The Medusa Bag and Middle East Water Projects

A description of the medusa bag will be found later in this paper.

Eastern Mediterranean - Israel

The transport of 250 - 400 million cubic meters per year (MCMy) of freshwater from the mouth of the Manavgat River in southern Turkey to Ashquelon in southern Israel (400 miles/600 km) was the subject of a preliminary feasibility study, August to October 1989, by Tahal, the Israeli State engineering company. This study assumed the medusa bags would perform as predicted and, having in mind storms, collisions and machinery breakdown, estimated an 80% service factor. On the basis of a $20/Bbl crude oil price and a 7 1/2% interest rate, a cost of around 20 cents/CM was estimated for the first 250 MCMy and 10 cents/CM for additional volumes.

Six bags of about 1.5 MCM capacity each would be used with six tugs in a circuit of about 12 days: 1 bag filling for two days, 3 bags loaded in transit for six days at about 2 knots, 1 bag emptying for two days and one bag returning empty in two days. The bags and tugs would cost about $6 million each and total project investment was about $300 million. It was assumed that operations would continue all months of the year and that the bags would have a life of 7 years, the tugs 15 years and the civil works 30 years. At the Manavgat, water could be taken from a hydro-electric dam 12 km from the coast with sufficient head to reach the loading buoy 2 km offshore by submarine pipe without need for a pump station. At Ashquelon a 3 km submarine pipe would be required but the pump station could still be located on shore with a 16 km connector into the National Water Carrier.

The 15 - 20 cent/CM price did not include a royalty to the Turkish government. Since the ultimate beneficiary of the water is agriculture, and since agriculture cannot afford to pay much more than 10 cents/CM and since there will be delivery cost, there is no room for a high royalty. Noting that Indonesia has recently agreed to sell water to Singapore at one half cent per CM, Turkey should look for a similar price and seek to get the main economic benefit out of the project as construction and operating revenues. Otherwise there will be no demand for their water.

The sequence of events required to put this project in effect were:

1. a statement of intentions by governments to supply and purchase
2. further development and prototyping of Medusa technology (100,000t bag/8 mos.)
3. commencement of a pilot project (500,000t bags/1 yr.)
4. performance of a complete design and feasibility study
5. securing of finance
6. construction (2 yrs.)

for a total of about 5 years. No progress has been made down this sequence and Israel has switched its development interests to the desalination area.

Other E. Mediterranean Projects

As we move away from this project, the quality of our cost estimates deteriorates. Nonetheless we can do some interesting speculation.

The Manavgat river has an average flow of 140 CMS. The Turkish government has suggested that some 60 CMS of this might be available for export. Since 8 CMS supplies 250 MCMy, this amounts to 1875 MCMy of total projects. In comparison, the Great Pipeline proposal is for 2,200 MCMy. The Manavgat volumes could be allocated as follows:

	MCMy	Capital Cost $ Millions
Turkey	-	125
Cyprus, Malta, Greek Islands, etc.	125	100
Haifa Bay, (Israel 250, Jordan 250)	500	300
Ashkelon (Israel 250, Gaza 100, Egypt 150)	500	400
El Arish East (Egypt)	400	250
El Arish West (Egypt)	350	250
TOTAL	1,875	$1,500

Haifa Bay

East of Haifa there is a valley which rises to about 75m altitude in the first 20 km where National Water Carrier crosses, and then runs downhill a further 40 km to the Jordan River. The Israeli water could join the NWC and head south at this point, except for some which could supply the area north of Haifa.

The 250 MCMy for Jordan could enter a newly built conduit system heading east and down to the East Ghor canal the other side of the Jordan River. This would roughly double the landed price of the water from say 13 cents/CM to about 26 when it enters Jordan. We would also have the spectacle of more than 250 MCMy of Israeli water flowing from Galilee towards Haifa while the Jordanian water flowed in the opposite direction.

It would make economic sense to have Galilee water flow to Jordan in exchange for Jordan's water delivered to Israel at Haifa. Since the direct cost of lifting water out of Galilee is about 15 cents, the savings <u>could</u> be used to pay for Jordan's water at Haifa, i.e., water could be delivered to Jordan out of Galilee for nothing and Israel would still get its 250 MCMy at a reasonable cost because of the large size of the project. The Israelis could have reservations about this proposal on the repercussions from an interruption.

Ashkelon

The Israeli 250 MCMy could enter the National Water Carrier as previously proposed. A new conduit would be needed running south through Gaza (where 100 MCMy could be delivered, and into Egypt where 150 MCMy would form the most easterly part of the "El Arish Project".

El Arish E + W

Two terminals could be located 20 km east and west of El Arish. Together with the Ashkelon water there would be a total of 900 MCMy for the Egyptian Sinai. Reserving 50 - 75 MCMy for human consumption there would be enough water to irrigate 1000 km2 or 100,000 hectares in a strip along the coast 65 km long and 15 km deep. The domestic water allowance could support a population of about 400,000, many of whom should be Europeans living in recreational or retirement developments along the coast. It is possible that careful development of the coast could earn back the investment in the Medusa and irrigation distribution systems so that the cost of water to the farmers could be much less than the 15 cent/CM landed cost.

