\n",
         ctr.inptFName);
  quit(1);
  }

loadSTM();
fclose(ctr.pInptHand);
ctr.pInptHand = NULL;

/*--- open input (.Rxx) files ---*/
if(ctr.pInptHand)
  {
  printf("\n\nERROR loadData(): The input handle should be NULL here!\n");
  quit(1);
  }
for(iR = 0; iR < ctr.nbrRgns; iR++)
  {
  ctr.inptFName[ctr.inptFLen] = '\0';
  sprintf(cBuf,"R%02d\0",iR+1); /* file extention 1 greater than array*/
  strcat(ctr.inptFName, cBuf);
  ctr.pInptHand = fopen(ctr.inptFName, "r");
  if( ! ctr.pInptHand )
    {
    printf("\n\nERROR in loadData(): Cannot open file <%s>\n",
           ctr.inptFName);
    quit(1);
    }
  loadRxx(iR);
  fclose(ctr.pInptHand);
  ctr.pInptHand = NULL;
  }

/*--- open input (.Nxx) files ---*/
if( ctr.nbrRgnNew)
  {
  for(iN = 0; iN < ctr.nbrRgnNew; iN++)
    {
    ctr.inptFName[ctr.inptFLen] = '\0';
    sprintf(cBuf,"N%02d\0",iN+1); /* file extention 1 greater than array*/
    strcat(ctr.inptFName, cBuf);
    ctr.pInptHand = fopen(ctr.inptFName, "r");
    if( ! ctr.pInptHand )
      {
      printf("\n\nERROR in loadData(): Cannot open file <%s>\n",
             ctr.inptFName);
      quit(1);
      }
    loadNxx(iN);
    fclose(ctr.pInptHand);
    ctr.pInptHand = NULL;
    }
  }
if( ctr.pOtptHand ) { fclose(ctr.pOtptHand); ctr.pOtptHand = NULL; }
}

/************************************************************************/
/*  quit()   Flush streams and exit                                    */

void quit(int code)
{
flushall();
exit(code);
printf("\n\nAbnormal Termination.\n");
}

/************************************************************************/
```

```
/*  parseRowF()  input a row of float fields.  Read in order, if too   */
/*               few fields in buffer, set trailing values = 0.         */

void parseRowF(char *cBuf, float fVal[], int nbrFld)
{
int j, cPos, eOL;

cPos = eOL = 0;
if( nbrFld > MAX_TBL_COL )
   {
  printf("\n\nERROR in parseRowF(): tried to parse %i fields,", nbrFld);
  printf(" max = MAX_TBL_COL\n");
  quit(1);
   }
for(j = 0; j < nbrFld; j++) fVal[j] = 0;
for(j = 0; j < nbrFld; j++)
   {
  fVal[j] = fField(cBuf, &cPos, &eOL);
  if( eOL && (j != nbrFld - 1) )
     {
    printf("\n\nERROR in parseRowF(): fewer fields than expected\n");
    printf("Check for blank fields in record\n<%s>\n", cBuf);
    quit(1);
     }
   }
}

/************************************************************************/
/*  fField()                                                            */
/*  convert the next field in the buffer to float                       */

float  fField(char cBuf[], int *cPos, int *eOL)
{
char tmpBuf[CBUF_W+2];
int  i, j;

for( i = *cPos; (i < CBUF_W) && (cBuf[i] == ' '); i++);/* skip leading
spaces*/

for( j = i;
      (j < CBUF_W) && (cBuf[j]) && (cBuf[j] != ' ') && (cBuf[j] != '\0');
      j++
    )
    tmpBuf[j - i] = cBuf[j];
tmpBuf[j - i] = '\0';

if( (cBuf[j] == '\0') || (cBuf[j] == '\n') )  *eOL = 1;

*cPos = j;
return atof(tmpBuf);
}

/************************************************************************/
/*  pvFactor(int iYr, rate)  present value factor for year iYr          */
/*  and discount rate "rate". Note discount applied at the beginning    */
/*  of the year by applying iYr+1.                                      */

float  pvFactor(int iYr, float rate)
{
return pow(1.0 + rate, iYr+1);
}

/************************************************************************/
/*  output()  output a summary of the results                           */

void output(void)
{
```

```
int     i, iC, iR, iN;
float   cV[15], drainCst[4];
float   sumV[15], sumPartOne, pvTot, facP;
time_t t;
char  *format1[5] = {"Upper Egypt  %10.3f%10.1f%10.3f%14.3f%14.3f\n",
                     "Middle Egypt %10.3f%10.1f%10.3f%14.3f%14.3f\n",
                     "East Delta   %10.3f%10.1f%10.3f%14.3f%14.3f\n",
                     "Middle Delta %10.3f%10.1f%10.3f%14.3f%14.3f\n",
                     "West Delta   %10.3f%10.1f%10.3f%14.3f%14.3f\n" };

/*--- open the results summary file .RSU ---*/
if(ctr.pOtptHand)
  {
  printf("\n\nERROR output: ctr.pOtptHand already attached\n");
  quit(1);
  }
ctr.inptFName[ctr.inptFLen] = '\0';
strcat(ctr.inptFName, "RSU");
ctr.pOtptHand = fopen(ctr.inptFName, "w");
if( ! ctr.pOtptHand )
  {
  printf("\n\nERROR in loadData(): Cannot open file <%s>\n",
         ctr.inptFName);
  quit(1);
  }

