APPENDIX A

CALCULATION SHEETS

WINTER OPTION

URS

CALCULATION SHEET

Calc. No. _____

Name	K. Swanson	Date	5/30/02	Checked	KB	Date	5/30/02
Project	Point Thomson Gas Cycling Project			Job No.	74-38877200.00		
Subject	Dredging and Disposal - Winter Option			Sheet	1	of	5

ASSUMPTIONS

Schedule

- Prudhoe to Point Thomson sea ice road construction will start November 15th and be completed by January 15.[b]
- Ice road traffic will be open on February 15.
- Ice road traffic will be closed on April 15.
- Mobilization and demobilization will take approximately 6 days total (144 hours) for North Slope equipment.
- Work will be conducted on a 24-hour per day schedule.
- Dredging operations will be continuous. Spoils could be temporarily stockpiled; however, continuous hauling is planned.

Equipment

- One backhoe will be used to excavate with an additional backhoe retained for contingency.
- 30-cy dump trucks will be utilized.
- Dump trucks are available on the North Slope.[b]
- Dump trucks can dispose of their contents without additional equipment within 5 minutes.
- Spoils excavated with a backhoe will gain about 5% volume from entrainment of additional seawater. Reference states that bucket has 100% efficiency; however, to be conservative, a 5% increase in volume has been assumed (95% efficiency).[e,g]
- The water/ice above the area to be dredged will be thickened and cut with a ditch witch prior to excavation of the ice with a backhoe.[b]
- The ditch witch will cut out the area to be dredged in eight passes with 50 ft between each pass; 8,400 linear feet will be cut.
- Calculations do not include time or materials to manipulate dredge spoils after they are deposited on the ice. It is anticipated that grading spoils within the ocean dumping zone will not result in extending the construction schedule.

Ice roads

- Standard ice road width is 35 ft with a maximum posted speed of 35 mph.[d]
- Ice roads are built at a standard rate of 1 to 2 inches of height per day. Production rates depend primarily on weather conditions and equipment limitations, but a standard assumption is 1 mile/day.[b]
- The sea ice road distance along the shoreline from Endicott to Point Thompson is approximately 42 miles and will be the primary ice road used for ground transportation.[f]
- The longest floating sea ice road that can feasibly be constructed is approximately 20 miles, using the maximum number of available pumper trucks (12).[b]
- Cost for an ice road near the shoreline in shallow water less than 2 ft deep is approximately $30,000 per mile. Ice road maintenance costs are approximately $7,500/day during ocean dredging and disposal activities to keep the road passable and remove snow drifts.[b]
- Costs for a floating ice road constructed on ocean depths ranging from 2 to 6 ft are approximately $100,000/mile, while a road constructed on depths greater than 6 ft are $300,000/mile. Maintenance costs are approximately $7,500/day.[b]

Miscellaneous

- Room and board will be provided by the project to the equipment operators.
- Support services, fuel and personnel will be available within the Point Thomson Unit.
- The existing gravel road distance from Deadhorse to Endicott is approximately 20 miles.
- The ice thickness over the dredge site will be approximately 7.5 feet thick.[h]

URS

CALCULATION SHEET

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Subject	Dredging and Disposal - Winter Option			Sheet	2	of	5

CALCULATIONS

Ice and Dredge Material Quantity

- The area to be dredged is 1,000 ft x 400 x 2 ft and is located in water 7 to 9 ft deep.[f]
- The volume of in situ material to be dredged is 30,000 cy.[f]
- Sea water weighs 0.83 tons/cy (assumed).
- Average fine to medium grained soil weighs 1.5 tons/cy (assumed).

