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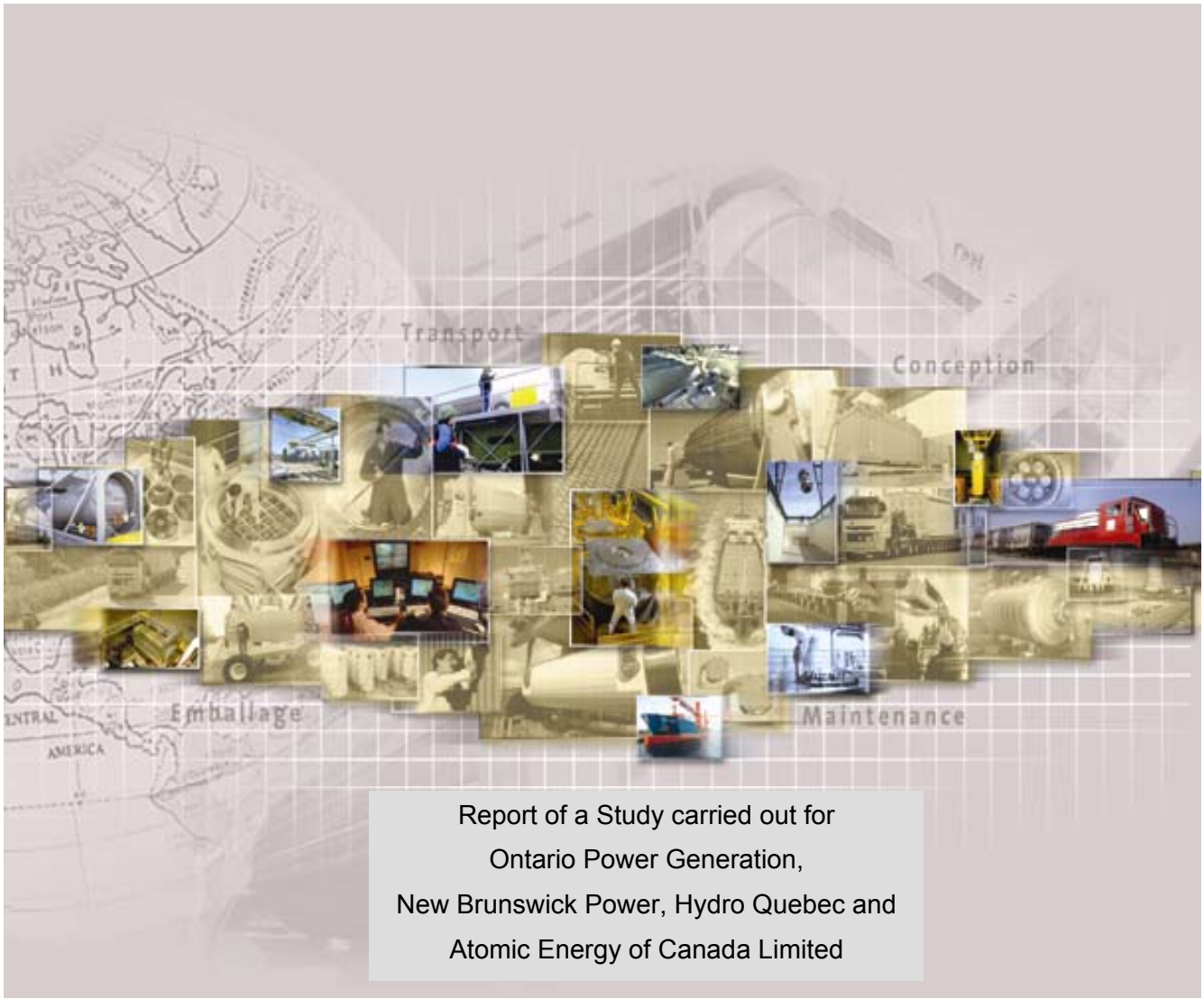
Cost Estimate for Transportation of Used Fuel to a Centralised Facility



Report of a Study carried out for
Ontario Power Generation,
New Brunswick Power, Hydro Quebec and
Atomic Energy of Canada Limited

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EXECUTIVE SUMMARY

Canadian CANDU Used Fuel is currently stored at each Nuclear Power Plant where it has been produced, prepared into modules or baskets and temporarily stored in wet or dry storage. The purpose of the Used Fuel Transportation System is to transport all the Used Fuel arising from current Canadian program, consisting of approximately 3.6 million bundles, from their current storage facilities to a centralised long-term management facility. This facility may be a Deep Geological Repository or a Centralised Extended Storage facility, depending on the option chosen by the federal government after the review of options required by the Nuclear Fuel Waste Act. If continued storage at the current sites is chosen, then no transportation system will be required. For the purposes of the study, it was assumed that the centralised facility would be located somewhere in Ontario.

The Used Fuel is produced at nuclear facilities owned by Ontario Power Generation (OPG), New Brunswick Power (NBP), Hydro Quebec (HQ) and Atomic Energy of Canada Limited (AECL). The scope of the study was limited to CANDU fuel, and did not include AECL's research fuels.

Three alternative transportation modes have been identified and develop in a conceptual design phase : one all road mode, one mostly rail mode and one mostly water mode. The result of the conceptual design is to make respectively by each mode 18,707 or 1,930 or 647 shipments.

The Used Fuel Transportation System components include the casks loading facilities at each Nuclear Power Plant, the Transportation Packages, the vehicles, the maintenance facility, the real time tracking system and the emergency means. The Transportation Package would be able to transport safely up to 192 bundles by road or up to 384 by rail or water and would provide the necessary shielding to reduce the doses for staff in contact with the package a minima. Depending of the chosen transportation mode, the Transportation Package is assumed to be similar to the current design of OPG's Irradiated Fuel Cask (IFTC) for all road mode or it would be the same, together with the Dry Storage Container (DSC) for the both other modes.

The Used Fuel Transportation System operations include all the operations from the loading of the modules or baskets into the Transportation Package to the Transportation Package unloading from the vehicle at the centralised facility and including the transportation equipment maintenance. Where needed in the design and logistics, the details of the shipping program applicable to a 2035 in-service date were used.

The development, construction, operation and decommissioning phases for the Used Fuel Transportation System are assumed to span from year 12 to year 62 of the centralised facility development program (i.e. from 2017 to 2067, with the date of 2035). This schedule does not include the safety assessment and public affairs duration or impacts on the transportation program during the siting phase of the overall program.

The total future costs, in January 2002 constant million Canadian dollars, are presented hereunder for each transportation mode. The Goods & Services Taxes, Federal or Provincial taxes and Custom duties are excluded.

Cost in million Canadian Dollars	All road mode	Mostly rail	Mostly water
Capital equipment cost	**292**	**358**	**422**
Operation cost	**543**	**680**	**876**
Other cost	**93**	**92**	**99**
Total cost	**928**	**1 130**	**1 397**

GLOSSARY

List of abbreviations used in this document

ACL	AREVA COGEMA Logistics
AECL	Atomic Energy of Canada Limited
CA	Compressed air
CAD	Canadian Dollar
CES	Centralised Extended Storage
CNSC	Canadian Nuclear Safety Commission
DGR/CES	Deep Geological Repository / Centralised Extended Storage
DSC	Dry Storage Container
DUFDSF	Darlington Used Fuel Dry Storage Facility
EA	Environmental Assessment
EUR	Euro currency
FSAR	Final Safety Analysis Report
FTE	Full Time Equivalent
GST	Good and Service Taxes
HQ	Hydro Quebec
IFB	Irradiated Fuel Bay
IFTC	Irradiated Fuel Transportation Cask
IFTC/BM	Irradiated Fuel Transportation Cask for Baskets and Modules
I & C	Instrumentation and Control
IAEA	International Atomic Energy Agency
KCAD	Thousand Canadian Dollar
MCAD	Million Canadian Dollar
NBP	New Brunswick Power
NPP	Nuclear Power Plant
NWMD	OPG Nuclear Waste Management Division
OPG	Ontario Power Generation
PUFDSF	Pickering Used Fuel Dry Storage Facility
PSAR	Preliminary Safety Analysis Report
TBD	To be defined
TC	Transportation Cask
UF	Used Fuel
UFTS	Used Fuel Transportation System
WBS	Work Breakdown Structure
WEDS	Work Element Definition Sheet
WMO	Waste Management Organisation
WUFDSF	Western Used Fuel Dry Storage Facility

1. COST ESTIMATE INTRODUCTION AND MAIN ASSUMPTIONS

1.1. INTRODUCTION OF COST ESTIMATE REPORT

The purpose of this report is to document an estimate for an assumed program to design, procure, construct, operate and decommission a transportation system for Used Fuel (UF). This system would have the capacity to safely package and ship Used Fuel produced at nuclear facilities owned by Ontario Power Generation (OPG), New Brunswick Power (NBP), Hydro Quebec (HQ) and Atomic Energy of Canada Limited (AECL) to a Centralised Extended Storage (CES) or Deep Geological Repository (DGR).

The Used Fuel from Canada's NPP is currently stored in water-filled pools (wet storage) or concrete structures such as Dry Storage Containers (DSCs) or silos (dry storage) . The Used Fuel is stored by each nuclear facilities owner at the locations where it has been produced (see section 1.2 the locations).

Ontario Power Generation (OPG) has identified three alternative transportation modes for the Used Fuel : one all road mode, one mostly rail mode and one mostly water mode. These 3 modes, based on COGEMA LOGISTICS experience , intend to optimise the shipments quantities and to demonstrate the feasibility of a safe transportation system.

The present document developed by COGEMA LOGISTICS in phase 3 presents Capital and Operating Cost estimates of the Used Fuel Transportation System corresponding to the three transportation modes. The cost estimates are based on the Conceptual Design Report and the Logistics Report elaborated by COGEMA LOGISTICS in phases 1 and 2 of the study and reviewed and commented by OPG. The systems are based on realistic designs and scheduling, but have not been optimised. Cost variations would be expected based on the particular destination and combination of modes actually used, on the transportation program adopted, and on optimisation of equipment designs. Each transportation mode is associated with the construction of new buildings or existing building refurbishment to load the used fuel modules or baskets into the transportation package and the utilities supplying to support these operations. The cost estimates exclude licensing and approval works and some other costs related to the centralised facility and to refurbishment and construction at the current storage sites which will be developed by the waste owners in order to support decision making.

1.2. MAJOR ASSUMPTIONS FOR THE THREE MODES OF USED FUEL TRANSPORTATION SYSTEMS

1) The nuclear facilities include Ontario Power Generation (Bruce Nuclear A and B, Pickering Nuclear A and B, Darlington), Atomic Energy of Canada Limited (Whiteshell, Douglas Point, Chalk River Laboratories, Gentilly 1), Hydro Quebec (Gentilly 2) and New Brunswick Power (Point Lepreau).

2) All the UF transported is stored in fuel modules in the facility's Irradiated Fuel Bay (IFB) or in DSCs Storage Facility or in fuel baskets in silos. The modules or baskets are ready to be loaded into the cavity of the UF transportation package. The design, procurement, commissioning, operation, maintenance, and decommissioning of tray to module or basket conversion equipment are not included.

3) The IFBs have been maintained and are still in active service following the shutdown of the nuclear facility. The operating and maintenance costs for keeping the IFBs in-service are not included.

4) The cost estimates associated with the design, construction, commissioning, operation, maintenance and decommissioning of the loading facilities at the nuclear facilities are included. The loading facility will be used to transfer the used fuel modules or baskets into the UF transportation package and the used fuel is stored :

- in a Dry Storage Container (DSC) and have been prepared in fuel modules.
- In a wet bay and have been prepared in fuel modules .
- In a dry storage silo or Canstor vault and have been prepared in fuel baskets.

5) All equipment and activities required before the retrieval of the Used Fuel modules from a Dry Storage Container (DSC) are not included. For DSCs retrieval, the transfer of the DSC to a Transfer Facility via a transporter, and the removal of the DSC containment lids are not included. All equipment, loading facility and activities to achieve the next operations are included.

6) All equipment and activities for the retrieval of the Used Fuel modules from wet bays are included. For modules retrieval, the modules transfer into the packaging and the packaging handling to a Transfer Facility via a transporter are included. The pool building improvement or strengthening are not included.

7) All equipment and activities for the retrieval of the Used Fuel baskets from a silo or a Canstor vault are not included. For baskets retrieval, the transfer of the baskets into a transfer flask and the transfer flask handling to a Transfer Facility via a transporter are not included. All equipment, loading facility and activities to achieve the next operations are included.

8) AECL, NBP and HQ will not be storing any used fuel in DSCs.

9) Only CANDU UF is transported from the nuclear facility to the DGR/CES; enriched or other forms of used fuel or waste are not included.

10) Cost estimates associated with the Transportation Package unloading of the Used Fuel, contamination checks, documentation and safety mark checks, at the DGR/CES are not included. Cost estimates associated with the decontamination and maintenance of the UF transportation packages and transporters are included.

11) The DGR/CES will be located on the Ontario portion of the Canadian Shield. The approximate road transportation distances from the nuclear facilities to the DGR/CES are assumed as follows:
OPG – all nuclear facilities : 1,000 km
NBP – Point Lepreau : 2,500 km
HQ – Gentilly 2 : 1,500 km
AECL :
- Chalk River : 1,000 km
- Whiteshell : 1,000 km
- Douglas Point : 1,000 km
- Gentilly 1 : 1,500 km

12) The trailers, tractors and railcars maintenance facility are able to carry out the preventive maintenance, the annual maintenance and every 4 years a complete overhaul.

13) The trailers, tractors and transportation packages quantities have been optimised and these equipment cost will be financially shared between all the Nuclear Power Plant and waste owners. The result is that the most part of this equipment is to procure at the beginning of UF loading and transportation operation and it will be used only at the beginning of transportation operation by the both first Nuclear Power Plant storage to empty (PICKERING and BRUCE). The consequence is that the cost apportionment for all Nuclear Power Plant waste owners is financially advanced and without relation to the expected transportation operation dates for each NPP.

14) To estimate the capital equipment or facilities cost all the contractor unit costs used are selling rates including social charges, overheads and profit (WBS 610.40).
To estimate the Operation cost all the OPG's rates are only burdened rates without overheads and profit (WBS 610.50).

2. OBJECTIVES OF THE STUDY PHASE 3

The cost estimates for the Used Fuel Transportation System options would help in developing a life-cycle cost estimate for each used fuel management option as input to the study of options required by the Nuclear Fuel Waste Act.

3. USED FUEL TRANSPORTATION SYSTEM OPTIONS DESCRIPTION

In this section, we describe the Used Fuel Transportation System for each option:
- "All Road" mode
- "Mostly Rail" mode
- "Mostly Water" mode

For each transportation mode, we summarise the main features of the Used Fuel Transportation System Used Fuel generated by all Canadian NPPs is transported from their current storage site to the DGR/CES site. The UFTS includes two main phases : the first concerns the capital equipment and facility cost, the second the loading and transportation operation cost.
Some items are common parts and should be financially apportioned between all waste owners such as : Mode and route development, System development, Safety Assessment, Public Affairs, Casks maintenance facility, Trailers and tractors maintenance facility, Real time tracking system, Emergency means and response plan, Centralised Facility operations, Program management, Environmental Management System, and Decommissioning.

3.1. OPTION 1 : ALL ROAD MODE DESCRIPTION

Each of the current storage facilities has road access and the transportation mode studied and assessed is only a road mode.
The empty transportation package is prepared before shipment.
The fuel modules in wet bays will be directly load into the packaging in the pool building at each site. The fuel baskets in silos or Canstor will be transferred from the current storage to the Transportation Package loading facilities at each site with a transfer flask. The full DSCs stored in the dry storage facility will be transferred from the current dry storage to the Transportation Package loading facilities at each site with a trolley.
The packaging will be loaded in wet bays, will be transferred to the Transportation Package loading facilities. The fuel baskets in silos or Canstor will be load into the Transportation Package in a shielded enclosure. The DSCs will be cut and open in a hot cell, the fuel modules will be load into the Transportation Package in the hot cell. Then the Transportation Package will be prepared and checked before its loading onto the road trailer.
The current storage facilities are assumed without adequate existing loading buildings. The equipment and facilities needed to transfer the fuel modules or fuel baskets from the current storage into the transportation package should be constructed or the equipment should be installed in existing building after some improvement works.
The recommended Transportation Package is the IFTC/BM. The IFTC/BM weight is assumed to be in compliance with the Canadian transportation rules.
Then the loaded vehicle will be driven to the DGR/CES site where the full Transportation Package will be unloaded, and the empty vehicle will be reloaded with an empty Transportation Package and return back to one NPP to reload an other full Transportation Package.

3.2. OPTION 2 : MOSTLY RAIL MODE DESCRIPTION

Each of the current storage facilities has not rail access, the centralised site (DGR/CES) is also assumed to be without rail access and the transportation mode studied and assessed is a mixed road and mostly rail mode.
The empty transportation package is prepared before shipment.
The fuel modules in wet bays will be directly load into the packaging in the pool building at each site.
The fuel baskets in silos or Canstor will be transferred from the current storage to the Transportation Package loading facilities at each site with a transfer flask. The full DSCs stored in the dry storage facility will be transferred from the current dry storage to the Transportation Package loading facilities at each site with a trolley.
The packaging how will be loaded in wet bays, will be transferred to the Transportation Package loading facilities. The fuel baskets in silos or Canstor will be load into the Transportation Package in a shielded enclosure. The DSCs will be fitted with an outer packaging to form the DSCTP. Then the Transportation Package will be prepared and checked before its loading onto the road trailer or railcar.

Depending of the current storage site, the transportation package will be directly loaded on a railcar at the NPP or on a trailer. In this case the transportation package will be transport by road to a road / rail transfer station. Then the loaded railcars will be driven near the DGR/CES site to the rail / road transfer station where the full Transportation Package will be reloaded on a trailer. Then the loaded vehicle will be driven to the DGR/CES site where the full Transportation Package will be unloaded and the empty vehicle will be reloaded with an empty Transportation Package and then will return back to a NPP to be reloaded with UF.

3.3. OPTION 3 : MOSTLY WATER MODE DESCRIPTION

Each of the current storage facilities has not water access, the centralised site is also assumed to be without water access and the transportation mode studied and assessed is a mixed road and mostly water mode.
The empty transportation package is prepared before shipment.
The fuel modules in wet bays will be directly load into the packaging in the pool building at each NPP. The fuel baskets in silos or Canstor will be transferred from the current storage to the Transportation Package loading facilities at each site with a transfer flask. The full DSCs stored in the dry storage facility will be transferred from the current dry storage to the Transportation Package loading facilities at each site with a trolley.
The packaging how will be loaded in wet bays, will be transferred to the Transportation Package loading facilities. The fuel baskets in silos or Canstor will be load into the Transportation Package in a shielded enclosure. The DSCs will be fitted with an outer packaging to form the DSCTP. Then the Transportation Package will be prepared and checked before its loading onto an on-site trolley to transfer it to a water dock sited at each site or on a road trailer if no water mode is possible.
The cost estimate includes provision of a new dock at each current storage site (except Whiteshell and Chalk River).
An alternative for the Gentilly site, not quoted, would be use of an existing nearby port via road link.
Depending of the current storage site, the transportation package will be directly loaded on a vessel at the NPP or on a trailer. In this case the transportation package will be transport by road directly to the DGR/CES site. Then the loaded vessel will be driven near the DGR/CES site to the water / road transfer terminal where the full Transportation Package will be reloaded on a trailer. Then the loaded vehicle will be driven to the DGR/CES site where the full Transportation Package will be unloaded and the empty vehicle will be reloaded with an empty Transportation Package which will be returned back to a NPP to be reloaded with UF.