/*--- Date/Time Stamp and Title ---*/
t = time(NULL);
fprintf(ctr.pOtptHand,"%s\n\n", ctime(&t) );

ctr.inptFName[ctr.inptFLen] = '\0';
fprintf(ctr.pOtptHand,"Allocation of Joint Costs as Present Values "
                     "(mil LE) for File: %s\n", ctr.inptFName);
fprintf(ctr.pOtptHand,"Part One of Two\n\n");

/*--- First Table Headings ---*/
fprintf(ctr.pOtptHand,"             ");
fprintf(ctr.pOtptHand,"  ---- AGRICULTURE ----            RURAL          ");
fprintf(ctr.pOtptHand,"    NAV      TOTAL\n");
fprintf(ctr.pOtptHand,"             ");
fprintf(ctr.pOtptHand,"                              --- WATER SUPPLY ---\n");
fprintf(ctr.pOtptHand,"             ");
fprintf(ctr.pOtptHand,"  Region    Stem     HAD  Region    Stem     HAD ");
fprintf(ctr.pOtptHand,"  Region\n\n");

/*--- Table body ---*/
for(iC = 0; iC < 12; iC++)
  sumV[iC] = 0.0;

/*--- print old land region values ---*/
for(iR = 0; iR < ctr.nbrRgns; iR++)
  {
  for(iC = 0; iC < 12; iC++)
    cV[iC] = 0.0;

  cV[0] = rgn[iR].alJCA;

  cV[1] = stm.alJCOA * rgn[iR].agArea/bwd.sumORgAgAr;

  cV[2] = had.alJCOA * rgn[iR].agArea/bwd.sumORgAgAr;

  cV[3] = rgn[iR].alJCW;

  cV[4] = stm.alJCW * rgn[iR].popul/bwd.sumORgPop;

  cV[5] = had.alJCW * rgn[iR].popul/bwd.sumORgPop;
```

```
  cV[6] = rgn[iR].alJCN;

  for(iC = 0; iC < 7; iC++) cV[7] += cV[iC];
  fprintf(ctr.pOtptHand,"Old R%02d ", iR+1);
  for(iC = 0; iC < 8; iC++) fprintf(ctr.pOtptHand,"%8.1f",cV[iC]);
  fprintf(ctr.pOtptHand,"\n");

  for(iC = 0; iC < 12; iC++) sumV[iC] += cV[iC];
  }

/*--- print new land region values ---*/
for(iN = 0; iN < ctr.nbrRgnNew; iN++)
  {
  for(iC = 0; iC < 12; iC++)
    cV[iC] = 0.0;

  cV[0] = rnl[iN].alJCA;

  cV[1] = stm.alJCNA * rnl[iN].agArea/bwd.sumNRgAgAr;

  cV[2] = had.alJCNA * rnl[iN].agArea/bwd.sumNRgAgAr;

  for(iC = 0; iC < 3; iC++) cV[7] += cV[iC];
  fprintf(ctr.pOtptHand,"New N%02d ", iN+1);
  for(iC = 0; iC < 3; iC++) fprintf(ctr.pOtptHand,"%8.1f",cV[iC]);
  for(iC = 3; iC < 7; iC++) fprintf(ctr.pOtptHand,"        ");
  fprintf(ctr.pOtptHand,"%8.1f\n",cV[7]);

  for(iC = 0; iC < 12; iC++) sumV[iC] += cV[iC];
  }
/* --- print the sums at the bottom ---*/
fprintf(ctr.pOtptHand,"\nTotals  ");
for(iC = 0; iC < 8; iC++) fprintf(ctr.pOtptHand,"%8.1f",sumV[iC]);

caT.pvTotJCst = sumV[7];

/* --- print stem and HAD values for NAV, PWR, TRN, TOU, FIS, FLD ---*/
/* --- print table headings ---*/
fprintf(ctr.pOtptHand,"\n\n\nAllocation of Joint Costs as Present Values "
                      "(mil LE) for File: %s\n", ctr.inptFName);
fprintf(ctr.pOtptHand,"Part Two of Two\n");
fprintf(ctr.pOtptHand,"\n          NAV     PWR     TRN     TOU  ");
fprintf(ctr.pOtptHand,"   FIS     FLD    TOTAL\n\n");

/* --- for the barrages --- */
for(iC = 0; iC < 12; iC++)
  {
  cV[iC] = 0.0;
  sumV[iC] = 0.0;
  }

cV[0]  = stm.alJCN;  /* Navigation*/

cV[1]  = stm.alJCP;  /* Power */

cV[2]  = stm.alJCT;  /* Ground Transportation */

cV[3]  = stm.alJCR;  /* Recreatin and Tourism */

cV[4]  = stm.alJCF;  /* Fishery */

cV[5]  = stm.alJCQ;  /* Flood */

for(iC = 0; iC < 6; iC++) cV[6] += cV[iC];

fprintf(ctr.pOtptHand,"Stem    ");
for(iC = 0; iC < 7; iC++) fprintf(ctr.pOtptHand,"%8.1f",cV[iC]);
```