Volume of sediment to be removed in cubic yards:
(30,000 cy) + 10% additional water for entrainment and efficiency (3,000 cy) = 33,000 cy

Volume of ice to be excavated:
(1,000 ft)(400 ft)(6 ft) = 2,400,000 ft^3 = 88,900 cy

Weight of sediment to be removed in tons:
(30,000 cy)(1.5 tons/cy) + (3,000 cy)(0.83 tons/cy) = 47,490 tons

Weight per volume of sediment:
(47,490 tons) / (33,000 cy) = 1.44 tons/cy

Excavating Equipment Specifications

2-cy bucket backhoe:
- Available on the North Slope.[b]
- Production rate is 130 cy/hr.[a]
- Average cost including two operators (one per 12-hr shift) is $4,000 per 24-hr day.[b]

Ditch witch:
- Available on the North Slope.[b]
- Production rate is 350 linear ft/hr.[c]
- Average cost for a ditch witch including an operator is $4 per linear foot.[b]

Duration to complete excavation of sediment, assuming continuous dredging:
(33,000 cy) / (130 cy/hr) = 254 hrs; (254 hrs) / (24 hrs/day) = 11 days

Duration to complete excavation of ice:
Ditch witch: (8,400ft) / (350 ft/hr) =24 hrs; (24 hrs) / (24 hrs/day) = 1 day
Backhoe: (88,900 cy) / (130 cy/hr) = 684 hrs; (684 hrs) / (24 hrs/day) = 29 days

Hauling Equipment Specifications

30-cy dump truck:
- Available on the North Slope.[b]
- Is allowed to travel 35 mph.[d]
- Average cost for a dump truck including an operator is $3,500 per day.[b]

Number of truck loads required:
(33,000 cy)/(30 cy/truck) = 1,100 truck loads

Time to load dump trucks by backhoe:
(30 cy/truck) / (130 cy/hr) = .23 hr/truck (about 14 minutes)

The following costs are a reasonable estimate of the costs associated with basic dredging and hauling operations and are to be used only for comparison between different dredging and hauling options.

ALTERNATIVES

Alternative 1: 2-cy bucket backhoe; Two 30-cy dump trucks; Continuous dredging

Cycle time = (time to load 1 truck) x (available trucks)
(.23 hrs/truck)(2 trucks) = .46 hours
Time available to travel = (cycle time) - (time to load 1 truck) - (time to dump 1 truck)
(.46 hrs)-(.23 hrs)-(.08 hrs) = .15 hours (9 minutes)
Maximum truck travel distance from dredge site = ((available travel time)(truck speed))/2 (roundtrip)
((.15 hrs)(35mph))/2 = **2.63 miles**
Cost to build ice road = (length) x (ice road cost over 6 ft deep) = (2.63 miles) x ($300,000/mile)
= $789,000
Cost per day = (2 backhoes/day) + (2 dump trucks/day) + (ice road maintenance/day) =
($4,000x2) + ($3,500x2) + ($7,500) = $22,500
Duration of operation = (mob/demob) + (excavation) = (6 days) + (11 days) = 17 days
Total cost = (cost to build ice road) + (cost per day x duration) =
($789,000) + ($22,500 x 17 days) = **$1,171,500**

Alternative 2: 2-cy bucket backhoe; Three 30-cy dump trucks; Continuous dredging

Cycle time = (time to load 1 truck) x (available trucks)
(.23 hrs/truck)(3 trucks) = .69 hours
Time available to travel = (cycle time) - (time to load 1 truck) - (time to dump 1 truck)
(.69 hrs)-(.23 hrs)-(.08 hrs) = .38 hours (23 minutes)
Maximum truck travel distance from dredge site = ((available travel time)(truck speed))/2 (roundtrip)
((.38 hrs)(35mph))/2 = **6.7 miles**
Cost to build ice road = (length) x (ice road cost over 6 ft deep) = (6.7 miles) x ($300,000/mile)
= $2,010,000
Cost per day = (2 backhoes/day) + (3 dump trucks/day) + (ice road maintenance/day) =
($4,000x2) + ($3,500x3) + ($7,500) = $26,000
Duration of operation = (mob/demob) + (excavation) = (6 days) + (11 days) = 17 days
Total cost = (cost to build ice road) + (cost per day x duration) =
($2,010,000) + ($26,000 x 17 days) = **$2,452,000**