4. USED FUEL TRANSPORTATION SYSTEM OPTIONS PROGRAM

4.1. OVERVIEW

This section provides a description of work elements of the Used Fuel Transportation System cost estimate. The elements are identified on an overall WBS that provides an overview of how the cost estimate is organised. The WBS is established according to the schedule main tasks and the cost estimate main parts. It corresponds also with an UFTS siting, construction & operation phase type. The WBS provides an indication of the level developed for each element, sometimes the WBS has been more developed to reach a sufficient detail level on the equipment and material procurement or certain WBS have been rolled up into a higher level.

The WBS organisation charts are shown in Appendices J, K, L. The WBS contents 9 major work elements that would be required to site, develop, construct, operate and decommission the Used Fuel Transportation System.

4.2. WORK BREAKDOWN STRUCTURE (LEVEL 3 DESCRIPTION)

Each element on the WBS organisation chart is documented in a Work Element Definition Sheet. Work Element Definition Sheets are provided for each lowest level (or more if necessary) work elements in the WBS.

Cost data are given on each sheet and these data have been compiled in Appendices A, B & C (Work element costs per lowest level).

The Work Element Definition Sheets explain the scope of work and the assumptions for each WBS and the details used to develop the corresponding costs. Additional explanation and supplemental information are given in other Appendices, such as equipment lists and detailed costs per option shown in Appendices M, N, O & P. The WEDS who concern the auxiliary equipment / facilities and the casks maintenance facility are more detailed in these specific “workbooks”.

In the case of the mostly rail and mostly water cost estimates, the description of the deliverables and assumptions is given at level 3, and these sections are blank in the lower level WEDS. The basis for all calculations can be found in Section 6 and in the other Appendices.

The Work Element Definition Sheets for capital equipment and facilities are fixed cost or step-fixed cost work elements. Only the work elements concerning the operation phase are sensitive to changes in the staff resources and consumables quantities to operate the transportation system and are called variable cost elements.
Note: Each WBS item is tagged as “fixed cost” or “step-fixed cost” or “variable” cost in its Work Element Definition Sheet

The entire sets of Work Element Definition Sheets per option are presented in Appendices D, E & F and are under ACCESS format.

4.2.1 ALL ROAD MODE WORK BREAKDOWN STRUCTURE (LEVEL 3 DESCRIPTION)

4.2.1.1 WBS 610 UFTS all road mode

There are nine level 2 work elements which cover all aspects of the all road mode transportation system for used fuel.

WBS 610.15 Mode & route Development
Mode and Route Development work includes studies to assess the feasibility of transporting used fuel from the various current storage facilities to the DGR/CES. The studies would demonstrate the viability of shipping by road and perform the identification of a preferred shipping route.

WBS 610.20 System Development
System Development work includes the preliminary design and engineering of the used fuel transportation packages, tie-downs, trailers and tractors, weather covers.

WBS 610.25 Safety Assessment
Safety Assessment work includes an assessment of occupational and public radiological safety during the transport of the Used Fuel for transportation system optimisation. It includes the changes to the radiological and environmental protection regulations and assess the impact on the used fuel transportation system.
The results of the assessment will be used during route selection, site selection, site licensing, NPPs site auxiliary facility improvement or construction and environmental assessment.

WBS 610.35 Public Affairs
Public Affairs includes the following work : research and conduct studies to identify used fuel transportation social issues; develop and launch a stakeholder consultation strategy and plan; and negotiate impact agreements with preferred route communities.

WBS 610.40 Capital equipment or facilities
Capital equipment or facilities work includes the design, the procurement, the construction, the testing and the commissioning of all equipment or facility to implement the transportation system. It includes the transporters, the transportation packages, the auxiliary equipment such as transportation package loading facilities, the maintenance facility and the transfer facilities or infrastructures.

WBS 610.40.10 Project management
Project management work includes the application of project management principles during system development, system design, procurement, construction and commissioning of the capital equipment or facilities.

WBS 610.40.20 Transporter
Transporter (vehicles) work includes the detailed design (manufacturing drawings and supplier documentation), the procurement and commissioning of the trailers and tractors for the used fuel transportation system.

WBS 610.40.30 Transportation system maintenance facility
Transportation system maintenance facility work includes the design, the procurement, the licensing documentation, the construction, the testing and commissioning of the both centralised maintenance facilities : one for the transportation packages and one for the trailers and tractors.

WBS 610.40.40 Casks (transportation packages)
Transportation packages work includes the detailed design (manufacturing drawings and supplier documentation), the licensing documentation, the procurement and manufacturing, the testing and commissioning of the used fuel transportation packages IFTC/BM, the associated tie-down system and weather cover.

WBS 610.40.50 UFTS auxiliary equipment and facilities
UFTS auxiliary equipment and facilities work includes the design (from preliminary to detailed design), the licensing documentation, the procurement, the construction, the testing and commissioning of all the loading facilities to install in refurbished building or to construct and commission. Their main functions are : transfer the used fuel modules or baskets into the packaging, prepare, check and load the transportation packages onto the trailers. The DGR/CES common part concern the emergency response plan, the real time tracking system and the secure areas.

WBS 610.40.60 Transfer facilities and infrastructures
Transfer facilities and infrastructures work includes the studies to identify the upgrading, strengthening, improvement of the existing transport net and the subsequent works. It includes the new transfer facilities to transfer the transportation packages from one transportation mode to another mode if needed.

WBS 610.50 Operation
Operation work includes all the activities to operate the Used Fuel Transportation System from the used fuel modules or baskets reception in the loading facilities to the delivery of the loaded transportation packages at the DGR/CES. It includes also the associated activities to manage, support, secure and track all the transportation system during the transfer from the NPPs to the DGR/CES.

WBS 610.50.10 Nuclear facility loading
Nuclear facility loading includes the following activities : receive and prepare the used fuel transportation packages before loading, receive and handle the used fuel modules or baskets from the current storage (wet bays, DSCs, silos), load the modules or baskets into the packaging, prepare the transportation packages, carry out the pre shipment tests.
All these activities are carried out at the NPPs and near the current storage.

WBS 610.50.20 Transportation system operation
Transportation system operation includes the following activities : loading of the transportation packages onto the trailers, transport of the transportation packages from the NPPs to the DGR/CES.

WBS 610.50.30 Operational system operation
Operational system operation includes the following activities : operate the real time tracking system, operate the emergency response plan and secure areas, operate the casks maintenance facility, operate the trailers and tractors maintenance facility.

WBS 610.55 Environmental Management System
Environmental Management System work includes the setting up and monitoring transportation aspects of Environmental Management System for NWMO in accordance with ISO 14001.

WBS 610.60 Decommissioning
Decommissioning work includes the development and approval of plans to decommission the Used Fuel transportation systems and associated loading facilities; the decontamination of UF auxiliary equipment ; the decommissioning of the Used Fuel transportation systems and associated loading facilities and the storage of the decommissioning waste in an existing disposal facility.

WBS 610.90 Program Management (& administration)
Program Management and administration includes the senior-level staff direction to the program as well as financial, scheduling, Quality Assurance and business support for the program. It constitutes the company overheads.

4.2.2 MOSTLY RAIL MODE WORK BREAKDOWN STRUCTURE (LEVEL 3 DESCRIPTION)

4.2.2.1 WBS 620 UFTS Mostly rail mode

There are nine level 2 work elements which cover all aspects of the mostly rail mode transportation system for used fuel.

WBS 620.15 Mode & route Development
Mode and Route Development work includes studies to assess the feasibility of transporting used fuel from the various current storage facilities to the DGR/CES.
The studies would demonstrate the viability of shipping mostly by rail and perform the identification of a preferred shipping route.

WBS 620.20 System Development
System Development work includes the preliminary design and engineering of the used fuel transportation packages, tie-downs, trailers and tractors, railcars, weather covers.

WBS 620.25 Safety Assessment
Safety Assessment work includes an assessment of occupational and public radiological safety during the transport of the Used Fuel for transportation system optimisation. It includes the changes to the radiological and environmental protection regulations and assess the impact on the used fuel transportation system.
The results of the assessment will be used during route selection, site selection, site licensing, NPPs site auxiliary facility improvement or construction and environmental assessment.

WBS 620.35 Public Affairs
Public Affairs includes the following work : research and conduct studies to identify used fuel transportation social issues; develop and launch a stakeholder consultation strategy and plan; and negotiate impact agreements with preferred route communities.

WBS 620.40 Capital equipment or facilities
Capital equipment or facilities work includes the design, the procurement, the construction, the testing and the commissioning of all equipment or facility to implement the transportation system. It includes the transporters, the transportation packages, the auxiliary equipment such as transportation package loading facilities, the maintenance facility and the transfer facilities or infrastructures.

WBS 620.40.10 Project management
Project management work includes the application of project management principles during system development, system design, procurement, construction and commissioning of the capital equipment or facilities.

WBS 620.40.20 Transporter
Transporter (vehicles) work includes the detailed design (manufacturing drawings and supplier documentation), the procurement and commissioning of the trailers, tractors and railcars for the used fuel transportation system.

WBS 620.40.30 Transportation system maintenance facility
Transportation system maintenance facility work includes the design, the procurement, the licensing documentation, the construction, the testing and commissioning of all centralised maintenance facilities: one for the transportation packages (IFTC/BMs and DSC's outer packaging), one for the trailers and tractors, one for the railcars.

WBS 620.40.40 Casks (transportation packages)
Transportation packages work includes the detailed design (manufacturing drawings and supplier documentation), the licensing documentation, the procurement and manufacturing, the testing and commissioning of the used fuel transportation packages IFTC/BM, the associated tie-down system and weather cover and the DSC's outer packaging.

WBS 620.40.50 UFTS auxiliary equipment and facilities
UFTS auxiliary equipment and facilities work includes the design (from preliminary to detailed design), the licensing documentation, the procurement, the construction, the testing and commissioning of all the loading facilities to install in refurbished building or to construct and commission. Their main functions are : transfer the used fuel modules or baskets into the packaging, prepare, check and load the transportation packages onto the trailers or railcars. The DGR/CES common part concerns the emergency response plan and the real time tracking system, but without secure areas.

WBS 620.40.60 Transfer facilities and infrastructures
Transfer facilities and infrastructures work includes the studies to identify the upgrading, strengthening, improvement of the existing transport net and the subsequent works. It includes the new transfer facilities to transfer the transportation packages from one transportation mode to another mode if needed. For mostly rail transportation mode there will be 2 road / rail transfer stations near Bruce and Point Lepreau and one rail / road transfer station near the DGR/CES.

WBS 620.50 Operation
Operation work includes all the activities to operate the Used Fuel Transportation System from the used fuel modules or baskets reception in the loading facilities to the delivery of the loaded transportation packages at the DGR/CES. It includes also the associated activities to manage, support, secure and track all the transportation system during the transfer from the NPPs to the DGR/CES.

WBS 620.50.10 Nuclear facility loading
Nuclear facility loading includes the following activities : receive and prepare the used fuel transportation packages before loading, receive and handle the used fuel modules or baskets from the current storage (wet bays, DSCs, silos), load the modules or baskets into the packaging, prepare the transportation packages, carry out the pre shipment tests.
All these activities are carried out at the NPPs and near the current storage.

WBS 620.50.20 Transportation system operation
Transportation system operation includes the following activities : load the transportation packages onto the trailers or railcars, transfer the transportation packages from road to rail mode if necessary, transport the transportation packages from the NPPs to the rail / road transfer station, transfer the transportation packages from rail to road mode and transport them to the DGR/CES.

WBS 620.50.30 Operational system operation
Operational system operation includes the following activities : operate the real time tracking system, operate the emergency response plan, operate the casks maintenance facility, operate the trailers, tractors and railcars maintenance facility.

WBS 620.55 Environmental Management System
Environmental Management System work includes the setting up and monitoring transportation aspects of Environmental Management System for NWMO in accordance with ISO 14001.

WBS 620.60 Decommissioning
Decommissioning work includes the development and approval of plans to decommission the Used Fuel transportation systems and associated loading facilities; the decontamination of UF auxiliary equipment ; the decommissioning of the Used Fuel transportation systems and associated loading facilities and the storage of the decommissioning waste in an existing disposal facility.

WBS 620.90 Program Management (& administration)
Program Management and administration includes the senior-level staff direction to the program as well as financial, scheduling, Quality assurance and business support for the program. It constitutes the company overheads.

4.2.3 MOSTLY WATER MODE WORK BREAKDOWN STRUCTURE (LEVEL 3 DESCRIPTION)

4.2.3.1 WBS 630 UFTS Mostly water mode

There are nine level 2 work elements which cover all aspects of the mostly water mode transportation system for used fuel.

WBS 630.15 Mode & route Development
Mode and Route Development work includes studies to assess the feasibility of transporting used fuel from the various current storage facilities to the DGR/CES. The studies would demonstrate the viability of shipping mostly by water and perform the identification of a preferred shipping route.

WBS 630.20 System Development
System Development work includes the preliminary design and engineering of the used fuel transportation packages, tie-downs, trailers and tractors, vessels equipment, weather covers.

WBS 630.25 Safety Assessment
Safety Assessment work includes an assessment of occupational and public radiological safety during the transport of the Used Fuel for transportation system optimisation. It includes the changes to the radiological and environmental protection regulations and assess the impact on the used fuel transportation system.
The results of the assessment will be used during route selection, site selection, site licensing, NPPs site auxiliary facility improvement or construction and environmental assessment.

WBS 630.35 Public Affairs
Public Affairs includes the following work : research and conduct studies to identify used fuel transportation social issues; develop and launch a stakeholder consultation strategy and plan; and negotiate impact agreements with preferred route communities.

WBS 630.40 Capital equipment or facilities
Capital equipment or facilities work includes the design, the procurement, the construction, the testing and the commissioning of all equipment or facility to implement the transportation system. It includes the transporters, the transportation packages, the auxiliary equipment such as transportation package loading facilities, the maintenance facility and the transfer facilities or infrastructures.

WBS 630.40.10 Project management
Project management work includes the application of project management principles during system development, system design, procurement, construction and commissioning of the capital equipment or facilities.

WBS 630.55 Environmental Management System
Environmental Management System work includes the setting up and monitoring transportation aspects of Environmental Management System for NWMO in accordance with ISO 14001.

WBS 630.60 Decommissioning
Decommissioning work includes the development and approval of plans to decommission the Used Fuel transportation systems and associated loading facilities; the decontamination of UF auxiliary equipment; the decommissioning of the Used Fuel transportation systems and associated loading facilities and the storage of the decommissioning waste in an existing disposal facility.

WBS 630.90 Program Management (& administration)
Program Management and administration includes the senior-level staff direction to the program as well as financial, scheduling, Quality assurance and business support for the program. It constitutes the company overheads.

4.3. WBS ORGANISATION CHART PER TRANSPORTATION MODE

The Appendices J, K & L show the entire WBS for each transportation mode and the work elements at lowest level.

5. SCHEDULE ESTIMATE

The Appendices G, H & I show the detailed schedule for each transportation mode at the WBS lowest level.

6. COST ESTIMATE

The methodology used to develop the cost estimate for the UFTS is described in the following sections. The methodology concern the 2 main phases :

- At first : siting and construction phases which are corresponding to the capital cost for the UFTS that includes studies, licensing, detailed design, procurement, construction, testing and commissioning.
- At second : the operation phase which is corresponding to the operating cost, mainly the operators, consumables and utilities costs.
  These 2 main phases are subdivided into several functions. This splitting allows the presentation as shown in sections 6.6 to 6.8 Capital and operating costs per WBS / owners / NPP.

6.1. BASIS OF ESTIMATE

6.1.1 ECONOMICAL ASSUMPTIONS

- All costs are given in January 2002 constant thousand of Canadian dollars (KCAD),
- The Goods & Services Taxes, Federal or Provincial taxes, Custom Duties are excluded,
- The financing costs are excluded,
- The services such as the program management (WBS 610.90) are included, other services or overheads are excluded from the operation cost,
- The exchange rate assumption is 1.4 CAD = 1 EUR (average exchange rate January 2002).

6.1.2 CAPITAL COST ASSUMPTIONS

6.1.2.1 Engineering labour rates :
The cost is valued with an average man-hour rate of 140 CAD / hour,
This rate is a mixed rate including 80% of Canadian man-hours & 20 % of French man-hours,
It is a burdened rate including social security taxes, overheads, profit, living & travel expenses,

6.1.2.2 On site installation labour rates :
The on site man-hours for installation and construction are valued with an average rate of 70 CAD / hour,
The man-hour rates were provided by E.S. FOX for each speciality such as electrical, mechanical, piping and ventilation,
It is a burdened rate including social security taxes, overheads, profit, living & travel expenses,

6.1.3 OPERATION COST ASSUMPTIONS

The main cost data are the following :
- The Number of working days per year is 250 days (250 days per year is the available resource time assumed but not the number of days available to a particular employee).
- Management costs are included under Program Management.
- The labour rates used for the operation cost estimate are the four following OPG's categories :
  - Cat 1 Management / Executive : 77.62 CAD / hour
  - Cat 2 Administration : 44.36 CAD / hour
  - Cat 3 Engineering/ Technical/ Specialists : 65.87 CAD / hour
  - Cat 4 Operations & maintenance : 52.49 CAD / hour

  These labour rates are burdened labour cost but do not include OPG overheads costs.
  They are given in January 2002 constant Canadian dollars (CAD).

6.1.4 LIMITS / SCOPE OF THE UFTS COST ESTIMATE

6.1.4.1 Limits :

The main limits of the estimated scope are :
- At the current storage sites, the cost of new buildings or refurbished buildings and hot cells or shielded enclosure is included. Equipment and labour for moving the modules into the casks are included.
- The equipment and labour to transfer the DSCs to the hot cell, cut the lid and open the DSCs is listed but the cost is not included.
- In the wet bays all equipment needed to put the cask in the bay, drain it, the hoist to put the modules into the cask are included or are existing equipment assumed to be in service at the operation dates.
- At the DGR/CES site all the equipment and labour to unload from the vehicles and transfer the IFTC/BMs to an existing unloading hot cell area are not included.
- At the DGR/CES site all the equipment and labour to remove the modules or baskets from the IFTC/BMs are not included.
- At the DGR/CES site all the equipment and labour to unload from the vehicles and transfer the DSCTPs to an existing Dry Storage Facility are not included.
- At the DGR/CES the drivers turnaround/ waiting time is included in the estimate, but nothing else.
- The management team is included in program management.