```
fprintf(ctr.pOtptHand,"\n");

for(iC = 0; iC < 7; iC++) sumV[iC] += cV[iC];

/* --- for the HAD ---*/
for(iC = 0; iC < 12; iC++)
  cV[iC] = 0.0;

cV[0]  = had.alJCN;  /* Navigation*/

cV[1]  = had.alJCP;  /* Power */

cV[2]  = had.alJCT;  /* Ground Transportation */

cV[3]  = had.alJCR;  /* Recreatin and Tourism */

cV[4]  = had.alJCF;  /* Fishery */

cV[5]  = had.alJCQ;  /* Flood */

for(iC = 0; iC < 6; iC++) cV[6] += cV[iC];

fprintf(ctr.pOtptHand,"HAD     ");
for(iC = 0; iC < 7; iC++) fprintf(ctr.pOtptHand,"%8.1f",cV[iC]);
fprintf(ctr.pOtptHand,"\n\n");

for(iC = 0; iC < 7; iC++) sumV[iC] += cV[iC];
caT.pvTotJCst += sumV[6];
caT.acTotJCst = annCst(caT.pvTotJCst);

/*--- print the column  totals ---*/
fprintf(ctr.pOtptHand,"Totals  ");
for(iC = 0; iC < 7; iC++)
  fprintf(ctr.pOtptHand,"%8.1f", sumV[iC]);
fprintf(ctr.pOtptHand,"%8.1f\n", caT.pvTotJCst);
/* ---------------------------------------------------------------- */
/* output by annual cost                                            */
/* ---------------------------------------------------------------- */

fprintf(ctr.pOtptHand,"\n\n\nAllocation of Joint Costs as Annual Costs "
                      "(mil LE/YR) for File: %s\n", ctr.inptFName);
fprintf(ctr.pOtptHand,"Part One of Two\n\n");

/*--- First Table Headings ---*/
fprintf(ctr.pOtptHand,"        ");
fprintf(ctr.pOtptHand,"  ---- AGRICULTURE ----            RURAL          ");
fprintf(ctr.pOtptHand,"    NAV     TOTAL\n");
fprintf(ctr.pOtptHand,"        ");
fprintf(ctr.pOtptHand,"                                   --- WATER SUPPLY ---\n");
fprintf(ctr.pOtptHand,"        ");
fprintf(ctr.pOtptHand,"  Region    Stem     HAD  Region    Stem     HAD ");
fprintf(ctr.pOtptHand,"  Region\n\n");

/*--- Table body ---*/
for(iC = 0; iC < 12; iC++)
  sumV[iC] = 0.0;

/*--- print old land region values ---*/
for(iR = 0; iR < ctr.nbrRgns; iR++)
  {
  for(iC = 0; iC < 12; iC++)
    cV[iC] = 0.0;

  cV[0] = rgn[iR].alJCA;

  cV[1] = stm.alJCOA * rgn[iR].agArea/bwd.sumORgAgAr;
```

```
  cV[2] = had.alJCOA * rgn[iR].agArea/bwd.sumORgAgAr;

  cV[3] = rgn[iR].alJCW;

  cV[4] = stm.alJCW * rgn[iR].popul/bwd.sumORgPop;

  cV[5] = had.alJCW * rgn[iR].popul/bwd.sumORgPop;

  cV[6] = rgn[iR].alJCN;

  for(iC = 0; iC < 7; iC++) cV[iC] = annCst(cV[iC]);

  for(iC = 0; iC < 7; iC++) cV[7] += cV[iC];
  fprintf(ctr.pOtptHand,"Old R%02d ", iR+1);
  for(iC = 0; iC < 8; iC++) fprintf(ctr.pOtptHand,"%8.2f",cV[iC]);
  fprintf(ctr.pOtptHand,"\n");

  for(iC = 0; iC < 12; iC++) sumV[iC] += cV[iC];
  }

/*--- print new land region values ---*/
for(iN = 0; iN < ctr.nbrRgnNew; iN++)
  {
  for(iC = 0; iC < 12; iC++)
    cV[iC] = 0.0;

  cV[0] = rnl[iN].alJCA;

  cV[1] = stm.alJCNA * rnl[iN].agArea/bwd.sumNRgAgAr;

  cV[2] = had.alJCNA * rnl[iN].agArea/bwd.sumNRgAgAr;

  for(iC = 0; iC < 3; iC++) cV[iC] = annCst(cV[iC]);

  for(iC = 0; iC < 3; iC++) cV[7] += cV[iC];
  fprintf(ctr.pOtptHand,"New N%02d ", iN+1);
  for(iC = 0; iC < 3; iC++) fprintf(ctr.pOtptHand,"%8.2f",cV[iC]);
  for(iC = 3; iC < 7; iC++) fprintf(ctr.pOtptHand,"        ");
  fprintf(ctr.pOtptHand,"%8.2f\n",cV[7]);

  for(iC = 0; iC < 12; iC++) sumV[iC] += cV[iC];
  }
/* --- print the sums at the bottom ---*/
fprintf(ctr.pOtptHand,"\nTotals  ");
for(iC = 0; iC < 8; iC++) fprintf(ctr.pOtptHand,"%8.2f",sumV[iC]);
sumPartOne = sumV[7];

