Proposed Bushman's River Pilot Dredging Project

A number of environmental factors, measurements and observations indicate the situation regarding the accumulation of sediment in the Bushman's River. The removal of the accumulated sediment from the estuary is critical factor for the sustainable health of estuary in the future.

Environmental factors

The Eastern Cape coast is subjected to the influence of the Mocambique current which flows down the coast in a westerly direction at rates up to 8km per hour offshore. The current, by nature, sets up a counter current inshore which flows in an easterly direction. The counter current in turn causes a natural movement of sand from the east to the west along the coast line.

The influence of the current varies with weather conditions; in particular, the inshore counter current is greatly influenced by the wind direction and strength. In addition to the influence of the current is the affect of the wind on the onshore sandy beaches. The predominant prevailing wind along the coast is the westerly which assists the movement of sand in an easterly direction.

A factor which influences the accumulation of sand in the Bushmans Estuary is similar to most Eastern Cape estuaries. The incoming tide (flow tide) flows for a shorter time than the outgoing tide (ebb tide) for the same volume of water. The energy input of the flow tide is therefore greater with the incoming tide and thus the carrying capacity is greater. It is this energy imbalance which is a major cause of the accumulation of sediment in the estuary basin.

The net influence of the wind and the counter current is thus to move sand into the estuary basin with the tide. The accumulated sandy sediment was historically, occasionally flushed out by periodic strong flooding of the river. This affect was the rectification of the accumulated energy imbalance over time.

The forceful flooding of the river has not occurred for past 55 years because the net inflow of fresh water has been restricted by an infinite number of farm dams and weirs and larger reservoirs. The normal run off into the river system, in recent years, has been so restricted that the upper reaches of the tidal portion of the river has become more saline than sea water i.e. hypersaline. The cause for the increased salinity is because the net evaporation rate exceeds the freshwater inflow rate. This has resulted, for example, in plant species like the river bank reeds, *Fragmites sp*, dying and largely reduced in number in the upper reaches.

The health of the "estuary" has also been compromised in as much as there is a certain quantity and frequency of fresh water inflow with nutrients needed to sustain the micro biota which form the basis of the food chain and ecological systems in estuaries. The "estuary" has now become an extension of the sea rather than a true estuary.

Another environmental impact on the natural system has been the road bridge which has restricted the tidal flow and has pinned the channels to the banks at certain points. In a natural system these channels would migrate with the meanders of the river over time.

Two other manmade influences on the "estuary" are the planting of alien invader species 1) to stabilize the dunes to the west of the river mouth and 2) the stabilization of the natural wind channel of Dry Bones Valley. The affect of stabilization is two fold.

Firstly, the natural movement of sand from west to east has been restricted and has resulted in the erosion of the Bushman's western bank between the slipway and the river mouth which threatened to undercut the road to the beach. (A groin was constructed and the so called "Deacon Bags" were placed to prevent further erosion to the west). The aeolian sand was

naturally fed into the river by the westerly winds which sustained the western bank and Bushman's River Beach. An enormous sand dune has now formed behind the stabilized dune area. The dune has detached from the "normal" buttress type dunes and has taken the shape of a typical barchan type dune. This dune has reached a critical height it has started migrating towards the river. Def (A barchan a moving isolated, crescent-shaped sand dune lying transverse to the direction of the prevailing wind, with a gently sloping side facing the wind so the wings or horns of the crescent point downwind 'leeward' and an abrupt or steeply sloping concave or 'leeward' side inside the horns. It can grow to over 30m in height and widths of up to 350m from horn to horn.) The position and size of the dunes is illustrated in the new set of aerial, stereo pair, photographs provided by Kwena Air, Port Alfred in July, 2004.

Secondly, the restriction of the natural movement of sand through Dry Bones Valley, from west to east, has resulted in an accumulation of sand along the eastern bank of the river from the car park to the point of the junction of River and Westbourne Roads at Kenton. A second enormous dune has accumulated opposite the car park to the west of the stabilized area. This dune has also taken on the typical barchan shape although not completely detached from the for dune to the south. The dune has also reached a critical height and has started migrating towards the car park and the houses on the margin of the Joan Muirhead Reserve. This presents a potential threat to all of the houses on the margin of Dry Bones Valley.

The lack of sand movement through Dry Bones Valley has resulted in a change in the profile of Middle Beach at Kenton. The buttress dunes on the naturally vegetated coastal fore dune are now being eroded and truncated. With time the fore dune will be undercut and the vegetation will be undercut causing collapse.

A second effect of the lack of movement of sand through Dry Bones Valley is the complete choking of the channel on the Kenton side of the Bushman's River and a net accumulation of a vast sand bank which used to be an island in the river.

The situation is not dissimilar to Cape St Francis where the "Sand River" was stabilized and has resulted in the erosion of the beach to the extent that houses built in the fore dune area are under threat of under cutting and collapse. Expenditure both by the Cape St Francis Municipality and private landowners in the form of walls, packed stones etc has not remedied the situation.