The following WBS are estimated by OPG :
610.25 Safety assessment
610.35 Public affairs
610.55 Environmental Management System

6.1.4.2 Capital cost main exclusions

The detailed limits are shown in the section 6.4 (detailed technical assumptions per transportation mode).

The licensing and approvals cost of safety competent authority is excluded.
The procurement of DSCs to reach the total storage capacity is excluded.
The interim storage capital cost for emptied DSCs after modules transfer into the IFTC/BM is excluded, this assumption is only made in case of transport by all road mode.
The procurement of additional modules or baskets to reach the total storage capacity or required for the transportation operation is excluded.
No equipment is included for cutting and opening the DSCs.
The building construction necessary to place the Emergency Crisis Room, the Real Time Tracking System, the Emergency Means is excluded. Suitable accommodation is assumed to be available in the building included in the centralised facility estimate.
No offices etc. are included for accommodation of the management team. The team can be assumed to be in existing buildings at the current storage sites or to be accommodated in the building included in the centralised facility estimate.
The pool buildings improvement or strengthening works to install the modules retrieval equipment from the wet bays are excluded.

The Dry Storage Facility buildings improvement or strengthening works to support a new 120 tons crane are excluded.

All the equipment and facilities sited at DGR/CES to unload the transportation packages and the modules or baskets out of the packaging are excluded.

6.1.4.3 Operation cost main exclusions

The detailed limits are shown in the section 6.4 (detailed technical assumptions per transportation mode).
The main operation or expenses items hereunder are excluded :

The OPG's overheads other that the management team included in the program management.
The side effects on the existing NPPs operations due to the UFTS new operations.
The health physics consumables and management.
The cost for samples and laboratory analysis.
The small utilities consumption such as compressed air, de-ionized water, hot water, steam, fire water, vacuum, gases, etc.

- **NPP's wet bays exclusions**

All activities for the retrieval of Used Fuel from a storage facility and the preparation of full modules or baskets with the Used Fuel are excluded. Tray-to-module conversion at the Bruce bays is not included.
Shipments from Pickering are only from two bays, i.e. there are no shipments from the Pickering A primary bay.

- **NPP's DSCs exclusions**

The labour to transfer he DSCs to the hot cell, cut the lid and open the DSCs is not included.
The labour to transfer out of the cell the emptied and opened DSCs is not included.
The labour to decontaminate and decommission the emptied DSCs is not included.

- **DGR/CES site exclusions**

The operations at DGR/CES site to unload the transportation packages from the trailer and transfer it to the storage facility or to emptied the IFTC/BMs or DSCTPs are excluded.
Accommodation at the DGR/CES site is not included. It was decided that it could be assumed that such accommodation would be in a drivers' hostel at negligible cost.

• **Maintenance exclusions**
Exceptional maintenance or replacement of vehicles is not included. The trailers and tractors significant repairs to be carry out by the equipment manufacturer are excluded. However, the maintenance costs are relatively high, and it was agreed they are adequate to represent either high quality maintenance with parts replacement, or vehicle replacement.

6.2. ACCURACY AND UNCERTAINTY

The estimation for UFTS capital and operating cost includes uncertainty. The UFTS program will last many years which will be the source of cost and schedule uncertainty. It is difficult today to foresee the cost and timing variations of activities so far in the future. The work elements are defined at a conceptual design level and it is prudent to introduce cost uncertainty. The level of uncertainty is identified for each element and is quantified as contingency costs. The contingency cost is determined as a percentage of the estimated cost for each element and is as follows :

		ALL ROAD	MOSTLY RAIL	MOSTLY WATER
610.15	Mode & route development	10 %	10 %	10 %
610.20	System development	10 %	10 %	10 %
610.25	Safety assessment	30 %	30 %	30 %
610.35	Public affairs	50 %	50 %	50 %
610.40	Capital Equipment or facilities			
610.40.10	Project management	15 %	15 %	15 %
610.40.20	Transporter (vehicle for off-site transport)	10 %	10 %	10 %
610.40.30	Transportation system maintenance facility	20 %	20 %	20 %
610.40.40	Casks	10 %	10 %	10 %
610.40.50	UFTS Auxiliary equipment	15 %	15 %	15 %
610.40.60	Transfer Facilities or Infrastructures	15 %	25 %	25 %
610.50	**Operation**			
610.50.10	Nuclear facility loading	15 %	15 %	15 %
610.50.20	Transportation system operation	15 %	15 %	15 %
610.50.30	Operational systems	15 %	15 %	15 %
610.55	Environmental Management System	30 %	30 %	30 %
610.60	Decommissioning	20 %	20 %	20 %
610.90	Program management (& administration)	10 %	10 %	10 %
	Overall contingency percentage	**15,33 %**	**15,67 %**	**15,24 %**

Table : Contingency Assumptions

These percentages are used on each work element and the calculation result is the overall contingency percentages shown above per option.

The contingency cost allowance includes items or activities that cannot be identified at this time but may have a significant impact on cost if required in the program. This includes, for example, a small change in the features of Used Fuel or a modification to the UFTS design requested by OPG to reach suitable operating conditions.
The contingency costs do not cover the cost of major scope changes in fundamental assumptions on which this cost is estimated (e.g. high-level assumptions listed in sections 1.2 and 6.1).

6.3. COST CATEGORIES

The costs for each element are categorised according to the four cost categories : Equipment and material, Labour, Other, Contingency. OPG's labour cost is the burdened cost but does not include any other overhead costs.

- Equipment and material cost is the cost of acquiring permanent materials, equipment and facilities for transportation system : e.g. Used Fuel transportation packages, vehicles, hot cell buildings and loading facilities, maintenance facilities, real time tracking system and emergency means.

- Labour is the cost of sub-contractors, site construction labour, Engineering services or consultant to construct the facilities included in the equipment or facilities capital cost. It is also the OPG's operators labour cost to operate the entire UFTS. OPG's labour cost is the burdened cost but does not include any overhead costs.

- Other costs include rail or water transportation services subcontracts, consumables (fuel, utilities and non permanent materials), permits and fees, taxes, communication expenses, furniture, temporary monitoring equipment, travel and accommodation expenses.

- Contingency cost is a separately planned allowance as defined above in section 6.3

6.4. DETAILED TECHNICAL ASSUMPTIONS PER TRANSPORTATION MODE

In addition to the paragraph 6.1, the specific assumptions are summarised for each transportation mode hereunder.

6.4.1 ALL ROAD MODE SPECIFIC ASSUMPTIONS

6.4.1.1 General assumptions for all road mode transportation system

1) All the Used Fuel (UF) will be only transported from the various nuclear facilities to the Used Fuel DGR/CES site via the road mode of transportation. Emergency Response Plans, Safeguard and Security Plans, Public Affairs, Project Management and Safety Assessments will be based on transporting the UF via the road mode of transportation.

2) The reference design for transporting the UF is a package similar to Ontario Power Generation's (OPG's) Irradiated Fuel Transportation Cask (IFTC). As recommended in the Conceptual Design, a new transportation cask will be developed and named Irradiated Fuel Transportation Cask for Baskets and Modules IFTC/BM. The qualification and licensing costs with the Canadian Nuclear Safety Commission (CNSC) are included.
All the nuclear facilities will be able to comply with all the UF packaging licensing requirements.

3) Highway grade roads are available for use over the entire distance from the nuclear facility to the DGR/CES. The shipping of the UF is assumed to occur throughout the year and an allowance for Hazards is made in cycle times.

4) The gross mass of the Used Fuel (UF) transportation system (tractor, trailer, loaded transportation package, and tie downs) will be less than the allowable road limits within each province during the entire shipping season. It is assumed that upgrading of on-site or off-site roads should not be required for the IFTC/BM and the compliant trailers and tractors. The assumption for IFTC/BM transportation operation is that no escort vehicle is required (Conceptual design and description for all the UFTS components in the case of "all road" mode for each current Storage Site, APPENDIX D sections "Trailer for the road transportation") and it is assumed that at the time of transportation the drivers would be trained as security person .

5) The design and gross mass of the UF transportation package can be accommodated at each NPPs loading facility or Irradiated Fuel Bay (IFB).

6) Each nuclear facility has the required crane capacity and crane hook size for handling the IFTC/BM package. The mass of the IFTC/BM, including the contents, is estimated to be approximately 42,500 kg (93, 500 lbs).

7) The transportation system (tractor, trailer, transportation package & tie-downs) can be accommodated or received at the DGR/CES .

8) The trailer design will include space for transporting the auxiliary equipment such as leak testing equipment, spare parts, etc.

9) Sufficient space or a decontamination room is available to perform the pre & post shipment testing at each nuclear facility (see the detailed assumptions and limits per each site sections 6.4.1.2 & 6.4.1.3).

10) Service amenities such as low-pressure service air, electrical supply, etc. are readily available at each nuclear facility.

11) The Total quantities of transporters and transportation packages are determined at first per each nuclear facility. Then an optimised calculation has been performed to minimise the transportation equipment fleet. The cost estimate financial rule is to apportion the equipment cost by each Nuclear Power Plant throughout a proportional calculation based on the number of packages shipped required per NPP.

12) During the overnight stops, the cost to keep in a secure area the transportation packages and transporters is included.

6.4.1.2 Detailed assumptions for all road mode auxiliary equipment & facilities

Four families of additional transfer building are identified for each Nuclear Power Plant and current storage, they are the following :
Type 1 : Whiteshell,
Type 2 : Bruce A & B, Pickering A & B and Darlington for the Used Fuel transfer from the DSCs,
Type 3 : Bruce B, Pickering A & B and Darlington for the Used Fuel transfer from the wet bays,
Type 4 : Bruce Douglas Point, Chalk River, Gentilly 1 & 2 and Point Lepreau for the Used Fuel transfer in baskets from the silos or Canstor.

The summary of loading facilities taken in account to develop the corresponding cost estimates is the following :

Family type	Type 1 Whiteshell	Type 2 : DSCs	Type 3 : Wet bays	Type 4: silos or Canstor
Description : See the footnotes 1 to 3 hereunder	Area 2	Hot cell + area 1 + area 2 + utilities	Pool improvement + area 1 + area 2 + utilities	Shielding enclosure + area 1 + area 2 + utilities
Whiteshell	1			
Bruce A & B DSCs		1		
Bruce B wet bays			1 shared	
Douglas Point				1 shared
Pickering A & B DSCs		1		
Pickering B bay			1 shared	
Pickering Auxiliary bay			1 shared	
Darlington DSCs		1		
Darlington wet bays			1 shared	
Point Lepreau				1
Chalk River				1
Gentilly 1 & 2				1 shared

1) *The hot cell part allocated to load the modules into the IFTC/BMs : part of phase 2 (without DSC opening equipment) and phase 3 such as described in section 3.1.9 of Appendix D of the Conceptual Design Report.*

2) *Area 1 includes all equipment items to prepare the packaging and the transportation package before and after the modules loading into the packaging : phases 4 & 5 such as described in section 3.1.9 of Appendix D of the Conceptual Design Report.*

3) *Area 2 includes all equipment items to unload or load the transportation package from or onto the trailer : phase 6 such as described in section 3.1.9 of Appendix D of the Conceptual Design Report. The hot cell area or shielding enclosure area, area 1 & 2 could be adjacent in the same standalone facility or refurbished building.*

4) *The shielding enclosure is the enclosure used to transfer the baskets from the on-site transfer flask into the IFTC/BMs.*

The needed sizes per family are assumed as follows :

	Type 1	Type 2	Type 3	Type 4
UF transfer from transfer flask to IFTC/BM	25 x 10 x10m			
Pool Facility improvement			excluded	
UF transfer from DSCs or silos to IFTC/BM Hot cell or shielded enclosure		22 x 5 x 7m		10 x 5 x 6m
Hot cell or shielded enclosure building		38 x 13 x 12m		24 x 13 x 12m
Loading building area 1 : IFTC/BM preparation		10 x 10 x 6m	18 x 10 x 8m	10 x 10 x 6m
Loading building area 2 : IFTC/BM loading onto the trailer		28 x 10 x 11m	28 x 10 x 11m	28 x 10 x 11m
Loading building area 3 : utilities		10 x 10 x 6m	10 x 10 x 8m	10 x 10 x 6m
IFTC/BM loading onto the trailer	20 x 10 x 11m			

The pool or wet bays building strengthening works to support a new crane of 60 tons capacity are not included.
The pool or wet bays buildings improvement works to install one cask water emptying system and one cask external decontamination are not included. The building or utilities modifications such as electricity, ventilation, civil-works, Instrumentation & control required by the new equipment installation are not included. Only the process equipment needed to retrieve the Used Fuel modules from the pool is included. Account is taken of existing equipment (details can be found in Section 6.4.1.3 and in Appendix M).

6.4.1.3 Detailed limits for all road mode auxiliary equipment & facilities

The following tables show the detailed limits taken in account in the cost estimate for each auxiliary facility per NPP and per current storage facility.

Auxiliary equipment and assumed location main assumptions
Main scope of work per Nuclear Power Plant

Building **Function**	Hot cell or shielded enclosure building (loading the modules or baskets into the IFTC/BMs)		Shipment area 1 building (IFTC/BMs shipment preparation)		Shipment area 2 building (IFTC/BMs loading onto the trailer)	
Sites						
Bruce A/B DSCs	hot cell in converted WUFDSF workshop	1 process line	space in converted WUFDSF workshop	1 shared process line	space in converted WUFDSF workshop	1 shared process line
Out of scope			One crane is existing equipment and small refurbishment works in shipment area		One crane is existing equipment and small refurbishment works in shipment area	
UFTS scope	Construct and Install the hot cell and equipment in the WUFDSF workshop refurbish the WUFDSF workshop		Procure and install the pre shipment equipment in the WUFDSF refurbished workshop		Procure and install the handling equipment in the WUFDSF refurbished workshop	
Bruce B wet bays	B bay	1 process line	Building and equipment shared with Bruce DSCs auxiliary	1 shared process line	Building and equipment shared with Bruce DSCs auxiliary	1 shared process line
Out of scope	Cranes and decontamination system are existing equipment The pool building strengthening works are excluded		See Bruce A/B DSCs		See Bruce A/B DSCs	
UFTS scope	Procure and Install the other equipment in the B bay		See Bruce A/B DSCs		See Bruce A/B DSCs	
Pickering A/B DSCs	hot cell in converted PUFDSF workshop	1 process line	space in converted Pickering A Turbine Hall	1 shared process line	space in converted Pickering A Turbine Hall	1 shared process line
Out of scope			One crane is existing equipment and small refurbishment works in shipment area		One crane is existing equipment and small refurbishment works in shipment area	
UFTS scope	Construct and Install the hot cell and equipment in the PUFDSF workshop refurbish the PUFDSF workshop		Procure and install the pre shipment equipment in the Pickering refurbished Turbine Hall		Procure and install the handling equipment in the Pickering refurbished Turbine Hall	
Pickering B wet bays	B bay	1 process line	Building and equipment shared with Pickering DSC's auxiliary	1 shared process line	Building and equipment shared with Pickering DSC's auxiliary	1 shared process line
Out of scope	Cranes and decontamination system are existing equipment The pool building strengthening works are excluded		See Pickering A/B DSCs		See Pickering A/B DSCs	
UFTS scope	Procure and Install the other equipment in the B bay		See Pickering A/B DSCs		See Pickering A/B DSCs	
Pickering Auxiliary wet bays	Auxiliary bay	1 process line	Building and equipment shared with Pickering DSC's auxiliary	1 shared process line	Building and equipment shared with Pickering DSC's auxiliary	1 shared process line
Out of scope	Cranes and decontamination system are existing equipment The pool building strengthening works are excluded		See Pickering A/B DSCs		See Pickering A/B DSCs	
UFTS scope	Procure and Install the other equipment in the Auxiliary bay		See Pickering A/B DSCs		See Pickering A/B DSCs	

Building **Function**	Hot cell or shielded enclosure building (loading the modules or baskets into the IFTC/BMs)		Shipment area 1 building (IFTC/BMs shipment preparation)		Shipment area 2 building (IFTC/BMs loading onto the trailer)	
Sites						
Darlington DSCs	hot cell in converted DUFDSF workshop	1 process line	space in converted DUFDSF workshop	1 shared process line	space in converted DUFDSF workshop	1 shared process line
Out of scope			One crane is existing equipment and small refurbishment works in shipment area		One crane is existing equipment and small refurbishment works in shipment area	
UFTS scope	Construct and Install the hot cell and equipment in the DUFDSF workshop refurbish the DUFDSF workshop		Procure and install the pre shipment equipment in the DUFDSF refurbished workshop		Procure and install the handling equipment in the DUFDSF refurbished workshop	
Darlington wet bays	East bay	1 process line	Building and equipment shared with Darlington DSC's auxiliary	1 shared process line	Building and equipment shared with Darlington DSC's auxiliary	1 shared process line
Out of scope	Cranes and decontamination system are existing equipment The pool building strengthening works are excluded		See Darlington DSCs		See Darlington DSCs	
UFTS scope	Procure and Install the other equipment in the East bay		See Darlington DSCs		See Darlington DSCs	

	Building	Hot cell or shielded enclosure building		Shipment area 1 building		Shipment area 2 building	
	Function	(loading the modules or baskets into the IFTC/BMs)		(IFTC/BMs shipment preparation)		(IFTC/BMs loading onto the trailer)	
Sites							
Whiteshell		In an existing building		In an existing building		In an existing building	
	Out of scope	The building improvement and 2 Gantry cranes are taken in account by AECL					
	UFTS scope	The other equipment are shared with Bruce Douglas Point (3 shipments against 138 at Douglas Point)					
Douglas Point		In an existing building	1 process line	Building and equipment shared with Bruce DSC's auxiliary	1 shared process line	Building and equipment shared with Bruce DSC's auxiliary	1 shared process line
	Out of scope	The transfer flask, the gantry crane (for transfer flask), the trolley with tractor		See Bruce A/B DSCs		See Bruce A/B DSCs	
	UFTS scope	Construct and Install the shielded enclosure and equipment in an existing building refurbish the existing building		See Bruce A/B DSCs Cost shared with Bruce A/B = 1,75 % negligible part		See Bruce A/B DSCs Cost shared with Bruce A/B = 1,75 % negligible part	
Point Lepreau		New building construction required	1 process line	New building construction required	1 process line	New building construction required	1 process line
	Out of scope	The transfer flask, the gantry crane (for transfer flask), the trolley with tractor					
	UFTS scope	Construct a new building Construct and Install the shielded enclosure and equipment in the new building		Construct a new building Procure and Install the preshipment equipment		Construct a new building Procure and Install the handling equipment	
Chalk River		In an existing building	1 process line	In an existing building	1 process line	In an existing building	1 process line
	Out of scope	The transfer flask, the gantry crane (for transfer flask), the trolley with tractor		One crane is existing equipment and small refurbishment works in shipment area		One crane is existing equipment and small refurbishment works in shipment area	
	UFTS scope	Construct and Install the shielded enclosure and equipment in an existing building refurbish the existing building		Procure and install the pre shipment equipment in the refurbished existing building		Procure and install the handling equipment in the refurbished existing building	
Gentilly 1 & 2		One common process line equipment in an existing building, the cost is shared between Gentilly 1 and 2					
	Out of scope	The transfer flask, the gantry crane (for transfer flask), the trolley with tractor		One crane is existing equipment and small refurbishment works in shipment area		One crane is existing equipment and small refurbishment works in shipment area	
	UFTS scope	Construct and Install the shielded enclosure and equipment in an existing building refurbish the existing building		Procure and install the pre shipment equipment in the refurbished existing building		Procure and install the handling equipment in the refurbished existing building	

6.4.1.4 Detailed assumptions for all road mode transporter and transportation packages

The main equipment quantities for the transportation system are summarised in this section.
The number of IFTC/BM transportation package is 25 units plus one mock-up transportation package.
The number of transportation vehicles (trailer & tractor) is 24 units.
It is assumed that this quantities are sufficient to take in account the foreseeable maintenance periods during the shipping time.