/* --- print stem and HAD values for NAV, PWR, TRN, TOU, FIS, FLD ---*/
/* --- print table headings ---*/
fprintf(ctr.pOtptHand,"\n\n\nAllocation of Joint Costs as Annual Costs "
                      "(mil LE/Yr for File: %s\n", ctr.inptFName);
fprintf(ctr.pOtptHand,"Part Two of Two\n");

fprintf(ctr.pOtptHand,"\n          NAV     PWR     TRN     TOU  ");
fprintf(ctr.pOtptHand,"   FIS     FLD    TOTAL\n\n");

/* --- for the barrages --- */
for(iC = 0; iC < 12; iC++)
  {
  cV[iC] = 0.0;
  sumV[iC] = 0.0;
  }

cV[0]  = stm.alJCN;  /* Navigation*/

cV[1]  = stm.alJCP;  /* Power */
```

```
cV[2]  = stm.alJCT;  /* Ground Transportation */

cV[3]  = stm.alJCR;  /* Recreatin and Tourism */

cV[4]  = stm.alJCF;  /* Fishery */

cV[5]  = stm.alJCQ;  /* Flood */

for(iC = 0; iC < 6; iC++) cV[iC] = annCst(cV[iC]);
for(iC = 0; iC < 6; iC++) cV[6] += cV[iC];

fprintf(ctr.pOtptHand,"Stem    ");
for(iC = 0; iC < 7; iC++) fprintf(ctr.pOtptHand,"%8.2f",cV[iC]);
fprintf(ctr.pOtptHand,"\n");

for(iC = 0; iC < 7; iC++) sumV[iC] += cV[iC];

/* --- for the HAD ---*/
for(iC = 0; iC < 12; iC++)
  cV[iC] = 0.0;

cV[0]  = had.alJCN;  /* Navigation*/

cV[1]  = had.alJCP;  /* Power */

cV[2]  = had.alJCT;  /* Ground Transportation */

cV[3]  = had.alJCR;  /* Recreatin and Tourism */

cV[4]  = had.alJCF;  /* Fishery */

cV[5]  = had.alJCQ;  /* Flood */

for(iC = 0; iC < 6; iC++) cV[iC] = annCst(cV[iC]);
for(iC = 0; iC < 6; iC++) cV[6] += cV[iC];

fprintf(ctr.pOtptHand,"HAD     ");
for(iC = 0; iC < 7; iC++) fprintf(ctr.pOtptHand,"%8.2f",cV[iC]);
fprintf(ctr.pOtptHand,"\n\n");

for(iC = 0; iC < 7; iC++) sumV[iC] += cV[iC];

/*--- print the column  totals ---*/
fprintf(ctr.pOtptHand,"Totals  ");
for(iC = 0; iC < 7; iC++)
  fprintf(ctr.pOtptHand,"%8.2f", sumV[iC]);
fprintf(ctr.pOtptHand,"%8.2f\n", sumPartOne+sumV[6]); /*sum the two parts*/

/* ------------------------------------------------------------ */
/* output by percent of total                                   */
/* ------------------------------------------------------------ */
pvTot   = caT.pvTotJCst;
facP    = pvTot/100;

fprintf(ctr.pOtptHand,"\n\n\nAllocation of Joint Costs as Percentages "
                      "of the Total for File: %s\n", ctr.inptFName);
fprintf(ctr.pOtptHand,"Part One of Two\n\n");

/*--- First Table Headings ---*/
fprintf(ctr.pOtptHand,"        ");
fprintf(ctr.pOtptHand,"  ---- AGRICULTURE ----          RURAL        ");
fprintf(ctr.pOtptHand,"    NAV     TOTAL\n");
fprintf(ctr.pOtptHand,"        ");
fprintf(ctr.pOtptHand,"                               --- WATER SUPPLY ---\n");
fprintf(ctr.pOtptHand,"        ");
fprintf(ctr.pOtptHand,"  Region    Stem     HAD  Region    Stem     HAD ");
fprintf(ctr.pOtptHand,"  Region\n\n");
```

```
/*--- Table body ---*/
for(iC = 0; iC < 12; iC++)
  sumV[iC] = 0.0;

/*--- print old land region values ---*/
for(iR = 0; iR < ctr.nbrRgns; iR++)
  {
  for(iC = 0; iC < 12; iC++)
    cV[iC] = 0.0;

  cV[0] = rgn[iR].alJCA;

  cV[1] = stm.alJCOA * rgn[iR].agArea/bwd.sumORgAgAr;

  cV[2] = had.alJCOA * rgn[iR].agArea/bwd.sumORgAgAr;

  cV[3] = rgn[iR].alJCW;

  cV[4] = stm.alJCW * rgn[iR].popul/bwd.sumORgPop;

  cV[5] = had.alJCW * rgn[iR].popul/bwd.sumORgPop;

  cV[6] = rgn[iR].alJCN;

  for(iC = 0; iC < 7; iC++) cV[iC] = cV[iC]/facP;