The lack of sand movement through Dry Bones Valley is not a single cause, but a contributing factor to the accumulation of sand in the estuary basin.

Consideration for the removal of the accumulated sand

The acceleration of the problem or appearance of the magnitude of the problem has become even more obvious in the past two years. It is estimated that over 1 million cubic metres of sterile marine sand has moved into the Bushman's River estuary over the past 55 years. The estimate of the accumulation of sand is made by measurement of the island areas, loss of river surface area and the estimated increase in height of the islands relative to the marker beacons.

Various schemes have been devised in the past to rid the "estuary" of the choking sand. The first dredging operations only removed sand from the river to the river bank and the sand soon found its way back into the river. The Bushman's River Mouth Ratepayers Association in collaboration with Dennis Laubscher has had the approval of SRK to try a prototype of the tidal flooding principle. An exhaustive study (1999-2001) under the guidance of the Institute of Natural Resources (INR) and the CSIR cast doubt on the viability of the tidal flooding model. Some of these proposals may work but the only proven way is to dredge the sand and remove it in its totality from the basin. This would require pumping the sand onto the seashore. There are only two options:1) to pipe the sand through Dry Bones Valley and onto the sea beach past the Middle Beach car park 2) onto the beach at the Bushman's Sea Beach some distance from the mouth of the river. Each scenario has merits and problems.

At Kenton the pumped sand should help the natural reformation of the buttress dunes and prevent the fore dune between the Middle Beach car park and the Kariega Car Park from being undercut. A potential disadvantage would be that the area is relatively sheltered, built up and is a popular bathing area. The dispersal of the spoil into the natural system would be more difficult.

There may well be some opposition to pumping large volumes of sand to the end of Dry Bones Valley. There could also be opposition to laying a pipeline through Dry Bones Valley and along the beach past the car park. There may also be opposition to laying a pipeline to dredge material from the Bushman's side of the river to Kenton.

An alternative would be to pump the sand onto the beach from the level of the dune pods at the Bushman's Sea Beach. This scenario may pose problems of the pipeline crossing the river. Laying a floating pipeline across the river or submerging a line under the river could also pose technical problems.

Proposal for Dredging

The proposal for dredging the sand from the estuary basin involves capital equipment and running/maintenance costs. The capital and running costs will vary with the distance that the sand needs to be transported.

In principal the proposal involves an electrically driven system with a "permanent" pump station as a booster along the pipeline to the discharge end. A diesel driven system is not considered to be an option because of possible pollution, difficulty of refuelling and noise pollution. The system would involve electrical boxes where the pump electrical drive motors could be plugged into a supply which is not that different to a domestic supply box. ESCOM, Agrilec, has been approached in this regard. There would be a line rental charge for each box and other costs of cabling and switchgear.

A) PIPE LINE

Class, Gauge of pipe

The gauge and class of pipe can change along the length but it needs to be a minimum of 150mm diameter and class 4 HPDE. The larger the diameter the less the frictional loss will be over the length of the pipe. Double flanged pipes each of 15m length are the ideal. The maximum distance to be pumped is in the order of 2.5 km. The minimum required pipeline will be in the order of 1000m to dredge from the slipway to the proposed beach dune pod at Bushman's Sea Beach.

Route of Pipeline

The routing of the pipeline would be from the dredger coupled onto a section of floated Canoflex flexible pipe to the main pipeline. The pipeline would cross the sand bank from the Kenton side to the high water mark on the Bushman's side and progress along the beach high tide mark for approximately 1000 m. From here it would turn towards the north into a dune pod and around to face the sea 25m into the dune pod but below the high water mark or storm line. A booster pump would be situated proximal to the Bushman's Sea Beach car park in the vicinity of the Albany Coast Water Board sea water pump station. It is suggested that this discharge end of the pipeline be temporarily buried 0.5m below the surface to the sand so as to avoid being tampered with or damaged.

The pipeline would have a coupling at the booster pump station point to allow for a second pipe line to be joined from the Albany Coast Water Board reverse osmosis (RO) brine discharge line so as to avoid discharging brine into the Bushman's river which is the case at present.

B) DREDGER

The dredger would be a floating, foam filled, 9m catamaran barge type with the motive and initial discharge pump on board together with switchgear and variable speed motor and soft starter. The 75kw required by the motive and discharge pump through a 160mm pipe would have to achieve a rate better than 3m per second so as to avoid sedimentation in the pipeline. The whole system is of very similar design to the pump used at The Royal Port Alfred Marina but different in that a stationary, land based booster pump would be used so as to increase the percentage of solid material that could be transported. The system at Port Alfred rarely achieves a solid:fluid ratio of more than 1:10 whereas the envisaged system would run at approximately 1:5.

a) Warman pump 100 tons per hour

To pump 100 tons per hour at 1.65 Slurry SG a 200mm Jet pump is required. This equates to an induced slurry rate of 42 l/sec. To dive the jet pump a motive water supply of 17.5 l/sec at 70 m is needed. The calculation was based on a 160mm ID pipe. Total flow rate in the discharge line will be 60 l/sec at 3.0 m/sec line velocity. These are preliminary specifications but actual static head according to pipeline length, friction coefficients and solid:fluid ratio with safety factors would need to be fine tuned. The proposed employment of a booster pump will also assist with the flow dynamics of the system.

b) Drive system

The motive system chosen is electrical. The reasons for using electrical power is eight fold.