6.4.1.5 Detailed assumptions for all road mode Nuclear facility loading operation, Transportation system operation and maintenance

The main labour quantities to achieve the Nuclear facility loading operation and Transportation system operation are summarised in this section.

• 610.50.10 Nuclear Facility Loading operation

The Nuclear Facility Loading operation assumptions and resources for all Sites are the following :
The total duration of loading operation is estimated to last for 30 years and the number of working days per year is 250 days.
The total number of bundles to transport is : 3,557,451 UF currently stored in DSCs, wet bays, silos or Canstor.
The total number of IFTC/BMs to fill with the UF modules or baskets is 18 707 IFTC/BMs.
The total number of transportation packages to ship is: 18 707 IFTC/BMs.
The nuclear facility loading operation resources to transfer the UF modules or baskets into the transportation package and to perform the pre shipment are :

Resources to load & pre ship the IFTC/BMs from the DSCs or silos :
- Loading the modules into the packaging : 1 day 2 persons
- Pre-shipment packaging preparation : 1.50 day 2 persons
- Internal transfer of the transportation cask : 0.50 day 3 persons

and the total corresponds to 6.5 working days or 52 hours per IFTC/BM.

Resources to load & pre-ship the IFTC/BMs from the wet bays :
- Loading the modules into the packaging : 1 day 2 persons
- Pre-shipment packaging preparation : 2 days 2 persons
- Internal transfer of the transportation cask : 0.50 day 3 persons

and the total corresponds to 7.5 working days or 60 hours per IFTC/BM.

To calculate the total cost of facility loading operation (WBS 610.50.10) it is added one allowance who represents 20 % of the direct resources cost to take in account the following items:
- The small operation material procurement such as gloves, clothes, shoes, glasses to protect the operators,
- The small operation material procurement such as oil, vinyl, small tools, etc.,
- The electricity consumption,
- The maintenance labour for the auxiliary equipment,
- The auxiliary equipment spare parts to procure and to install.

• 610.50.20 Transportation system operation

The transportation system operation assumptions and resources for all Sites are the following :
The total duration of transportation operation is estimated to last for 30 years and the number of working days per year is 250 days.
The driving time is 10 hours per day and for 2 drivers.
The total number of shipments is: 18,707 IFTC/BMs
- Two drivers will be required for the shipments and it is assumed that a separate escort vehicle is not required. One of the both drivers will be a trained security person.
- The average vehicle speed is assumed at 60 km/h with an empty IFTC/BM.
- The average vehicle speed is assumed at 50 km/h with a loaded IFTC/BM.
- The nuclear facility loading operation resources to load the transportation package onto the trailer are : 3 persons during 0.5 day or 12 hours.
- The number of persons for transportation operation is : 2 persons during 8 days for Bruce, Pickering, Darlington, Chalk River and Whiteshell sites.
- The number of persons for transportation operation is : 2 persons during 14 days for Point Lepreau site.
- The number of persons for transportation operation is : 2 persons during 9.5 days for Gentilly site.

• 610.50.30 Operational systems operation
The operational systems includes the three following main components :

610.50.30.100.10 DGR/CES Emergency response plan system operation
The Emergency Response Plan system operation resources are the following :
One FTE technician to maintain the recovery equipment and to update the necessary documentation.
One annual emergency exercise.
One emergency actual exercise.
Three FTE persons to guard the vehicles during overnight stops.

All the persons are employed FTE per year and during the entire period of Used Fuel transportation assumed to span 30 years.

610.50.30.100.20 DGR/CES Real time tracking system operation
The team to operate the real tracking system includes 3 shifts of 2 operators, plus one supervisor and one administrative person. All are employed FTE per year and during the entire period of Used Fuel transportation assumed to span 30 years.

610.50.30.100.30 Transportation system maintenance operation
The transportation system maintenance assumptions and operation resources are the following :
- The number of persons required for the trailers and tractors maintenance is : 4 FTE persons
- The cask maintenance ratio is assumed to be 5 % of the total number of shipped packages so there is an equivalent of 32 entire maintenance cycles per year to perform during the total shipping time assumed to span 30 years. One entire maintenance cycle consists after 15 shipments of one corrective maintenance operation and after 45 shipments of one entire maintenance operation.
- The number of persons required for the IFTC/BMs maintenance is : 8 FTE persons
- The spare parts procurement cost for the trailers and tractors is 2 % of the capital cost per year.
- The spare parts procurement cost for the IFTC/BMs is 1 % of the capital cost per year.
- The spare parts procurement cost for the cask maintenance facility is 1 % of the capital cost per year.

6.4.1.6 Detailed assumptions for common WBS
The main labour quantities to perform the common WBS are summarised in this section.
The WBS assumed such as common are the following :
- 610.15 Mode & route development
- 610.20 System development
- 610.25 Safety assessment
- 610.35 Public affairs
- 610.55 Environmental Management System
- 610.60 Decommissioning
- 610.90 Program management (& administration)

610.15 Mode & route development
The number of persons required to perform the work is one FTE engineer during 2 years.

610.20 System development
The number of persons required to perform the work is :
- Casks engineering : 3 FTE engineer during 4 years.
- Licensing : 1 FTE engineer during 2 years.
- Trailer and truck engineering : 2 FTE engineer during 4 months.

610.25 Safety assessment
The number of persons required to perform the work is :
2 technical staff + management support from year 12 – 18 (EA approval for DGR/CES);
300 h/y from year 19 – 29 (start of transportation system operation)
100 h/y during transportation system operation

610.35 Public affairs
The number of persons required to perform the work is :
- 2 staff in years 12 – 18 (EA approval for DGR/CES).
- 4 staff in years 19 – 22 (development of detailed communications/consultation plans).
- 2 staff in years 23 – 29 (start of engineering development up to start of operation).
- program subsumed into DGR/CES/UFTS day-to-day operations following year 29.

610.55 Environmental Management System
The number of persons required to perform the work is :
- 2 staff persons up to start of operation plus expenses.
- 500 h/y during operation plus expenses.

610.60 Decommissioning
The cost of decommissioning is valued using a 10 % ratio of the capital cost estimate for the Used Fuel transportation system. The capital cost amount used as basis includes the transporter, the transportation packages, the UFTS auxiliary equipment and facilities, the transportation packages maintenance facility An allowance for disposal operation cost of decommissioning waste is included.

610.90 Program management (& administration)
The program management team to manage the Used Fuel Transportation System includes a staffed team of 12 FTE persons during the entire period of Used Fuel transportation assumed to span 30 years and includes :

- One project director,
- Four schedulers (one per main NPPs),
- One accountant,
- One secretary,
- One maintenance supervisor,
- Two forwarding technicians,
- Two Assurance Quality and Inspection technicians.

6.4.1.7 Detailed assumptions for transportation system maintenance facility (WBS 610.40.30)
The transportation system maintenance facility includes the facilities and equipment to perform the preventive, annual maintenance and every 4 years a complete overhaul of the IFTC/BMs and of the tractors and trailers.

610.40.30.100.10 Casks maintenance facility
The maintenance Cask facility building is constructed for the transportation packages (IFTC / BMs) used in case of road mode transportation. It is a standalone nuclear facility sited near the DGR/CES.
The assumed size of the maintenance building is 24,000 cubic meters.
The main functions performed at casks maintenance facility are the following :
- External decontamination of casks presenting a too high activity level after control carried out in the unloading building ,
- Performance of some punctual inspection and external maintenance operations,
- Internal decontamination of casks cavities to make easier internal maintenance operations performed in this facility,
- Changing the cask's internal required structures to transport baskets or modules,
- The maintenance capacity of the single process line facility is a quantity assumed within the range of 30 to 32 casks per year.
The detailed equipment list is attached in APPENDIX P.

610.40.30.100.20 Tractors and trailers maintenance facility
The tractors and trailers facility building is constructed for the transportation vehicles used in case of road transportation mode. It is a standalone and industrial type facility sited near the DGR/CES.
The assumed size of the maintenance building is 300 square meters.
The building will be equipped with the tractors and trailers maintenance tools or equipment.

6.4.2 MOSTLY RAIL SPECIFIC ASSUMPTIONS

6.4.2.1 General assumptions for mostly rail mode transportation system

1) All the Used Fuel (UF) will be only transported from the various nuclear facilities to the Used Fuel DGR/CES site via the mostly rail mode of transportation. Emergency Response Plans, Safeguard and Security Plans, Public Affairs, Project Management and Safety Assessments will be based on transporting the UF via a mixed road and mostly rail mode of transportation. The general scheme to transport the UF from the NPPs to the DGR/CES site is :

Site	Casks	Total mode	1st Mode	2d Mode	3d Mode
Whiteshell	IFTC/BMs	all road	Road only		
Bruce A & B	IFTC/BMs & DSCTPs	Mixed mode	Road	Rail	Road
Bruce Douglas Point	IFTC/BMs	Mixed mode	Road	Rail	Road
Pickering A & B	IFTC/BMs & DSCTPs	Mixed mode	Rail	Road	
Darlington	IFTC/BMs & DSCTPs	Mixed mode	Rail	Road	
Point Lepreau	IFTC/BMs	Mixed mode	Road	Rail	Road
Chalk River	IFTC/BMs	all road	Road only		
Gentilly 1 & 2	IFTC/BMs	Mixed mode	Rail	Road	

2) All Used Fuel currently stored at OPG's NPPs in DSC would be transported in this cask. The DSC together with an outer packaging constitutes the transportation package : DSCTP. The DSCTP is currently only licensed for transport by rail or water. It is assumed that the DSCTP could be easily re-licensed for road transport. The DSCTP should be used to transport all fuel bundles stored in DSCs at the time of transportation by road and mostly rail. The main consequence is that no hot cells are required to transfer the UF from the DSCs into the IFTC/BMs.

3) All the other Used Fuel currently stored in wet storage or silos should be transported in the IFTC/BM (see general assumptions for all road mode transportation system).

4) Highway grade roads and railways are available for use over the entire distance from the nuclear facility to the DGR/CES. The shipping of the UF is assumed to occur throughout the year.

5) The gross mass of the Used Fuel (UF) transportation system with the IFTC/BM (tractor, trailer, loaded transportation package, and tie downs) will be less than the allowable road limits within each province during the entire shipping season. It is assumed that upgrading of on-site or off-site roads should not be required for the IFTC/BM and the compliant trailers and tractors. The assumption for IFTC/BM transportation operation is that no escort vehicle is required (Conceptual design and description for all the UFTS components in the case of "all road" mode for each current Storage Site, APPENDIX E sections "Trailer for the road transportation") but it is assumed that at the time of transportation the drivers would be trained as security person.

6) The gross mass of the Used Fuel (UF) transportation system with the DSCTP (tractor, trailer, loaded transportation package, and tie downs) will be more than the allowable road limits within each province during the entire shipping season. It is assumed that upgrading of on-site or off-site roads should not be required for the DSCTP and the compliant nine axles trailers and tractors. It is foreseen to verify some infrastructure ability to support or not the DSCTP's vehicles. The DSCTP overweight road transport configuration involves an escort front and rear the trailer and tractor plus police.

7) The design and gross mass of the UF transportation package can be accommodated at each NPP loading facility or Irradiated Fuel Bay (IFB).

8) Each NPP has the required crane capacity and crane hook size for handling the transportation packages. The mass of the IFTC/BM, including the contents, is estimated to be approximately 42,500 kg (93,500 lbs). The mass of the DSCTP, including the contents, is estimated to be approximately 100,000 kg (220,000 lbs)

9) The transportation systems (tractor, trailer, transportation package & tie-downs) for both transportation packages can be accommodated or received at the road to rail transfer stations (Bruce & Point Lepreau), at the centralised rail to road transfer station and at the DGR/CES .

10) The trailers design will include space for transporting the auxiliary equipment such as leak testing equipment, spare parts, etc.

11) Sufficient space or a decontamination room is available to perform the pre & post shipment testing at each nuclear facility (see the detailed assumptions and limits per each site sections 6.4.2.2 & 6.4.2.3).

12) Service amenities such as low-pressure service air, electrical supply, etc. are readily available at each nuclear facility.

13) The Total quantities of transports and transportation packages are determined at first per each nuclear facility. Then an optimised calculation has been performed to minimise the transportation equipment fleet. The cost estimate financial rule is to apportion the equipment cost by each Nuclear Power Plant throughout a proportional calculation based on the number of packages shipped required per NPP.

14) Given the road transportation distances, it is assumed that the road transportation vehicles would be driven during the day and no secure area is required.

6.4.2.2 Detailed assumptions for mostly rail mode auxiliary equipment & facilities

Four families of additional transfer building are identified for each Nuclear Power Plant and current storage, they are the following :
Type 1 : Whiteshell,
Type 2 : Bruce A / B, Pickering A & B and Darlington for the DSCTPs preparation and loading,
Type 3 : Bruce B, Pickering A & B and Darlington for the Used Fuel transfer from the wet bays,
Type 4 : Bruce Douglas Point, Chalk River, Gentilly 1 & 2 and Point Lepreau for the Used Fuel transfer in baskets from the silos or Canstor.

The summary of loading facilities taken in account to develop the corresponding cost estimates is the following :

Family type	Type 1 Whiteshell	Type 2 : DSCs	Type 3 : wet bays	Type 4: silos or Canstor
Description : see the footnotes 1 to 3 hereunder	Area 2	Area 2 + utilities	Pool improvement + area 1 + area 2 + utilities	Shielding enclosure + area 1 + area 2 + utilities
Whiteshell	1			
Bruce A & B DSCs		1		
Bruce B wet bays			1 shared	
Douglas Point				1 shared
Pickering A & B DSCs		1		
Pickering B bay			1 shared	
Pickering Auxiliary bay			1 shared	
Darlington DSCs		1		
Darlington wet bays			1 shared	
Point Lepreau				1
Chalk River				1
Gentilly 1 & 2				1 shared

1) The hot cell to load modules from the DSC into the IFTC/BMs is not required.
2) Area 1 includes all equipment items to prepare the packaging and the transportation package before and after the modules loading into the packaging : phases 3 & 4 such as described in section 3.2.9 of Appendix E of the Conceptual Design Report.

3) Area 2 includes all equipment items to unload or load the transportation package from or onto the trailer : phase 5 such as described in section 3.2.9 of Appendix E of the Conceptual Design Report. The shielding enclosure area, area 1 & 2 could be adjacent in the same standalone facility or refurbished building.
4) The shielding enclosure is the enclosure used to transfer the baskets from the on-site transfer flask into the IFTC/BMs.

The needed sizes per family are assumed as follows :

	Type 1	**Type 2**	**Type 3**	**Type 4**
UF transfer from transfer flask to IFTC/BM	25 x 10 x10m			
Pool Facility improvement			excluded	
UF transfer from silos to IFTC/BM shielded enclosure				10 x 5 x 6m
Shielded enclosure building				24 x 13 x 12m
Loading building area 1 : IFTC/BM preparation			18 x 10 x 8m	10 x 10 x 6m
Loading building area 2 : IFTC/BM or DSCTP loading onto the trailer		28 x 8 x 14m	28 x 10 x 11m	28 x 10 x 11m
Loading building area 2 : IFTC/BM or DSCTP loading onto the railcar		30 x 12 x 14m	30 x 12 x 14m	30 x 12 x 14m
Loading building area 3 : utilities		10 x 10 x 8m	10 x 10 x 8m	10 x 10 x 6m
IFTC/BM loading onto the trailer	20 x 10 x 11m			

The pool or wet bays building strengthening works to support a new crane of 60 tons capacity are not included.

The pool or wet bays buildings improvement works to install one cask water emptying system and one cask external decontamination are not included. The building or utilities modifications such as electricity, ventilation, civil-works, Instrumentation & control required by the new equipment installation are not included. Only the process equipment needed to retrieve the Used Fuel modules from the pool is included .

The WUFDSF or DUFDSF existing building strengthening works to support a new crane of 120 tons capacity are not included. Account is taken of existing equipment (details can be found in Section 6.4.2.3 and in Appendix N).

6.4.2.3 Detailed limits for mostly rail mode auxiliary equipment & facilities

The following tables show the detailed limits take in account in the cost estimate for each auxiliary facility per NPP and per current storage facility.