  for(iC = 0; iC < 7; iC++) cV[7] += cV[iC];
  fprintf(ctr.pOtptHand,"Old R%02d ", iR+1);
  for(iC = 0; iC < 8; iC++) fprintf(ctr.pOtptHand,"%8.3f",cV[iC]);
  fprintf(ctr.pOtptHand,"\n");

  for(iC = 0; iC < 12; iC++) sumV[iC] += cV[iC];
  }

/*--- print new land region values ---*/
for(iN = 0; iN < ctr.nbrRgnNew; iN++)
  {
  for(iC = 0; iC < 12; iC++)
    cV[iC] = 0.0;

  cV[0] = rnl[iN].alJCA;

  cV[1] = stm.alJCNA * rnl[iN].agArea/bwd.sumNRgAgAr;

  cV[2] = had.alJCNA * rnl[iN].agArea/bwd.sumNRgAgAr;

  for(iC = 0; iC < 3; iC++) cV[iC] = cV[iC]/facP;

  for(iC = 0; iC < 3; iC++) cV[7] += cV[iC];
  fprintf(ctr.pOtptHand,"New N%02d ", iN+1);
  for(iC = 0; iC < 3; iC++) fprintf(ctr.pOtptHand,"%8.3f",cV[iC]);
  for(iC = 3; iC < 7; iC++) fprintf(ctr.pOtptHand,"        ");
  fprintf(ctr.pOtptHand,"%8.3f\n",cV[7]);

  for(iC = 0; iC < 12; iC++) sumV[iC] += cV[iC];
  }
/* --- print the sums at the bottom ---*/
fprintf(ctr.pOtptHand,"\nTotals  ");
for(iC = 0; iC < 8; iC++) fprintf(ctr.pOtptHand,"%8.3f",sumV[iC]);
sumPartOne = sumV[7];

/* --- print stem and HAD values for NAV, PWR, TRN, TOU, FIS, FLD ---*/
/* --- print table headings ---*/
fprintf(ctr.pOtptHand,"\n\n\nAllocation of Joint Costs as Percentages of "
                      "the Total for File: %s\n", ctr.inptFName);
fprintf(ctr.pOtptHand,"Part Two of Two\n");
```

```
fprintf(ctr.pOtptHand,"\n              NAV      PWR      TRN      TOU  ");
fprintf(ctr.pOtptHand,"   FIS      FLD      TOTAL\n\n");

/* --- for the barrages --- */
for(iC = 0; iC < 12; iC++)
  {
  cV[iC] = 0.0;
  sumV[iC] = 0.0;
  }

cV[0]  = stm.alJCN;  /* Navigation*/

cV[1]  = stm.alJCP;  /* Power */

cV[2]  = stm.alJCT;  /* Ground Transportation */

cV[3]  = stm.alJCR;  /* Recreatin and Tourism */

cV[4]  = stm.alJCF;  /* Fishery */

cV[5]  = stm.alJCQ;  /* Flood */

for(iC = 0; iC < 6; iC++) cV[iC] = cV[iC]/facP;
for(iC = 0; iC < 6; iC++) cV[6] += cV[iC];

fprintf(ctr.pOtptHand,"Stem    ");
for(iC = 0; iC < 7; iC++) fprintf(ctr.pOtptHand,"%8.3f",cV[iC]);
fprintf(ctr.pOtptHand,"\n");

for(iC = 0; iC < 7; iC++) sumV[iC] += cV[iC];

/* --- for the HAD ---*/
for(iC = 0; iC < 12; iC++)
  cV[iC] = 0.0;

cV[0]  = had.alJCN;  /* Navigation*/

cV[1]  = had.alJCP;  /* Power */

cV[2]  = had.alJCT;  /* Ground Transportation */

cV[3]  = had.alJCR;  /* Recreatin and Tourism */

cV[4]  = had.alJCF;  /* Fishery */

cV[5]  = had.alJCQ;  /* Flood */

for(iC = 0; iC < 6; iC++) cV[iC] = cV[iC]/facP;
for(iC = 0; iC < 6; iC++) cV[6] += cV[iC];

fprintf(ctr.pOtptHand,"HAD     ");
for(iC = 0; iC < 7; iC++) fprintf(ctr.pOtptHand,"%8.3f",cV[iC]);
fprintf(ctr.pOtptHand,"\n\n");

for(iC = 0; iC < 7; iC++) sumV[iC] += cV[iC];

/*--- print the column  totals ---*/
fprintf(ctr.pOtptHand,"Totals  ");
for(iC = 0; iC < 7; iC++)
  fprintf(ctr.pOtptHand,"%8.3f", sumV[iC]);

fprintf(ctr.pOtptHand,"%8.3f\n", sumPartOne+sumV[6]); /*sum the two parts*/

/* ------------------------------------------------------------- */
/* output joint and total costs by major categories p.v./FD       */
/* ------------------------------------------------------------- */
```

```
fprintf(ctr.pOtptHand,"\n\nAllocation of Costs by Major Categories for"
                       " File: %s\n", ctr.inptFName);
fprintf(ctr.pOtptHand,"Present Value (P.V.) and Annual Cost (A.C.).\n\n");