Note that the northwest Sinai could absorb another 5,000 MCMy irrigation water. Egypt is constructing a conduit system east form the Suez Canal. The Seyhan and the Ceyhan are rated at about 180 CMS each but highly seasonal. If the Great Peace Pipeline project were to be abandoned, it is possible that 5,000 MCMy of Medusa projects could be developed for the Sinai from those rivers together. The cost would be roughly $4 billion plus more for irrigation infrastructure. The El Arish project mentioned here would be the best single project because of short terrestrial distances and potential for real estate development.

Summary

The Medusa technology permits freshwater to be transported in large quantities at sea at low cost. Such costs are roughly 4 - 6 cents/CM per terminal plus 1 cent/CM per 100 km of voyage. These costs include all operating costs plus service of capital. Over the 500 - 700 km distances in the E Mediterranean, these permit landed costs in the range 15 - 20 cents/CM, depending on the size of the project. It is much cheaper to move water in medusa bags than by terrestrial conduits, so that optimum development will see a series of landing terminals along the coast. To move water inland would be expensive unless an exchange can be arranged.

Turkey has attractive water resources and stands to gain substantially from the process of implementing Medusa projects. Both Israel and Jordan have expressed reservations about putting Turkey into a position of power as a water exporter. It is vital that Turkey overcome this concern by statements and acts, for example, by proceeding with a first project. Much the largest potential consumer is the Egyptian Sinai, but cost could be a problem after the El Arish area has been developed.

Similar projects are also possible in the Arabian Gulf based on water from Iran or Pakistan.

The Medusa Bag - Description

Material

Bags have a flat bottom and top joined around the edge (the "equator"). The top view (plan) is streamlined (see fig. 1). Other shapes are possible including drop shaped. Technically the bag is a streamlined pillow tank and not a body of revolution.

The base fabric is woven nylon coated on both sides with a flexible, waterproof coating such as plasticized PVC. The inside coating should be approved for holding potable water. Such fabric is available commercially in large quantities for use as pond and canal liner. The tensile strength of the base fabric will depend on the size of the bag, but will lie in the range of 300 - 500 lbs per inch (kg per 5cm). Fabric of this weight can be field welded by heat or solvent into very large areas (many acres).

Attached to the base fabric is a strapping system comprised of heavy nylon webbing. The pattern of this strapping is shown in fig. 1. The purpose of the strapping is threefold: (i) to stop propagating rips, (ii) to carry at least 80% of the hydrostatic forces, thus permitting the base fabric to be sufficiently light weight to be field weldable, (iii) to provide a strong point of attachment for the tow cable (fig. 2) or mooring cable (could be many points for mooring cables).

The combined base fabric and strapping (referred to as the compound fabric) will normally be denser than water so that empty bags will tend to sink. This may prove to be acceptable but if not the density must be reduced by providing foam or low profile multiple air chambers. The nose of the bag is always air filled. The empty bag is towed on the surface where it collapses like a handkerchief into a long, narrow configuration of low drag.

Filled shape

An empty bag on the surface would look like fig. 1 and be completely flat; the top and bottom touching with no air inside. There is normally never any air inside, even when filled with water, though a small amount may get in and is of no consequence. As freshwater enters the bag, the bottom descends as a plane and the top rises very slightly above the sea level. For instance, if the draft of the bag is 70ft (21m), typical of large bags, the top surface of the bag will be 1 3/4 ft (.5m) above sea level.

This head of 1 3/4 ft (.5m) pressurizes the inside of the bag in an unusual way. The pressure at the top and bottom of the bag is zero and .76 psi (5.2 kPa or .05 bar) at the water line with a linear change in between. The resulting shape of the edge of the bag is shown in fig. 3. The waterline pressure varies with the draft.

The outward pressure in all directions around the bag puts the compound fabric into tension which varies with the square of the draft. For the 70 ft draft example, the tension - equal in most parts of the bag - would be 150 lbs per inch (kg per 5cm). The compound fabric design strength must be strong enough to handle such tension with a good safety factor, for example, ten times. Such tension makes the fabric rigid and one would have no difficulty in walking or driving small vehicles over the flat top surface of the bag.

Nonetheless the bag is flexible and ocean waves will pass from the salt water into the freshwater and out the other side with almost no effect. The only effect of large waves is small stretching of the compound fabric to the extent of a few percent. Since nylon has a working elasticity of over 10%, the use of nylon means that no damage is done by the passage of the largest storm waves. This issue has been the subject of careful study in the wave basin of the National Research Council, Ottawa.

The bag is capable of this flexibility since it is far from tightly filled with freshwater. Typically the cargo would have a volume only 40% of what might be contained if the bag were fully extended.

Since a fluid is contained within an elastic membrane, it is possible to set up oscillations in the bag due to the passage of regularly spaced waves. However for large bags it has been established that the primary harmonic is very much longer (100 secs.) than large waves (11 - 13 secs.) which in any case are not regular during a storm, so dangerous harmonic oscillations are not possible in practice.

The internal pressure is sufficient to hold the bag extended in its design shape against the pressure of the ocean generated by towing. It will show a modest overall curvature ("banana action") when towed off-axis or when moored bow and stern in a beam sea.