Auxiliary equipment and assumed location main assumptions
Main scope of work per Nuclear Power Plant

Building / **Function**	Shielded enclosure building (loading the modules or baskets into the IFTC/BMs)		Shipment area 1 building (IFTC/BMs shipment preparation)		Shipment area 2 building (IFTC/BMs loading onto the trailer or DSCTPs loading onto rail car or trailer)	
Sites						
Bruce A/B DSCs	hot cell not required		No scope required for DSCTPs preshipment		space in converted WUFDSF workshop	1 shared process line
Out of scope					Small refurbishment works in shipment area	
UFTS scope					Procure and install the handling equipment in the WUFDSF refurbished workshop One new 120 tons crane	
Bruce B wet bays	B bay	1 process line	space in converted WUFDSF workshop	1 process line	Building and equipment shared with Bruce DSCs auxiliary	1 shared process line
Out of scope	Cranes and decontamination system are existing equipment The pool building strengthening works are excluded		Small refurbishment works in preshipment area		Small refurbishment works in shipment area	
UFTS scope	Procure and Install the other equipment in the B bay		Procure and install the preshipment equipment in the WUFDSF refurbished workshop		See Bruce A/B DSCs: One new 120 tons crane shared	
Pickering A/B DSCs	hot cell not required		No scope required for DSCTPs preshipment		space in a new extension at PUFDSF	1 shared process line
Out of scope						
UFTS scope					Procure and construct a new extension to the PUFDSF With one new 120 tons crane & other handling equipment	
Pickering B wet bays	B bay	1 process line	space in a new extension at PUFDSF	1 process line	Building and equipment shared with Pickering DSC's auxiliary	1 shared process line
Out of scope	Cranes and decontamination system are existing equipment The pool building strengthening works are excluded					
UFTS scope	Procure and Install the other equipment in the B bay		Procure and construct a new extension to the PUFDSF With preshipment equipment		See Pickering A/B DSCs	
Pickering Auxiliary wet bays	Auxiliary bay	1 process line	Building and equipment shared with PUFDSF extension auxiliary	1 shared process line	Building and equipment shared with Pickering DSC's auxiliary	1 shared process line
Out of scope	Cranes and decontamination system are existing equipment The pool building strengthening works are excluded					
UFTS scope	Procure and Install the other equipment in the Auxiliary wet bay		See Pickering B bay		See Pickering B bay	

Building	Shielded enclosure building		Shipment area 1 building		Shipment area 2 building	
Function	(loading the modules or baskets into the IFTC/BMs)		(IFTC/BMs shipment preparation)		(IFTC/BMs loading onto the trailer or DSCTPs loading onto rail car or trailer)	
Sites						
Darlington DSCs	hot cell not required		No scope required for DSCTPs preshipment		space in converted DUFDSF workshop	1 shared process line
Out of scope					Small refurbishment works in shipment area	
UFTS scope					Procure and install the handling equipment in the DUFDSF refurbished workshop One new 120 tons crane	
Darlington wet bays	East bay	1 process line	space in converted DUFDSF workshop	1 process line	Building and equipment shared with Darlington DSCs auxiliary	1 shared process line
Out of scope	Cranes and decontamination system are existing equipment The pool building strengthening works are excluded		Small refurbishment works in preshipment area		Small refurbishment works in shipment area	
UFTS scope	Procure and Install the other equipment in the East bay		Procure and install the preshipment equipment in the DUFDSF refurbished workshop		See Darlington DSCs: One new 120 tons crane shared	

Building		Shielded enclosure building		Shipment area 1 building		Shipment area 2 building	
Function		(loading the modules or baskets into the IFTC/BMs)		(IFTC/BMs shipment preparation)		(IFTC/BMs loading onto the trailer or DSCTPs loading onto rail car or trailer)	
Sites							
Whiteshell		In an existing building		In an existing building		In an existing building	
	Out of scope	The building improvement and 2 Gantry cranes are taken in account by AECL					
	UFTS scope	The other equipment are shared with Bruce Douglas Point (3 shipments against 138 at Douglas Point)					
Douglas Point		In an existing building	1 process line	Building and equipment shared with Bruce B bay auxiliary	1 shared process line	Building and equipment shared with Bruce B bay auxiliary	1 shared process line
	Out of scope	The transfer flask, the gantry crane (for transfer flask), the trolley with tractor		See Bruce B bay		See Bruce B bay	
	UFTS scope	Construct and Install the shielded enclosure and equipment in an existing building refurbish the existing building		See Bruce B bay Cost shared with Bruce B		See Bruce B bay Cost shared with Bruce B	
Point Lepreau		New building construction required	1 process line	New building construction required	1 process line	New building construction required	1 process line
	Out of scope	The transfer flask, the gantry crane (for transfer flask), the trolley with tractor					
	UFTS scope	Construct a new building Construct and Install the shielded enclosure and equipment in the new building		Construct a new building Procure and Install the preshipment equipment		Construct a new building Procure and Install the handling equipment	
Chalk River		In an existing building	1 process line	In an existing building	1 process line	In an existing building	1 process line
	Out of scope	The transfer flask, the gantry crane (for transfer flask), the trolley with tractor		One crane is existing equipment and small refurbishment works in shipment area		One crane is existing equipment and small refurbishment works in shipment area	
	UFTS scope	Construct and Install the shielded enclosure and equipment in an existing building refurbish the existing building		Procure and install the pre shipment equipment in the refurbished existing building		Procure and install the handling equipment in the refurbished existing building	
Gentilly 1 & 2		One common process line equipment in an existing building, the cost is shared between Gentilly 1 and 2					
	Out of scope	The transfer flask, the gantry crane (for transfer flask), the trolley with tractor		One crane is existing equipment and small refurbishment works in shipment area		One crane is existing equipment and small refurbishment works in shipment area	
	UFTS scope	Construct and Install the shielded enclosure and equipment in an existing building refurbish the existing building		Procure and install the pre shipment equipment in the refurbished existing building		Procure and install the handling equipment in the refurbished existing building	

6.4.2.4 Mostly rail main assumption changes from all road mode

To develop the mostly rail transportation mode cost estimate from the all road mode cost, the main changes from the all road cost estimate basis are described in this section. The changes are explain hereunder for each WBS at level 3. Small differences between modes cannot be estimated with precision at this stage and are considered to be cover within the accuracy of the estimate.

620.15 Mode & route development

The assumptions and the content used are the same as for all road cost estimate

620.20 System development

The assumptions and the content used are the same as for all road cost estimate. The development of DSCTP's trailer & tractor, DSCTP's railcar and DSCTP's outer packaging are taken in account and double the all road scope of work.

620.25 Safety assessment

The assumptions and the content used are the same as for all road cost estimate

620.35 Public affairs

The assumptions and the content used are the same as for all road cost estimate

620.40.20 Transporter

Quantities :
The number of road trailers & trucks for IFTC/BMs decreases to 10.
The number of road trailers & trucks for DSCTPs taken in account is 10 (payload assumed : 100 tons).
The number of trains for both transportation packages taken in account is 4 with 5 railcars each.
The train capacity per shipment is assumed to be 10 IFTC/BMs or 5 DSCTPs.

620.40.30 Transportation system maintenance facility

The casks fleet decreases to 18 units against 25 for all road. The casks maintenance main functions are the same as for all road transportation mode, the capital cost could not significantly be reduce, only the work load will decrease proportionally to the number of IFTC/BMs shipped (see operational systems). The casks maintenance facility would be able to perform the DSC's outer packaging maintenance works.
The road trailers and trucks maintenance facility is the same as for all road cost estimate
The railcars maintenance facility is assumed to be construct as a part of the centralised rail road transfer station and sited near the DGR/CES site.

620.40.40 Transportation packages

Quantities : The number of IFTC/BMs decreases to 18. The unit cost is the same as for all road cost estimate
The number of DSC's outer packaging taken in account is 17 .

620.40.50 UFTS Auxiliary equipment (including on-site transportation system)

For IFTC/BMs the loading process is the same as for all road cost estimate and the assumptions are the same.
For DSCTPs loading process, the loading hot cell is not required and only the trailer or railcar loading facilities are needed and require new 120 tons capacity cranes at each Dry Storage Facility.

- At Bruce the shipping facility is assumed at WUFDSF converted workshop for both IFTC/BMs and DSCTPs.
- At Pickering the shipping facility is assumed as a new extension (stage 2) to the Dry Storage Facility for both IFTC/BMs and DSCTPs. This extension will be equipped with a new 120 tons crane.
- At Darlington the shipping facility is assumed at DUFDSF converted workshop for both IFTC/BMs and DSCTPs.

The secure areas are not required (given the driven distances, no overnight stops are required) .
The emergency means capital cost is the same as for all road cost estimate.
The real time tracking system capital cost is the same as for all road cost estimate.

620.40.60 Transfer Facilities or Infrastructures (Railways or roads construction or upgrading)
Concerning the road or rail way net and the transfer station required at each site the assumptions are :
- Bruce A & B DSCs, Bruce B wet bays, Bruce Douglas Point : Road link (50 km) to railhead and one common road to rail transfer new station sited near Bruce at the railhead,
- Pickering A & B DSCs and wet bays : direct loading on railcars and extend spur line 1 km,
- Darlington DSCs and wet bays : direct loading on railcars and new spur line 1 km
- Whiteshell : only all road mode,
- Point Lepreau : road link (100 km) to railhead and one road to rail transfer new station sited near Point Lepreau at the railhead,
- Chalk River : only all road mode,
- Gentilly 1 & 2 : direct loading on railcars and extend spur line 1 km,
- For the DGR/CES site : one common rail to road transfer station who would be used and shared by all the NPPs except Whiteshell and Chalk River and a road link (100 km) to DGR/CES site.

620.50.10 Nuclear facility loading Operation (phases into the NPPs)
The labour to retrieve the modules from the DSCs and load the corresponding IFTC/BMs would not be required. Only the DSCTPs fitting of the outer packaging and radiological control labour would be taken in account.
The Nuclear Facility Loading operation assumptions and resources for all Sites are the following :
The total duration of loading operation is estimated to last for 30 years and the number of working days per year is 250 days.
The total number of bundles to transport is : 3,557,451 UF currently stored in DSCs, wet bays, silos or Canstor.
The total number of IFTC/BMs to fill with the UF modules or baskets is 7,148 IFTC/BMs.
The total number of DSCs to prepare and ship is 5,802 DSCTPs.
The total number of transportation packages to ship is: 12,950 IFTC/BMs or DSCTPs.

The nuclear facility loading operation resources to transfer the UF modules or baskets into the transportation package and to perform the pre shipment are :
For IFTC/BM preparation the same as for all road, i.e. 60 hours per transportation package.
For DSCTP preparation the resources are 36 hours per transportation package.
Resources for loading of the IFTC/BM on a trailor or railcar are 12 hours per package.
Resources for loading of the DSCTP on a trailor or railcar are 24 hours per package.

See the other detailed quantity assumptions in the Logistics Report.

620.50.20 Transportation system operation (From NPPs sites to the DGR/CES site)
The average transportation speed is assumed to be 60 km/h with a total train driving time of 24 hours a day. The average speed includes eventual stops that could occur during a train journey.
The average speed is the same for the transportation of IFTC/BM and DSCTP.
The rail distances taken in account are :
- OPG – all nuclear facilities : 1,000 km
- Douglas Point : 1,000 km
- Point Lepreau : 2,000 km
- Chalk River : 1,000 km by road
- Whiteshell : 1,000 km by road
- Gentilly 1 & 2 : 1, 500 km
- DGR/CES :The road distance from the rail / road terminal to DGR/CES is assumed to be 100 km

See the other detailed quantity assumptions in the Logistics Report.

620.50.30 Operational systems
The labour to operate the secure areas is not required.
The emergency means labour cost is the same as for all road cost estimate.
The real time tracking system labour cost is the same as for all road cost estimate.
The casks maintenance labour cost decreases according the number of packages shipped :
The IFTC/BMs shipping main period is estimated to last for 12 years (from 2035 to 2046) and the average number of packages shipped per year (595) is approximately the same as for all road (624). The resources to maintain the IFTC/BMs are estimated at 8 FTE persons during 12 years.
The casks maintenance facility would be able to perform the DSC's transportation packages maintenance works. The DSCTPs shipping main period is estimated to last for 20 years (from 2045 to 2064) and the number of DSCTP's outer packaging to maintain is 15 per year (with the maintenance ratio of 5 %).The resources to maintain the DSCTPs outer packaging are estimated at 2 FTE persons during 20 years.
The trailers and tractors maintenance labour cost decreases according the covering distances : 2 FTE persons.
The railcars maintenance labour cost would be added : 3 FTE persons.

620.55 Environmental Management System
The assumptions and the content used are the same as for all road cost estimate.

620.60 Decommissioning
The assumptions and the methodology used are the same as for all road cost estimate.

620.90 Program management (& administration)
The assumptions and the content used are the same as for all road cost estimate.

6.4.3 MOSTLY WATER SPECIFIC ASSUMPTIONS

6.4.3.1 General assumptions for mostly water mode transportation system

1) All the Used Fuel (UF) will be only transported from the various nuclear facilities to the Used Fuel DGR/CES site via the mostly water mode of transportation. Emergency Response Plans, Safeguard and Security Plans, Public Affairs, Project Management and Safety Assessments will be based on transporting the UF via a mixed road and mostly water mode of transportation. The general scheme to transport the UF from the NPPs to the DGR/CES site is :

Site	Casks	Total mode	1st Mode	2d Mode	3d Mode
Whiteshell	IFTC/BMs	all road	Road only		
Bruce A & B	IFTC/BMs & DSCTPs	Mixed mode	On-site Road	Water	Road
Bruce Douglas Point	IFTC/BMs	Mixed mode	On-site Road	Water	Road
Pickering A & B	IFTC/BMs & DSCTPs	Mixed mode	On-site Road	Water	Road
Darlington	IFTC/BMs & DSCTPs	Mixed mode	On-site Road	Water	Road
Point Lepreau	IFTC/BMs	Mixed mode	On-site Road	Water	Road
Chalk River	IFTC/BMs	all road	Road only		
Gentilly 1 & 2	IFTC/BMs	Mixed mode	On-site Road	Water	Road

2) All Used Fuel currently stored at OPG's NPPs in DSC would be transport in this cask. The DSC together with an outer packaging constitutes the transportation package : DSCTP. The DSCTP is currently only licensed for transport by rail or water. It is assumed that the DSCTP could be easily re-licensed for road transport. The DSCTP should be used to transport all fuel bundles stored in DSCs at the time of transportation by road and mostly rail. The main consequence is that no hot cells are required to transfer the UF from the DSCs into the IFTC/BMs.

3) All the other Used Fuel currently stored in wet storage or silos should be transported in the IFTC/BM (see general assumptions for all road mode transportation system).

4) Highway grade roads and waterways are available for use over the entire distance from the nuclear facility to the DGR/CES. The shipping of the UF is assumed to occur throughout the year and it is assumed that the waterways and dock facilities would be available over a 245 day shipping window per year.

5) The gross mass of the Used Fuel (UF) transportation system with the IFTC/BM (tractor, trailer, loaded transportation package, and tie downs) will be less than the allowable road limits within each province during the entire shipping season. It is assumed that upgrading of on-site or off-site roads should not be required for the IFTC/BM and the compliant trailers and tractors. The assumption for IFTC/BM transportation operation is that no escort vehicle is required (Conceptual design and description for all the UFTS components in the case of "all road" mode for each current Storage Site, APPENDIX F sections "Trailer for the road transportation") and it is assumed that at the time of transportation the drivers would be trained as security person.

6) The gross mass of the Used Fuel (UF) transportation system with the DSCTP (tractor, trailer, loaded transportation package, and tie downs) will be more than the allowable road limits within each province during the entire shipping season. It is assumed that upgrading of on-site or off-site roads should not be required for the DSCTP and the compliant nine axles trailers and tractors. It is foreseen to verify some infrastructure ability to support or not the DSCTP's vehicles. The DSCTP overweight road transport configuration involves an escort front and rear the trailer and tractor plus police.

7) The design and gross mass of the UF transportation package can be accommodated at each NPP loading facility or Irradiated Fuel Bay (IFB).

8) Each NPP has the required crane capacity and crane hook size for handling the transportation packages. The mass of the IFTC/BM, including the contents, is estimated to be approximately 42,500 kg (93,500 lbs). The mass of the DSCTP, including the contents, is estimated to be approximately 100,000 kg (220,000 lbs).

9) The transportation systems (tractor, trailer, transportation package & tie-downs) for both transportation packages can be accommodated or received at the on-site road to water transfer docks (all sites excepted Whiteshell and Chalk River), at the centralised water to road transfer dock and at the DGR/CES .

10) The trailers design will include space for transporting the auxiliary equipment such as leak testing equipment, spare parts, etc.

11) Sufficient space or a decontamination room is available to perform the pre & post shipment testing at each nuclear facility (see the detailed assumptions and limits per each site sections 6.4.3.2 & 6.4.3.3).

12) Service amenities such as low-pressure service air, electrical supply, etc. are readily available at each nuclear facility.

13) The Total quantities of transports and transportation packages are determined at first per each nuclear facility. Then an optimised calculation has been performed to minimise the transportation equipment fleet. The cost estimate financial rule is to apportion the equipment cost by each Nuclear Power Plant throughout a proportional calculation based on the number of packages shipped required per NPP.

14) Given the road transportation distances, it is assumed that the road transportation vehicles would be driven during the day and no secure area is required.

15) The water transportation system is assumed to be a vessel . The vessel is described in section 3.7.1 chapter 3 conceptual design.

6.4.3.2 Detailed assumptions for mostly water mode auxiliary equipment & facilities

Four families of additional transfer building are identified for each Nuclear Power Plant and current storage, they are the following :
Type 1 : Whiteshell,
Type 2 : Bruce A & B, Pickering A & B and Darlington for the DSCTPs preparation and loading,
Type 3 : Bruce B, Pickering A & B and Darlington for the Used Fuel transfer from the wet bays,
Type 4 : Bruce Douglas Point, Chalk River, Gentilly 1 & 2 and Point Lepreau for the Used Fuel transfer in baskets from the silos or Canstor.

The summary of loading facilities taken in account to develop the corresponding cost estimates is the following :

Family type	Type 1 : Whiteshell	Type 2 : DSCs	Type 3 : wet bays	Type 4 : silos or Canstor
Description : see the footnotes 1 to 3 hereunder	Area 2	Area 2 + utilities	Pool improvement + area 1 + area 2+ utilities	Shielding enclosure + area 1 + area 2 + utilities
Whiteshell	1			
Bruce A & B DSCs		1		
Bruce B wet bays			1 shared	
Douglas Point				1 shared
Pickering A & B DSCs		1		
Pickering B bay			1 shared	
Pickering Auxiliary bay			1 shared	
Darlington DSCs		1		
Darlington wet bays			1 shared	
Point Lepreau				1
Chalk River				1
Gentilly 1 & 2				1 shared

1) *The hot cell to load modules from the DSC into the IFTC/BMs is not required.*
2) *Area 1 includes all equipment items to prepare the packaging and the transportation package before and after the modules loading into the packaging : phases 2 & 3 such as described in section 3.2.9 of Appendix F of the Conceptual Design Report.*
3) *Area 2 includes all equipment items to unload or load the transportation package from or onto the trolley or trailer : phase 4 such as described in section 3.2.9 9 of Appendix F of the Conceptual Design Report. The shielding enclosure area, area 1 & 2 could be adjacent in the same standalone facility or refurbished building.*
4) *The shielding enclosure is the enclosure used to transfer the baskets from the on-site transfer flask into the IFTC/BMs.*

The needed sizes per family are assumed as follows :

	Type 1	Type 2	Type 3	Type 4
UF transfer from transfer flask to IFTC/BM	25 x 10 x10m			
Pool Facility improvement			excluded	
UF transfer from silos to IFTC/BM shielded enclosure				10 x 5 x 6m
Shielded enclosure building				24 x 13 x 12m
Loading building area 1 : IFTC/BM preparation			18 x 10 x 8m	10 x 10 x 6m
Loading building area 2 : IFTC/BM or DSCTP loading onto a trolley		28 x 8 x 14m	28 x 10 x 11m	28 x 10 x 11m
Loading building area 3 : utilities		10 x 10 x 8m	10 x 10 x 8m	10 x 10 x 6m
IFTC/BM loading onto the trailer	20 x 10 x 11m			

The pool or wet bays building strengthening works to support a new crane of 60 tons capacity are not included.
The pool or wet bays buildings improvement works to install one cask water emptying system and one cask external decontamination are not included. The building or utilities modifications such as electricity, ventilation, civil-works, Instrumentation & control required by the new equipment installation are not included. Only the process equipment needed to retrieve the Used Fuel modules from the pool is included .
The WUFDSF, Pickering Turbine Hall or DUFDSF existing building strengthening works to support a new crane of 120 tons capacity are not included. Account is taken of existing equipment (details can be found in Section 6.4.3.3 and in Appendix O).