/*--- Table Headings ---*/
fprintf(ctr.pOtptHand,"  CATEGORY   --------JOINT COST--------");
fprintf(ctr.pOtptHand,"  ---TOTAL COST---\n");
fprintf(ctr.pOtptHand,"                P.V.     A.C.          ");
fprintf(ctr.pOtptHand,"   P.V.     A.C.\n");
fprintf(ctr.pOtptHand,"                m LE   m LE/YR     %    ");
fprintf(ctr.pOtptHand,"   m LE   m LE/YR\n");

/* --- Existing Ag --- */
for(i=0; i < 12; i++) { cV[i] = sumV[i] = 0.0; }

for(iR = 0; iR < ctr.nbrRgns; iR++)
  {
  cV[0] += rgn[iR].alJCA
          + (stm.alJCOA+had.alJCOA)*rgn[iR].agArea/bwd.sumORgAgAr;
  }
cV[1]  = annCst(cV[0]);
cV[2] = 100 * cV[0]/caT.pvTotJCst;
cV[3] = cV[0] + bwd.pvDrain; /*Exst region total cost present value */
cV[4] = cV[1] + bwd.acDrain; /*Exst region total cost annual cost */
sumV[0] = cV[0]; sumV[1] = cV[1]; sumV[2] = cV[2];
sumV[3] = cV[3]; sumV[4] = cV[4];

fprintf(ctr.pOtptHand,"Existing Ag %9.1f%9.2f%9.2f%9.1f%9.2f\n",
                      cV[0],cV[1],cV[2],cV[3],cV[4]);

/* --- New New Lands --- */
for(i=0;i<12;i++) cV[i] = 0;

for(iN = 0; iN < ctr.nbrRgnNew; iN++)
  {
  cV[0] += rnl[iN].alJCA
          + (stm.alJCNA + had.alJCNA) * rnl[iN].agArea/bwd.sumNRgAgAr;
  }
cV[1] = annCst(cV[0]);
cV[2] = 100 * cV[0]/caT.pvTotJCst;
sumV[0] += cV[0]; sumV[1] += cV[1]; sumV[2] += cV[2];

fprintf(ctr.pOtptHand,"New New Land%9.1f%9.2f%9.2f\n",
                      cV[0],cV[1],cV[2]);

/* --- Rural Water Supply --- */
for(i=0;i<12;i++) cV[i] = 0.0;

for(iR = 0; iR < ctr.nbrRgns; iR++)
  {
  cV[0] += rgn[iR].alJCW
          +(stm.alJCW + had.alJCW) * rgn[iR].agArea/bwd.sumORgAgAr;
  }
cV[1] = annCst(cV[0]);
cV[2] = 100 * cV[0]/caT.pvTotJCst;
sumV[0] += cV[0]; sumV[1] += cV[1]; sumV[2] += cV[2];

fprintf(ctr.pOtptHand,"Water Supply%9.1f%9.2f%9.2f\n",
                      cV[0],cV[1],cV[2]);

/* --- Navigation --- */
for(i=0;i<12;i++) cV[i] = 0.0;

for(iR = 0; iR < ctr.nbrRgns; iR++)
  cV[0] += rgn[iR].alJCN;

cV[0] += stm.alJCN + had.alJCN;
```

```
cV[1]   = annCst(cV[0]);

cV[2] = 100 * cV[0]/caT.pvTotJCst;
sumV[0] += cV[0]; sumV[1] += cV[1]; sumV[2] += cV[2];

fprintf(ctr.pOtptHand,"Navigation  %9.1f%9.2f%9.2f\n",
                        cV[0],cV[1],cV[2]);

/* --- Power --- */
cV[0]   = stm.alJCP + had.alJCP;
cV[1]   = annCst(cV[0]);
cV[2]   = 100 * cV[0]/caT.pvTotJCst;
sumV[0] += cV[0]; sumV[1] += cV[1]; sumV[2] += cV[2];

fprintf(ctr.pOtptHand,"Power       %9.1f%9.2f%9.2f\n",
                        cV[0], cV[1], cV[2]);

/* --- Ground Transportation --- */
cV[0]   = stm.alJCT + had.alJCT;
cV[1]   = annCst(cV[0]);
cV[2]   = 100 * cV[0]/caT.pvTotJCst;
sumV[0] += cV[0]; sumV[1] += cV[1]; sumV[2] += cV[2];

fprintf(ctr.pOtptHand,"Transport   %9.1f%9.2f%9.2f\n",
                        cV[0], cV[1], cV[2]);


/* --- Tourism and Recreation --- */
cV[0]   = stm.alJCR + had.alJCR;
cV[1]   = annCst(cV[0]);
cV[2]   = 100 * cV[0]/caT.pvTotJCst;
sumV[0] += cV[0]; sumV[1] += cV[1]; sumV[2] += cV[2];

fprintf(ctr.pOtptHand,"Tourism     %9.1f%9.2f%9.2f\n",
                        cV[0], cV[1], cV[2]);


/* --- Fishery --- */
cV[0]   = stm.alJCF + had.alJCF;
cV[1]   = annCst(cV[0]);
cV[2]   = 100 * cV[0]/caT.pvTotJCst;
sumV[0] += cV[0]; sumV[1] += cV[1]; sumV[2] += cV[2];

fprintf(ctr.pOtptHand,"Fishery     %9.1f%9.2f%9.2f\n",
                        cV[0], cV[1], cV[2]);