Alternative 3: 2-cy bucket backhoe; Four 30-cy dump trucks; Continuous dredging

Cycle time = (time to load 1 truck) x (available trucks)
(.23 hrs/truck)(4 trucks) = .92 hours

Time available to travel = (cycle time) - (time to load 1 truck) - (time to dump 1 truck)
(.92 hrs)-(.23 hrs)-(.08 hrs) = .61 hours (37 minutes)

Maximum truck travel distance from dredge site = ((available travel time)(truck speed))/2 (roundtrip)
((.61 hrs)(35mph))/2 = **10.7 miles**

Cost to build ice road = (length) x (ice road cost over 6 ft deep) = (10.7 miles) x ($300,000/mile)
= $3,210,000

Cost per day = (2 backhoes/day) + (4 dump trucks/day) + (ice road maintenance/day) =
($4,000x2) + ($3,500x4) + ($7,500) = $29,500

Duration of operation = (mob/demob) + (excavation) = (6 days) + (11 days) = 17 days

Total cost = (cost to build ice road) + (cost per day x duration) =
($3,210,000) + ($29,500 x 17 days) = **$3,711,500**

Alternative 4: 2-cy bucket backhoe; 4 30-cy dump trucks; Continuous dredging; No floating ice road

Cycle time = (time to load 1 truck) x (available trucks)
(.23 hrs/truck)(4 trucks) = .92 hours

Time available to travel = (cycle time) - (time to load 1 truck) - (time to dump 1 truck)
(.92 hrs)-(.23 hrs)-(.08 hrs) = .61 hours (37 minutes)

Maximum truck travel distance from dredge site = ((available travel time)(truck speed))/2 (roundtrip)
((.61 hrs)(35mph))/2 = **10.7 miles**

Cost per day = (2 backhoes/day) + (4 dump trucks/day) =
($4,000x2) + ($3,500x4) = $22,000

Duration of operation = (mob/demob) + (excavation) = (6 days) + (11 days) = 17 days

Total cost = (cost per day)(duration) =
($22,000)(17) = **$374,000**

FOOTNOTES

References

a. 2001 R.S. Means. *Heavy Construction Cost Data*. 15th Addition. Construction Publishers and Consultants. 2000.

b. AIC, Anchorage. Phone call from Ms. Kristina Swanson (URS) to Mr. Ken Yokey (AIC) on May 21, 2002.

c. AIC, Anchorage. Phone call from Ms. Kristina Swanson (URS) to Mr. Ken Yokey (AIC) on May 30, 2002.

d. AIC, Deadhorse. Phone call from Ms. Kristina Swanson (URS) to Mr. Jim Workman (AIC) on May 20, 2002.

e. General Construction, Seattle. Phone call from Ms. Kristina Swanson (URS) to Mr. Ron McCray (General) on May 29, 2002.

f. URS, Anchorage. *Point Thomson Gas Cycling Project Environmental Report*. July 30, 2001.

g. U.S. Army Corps of Engineers. *Dredging and Dredged Material Disposal*. March 25, 1983.

h. MMS 1996

SUMMER OPTION

URS

CALCULATION SHEET

Calc. No. _____

Name	K. Swanson	Date	5/30/02	Checked	KB	Date	5/30/02
Project	Point Thomson Gas Cycling Project			Job No.	74-38877200.00		
Subject	Dredging and Disposal - Summer Option			Sheet	1	of	4

ASSUMPTIONS

Schedule

- Due to sea ice, Point Barrow is not open for marine traffic until August 1.
- Due to sea ice, marine traffic from West Dock to Point Thomson Unit is not open until July 15 at the earliest and July 25 at the latest.
- Due to fall whaling activities, marine traffic from West Dock to Point Thomson Unit is closed on August 31.
- Sealifts will arrive at Point Thomson on August 10.
- Summer dredging activities and the transportation of Point Thomson modules will happen within the same season.
- Mobilization and demobilization will take approximately 6 days total (144 hours) for North Slope equipment.
- Work will be conducted on a 24-hour per day schedule.
- Dredging operations will be continuous and spoils will not be stockpiled; therefore, barges have to keep up with dredging.