<u>Filling and Emptying</u>

There are apertures on both sides at the bow. These apertures are closed by air-inflated membranes when the bag is in transit, full or empty.

The bow of the bag is rigid so that it can be properly handled even when the bag is empty and limp. The precise nature of the reinforcement will be decided by further research.

The bow mates with a unit called the "docker" for filling or emptying. The docker surrounds the bow and locks onto the towing ring. It has apertures of the same shape as the bag that line up with the bag's apertures when the bag is docked. At that time the docker expands an inflatable cuff surrounding the apertures thus sealing them off from ocean water (the bow and docker are at the water line and half under water when the valving air is released, they sink slightly below water level, encouraging the emptying process.)

The docker has a large flexible hose entering it from below. This hose ("the riser") is connected to an ocean floor, submarine pipeline coming out from shore to the appropriate depth (e.g. 100 feet/30m) for mooring the bag. While the hose is flexible, it will not collapse from a small negative pressure. The docker also has air-inflated valves. When the docker is locked onto the bow with its cuffs inflated and its valves and the bag's valves are open, there is a complete hydraulic passage from a pump station on shore to the inside of the bag.

At the end of the submarine pipeline there is also a large single-point mooring buoy capable of holding the loaded bag. The docker is right beside the buoy and controlled by it but not physically part of the buoy. The buoy is manned and contains a winch capable of winching the buoy to the bag with the mooring line. The mooring line passes through the docker and the docker can move itself along the mooring line to mate the bag. Compressed air supply and electrical control lines originating in the buoy pass down to the ocean floor and are attached to the flexible hose and so access the docker.

The hydraulics of filling are very straightforward. The source of water on shore is either a pump station of several thousand horsepower taking water from an adjacent river mouth via Rainey Collectors (wells drilled into the river gravel) or it is a pipeline from an elevated river or lake with sufficient head to serve the submarine pipeline. In a fjord situation such as Alaska, where bags may approach close to shore and elevated water is common, a short floating pipeline may be acceptable. The bag can accept water at the system design rate from the beginning until it is full. The design rate for filling can be higher than for emptying. Fullness is determined by the draft of the bag which can be reported by transponder.

Emptying is more tricky. It is believed possible to locate the pump station on shore (typically 2 - 3km from the buoy) and to move the water through the submarine pipe by suction. The shoreward end of the submarine pipe might have to be buried 5 m or more below sea level to permit this. If this is not practical then a large volume, low head pump will have to be located on the buoy. So long as there are several feet of water in the bag, it will present itself at the aperture (at the water line) as a result of gravity flow due to the lower density of sea water. At some pint of emptying, insufficient water will arrive at the aperture. The drawing rate must be reduced and the potential for suction and the collapse of the bag near the bow increases.

To prevent suction-induced collapse of the bag and consequent blockage of the apertures, it is proposed that the bag be given some limited structure that will be able to resist the modest suction forces applied and to transmit suction pressures into the back half of the bag thus permitting complete emptying to occur over a period of several hours. The precise nature of this structure is confidential for the moment pending patent filings, but it is a neat and practical solution.

Operations

For a particular application, the size of the bag, the power and hence bollard pull of the tug the velocity of tow and the number of bags is set by mathematical optimization. For large projects, shallow drafts (less than 80ft/24m) are favoured because the cost of the compound fabric varies as the square of the draft, and slow speeds (around 2 knots or 1m/s) are favoured because drag varies as the square of velocity.

Typically 6 - 12 bags and tugs will be required: one bag filling, several full bags in tow, one bag emptying and a few bags returning empty. This circuit continues throughout the year. The optimization assumes a 7 1/2 year life for the bags, 15 years for the tugs and 30 years for the civil engineering, all of which are likely low.

The optimization assumes that tugs will be new built to order but obviously existing tugs could be used if cheaper. Typical tug size is 5000Hp with a bollard pull of about 50 short tons; this is very conventional. Typical crew is 6 or 7 people. Ideally the tugs should have low rpm engines (100 rpm vs 1000 rpm commonly seen) because of their high reliability and low fuel and maintenance costs.

The drag properties of the bags have been studied in tow tank tests in B.C. Research, Vancouver. There are three components of drag:

(i) skin friction - can be calculated
(ii) form drag due to wake - coefficient measured
(iii) wave drag - ignored because velocity so low

The drag of different sized bags at different velocities can thus be estimated for optimization purposes.

At very low velocities the bags are stable in tow (do not "fishtail"), at high velocity they are definitely unstable. Experience suggests that big bags will be stable at two knots but this issue has not been completely explored. If fishtailing is likely, there are several corrective actions that can be taken.

As previously mentioned, the bags will not be affected by storm waves. It is possible that towing may be affected and also docking. In operational studies it is assumed that the attained level of service will be, say, 90% of the theoretical maximum. This includes an allowance for repairing bags that have suffered from collisions.

Since the bags are very low in the water and very long, they will be more subject to collisions than most tows. Radar reflectors, balloons, flags, etc., can be put on the bags.

Further Development

The largest bag built to date was 320ft (100m) long, 5000 cubic meters (cm) displacement (4 acre-feet). It is proposed to next build a 100,000 tonne (cm) 900ft (275m) long prototype at a cost of about $400,000. Deployment, testing and demonstrating of this bag will cost as much again.