/* --- Flood ---*/
cV[0]   = stm.alJCQ + had.alJCQ;
cV[1]   = annCst(cV[0]);
cV[2]   = 100 * cV[0]/caT.pvTotJCst;
sumV[0] += cV[0]; sumV[1] += cV[1]; sumV[2] += cV[2];

fprintf(ctr.pOtptHand,"Flood Cntrl %9.1f%9.2f%9.2f\n",
                        cV[0], cV[1], cV[2]);


/* --- TOTALS ---*/
fprintf(ctr.pOtptHand,"\nTOTALS      %9.1f%9.2f%9.2f%9.1f%9.2f\n\n",
                        sumV[0],sumV[1],sumV[2],sumV[3],sumV[4]);

/*---------------------------------------------------------------------*/
/*---------------------------------------------------------------------*/
/* Output Annual Costs by Hierarchy                                    */
/*---------------------------------------------------------------------*/
fprintf(ctr.pOtptHand,"\n\nAllocation of Annual Costs (A.C.) by"
                        " Hierarchy for File: %s\n", ctr.inptFName);
```

```
fprintf(ctr.pOtptHand,"Annual Costs Allocated to Existing Agriculture\n\n");

/*--- Table Headings ---*/
fprintf(ctr.pOtptHand,"                  Area     Water     Annual  ");
fprintf(ctr.pOtptHand,"    A.C./FD    A.C./1000M3\n");
fprintf(ctr.pOtptHand,"                 mil FD    mil M3     Cost   ");
fprintf(ctr.pOtptHand,"      LE/FD      LE/1000M3\n");
fprintf(ctr.pOtptHand,"\nJOINT COSTS\n");

/* --- HAD ---*/
cV[0] = annCst(had.alJCOA);
cV[1] = bwd.sumORgAgAr;
cV[2] = bwd.sumORgAgW;
fprintf(ctr.pOtptHand,"HAD          %10.3f%10.1f%10.3f%14.3f%14.3f\n",
                 cV[1], cV[2], cV[0], cV[0]/cV[1], cV[0]/cV[2]*1000);

/* --- Stem including Esna --- */
cV[0] = annCst(stm.alJCOA);
cV[1] = bwd.sumORgAgAr;
cV[2] = bwd.sumORgAgW;
fprintf(ctr.pOtptHand,"Stem         %10.3f%10.1f%10.3f%14.3f%14.3f\n",
                 cV[1], cV[2], cV[0], cV[0]/cV[1], cV[0]/cV[2]*1000);

/* --- Existing Regions --- */
for(iR = 0; iR < ctr.nbrRgns; iR++)
  {
  cV[0] = annCst(rgn[iR].alJCA);
  cV[1] = rgn[iR].agArea;
  cV[2] = rgn[iR].agWater;
  fprintf(ctr.pOtptHand,format1[iR],
                 cV[1], cV[2], cV[0], cV[0]/cV[1], cV[0]/cV[2]*1000);
  }

/* --- Total Costs Including Drains for each Old Region ---*/

drainCst[0] = bwd.acDrain;
drainCst[1] = bwd.acDrain/bwd.sumORgAgAr;
drainCst[2] = bwd.acDrain/bwd.sumORgAgW*1000;

fprintf(ctr.pOtptHand,"\nDRAIN COSTS  ");
fprintf(ctr.pOtptHand,"%10.3f%10.1f%10.3f%14.3f%14.3f\n",
                 bwd.sumORgAgAr, bwd.sumORgAgW, drainCst[0],
                 drainCst[1], drainCst[2]);

fprintf(ctr.pOtptHand,"\nTOTAL COSTS  \n");

/* --- Total Costs Existing Regions --- */

for(i=0; i<12; i++) sumV[i] = 0.0;

for(iR = 0; iR < ctr.nbrRgns; iR++)
  {
  cV[0] = rgn[iR].agArea;
  cV[1] = rgn[iR].agWater;
  cV[2] = rgn[iR].alJCA
      + (stm.alJCOA + had.alJCOA) * rgn[iR].agArea / bwd.sumORgAgAr;
  cV[2] = annCst(cV[2]) + drainCst[1]*rgn[iR].agArea;
  cV[3] = cV[2] / cV[0];
  cV[4] = cV[2] / cV[1] * 1000;

  sumV[2] += cV[2];

  fprintf(ctr.pOtptHand,format1[iR],
                 cV[0], cV[1], cV[2], cV[3], cV[4]);
  }

fprintf(ctr.pOtptHand,"\nFLAT RATE                                   ");
```

```
fprintf(ctr.pOtptHand,"%14.3f%14.3f\n", sumV[2]/bwd.sumORgAgAr,
                       sumV[2]/bwd.sumORgAgW*1000);
}