Equipment

- Due to North Slope availability, no more than 2 self-propelled barges would be available for use at one time.[c]
- Barges are already equipped to contain dredge spoils and can dump their load without additional equipment within 60 minutes.
- One dredge will be used to excavate and an additional dredge (either backhoes or cutter-head suction dredges) retained contingency.
- Spoils excavated with a backhoe will gain about 5% volume from entrainment of additional seawater. Reference states that bucket has 100% efficiency; however, to be conservative, an additional 5% increase in volume has been assumed (95% efficiency).[d,f]
- Spoils excavated with a cutter-head suction dredge will gain approximately 650% volume from seawater (approximately 15% efficiency).[b,f]

Miscellaneous

- Room and board will be provided by project to the equipment operators.
- Support services and personnel will be available within the Point Thomson Unit.

URS

CALCULATION SHEET

Calc. No.

Name	K. Swanson	Date	5/30/02	Checked	KB	Date	5/30/02
Project	Point Thomson Gas Cycling Project			Job No.	74-38877200.00		
Subject	Dredging and Disposal - Summer Option			Sheet	2	of	4

CALCULATIONS

Dredge Material Quantity

- The area to be dredged is 1,000 ft x 400 x 2 ft and is located in water 7 to 9 ft deep.[e]
- The volume of in situ material to be dredged is 30,000 cy.[e]
- Sea water weighs 0.83 tons/cy (assumed).
- Average fine to medium grained soil weighs 1.5 tons/cy (assumed).

Volume of material to be removed in cubic yards:

Cutter-head suction dredge = (30,000 cy) + 650% entrained sea water (195,000 cy) = 225,000 cy
Backhoe = (30,000 cy) + 10% additional water for entrainment and efficiency (3,000 cy) = 33,000 cy

Weight of material to be removed in tons:

Cutter-head suction dredge = (30,000 cy)(1.5 tons/cy) + (195,000 cy)(0.83 tons/cy) = 206,850 tons
Backhoe = (30,000 cy)(1.5 tons/cy) + (3,000 cy)(0.83 tons/cy) = 47,490 tons

Weight per volume per dredging method:

Cutter-head suction dredge = (206,850 tons) / (225,000 cy) = 0.92 tons/cy
Backhoe = (47,490 tons) / (33,000 cy) = 1.44 tons/cy

Excavating Equipment Specifications

Cutter-head suction dredge:

- Available on the North Slope.[b]
- Production rate is 65 cy/hr.[b,f]
- Average cost including an operator is $1,000 per 24-hr day.[b]

2-cy bucket backhoe:

- Available on the North Slope.[b]
- Production rate is 130 cy/hr.[a]
- Average cost including an operator is $4,000 per 24-hr day.[b]

Duration to complete excavation, assuming continuous dredging:

Cutter head suction dredge:(225,000 cy)/(65 cy/hr) = 3,462 hrs; (3,462 hrs)/(24 hrs/day) = 144 days
2 cy bucket backhoe: (33,000 cy) / (130 cy/hr) = 254 hrs; (254 hrs) / (24 hrs/day) = 11 days

Hauling Equipment Specifications

Self-propelled hopper barge:

- Available on the North Slope.[c]
- Travels at an average speed of 7 mph.[c]
- Requires approxiately 8 ft of draft water depth to navigate when fully loaded.[c]
- Can travel 300 miles on one fuel tank.[c]
- Average capacity of 400 tons.[c]
- Average cost including an operator is $15,000 per 24-hr day.[c]

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CALCULATION SHEET

Calc. No. _____

Name K. Swanson Date 5/30/02 Checked KB Date 5/30/02

Project Point Thomson Gas Cycling Project Job No. 74-38877200.00

Subject Dredging and Disposal - Summer Option Sheet 3 of 4

Hauling Equipment Specifications Cont'd

Number of barge loads required:

- Self-propelled barge with cutter-head suction dredge = (206,850 tons) / (400 tons/barge) = 517 barge loads
- Self-propelled barge with 2 cy bucket backhoe = (47,490 tons) / (400 tons/barge) = 119 barge loads

Time to load barges:

Self-propelled barge with cutter-head suction dredge = (65 cy/hr)(0.92 tons/cy) = 60 tons/hr; (400 tons/barge) / (60 tons/hr) = 7 hrs/barge

Self-propelled barge with 2 cy bucket backhoe = (130 cy/hr)(1.44 tons/cy) = 187 tons/hr; (400 tons/barge) / (187 tons/hr) = 2.1 hrs/barge

The following costs are a reasonable estimate of the costs associated with basic dredging and hauling operations and are to be used only for comparison between different dredging and hauling options.

ALTERNATIVES

Alternative 1: 2 cy bucket backhoe; self-propelled barge; continuous dredging and loading

Cycle time = (time to load 1 barge) x (available barges)
(2.1 hrs/barge)(2 barges) = 4.2 hours

Time available to travel = (cycle time) - (time to load 1 barge) - (time to dump 1 barge)
(4.2 hrs)-(2.2 hrs)-(1 hr) = 1hour

Maximum barge travel distance from dredge site = ((available travel time)(barge speed))/2 (roundtrip)
((1hr)(7 mph))/2 = **3.5 miles**

Cost per day = (2 backhoes/day) + (2 barges/day) = ($4,000x2) + ($15,000x2) = $38,000

Duration of operation = (mob/demob) + (excavation) = (6 days) + (11 days) = 17 days

Total cost = (cost per day) x (duration) = ($38,000) x (17 days) = **$646,000**

Alternative 2: Cutterhead-suction-dredge; self-propelled barge; continuous dredging and loading

Cycle time = (time to load 1 barge) x (available barges)
(7 hrs/barge)(2 barges) = 14 hours

Time available to travel = (cycle time) - (time to load 1 barge) - (time to dump 1 barge)
(14 hrs)-(7 hrs)-(1 hr) = 6 hours

Maximum barge travel distance from dredge site = ((available travel time)(barge speed))/2 (roundtrip)
((6 hrs)(7mph))/2 = **21 miles**

Cost per day = (2 dredges/day) + (2 barges/day) = ($1,000x2) + ($15,000x2) = $32,000

Duration of operation = (mob/demob) + (excavation) = (6 days) + (144 days) = 150 days

Total cost = (cost per day) x (duration) = ($32,000) x (150 days) = **$4,800,000**

Alternative 3 : Cutterhead-suction-dredge; side-casting; continuous dredging and loading

Cost per day = (2 dredges/day) = $1,000x2 = $2,000

Duration of operation = (mob/demob) + (excavation) = (6 days) + (144 days) = 150 days

Total cost = (cost per day) x (duration) = ($2,000) x (150 days) = **$300,000**

URS

CALCULATION SHEET

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Project	Point Thomson Gas Cycling Project			Job No.	74-38877200.00		
Subject	Dredging and Disposal - Summer Option			Sheet	4	of	4

FOOTNOTES

References

a. 2001 R.S. Means. *Heavy Construction Cost Data*. 15th Addition. Construction Publishers and Consultants. 2000.

b. AIC, Anchorage. Phone call from Ms. Kristina Swanson (URS) to Mr. Ken Yokey (AIC) on May 21, 2002.

c. Agviq Marine, Deadhorse. Phone call from Ms. Kristina Swanson (URS) to T.J. Borden (Agviq) on May 20, 2002.

d. General Construction, Seattle. Phone call from Ms. Kristina Swanson (URS) to Mr. Ron McCray (General) on May 29, 2002.

e. URS, Anchorage. *Point Thomson Gas Cycling Project Environmental Report*. July 30, 2001.

f. U.S. Army Corps of Engineers. *Dredging and Dredged Material Disposal*. March 25, 1983.