Before the 100,000t bag is built, additional testing of the compound fabric will be required. Also proving of the rigid bow/docker/buoy loading and unloading system. Cost also about $400,000.

Altogether the next phase of development and demonstration has a budget of about $1.5 million and will require about 9 months. A significant part of this funding can be obtained as grants from interested governments and contributions in kind from potential strategic partners.

Following this, it would be ideal to start a small scale commercial pilot project and, at the same time, carry out a full feasibility study of a large project.

Participating in the development work to date were Professor Michael Isaacson, Civil Engineering (hydraulics), University of British Columbia and Dr. Frank Ko, Director, Fibrous Materials Research Institute, Drexel University, Philadelphia. The technology has been reviewed and declared promising by a number of commercial enterprises including: Avon Rubber (U.K.), Alexandra Towing (U.K.) Crowley Maritime (U.S.), Enka Fibers (Akso, Germany), Seaman Corp. (U.S.), etc., and by a number of professional authorities including Prof. Ray Thompson, Dean of Marine Engineering, University of Newcastle-upon-Tyne and President of the Institute of Marine Engineers, (U.K.), Mr. Christopher Savage, senior water engineer with Nippon Koei Engineering (Japan) and Mr. Glenn Tarbox, Vice-President Water Resources, Bechtel Corporation (U.S.).

While further development is required, we have no doubt about the technical success of the medusa bags in service.

Competition

The cost of moving water in medusa bags depends on the volume, distance and cost of terminals. Over four hundred miles with a volume of 250 MCMy (million cubic meters per year) delivered to one point, a cost of 15 - 20 cents per CM could be expected including service of capital at 7% p.a. Additional water would cost only 10 cents/CM. If there were additional points of delivery, the cost would go up somewhat. The cost of transport, i.e., the tug and the bag including service of capital but excluding terminals, is about 1.5 cents/CM per 100 miles.

The cost of moving a similar volume of water by terrestrial conduit is roughly twenty times this figure.

The cost to use a supertanker is at least $1.00/CM over 400 miles (compared to Medusa's 15 - 20 cents) excluding the cost of terminals. One can compare the cost of using a tug and a 2 million tonne bag with a 300,000t supertanker costing $100 million. The tanker investment is 8 times higher for 15% of the volume but the tanker would have a cycle time 4 times faster. The result is an investment 13 times higher per unit volume of water delivered.

Desalination of seawater has historically cost over $2.00/CM exclusive of energy costs. Recent engineering numbers are $1.00 with 70 cents an optimistic value. Such numbers assume integration with a power plan. Desalination of brackish water can be less; 25 cents/CM is typical in Florida.

Applications

Freshwater applications are foreseen wherever there is a combination of arid coastline and a not-too-distant source of river water, for example:

(1) Southern California (500 - 1000MCMy) supplied from Northern California or the Columbia River or Canada or Alaska.

(2) Baja California (200 - 1000MCMy) supplied from the north as an extension of an American project or supplied from a Mexican river such as the Balsas between Manzanillo and Acapulco. It is possible that a Mexican project could supply San Diego. The current demand in Baja California is not that great because of the lack of water. However with 3000 miles of prime recreational real estate, the long-term potential is enormous. If a big long-range project can be justified, many smaller communities can be served en route by downloading into smaller bags at sea without slowing the transit of the big bag. This is highly economic.

(3) The Mediterranean (1000 - 3000MCMy)
Many countries are prospective consumers: Morocco, Algeria, Tunisia, Egypt and Jordan. Water sources are the Rhone River in France, the Manavgat River in S. Turkey, and the Nile. It might prove economic to ship Turkish water to Egypt, across the isthmus of Suez and so supply the Gulf of Suez and Aqaba and the Red Sea Coasts. There is large recreational potential here.

(4) The Arabian Gulf (2000 - 4000MCMy)
Virtually all the Arabian states are potential consumers. The two potential resources are the Karoun River in Iran and the Indus in Pakistan. Both these sources should be developed to provide competition (most important). In practice Pakistan sourced water could supply primarily the Muscat, Oman and Yemen coasts.

In addition to these major projects, several cities have growing water problems, e.g.: Istanbul, Athens, Malta, Honolulu, Acapulco, Singapore and Shanghai.

Sewage effluent

In general 75% of the water that enters a city ends up in its sewers. For coastal cities sewage is (hopefully) given primary treatment and the effluent released through outfalls (large diameter pipes). Often this effluent is carried back to local beaches where it causes problems of contamination.

Medusa bags could be used to carry such effluent 100 miles offshore for release in surface water where it cannot possibly return to the coast before degradation. The cost (5 - 10 cents/CM) is very much less than that of secondary sewage treatment (50 - 75 cents/CM) because two bags and tugs can handle all the effluent of a large city (e.g. San Diego), the submarine pipe is already in place and only one buoy is needed.

Tanker oil spills

Tankers could carry 100,000 CM medusa type bags on board in steel cylinders permitting a rapid launch. The bags could have a flexible hose to the ships pumps permanently attached. When the tanker is holed, the bag can be launched and the holed tanks pumped immediately into the bag. It may not be necessary to empty the holed tanks as seawater flowing in the holes will prevent the tanks from leaking more oil once they are half empty. Cost of an entire installation about $1 million. This solution will not work in all circumstances, but then there is no one technique that will.