/**********************************************************************/
/*  initialize()  Initialize some of the data values to zero          */

void initialize(void)
{
int  i;
had.pvBP = had.pvBT = had.pvBF = had.pvBQ = had.pvCOM = had.pvSPACO = 0.0;
had.pvSPACT = had.pvSPACQ = had.pvSepCA = had.pvSepCP = had.pvSepCQ = 0.0;
had.alJCOA = had.alJCNA = had.alJCW = had.alJCN = had.alJCP = 0.0;
had.alJCT = had.alJCF = had.alJCR = had.alJCQ = 0.0;

stm.pvBN = stm.pvBT = stm.pvBR = stm.pvSPACT = stm.pvCOM = 0.0;
stm.alJCOA = stm.alJCNA = stm.alJCW = stm.alJCN = stm.alJCP = 0.0;
stm.alJCT = stm.alJCF = stm.alJCR = stm.alJCQ = 0.0;

esn.pvBP = esn.pvCCp = 0.0;
for(i = 0; i < MAX_RGNS; i++)
  {
  rgn[i].pvSPACW = rgn[i].pvBA = rgn[i].pvBW = rgn[i].pvBN = 0.0;
  rgn[i].pvCOM = rgn[i].pvPump = rgn[i].alJCA = 0.0;
  rgn[i].alJCW = rgn[i].alJCN = 0.0;
  }
for(i = 0; i < MAX_NEWL; i++)
  rnl[i].pvBA = rnl[i].pvCCpOM = rnl[i].alJCA = 0.0;

bwd.sumBOA = bwd.sumBNA = bwd.sumBW = bwd.sumBN = bwd.sumBP = 0.0;
bwd.sumBT = bwd.sumBF = bwd.sumBR = bwd.sumBQ = 0.0;
}

/**********************************************************************/
/* pvSolCA()  calculate the present value of a first year capital     */
/* investment followed by annual O&M charges                          */

float pvSolCA(float cap, float annual, int nYrs, float rate)
{
int   iYr;
float fVal;

fVal = cap / pvFactor(0, rate);
for( iYr = 1; iYr < nYrs; iYr++)
  fVal += annual / pvFactor(iYr, rate);

return fVal;
}

/**********************************************************************/
/* inptStAF()  Input/output a string followed by one or two floats    */
/*  Take the present value of the indicated costs                     */

void inptStAF(float *v1, float *v2, int nbrFlds, float *pvV)
{
char  cBuf[CBUF_W];
char *pC;

fgets(cBuf, CBUF_W, ctr.pInptHand);
pC = skipTxt(cBuf, ':');
if( nbrFlds == 1)
  {
  sscanf(pC,"%f", v1);
  *pvV = pvSolCA(*v1, *v1, ctr.nbrYrs, ctr.dscnt);
  if(ctr.pOtptHand)
    fprintf(ctr.pOtptHand,"%10.1f,          p.v. = %10.1f\n", *v1, *pvV);
  }
```

```
else if ( nbrFlds == 2)
  {
  sscanf(pC,"%f%f", v1, v2);
  *pvV = pvSolCA(*v1, *v2, ctr.nbrYrs, ctr.dscnt);
  if(ctr.pOtptHand) fprintf(ctr.pOtptHand,"%10.1f%10.3f, p.v. = %10.1f\n",
                                *v1, *v2, *pvV);
  }
else
  {
  printf("\n\nERROR inptSLAF() more than two input fields\n");
  quit(1);
  }
}

/***********************************************************************/
/*  skipTxt()                                                          */
/*  Skip and echo text in buffer until character c is encountered      */
char *skipTxt(char cBuf[], char c)
{
int  i, j;
char tmpBuf[CBUF_W+2];
char *pC = NULL;

for(j = 0; j < CBUF_W; j++) tmpBuf[j] = ' ';
tmpBuf[CBUF_W] = '\0';

for(i = 0; i < CBUF_W; i++)
  {
  tmpBuf[i] = cBuf[i];
  if( (! cBuf[i]) || (cBuf[i] == c) ) break;
  }

if(ctr.pOtptHand)
  for(j = 0; j < 35; j++) fputc(tmpBuf[j], ctr.pOtptHand);

if(cBuf[i] == c)
  {
  pC = &cBuf[i+1];
  return pC;
  }
else
  {
  printf("\n\nERROR skpTxt(): Expect a \"%c\" in record \n<%s>\n",c, cBuf);
  quit(1);
  }
return 0;
}

/***********************************************************************/
/***********************************************************************/
/*  blankLine(). Is this a blank line? 0 = FALSE, 1 = TRUE.            */
/***********************************************************************/
int blankLine(char cBuf[])
{
int  i;
/* skip leading spaces*/
for( i = 0; ( i < CBUF_W) && (cBuf[i] ==  ' ') && cBuf[i]; i++ );
if(cBuf[i] == '\n') return 1;
else return 0;
}

/***********************************************************************/
/***********************************************************************/
/* annCst(float presentValue)                                          */
/***********************************************************************/
float annCst(float pVal)
{
```

```
float rate = ctr.dscnt;
float nPer = ctr.nbrYrs;
float type = 0;
float rFact;

if(rate > 1.0E-5)
  {
  rFact = pow(1.0+rate,nPer);
  return (pVal*rFact/(1.0+rate*type)*rate/(rFact-1));
  }
else
  if(nPer < 1.0E-5)
    {
    printf("\n\nERROR in annCst(): The number of periods must be greater"
           " than zero.");
    quit(1);
    }
  return (pVal/nPer);
}
```