6.4.3.3 Detailed limits for mostly water mode auxiliary equipment & facilities

The following tables show the detailed limits take in account in the cost estimate for each auxiliary facility per NPPs and per current storage facility.

Mostly water Auxiliary equipment and assumed location main assumptions
Main scope of work per Nuclear Power Plant

Building	Shielded enclosure building		Shipment area 1 building		Shipment area 2 building	
Function	(loading the modules or baskets into the IFTC/BMs)		(IFTC/BMs shipment preparation)		(IFTC/BMs loading onto the trailer or DSCTPs loading onto rail car or trailer)	
Sites						
Bruce A/B DSCs	hot cell not required		No scope required for DSCTPs preshipment		space in converted WUFDSF workshop	1 shared process line
Out of scope					Small refurbishment works in shipment area	
UFTS scope					Procure and install the handling equipment in the WUFDSF refurbished workshop One new 120 tons crane & 120 tons trolley and tractor	
Bruce B wet bays	B bay	1 process line	space in converted WUFDSF workshop	1 process line	Building and equipment shared with Bruce DSCs auxiliary	1 shared process line
Out of scope	Cranes and decontamination system are existing equipment The pool building strengthening works are excluded		Small refurbishment works in preshipment area		Small refurbishment works in shipment area	
UFTS scope	Procure and Install the other equipment in the B bay		Procure and install the preshipment equipment in the WUFDSF refurbished workshop		See Bruce A/B DSCs: One new 120 tons crane & 120 tons trolley and tractor shared	
Pickering A/B DSCs	hot cell not required		No scope required for DSCTPs preshipment		space in converted Pickering A Turbine Hall	1 shared process line
Out of scope					Small refurbishment works in shipment area	
UFTS scope					Procure and install the handling equipment in the Pickering A refurbished Turbine Hall One new 120 tons crane & 120 tons trolley and tractor	
Pickering B wet bays	B bay	1 process line	space in converted Pickering A Turbine Hall	1 process line	Building and equipment shared with Pickering DSC's auxiliary	1 shared process line
Out of scope	Cranes and decontamination system are existing equipment The pool building strengthening works are excluded				See Pickering A/B DSCs	
UFTS scope	Procure and Install the other equipment in the B bay		Procure and install the pre shipment equipment in the Pickering A refurbished Turbine Hall		See Pickering A/B DSCs	
Pickering Auxiliary wet bays	Auxiliary bay	1 process line	See Pickering B bay	1 shared process line	Building and equipment shared with Pickering DSC's auxiliary	1 shared process line
Out of scope	Cranes and decontamination system are existing equipment The pool building strengthening works are excluded				See Pickering A/B DSCs	
UFTS scope	Procure and Install the other equipment in the Auxiliary wet bay		See Pickering B bay		See Pickering A/B DSCs	

Building	Shielded enclosure building		Shipment area 1 building		Shipment area 2 building		
Function	(loading the modules or baskets into the IFTC/BMs)		(IFTC/BMs shipment preparation)		(IFTC/BMs loading onto the trailer or DSCTPs loading onto rail car or trailer)		
Sites							
Darlington DSCs	hot cell not required		No scope required for DSCTPs preshipment		space in converted DUFDSF workshop	1 shared process line	
Out of scope					Small refurbishment works in shipment area		
UFTS scope					Procure and install the handling equipment in the DUFDSF refurbished workshop One new 120 tons crane & 120 tons trolley and tractor		
Darlington wet bays	East bay	1 process line	space in converted DUFDSF workshop	1 process line	Building and equipment shared with Darlington DSCs auxiliary	1 shared process line	
Out of scope	Cranes and decontamination system are existing equipment The pool building strengthening works are excluded		Small refurbishment works in preshipment area		Small refurbishment works in shipment area		
UFTS scope	Procure and Install the other equipment in the East bay		Procure and install the preshipment equipment in the DUFDSF refurbished workshop		See Darlington DSCs: One new 120 tons crane shared		

6.4.3.4 Mostly water main assumption changes from all road mode

To develop the mostly water transportation mode cost estimate from the all road mode cost, the main changes from the all road cost estimate basis are described in this section . The changes are explain hereunder for each WBS at level 3.

630.15 Mode & route development

The assumptions and the content used are the same as for all road cost estimate

630.20 System development

The assumptions and the content used are the same as for all road cost estimate. The development of DSCTP's trailer & tractor, transportation vessel and DSCTP's outer packaging are taken in account and double the all road scope of work.

630.25 Safety assessment

The assumptions and the content used are the same as for all road cost estimate.

630.35 Public affairs

The assumptions and the content used are the same as for all road cost estimate.

630.40.20 Transporter

Quantities :

The number of road trailers & trucks for IFTC/BMs decreases to 7.

The number of road trailers & trucks for DSCTPs taken in account is 7 (payload assumed : 100 tons).

The number of vessels for both transportation packages taken in account is 4.

The vessel capacity per shipment is assumed to be 32 IFTC/BMs or 15 DSCTPs.

630.40.30 Transportation system maintenance facility

The casks fleet increases to 63 units against 25 for all road. The casks maintenance main functions are the same as for all road transportation mode, the capital cost could not significantly be increase, only the work load will be increased proportionally to the number of IFTC/BMs shipped (see operational systems). The casks maintenance facility would be able to perform the DSC's outer packaging maintenance works. The road trailers and trucks maintenance facility is the same as for all road cost estimate.

The vessels maintenance facility is assumed to be an existing facility and its capital and operating costs would be invoiced to the WMO and included within the transportation services cost.

630.40.40 Transportation packages
Quantities : the number of IFTC/BMs increases to 63.
The unit cost is the same as for all road cost estimate.
The number of DSC's transportation packages taken in account is 59 units.

630.40.50 UFTS Auxiliary equipment (including on-site transportation system)
For IFTC/BMs the loading process is the same as for all road cost estimate and the assumptions are the same.
For DSCTPs loading process, the loading hot cell is not required and only the DSCTPs loading facilities are needed and require new 120 tons capacity cranes at each Dry Storage Facility and an on-site 120 tons capacity trolley and tractor.
- At Bruce the shipping facility is assumed at WUFDSF converted workshop for both IFTC/BMs and DSCTPs.
- At Pickering the shipping facility is assumed at converted Turbine for both IFTC/BMs and DSCTPs.
- At Darlington the shipping facility is assumed at DUFDSF converted workshop for both IFTC/BMs and DSCTPs

The secure areas are not required (given the driven distances, no overnight stops are required) .
The emergency means capital cost is the same as for all road cost estimate.
The real time tracking system capital cost is the same as for all road cost estimate.

630.40.60 Transfer Facilities or Infrastructures (Docks or roads construction or upgrading)
The assumptions for the road or water way net and the transfer station required at each site are :
- Bruce A & B DSCs , Bruce B wet bays, Bruce Douglas Point : on-site road link to the new dock and one common road to water transfer new station sited on Bruce site,
- Pickering A & B DSCs and wet bays : on-site road link to the new dock and one common road to water transfer new station sited near Auxiliary bay,
- Darlington DSCs and wet bays : on-site road link to the new dock and one common road to water transfer new station sited near DUFDSF,
- Whiteshell : only all road mode,
- Point Lepreau : on-site road link to the new dock and one common road to water transfer new station sited on Point Lepreau site,
- Chalk River : only all road mode,
- Gentilly 1 & 2 : on-site road link to the new dock and one common road to water transfer new station sited on Gentilly site. A road link to Porte de Becancour should be an alternative to be evaluated if a centralised option with this transportation mode is chosen in the future,
- For the DGR/CES site : one common water to road transfer station who would be use and share by all the NPPs except Whiteshell and Chalk River.

630.50.10 Nuclear facility loading Operation (phases into the NPPs)
The labour to retrieve the modules from the DSCs and load the corresponding IFTC/BMs would not be required. Only the DSCTPs fitting of the outer packaging and radiological control labour would be taken in account.
The Nuclear Facility Loading operation assumptions and resources for all Sites are the following :
The total duration of loading operation is estimated to last for 30 years and the number of working days per year is 250 days.
The total number of bundles to transport is : 3,557,451 UF currently stored in DSCs, wet bays, silos or Canstor.
The total number of IFTC/BMs to fill with the UF modules or baskets is 7,148 IFTC/BMs.
The total number of DSCs to prepare and ship is 5,802 DSCTPs.
The total number of transportation packages to ship is: 12,950 IFTC/BMs or DSCTPs.

The nuclear facility loading operation resources to transfer the UF modules or baskets into the transportation package and to perform the pre shipment are:
For IFTC/BM preparation the same as for all road, i.e. 60 hours per transportation package.
For DSCTP preparation the resources are 36 hours per transportation package.
Resources for loading of the IFTC/BM on a trailor or vessel are 12 hours per package.
Resources for loading of the DSCTP on a trailor or vessel are 24 hours per package.

See the other detailed quantity assumptions in the Logistics Report.

630.50.20 Transportation system operation (From NPPs sites to the DGR/CES site)
The average transportation speed is assumed to be 10 km/h with a total navigation time of 24 hours a day. The average speed is the same for the transportation of IFTC/BM and DSCTP. The number of vessel's working time is assumed to be 245 days per year and for 4 vessels. The transportation services will be invoiced on the basis of 245 days per year.
The water distances taken in account are :
- Pickering & Darlington : 1,000 km
- Bruce : 500 km
- Douglas Point : 500 km
- Point Lepreau : 3,500 km
- Chalk River : 1,000 km by road
- Whiteshell : 1,000 km by road
- Gentilly 1 & 2 : 1,700 km
- DGR/CES :The road distance from the water / road terminal to DGR/CES is assumed to be 100 km

See the other detailed quantity assumptions in the Logistics Report.

630.50.30 Operational systems
The labour to operate the secure areas is not required.
The emergency means labour cost is the same as for all road cost estimate.
The real time tracking system labour cost is the same as for all road cost estimate.
The casks maintenance labour cost decreases according the number of packages shipped :
The IFTC/BMs shipping main period is estimated to last for 12 years (from 2035 to 2046) and the average number of packages shipped per year (595) is approximately the same as for all road (624). The resources to maintain the IFTC/BMs are estimated at 8 FTE persons during 12 years.
The casks maintenance facility would be able to perform the DSC's transportation packages maintenance works. The DSCTPs shipping main period is estimated to last for 20 years (from 2045 to 2064) and the number of DSCTP's outer packaging to maintain is 15 per year (with the maintenance ratio of 5 %). The resources to maintain the DSCTPs outer packaging are estimated at 2 FTE persons during 20 years.
The trailers and tractors maintenance labour cost decreases according the covering distances : 2 FTE persons.
The vessel maintenance labour cost would be included within the transportation services costs.

630.55 Environmental Management System
The assumptions and the content used are the same as for all road cost estimate.

630.60 Decommissioning
The assumptions and the methodology used are the same as for all road cost estimate.

630.90 Program management (& administration)
The assumptions and the content used are the same as for all road cost estimate.

6.5. CAPITAL AND OPERATING COST PER OWNER

6.5.1 INTRODUCTION : COST APPORTIONMENT GENERAL RULE

The costs of identified and allocable WBS who are corresponding directly to DSC process could be assigned to OPG.
The costs of identified and allocable WBS who are directly valuable for one owner/site/current storage could be assigned to the corresponding waste owner.

When common costs corresponding to an identified WBS could not be directly assigned to a waste owner, we propose the following methodology to share these costs :

6.5.1.1 • All road mode

The total road transportation common cost is shared between all the waste owner according the number of road transportation packages shipped (the number of packages to ship at each current storage facility).

6.5.1.2 • Mostly rail or water mode

For Whiteshell and Chalk River sites only a road transportation mode will be used. The apportioned cost should be calculated according the number of road packages shipped.
For the other sites using mixed transportation mode (road, rail or water), the apportioned cost could be calculated according the number of road packages shipped and the number of rail packages shipped.
The total road transportation common cost part is shared between all the waste owner according the number of road packages shipped, the total rail or water transportation common cost part is shared between all the waste owner according the number of rail or water packages shipped and the both allocable cost parts (after apportion calculation) could be added to determine the total cost part assigned to each owner or site or current storage.

Footnote : number of packages shipped is the number of IFTC/BMs or DSCTPs to ship from each current storage facility by road, rail or water instead the number of shipment who represents the number of transportation system involved and this last number would probably not be a realistic apportion parameter.

6.5.2 CAPITAL AND OPERATION COST PER TRANSPORTATION MODE / PER OWNER

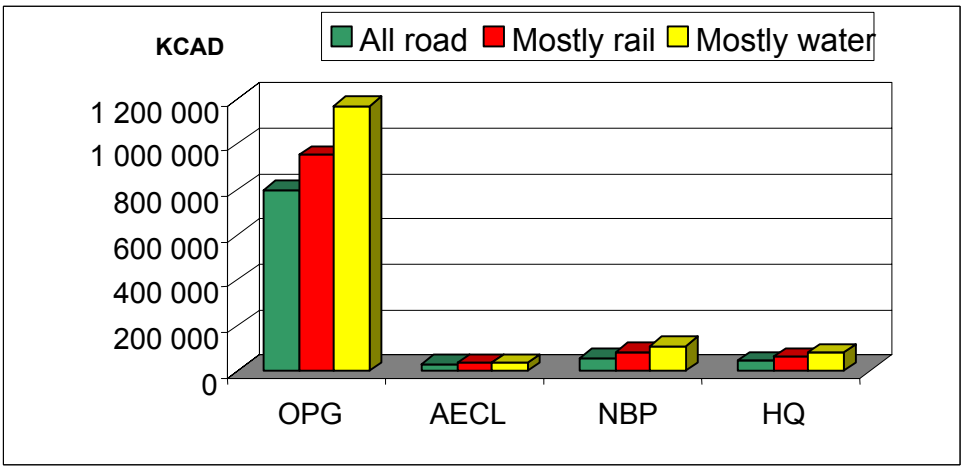
The capital and operating costs per each transportation mode are presented hereunder per waste owner. The total cost is subdivided in 3 parts : capital cost (WBS 610.40), operation cost (WBS 610.50) and other cost (miscellaneous WBS).

	OPG	AECL	NBP	HQ	Total
ALL ROAD MODE					
MISCELLANEOUS WBS	84 864	992	3 299	3 662	92 818
CAPITAL COST	228 184	21 247	25 991	16 492	291 914
OPERATION COST	486 429	5 852	27 067	23 468	542 815
	799 477	**28 092**	**56 358**	**43 621**	**927 547**

	OPG	AECL	NBP	HQ	Total
MOSTLY RAIL MODE					
MISCELLANEOUS WBS	80 908	1 426	4 742	5 262	92 338
CAPITAL COST	266 245	24 368	41 558	25 354	357 525
OPERATION COST	607 621	7 277	35 104	29 842	679 844
	954 775	**33 071**	**81 403**	**60 458**	**1 129 707**

	OPG	AECL	NBP	HQ	Total
MOSTLY WATER MODE					
MISCELLANEOUS WBS	87 024	1 534	5 100	5 660	99 318
CAPITAL COST	309 993	25 198	47 875	39 017	422 083
OPERATION COST	776 328	7 772	56 469	35 255	875 823
	1 173 345	**34 503**	**109 444**	**79 932**	**1 397 224**

Results obtained in the above table cost per owner / per each transportation mode are displayed in the following graph :



6.6. CAPITAL AND OPERATING COST PER OWNER PER NPP

The three transportation mode capital and operating costs are presented hereunder per waste owner and per NPP.
The common costs are apportioned according the packages shipped number.

The direct cost column represents all the costs allocable by owner / site / current storage facility.
They are directly assigned to the corresponding WBS without an apportionment rule.

The common cost to share column represents all the common costs, as well as costs which cannot be allocated by owner / site / current storage facility. They are assigned with the apportionment rule defined in section 6.5.1.