Commercial Situation

The Medusa Corporation is a Canadian development corporation. It would not likely operate any national project but rather act as an international technology supplier under licence.

The Medusa technology has been patented in several market areas of interest.

Medusa is currently seeking an investor to fund the further development program in return for an equity position in the international company. Promoters and investors are also being sought for national projects.

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Medusa Bag Strapping Pattern (Provisional)

Scale Approximately 1: 2000

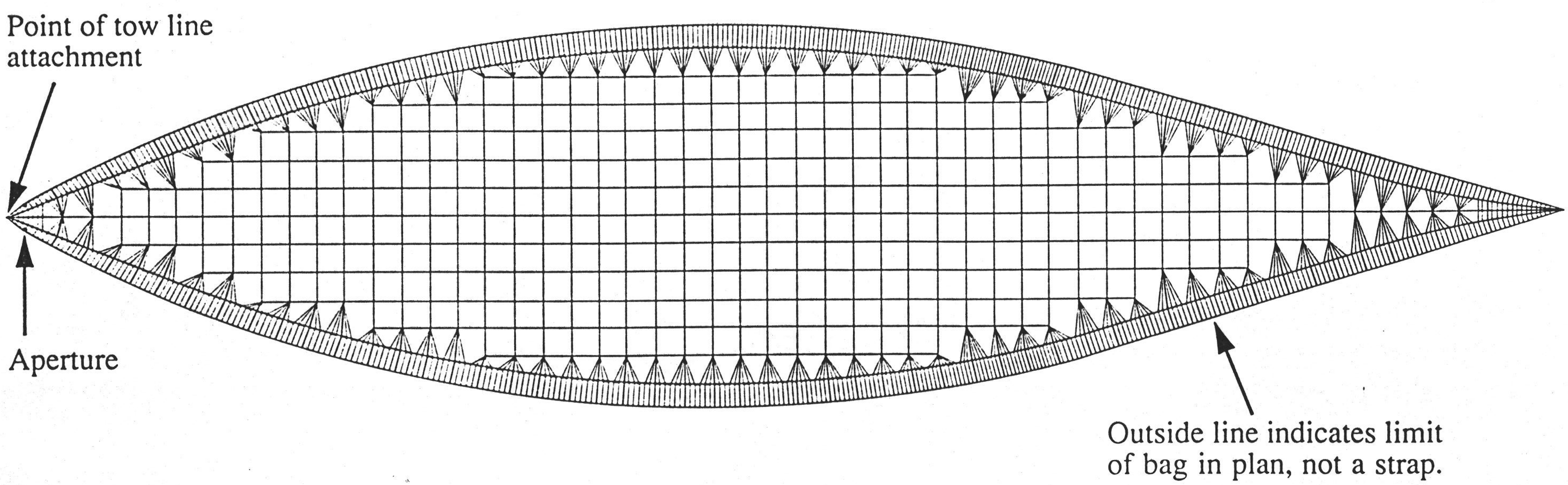

Figure 1

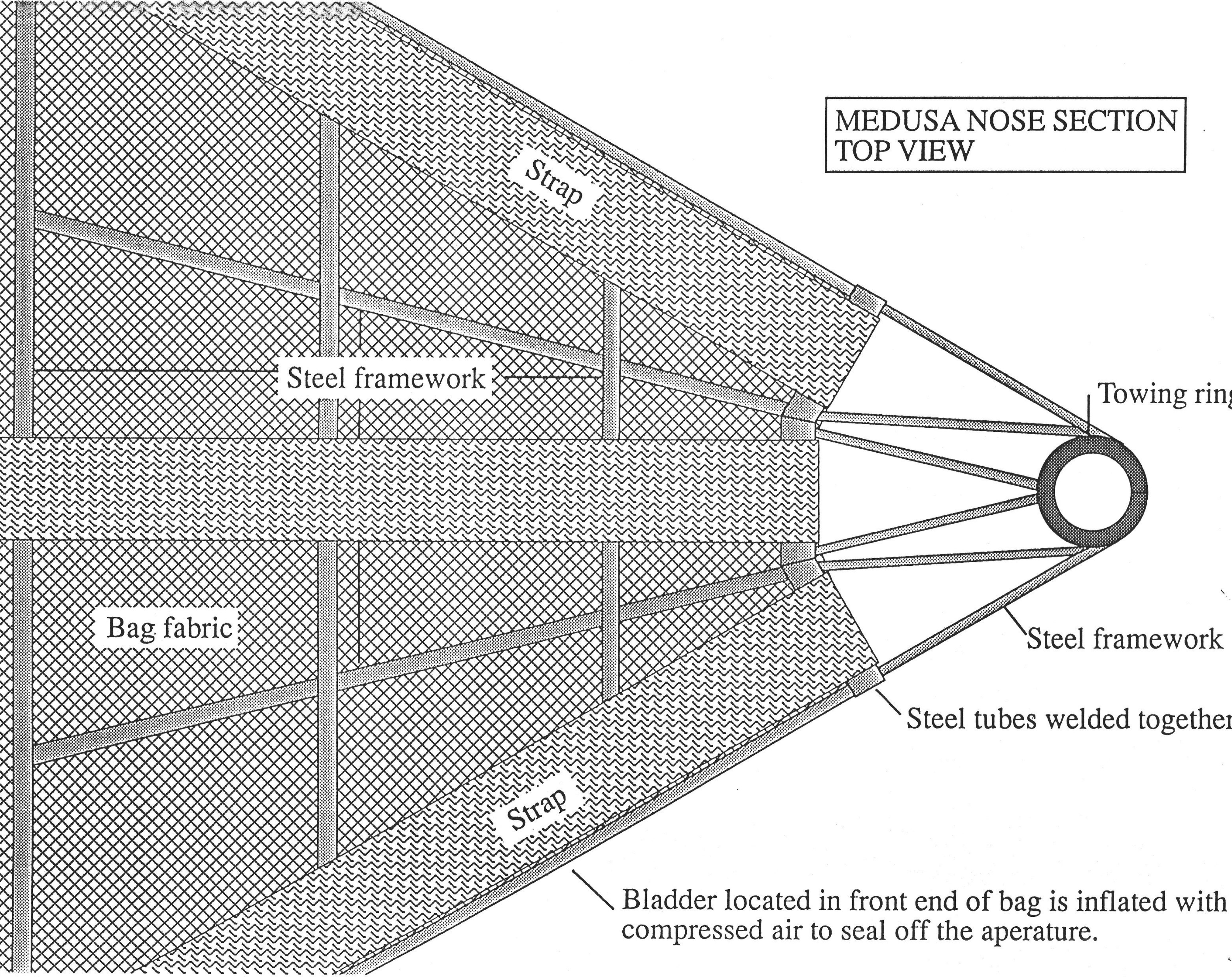
MEDUSA NOSE SECTION
TOP VIEW
Strap
Steel framework
Towing ring
Bag fabric
Steel framework
Steel tubes welded together
Strap
Bladder located in front end of bag is inflated with
compressed air to seal off the aperature.