1) It is quiet. Port Alfred was previously threatened with legal action because of noise from the diesel motor. There is no noise problem now with the electrically driven operation which is hardly audible within 25m of the operating dredger.
2) It has far less maintenance and repair costs are a fraction mechanical power.
3) Diesel, a fossil fuel is polluting and costs are considerably higher than the equivalent kilowatt electrical power costs.
4) Pollution in the river a possibility with refuelling diesel and diesel spills.
5) Downtime and servicing far less and there is ease of operation.
6) All major dredging operations i.e. Marina Martinique, Club Mykanos, Richards Bay etc. use electrical power. Mechanical power is only used for portability to sites without a viable electrical supply.
7) Electrical motors deliver maximum torque soon after startup and the correct rpm can be matched more accurately than with diesel power.
8) The power grid runs parallel to the river on both sides and is therefore readily available.

Proposed Areas to be Dredged

There are two areas which are proposed. The first is the area from the Kenton River Car Park through to Dassie's Klip and the second from The Bushman's River slipway to the end of Green Island. The areas are illustrated on maps 1 and 2 and the possible pipeline routes in maps 3 and 4. Some of the pipeline route would be common to both proposed areas.

The Kenton area is dry sterile marine sand at present which has been deposited over the past 30 years. The economics of dredging need to be considered against a duel method of removal which would entail mechanical removal of the first part which is now above sea level and dredging of the second part once at sea level. There is no ecological threat as there are no macro living organisms in the area or dependent on the area. The total surface area for sand to be removed at the Kenton area is approximately 10,000sq m.

The proposed dump site for the mechanically removed sand would be the borrow pit which was excavated during the construction of the R72 bridge. The area could then be transformed into playing fields for the adjacent school from the current derelict waste dump that it is at present. The dredge phase would be via pipeline to the inter tidal surf zone on the beach.

The Bushman's River side proposed area to be dredged would be the shallow water area (only partially submerged at low tide) from the slipway through to Green Island. The area is largely marine sand but does have some *Zostera spp* beds which are the mainstay of the food chain in the degraded estuary at present. The *Zostra* beds should be avoided when removing the sand so as not to affect the ecology in an adverse manner. The vast majority of this sand has also accumulated over the past 50 years and is now at the level where it will reach a level where all macro living organisms will die because of lack of water. The total area for sand to be removed from the Bushman's side is approximately 10,000 sq m.

The routing of the pipeline would be parallel to the river shoreline at the high tide mark to tie into the Albany Coast Water Board brine discharge line in the region of the artificial groin. A possible synergy with the pipeline along the high water mark would be that a sewerage pipeline could be laid at the same time to service the properties on the river front as these are now found to be seeping effluent into the tow path. The reason is because most are still on an old antiquated system of septic tank and French drain. Either the sewerage pipeline could be laid separately or the dredge line could be used as a sewerage line after completion of the pilot project.

The Envisaged Operational dredging design

The operational design of the dredging operation is not to complete the desired dimension in a single pass. It would be to dredge a line wide enough to a depth of 2m below the low tide mark wide enough for the dredger to pass and then allow the sand to collapse into a natural vee shape. A second and possibly third pass would be made and allow the optimal width to from naturally. Ideally the optimum width would be of the order of 10m with the deepest point 2m below the low water mark.

Environmental and other considerations

There are three environmental aspects to be taken into account.

1) The area to be dredged regarding the effect on the environment
2) The pipeline position and route and the immediate term and short term effects of the pipeline.
3) The effect on the environment of the spoil or dredge material on the inter tidal surf zone.

The possible effects of these activities positive or negative with respect to the following need to be considered.

1) Disturbance of any flora or fauna in laying the pipeline on shore.
2) Stability of the pipeline in the dune or roadside area where the "fixed" pipeline is laid.
3) Disturbance and effect of fauna and flora in the proposed dredged areas and the impact/recovery of those areas.
4) The effect of the discharge at the point in the inter tidal surf zone proximal to the dune pod and the sea.
5) Possible noise pollution, chemical, oil pollution on the dredger and the "fixed" booster pump station.
6) Safety of the public, boating population and all IAP's especially the home owners along the river banks and ratepayers of ward 3 and 4. In addition, SanParks, MCM, DWAF and

DEAET and environmental groups including academic, research institutions and organisations like Rhodes University, SAIAB, NMMU and WESSA.

7) Employment opportunities, short term and long term “permanent employment”.
    a) Labour costs would be in the region of R1,000 per week (operator, assistant and casuals to help moves). This would include workman’s compensation, UIF, etc.
    b) Electrical at 2.5 c per Kw/Hr or R25.00 per hour of operation.
    c) Maintenance costs would depend on type of operation.

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