6.6.1 ALL ROAD TRANSPORTATION MODE PER OWNER / PER NPP

ROAD					
Owner	**Site**	**direct cost**	**common cost to be shared**	**TOTAL Road cost**	**Number of packages shipped**
		kCAD	kCAD	kCAD	unit
OPG All Road	Bruce A/B	198 937	152 750	**351 687**	7 674
	Pickering A/B	133 674	96 499	**230 172**	4 848
	Darlington	126 414	91 204	**217 618**	4 582
AECL All Road	Whiteshell	132	60	**192**	3
	Douglas Point	12 742	2 747	**15 489**	138
	Chalk River	10 101	597	**10 698**	30
	Gentilly 1	1 136	577	**1 713**	29
HQ All Road	Gentilly 2	28 931	14 690	**43 621**	738
NBP All Road	Point Lepreau	43 121	13 237	**56 358**	665
(1 + 2)	common cost	372 360			
	TOTAL COST	**927 547**	kCAD	**927 547**	18 707

6.6.2 MOSTLY RAIL TRANSPORTATION MODE PER OWNER / PER NPP

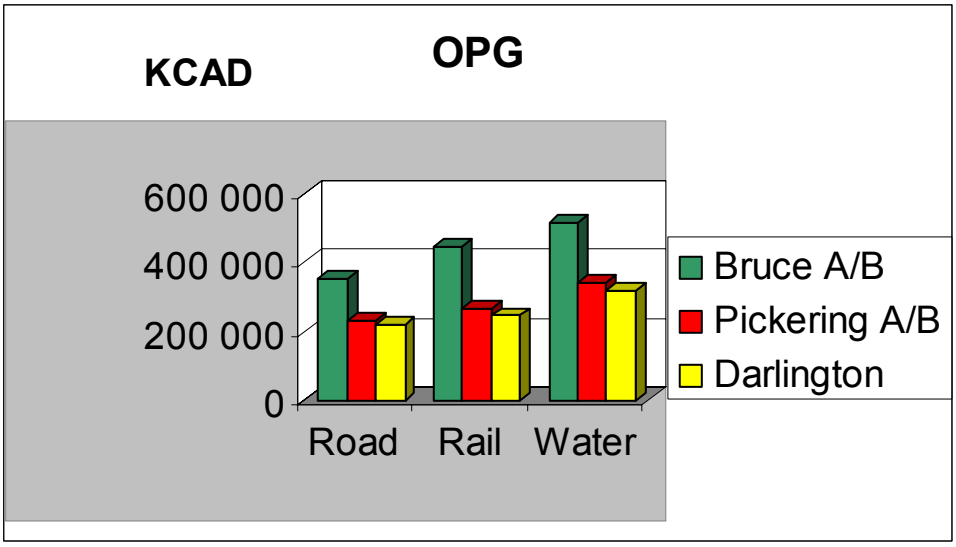
RAIL					
Owner	**Site**	**direct cost**	**common cost to be shared**	**TOTAL Rail cost**	**Number of packages shipped**
		kCAD	kCAD	kCAD	unit
OPG All Road	Bruce A/B	302 185	142 438	**444 623**	4 833
	Pickering A/B	168 173	97 729	**265 902**	3 316
	Darlington	149 998	94 251	**244 249**	3 198
AECL All Road	Whiteshell	135	88	**223**	3
	Douglas Point	15 394	4 067	**19 461**	138
	Chalk River	10 128	884	**11 012**	30
	Gentilly 1	1 520	855	**2 375**	29
HQ All Road	Gentilly 2	38 708	21 750	**60 458**	738
NBP All Road	Point Lepreau	61 804	19 599	**81 403**	665
(1 + 2)	common cost	381 662			
	TOTAL COST	**1 129 707**	kCAD	**1 129 707**	12 950

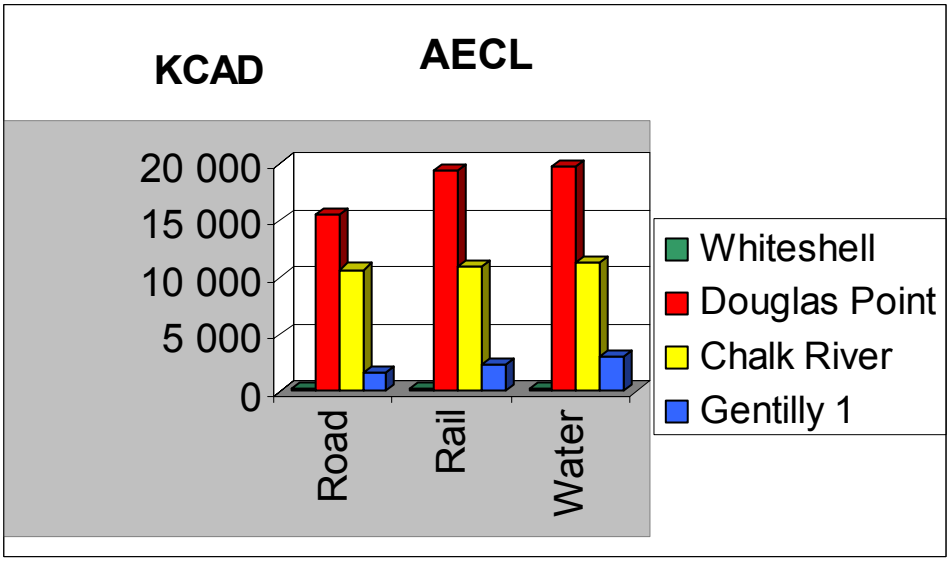
6.6.3 MOSTLY WATER TRANSPORTATION MODE PER OWNER / PER NPP

WATER					
Owner	**Site**	**direct cost**	**common cost to be shared**	**TOTAL Water cost**	**shipments quantity**
		kCAD	kCAD	kCAD	unit
OPG All Road	Bruce A/B	384 561	130 879	**515 440**	4 833
	Pickering A/B	251 549	89 799	**341 347**	3 316
	Darlington	229 954	86 603	**316 557**	3 198
AECL All Road	Whiteshell	168	81	**250**	3
	Douglas Point	16 098	3 737	**19 835**	138
	Chalk River	10 462	812	**11 275**	30
	Gentilly 1	2 359	785	**3 144**	29
HQ All Road	Gentilly 2	59 947	19 985	**79 932**	738
NBP All Road	Point Lepreau	91 435	18 008	**109 444**	665
(1 + 2)	common cost	350 691			
	TOTAL COST	**1 397 224**	kCAD	**1 397 224**	12 950

6.6.4 COST GRAPHS PER TRANSPORTATION MODE / PER OWNER / PER NPP

Per owner who owns several NPPs the results are displayed in the following graphs per transportation mode / per NPP. Only OPG and AECL operate several NPPs.



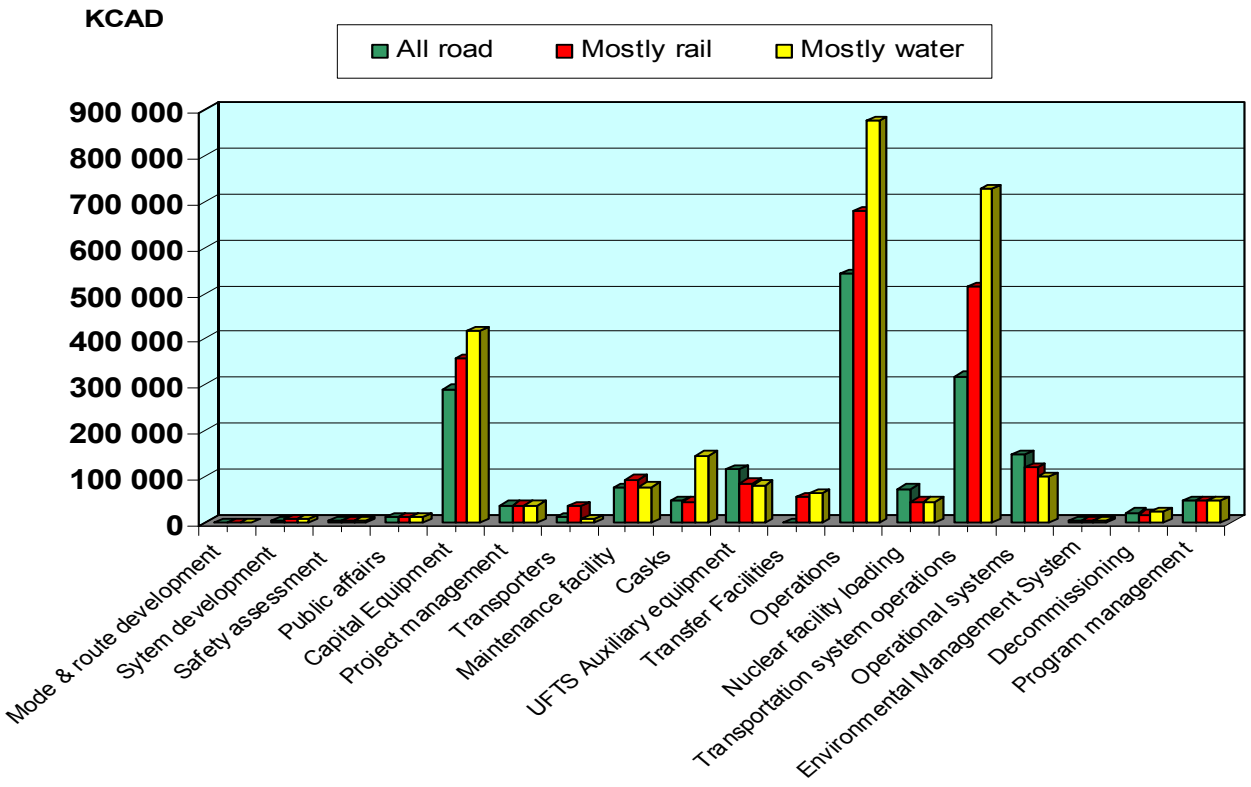


6.7. CAPITAL AND OPERATING COST PER WBS, PER TRANSPORTATION MODE

The capital and operating costs are presented hereunder per transportation mode and per WBS at level 3.

Cost in Kcad per Level 3 WBS		All road	Mostly rail	Mostly water
610.15	**Mode & route development**	505	505	505
610.20	**Sytem development**	3 704	7 408	7 408
610.25	**Safety assessment**	3 852	3 852	3 852
610.35	**Public affairs**	11 718	11 718	11 718
610.40	**Capital Equipment**	**291 914**	**357 525**	**422 083**
610.40.10	Project management	38 061	38 061	38 061
610.40.20	Transporters	12 603	36 092	8 663
610.40.30	Maintenance facility	76 644	94 878	78 171
610.40.40	Casks	48 735	46 044	150 987
610.40.50	UFTS Auxiliary equipment	115 870	86 797	81 587
610.40.60	Transfer Facilities	0	55 653	64 613
610.50	**Operations**	**542 815**	**679 844**	**875 823**
610.50.10	Nuclear facility loading	74 606	46 196	46 196
610.50.20	Transportation system operations	319 809	513 861	728 405
610.50.30	Operational systems	148 401	119 787	101 222
610.55	**Environmental Management System**	4 104	4 104	4 104
610.60	**Decommissioning**	21 958	17 775	24 754
610.90	**Program management**	46 976	46 976	46 976
TOTAL in kCAD		**927 547**	**1 129 707**	**1 397 224**

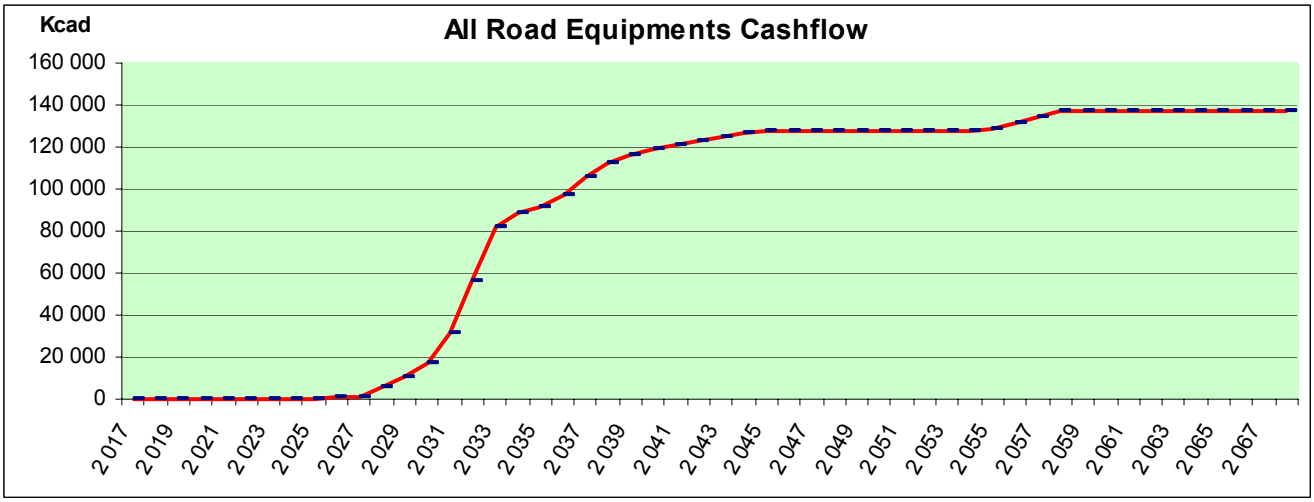
The results obtained in the above table cost per WBS are displayed in the following graph

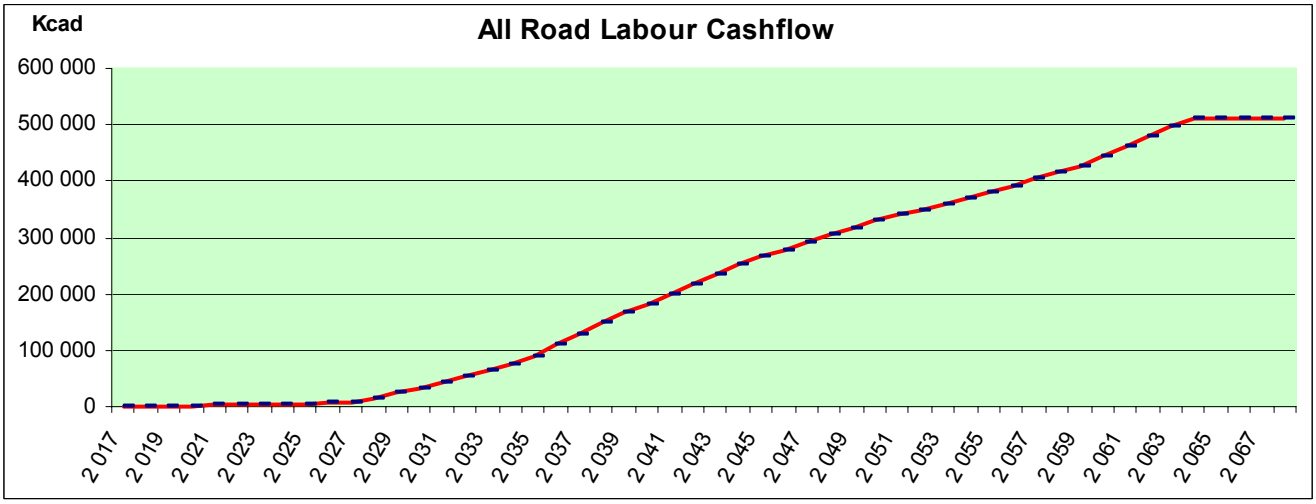


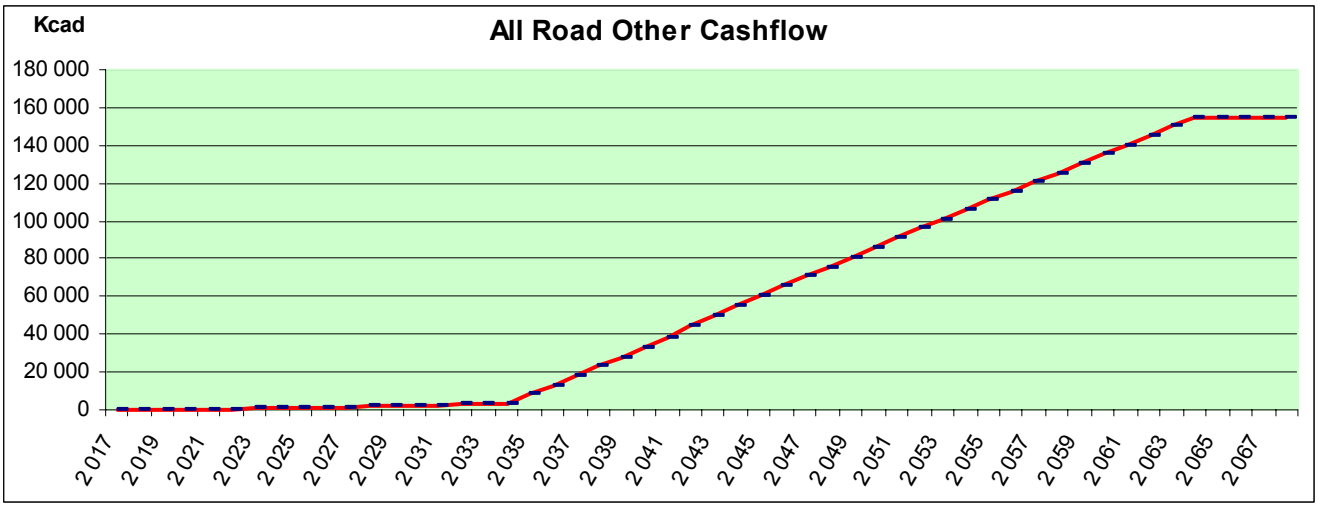
6.8. ANNUAL CASH FLOWS PER TRANSPORTATION MODE, PER COST CATEGORIES

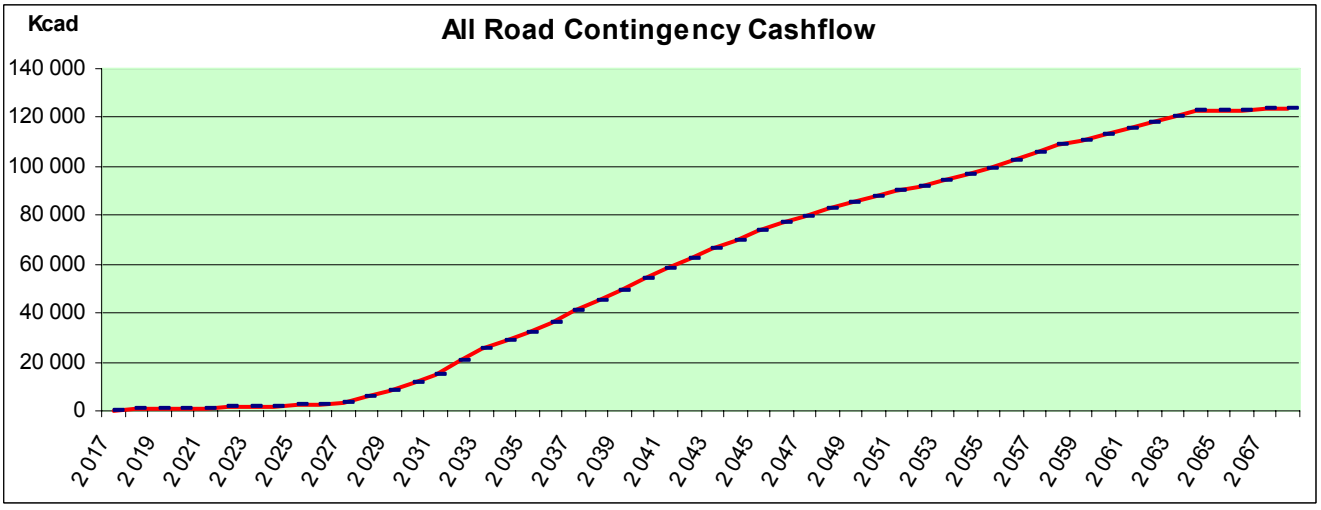
6.8.1 ALL ROAD MODE ANNUAL CASH-FLOWS GRAPHS

The total capital and operation cost is shared in the 4 categories as defined at section 6.3 :
- Equipment and material cost,
- Labour cost,
- Other cost,
- Contingency cost.