Figure 2

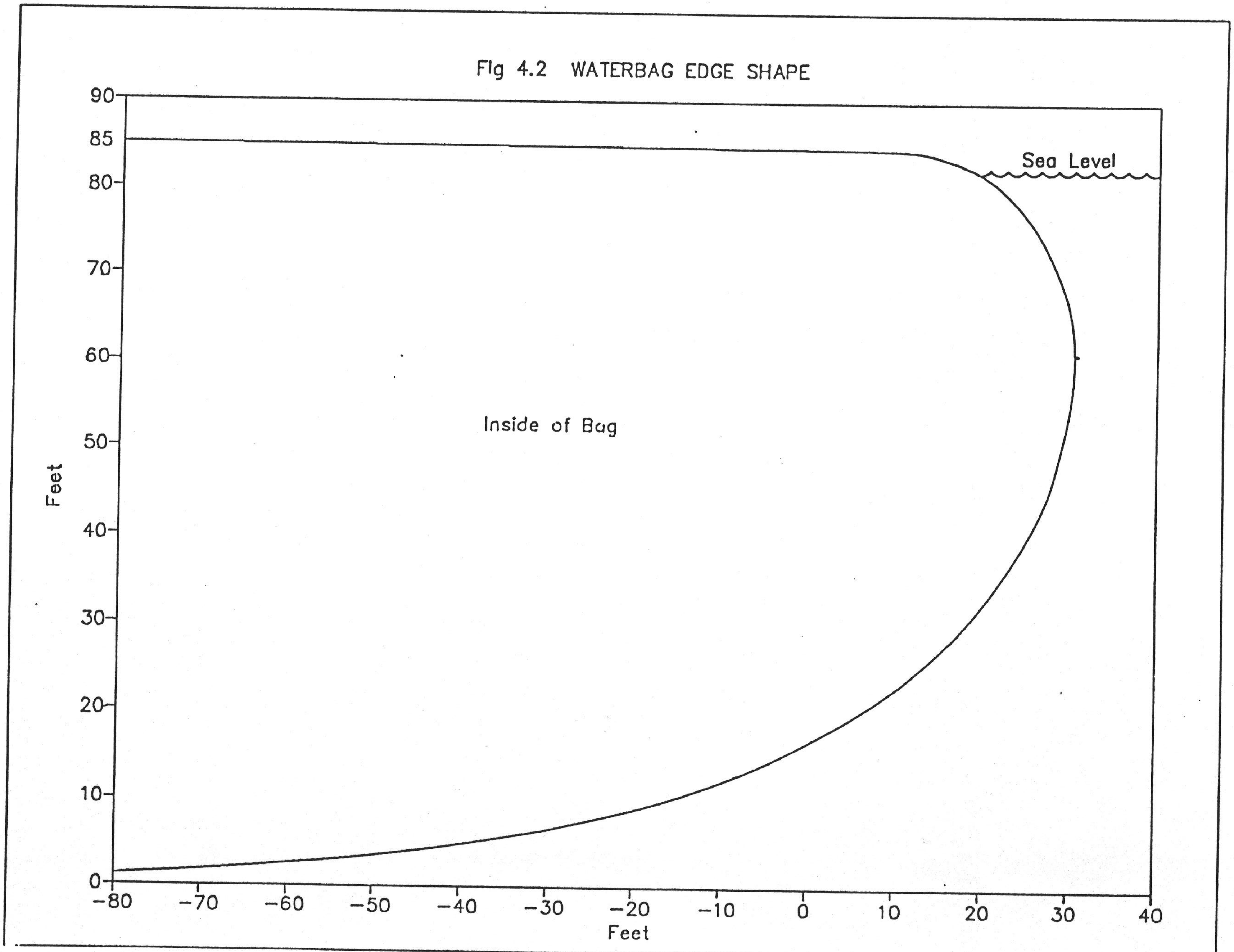

Fig 4.2 WATERBAG EDGE SHAPE
Sea Level
Inside of Bag
Feet
Feet
90
85
80
70
60
50
40
30
20
10
0
-80
-70
-60
-50
-40
-30
-20
-10
0
10
20
30
40

Figure 3

MEDUSA
CORPORATION INC.

Mr. Allen Kieswetter, Chief Negotiator
Multilateral Working Group on Water Resources
Near Eastern and South Asian Bureau
United States Department of State
Washington, D.C., 20520

Aug. 17, 1992

Dear Mr. Kieswetter,

Thank you for your note of July 13 acknowledging the receipt of my fax of May 7. I enclose a hard copy of copy that paper for easier reading plus a color xerox showing some of our development work.

You mentioned that you have forwarded this material to experts for their thoughts. I have been contacted by a Michael Saunders of Harza Engineers in Chicago who said he was retained by AID to review several far out schemes including the Med-Dead pipeline. We had a good conversation and I have asked him to call me again when he has had a chance to digest what I sent him. I assume he is doing the work for you. By definition, there are no experts in new technology. I have supplied names of respected academics and some related industrial people that have given careful consideration to the Medusa technology and are supportive, but I am sure no one, including myself, will put their hand in the fire and swear it definitely will work. More development and ideally some piloting will be needed. This will require time , a consideration that will be of concern to you.

May I respectfully suggest that you adopt the following position on the Medusa technology:

(1) It seems much <u>more likely than not</u> that it can be successfully commercialized (from a technical point of view).

(2) It promises to be <u>significantly</u> lower cost than desalination, supertankers or terrestrial conduits of similar capacity.

(3) Nearly a year of further development effort must be expended before it can be <u>seriously</u> advanced as a solution to a water supply problem.

(4) Considering the promised benefits in the Middle East, an <u>appropriate attitude</u> to take is not "Will it work?" but rather "Let's make it work!"

The paper describes first the findings of the pre-feasibility study by the Israeli engineering company Tahal, commissioned by the Water Commissioner Zemach Ishay: 250 MCMy from the Manavgat River in Southern Turkey to Ashkelon in Southern Israel and pumped into the National Water Carrier would cost 17 U.S. cents per cubic meter and additional amounts 9 cents. These very attractive numbers, produced by independent engineers, not proponents, can be compared to desalination at $0.75 - 1.25, supertanker transport $0.70 - 1.10 or the Turkish Peace Pipeline to Jordan $0.60.

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You will see how I have taken these numbers and generalized them to five projects totalling 1800 MCMy, all available from the Manavgat. While Egypt is a major beneficiary, I propose that Israel be supplied with enough water that they can "happily" release 250 MCMy to Jordan free, supply Gaza with 100 MCMy and still have so much water for themselves that they could ease up on abstractions form the West Bank clastic aquifer. And all of this is at an attractive cost to Israel, Gaza and Egypt. Please be so kind as to give me your comments on these proposals, particularly the free supply to Jordan, which I believe could remove a major stumbling block in the peace process.

The following issues arise out of these proposals:

(1) The Arabs must be brought to realize that they, collectively, are the major beneficiaries of this scheme. I believe Munther Haddadin understands this but Elias Salameh is negative. Israel has just enough water now and can get by in future by reducing the supply to agriculture. Two years ago the Arab world came down like a ton of bricks on Turkey when the proposed Medusa scheme (to Ashkelon only) was discussed in an article in the Wall Street Journal. This was an understandable but completely perverse reaction which put a stop to Medusa developments in the Middle East. This message needs to get through: additional water for anyone will benefit everyone.

(2) The project to supply Israel (and hence Jordan and Gaza) and Egypt should be set up so that any shortages, particularly by sabotage, will be shared pro rata.

(3) An assurance scheme with teeth (e.g. the Seventh Fleet) must be put in place so that Israel can have confidence on security of supply. Guarantors could be the US, UN or EC, etc.

(4) Turkey must be quietly persuaded to look for benefits to them (from water they are currently wasting) in construction and operations, rather than from a high selling price on the water which would kill the project. Turkey is basically positive and are currently pursuing a proposal to build a freshwater loading terminal at the Manavgat.

(5) Egypt needs to be brought into the picture. They are currently building a water supply system into the Western Sinai, headed for El Arish, with a conduit under the Suez Canal. If they could be assured of inexpensive supply from Turkey, I believe this latter would be seen to be a preferred method of supplying the El Arish area. Surplus Nile water could be much more profitably diverted to Red Sea customers. I suspect the active involvement of the Egyptians would be politically attractive to the project. The project should be beneficial to them and its promotion could be another way for the US to assist Egypt's development.