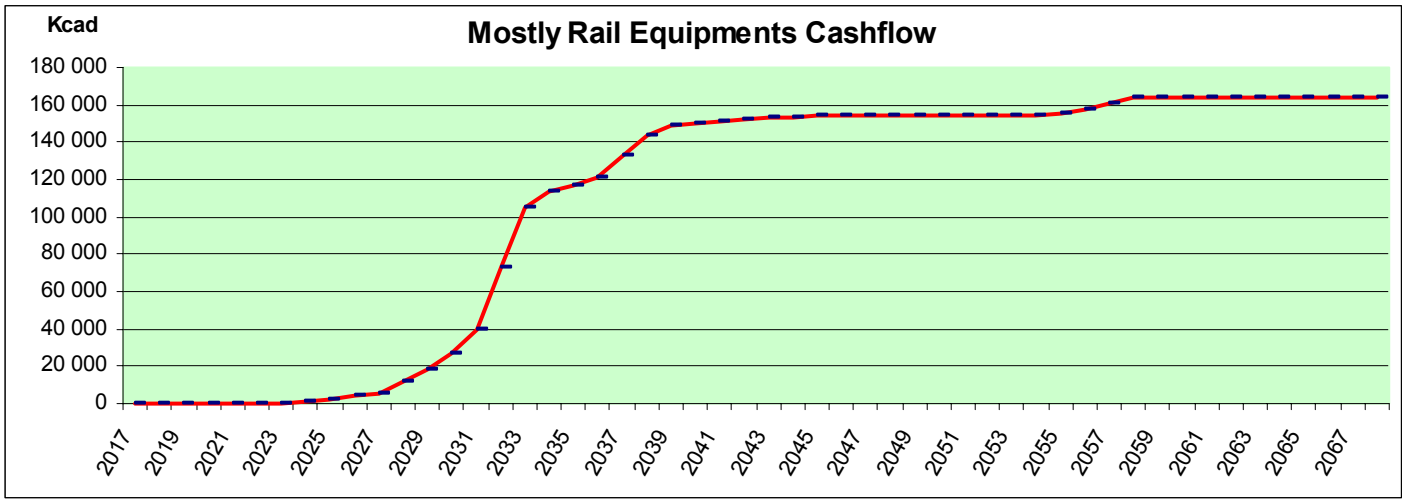


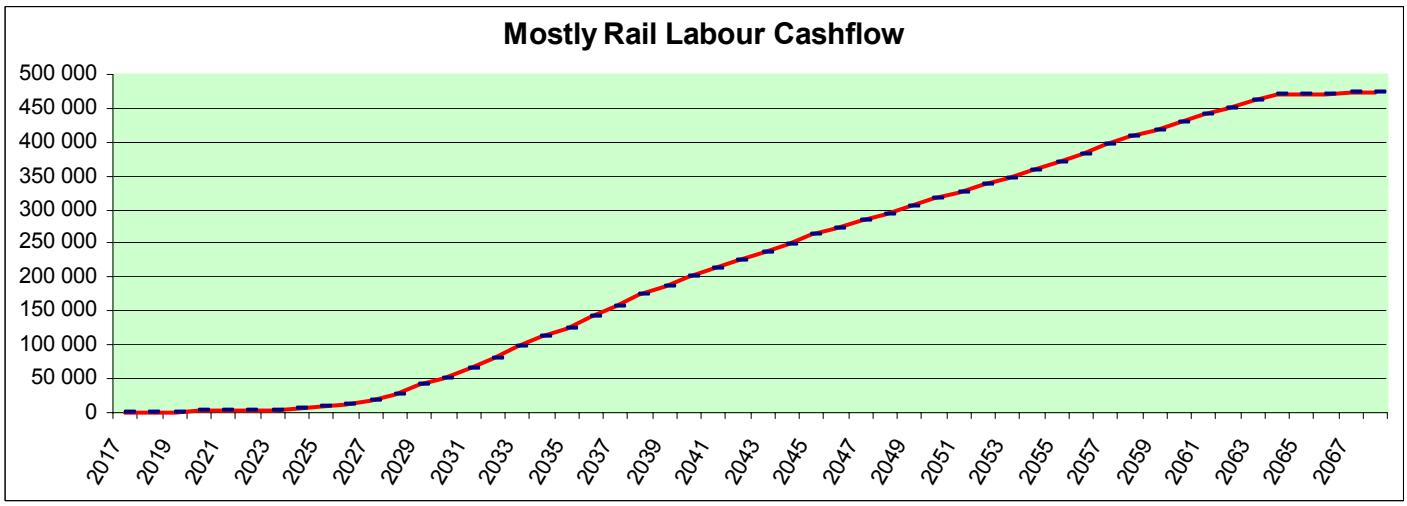


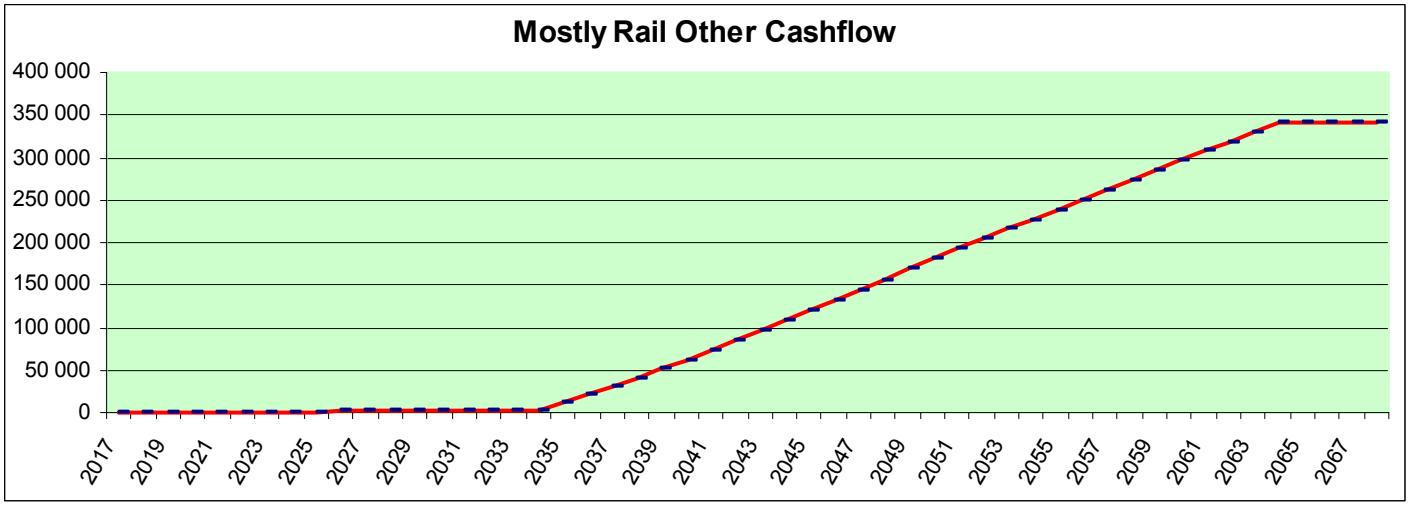

Kcad
All Road Other Cashflow
180 000
160 000
140 000
120 000
100 000
80 000
60 000
40 000
20 000
0
2 017
2 019
2 021
2 023
2 025
2 027
2 029
2 031
2 033
2 035
2 037
2 039
2 041
2 043
2 045
2 047
2 049
2 051
2 053
2 055
2 057
2 059
2 061
2 063
2 065
2 067

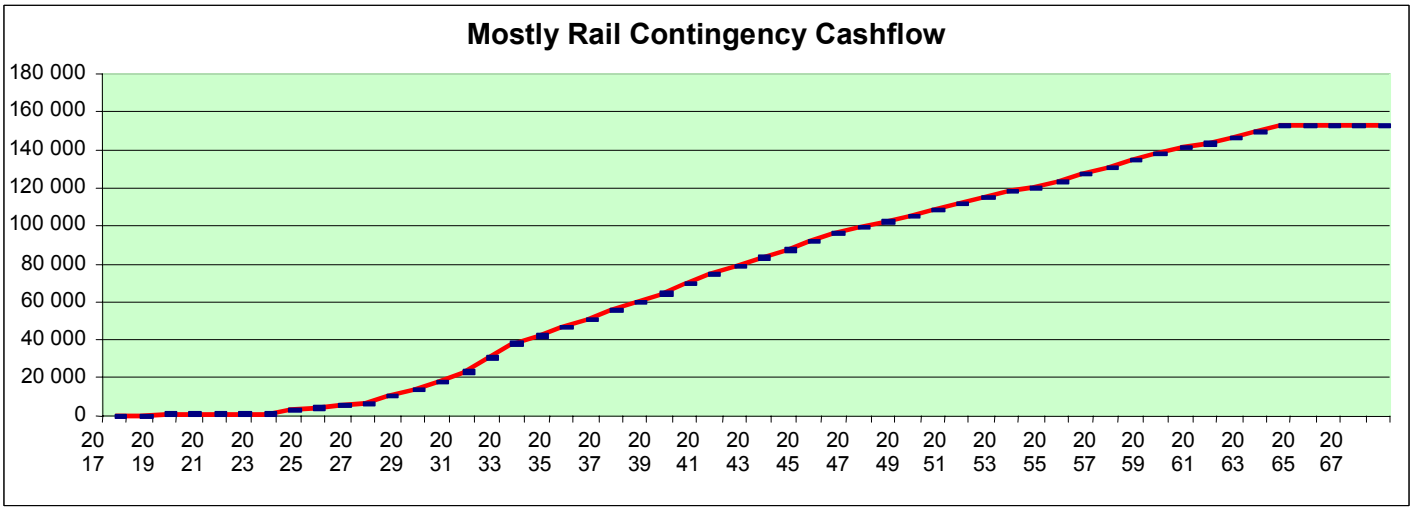

Kcad
All Road Contingency Cashflow
140 000
120 000
100 000
80 000
60 000
40 000
20 000
0
2 017
2 019
2 021
2 023
2 025
2 027
2 029
2 031
2 033
2 035
2 037
2 039
2 041
2 043
2 045
2 047
2 049
2 051
2 053
2 055
2 057
2 059
2 061
2 063
2 065
2 067

6.8.2 MOSTLY RAIL MODE ANNUAL CASH-FLOWS GRAPHS

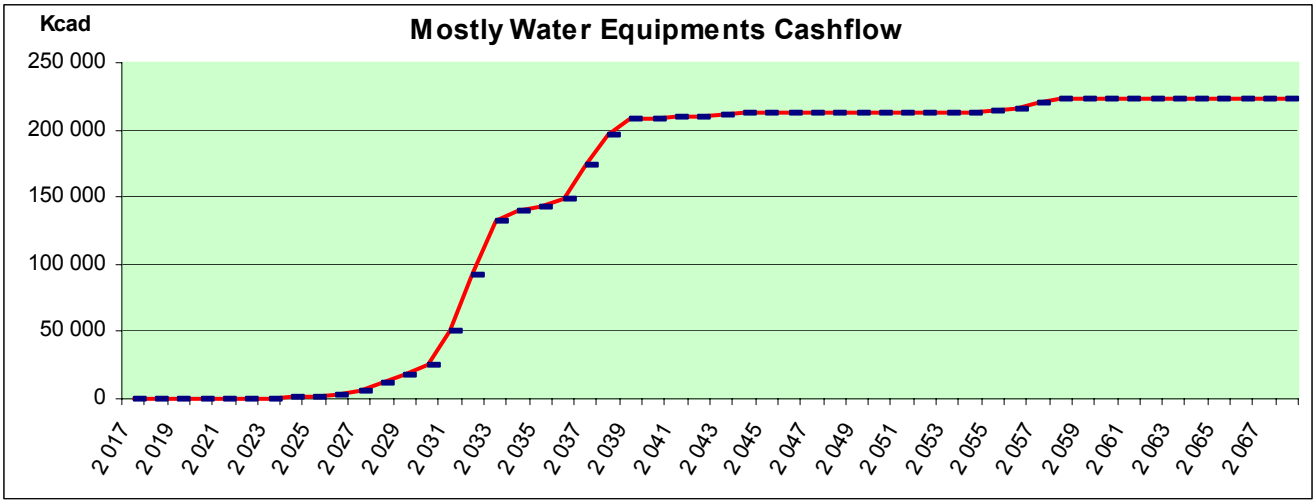


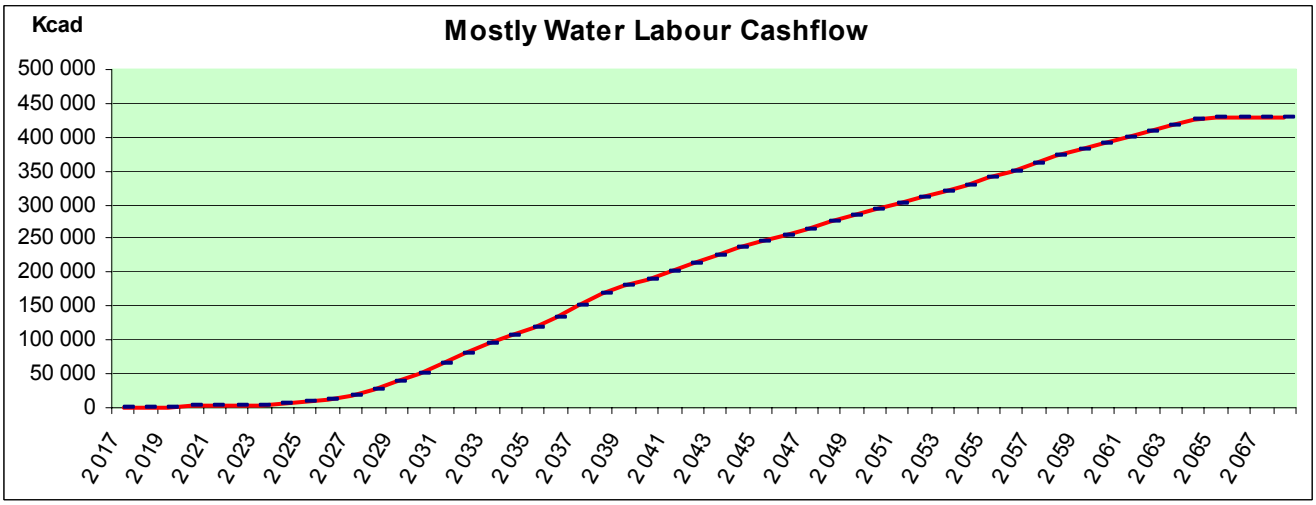


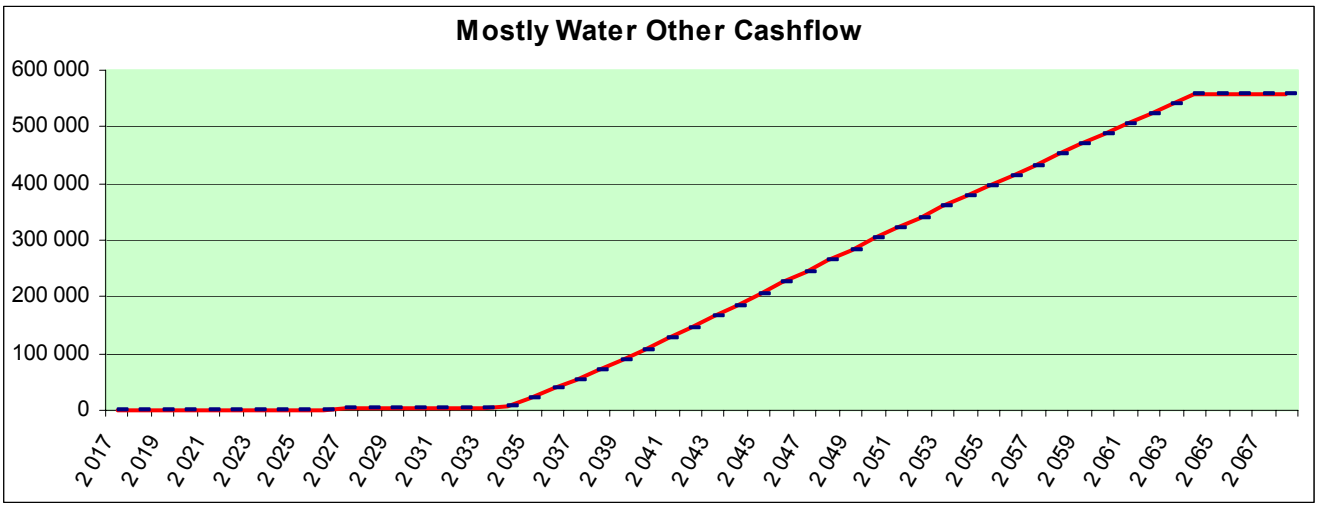

Mostly Rail Other Cashflow
400 000
350 000
300 000
250 000
200 000
150 000
100 000
50 000
0
2017
2019
2021
2023
2025
2027
2029
2031
2033
2035
2037
2039
2041
2043
2045
2047
2049
2051
2053
2055
2057
2059
2061
2063
2065
2067


Mostly Rail Contingency Cashflow
180 000
160 000
140 000
120 000
100 000
80 000
60 000
40 000
20 000
0
2017
2019
2021
2023
2025
2027
2029
2031
2033
2035
2037
2039
2041
2043
2045
2047
2049
2051
2053
2055
2057
2059
2061
2063
2065
2067

6.8.3 MOSTLY WATER MODE ANNUAL CASH-FLOWS GRAPHS






Mostly Water Other Cashflow
600 000
500 000
400 000
300 000
200 000
100 000
0
2 017
2 019
2 021
2 023
2 025
2 027
2 029
2 031
2 033
2 035
2 037
2 039
2 041
2 043
2 045
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2 049
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2 055
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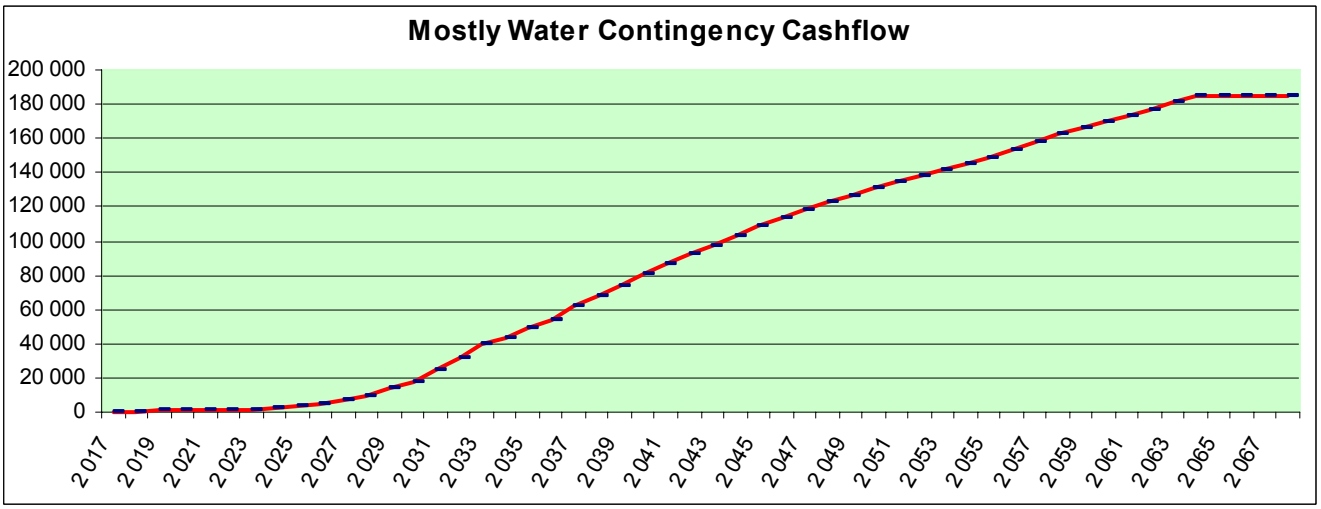
2 061
2 063
2 065
2 067


Mostly Water Contingency Cashflow
200 000
180 000
160 000
140 000
120 000
100 000
80 000
60 000
40 000
20 000
0
2 017
2 019
2 021
2 023
2 025
2 027
2 029
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2 067