You will recognize that such issues are project related. They only arise once there is general acceptance that Medusa supply is reliable and low cost, which is not now the case. This acceptance can be established by (i) completing the Medusa technical development with the construction and demonstration of a sizeable 100,000 tonne prototype ($1.5 million, 8 - 10 months) and (ii) carrying out pre-feasibility studies of the proposed projects involving engineers from Turkey, Israel, Jordan and Egypt (8 engineers over 2 - 3 months).

You remark in your letter that you are currently concentrating on simple, beginning steps. I wish to point out to you that there is very useful work that should proceed concurrently, heading towards novel, incremental supply options that completely change the atmosphere from the invidious, zero-sum games that are all that is available at present.

Yours sincerely,

James A. Cran

James A. Cran
President

cc Michael Saunders, Harza Engineers, Chicago
Prof. John Kolars, U. of Michigan, Ann Arbor
Prof. Thomas Naff, U. of Pennsylvania, Philadelphia
Marc Perron, Assistant Deputy Minister, Middle East and African Bureau, External Affairs, Ottawa

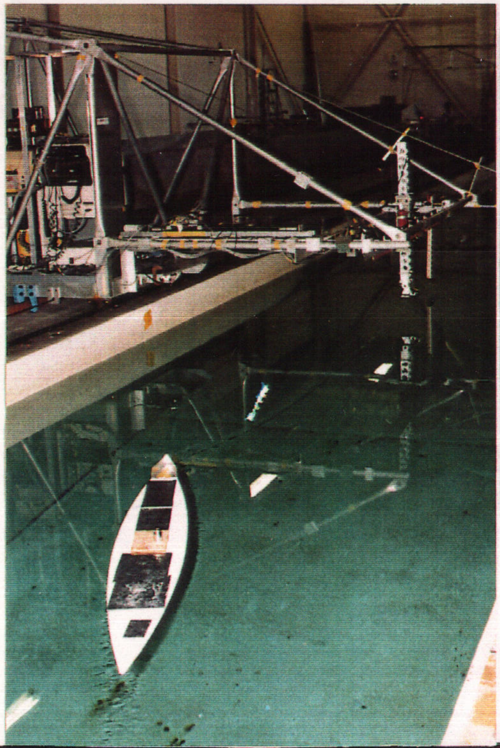
Dear Prof Naff,

I had the pleasure of meeting Prof Keenan in Waterloo in May at a water conference.

Thank you for your help in the past. Do you know Kieswetter? Could you possibly contact him & discuss the value of Medusa if would work ~~at~~ as anticipated?

Cheers

Jim

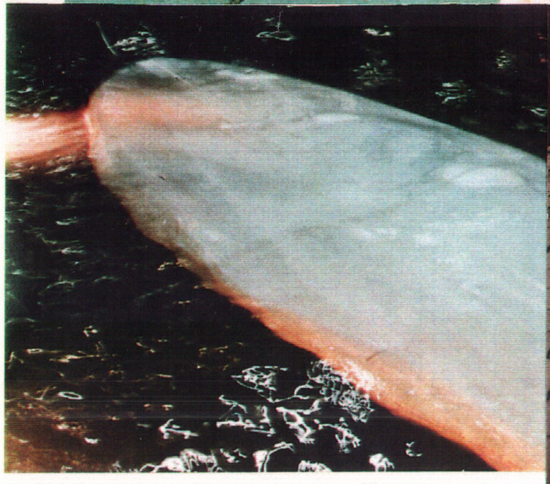


Prototype bag 100m long, 5000t displacement under construction.

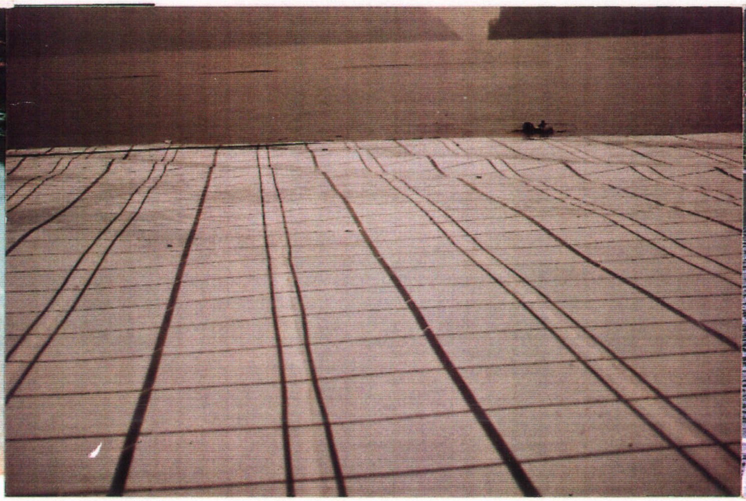
Prototype filling from waterfall. Tension supports weight of man and boat.

Medusa

← Testing a 2m model for stability under tow and to establish drag parameters.



Wave tank test of 10m model with waves scaled to Pacific storm sizes.



Waves pass through bag unobstructed.

Prototype under tow by work boat shows stability.