THE INTERNATIONAL AND HERITAGE SIGNIFICANCE OF DOCTOR'S CREEK

DERBY, W.A

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FEBRUARY 2005

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SUMMARY

"In summary, a case can be developed for the protection of not just a type site of a geologic record, but more broadly an area that has been studied extensively from a geologic, geomorphologic and ecologic perspective. Had such broader criteria been applied by the Wilson review of marine/parks, it is possible that Doctors Creek may have achieved protected status at an earlier time" (Professor B.G. Thom, in Western Australia Environmental Protection Authority Bulletin 942; 1999, Attachment 1).

Doctors Creek near Derby in Western Australia is identified as a type-site of State, National and International geologic and ecologic heritage significance. Its geologic significance is as a well-documented, unique global classroom in "its setting as a macrotidal tropical semi-arid mangrove coast, its erosional patterns, its tide-dominated deltaic estuarine setting, and the fractal laboratory therein." Its ecologic significance is in the role it plays in the breeding cycles of the barramundi and the critically endangered freshwater sawfish (Pristis microdon) populations of the Fitzroy River, and habitat for the rare and critically endangered speartooth shark (Glyphis sp. A) and the extremely rare and endangered northern river shark (Glyphis sp. C). Its geomorphology gives rise to the globally significant complex of mangrove species associations evolving therein. It is the culturally significant traditional fishing ground for indigenous people who rely on it for much of their fresh nutrition. The need to protect Doctors Creek is urgent because of environmental threats from existing and proposed residential and industrial developments within its catchment.

1. International geoheritage significance of Doctors Creek

1.1 International significance of the Doctors Creek system

"The International and heritage significance of Doctors Creek inlet should militate against any development in this area on a priori principles alone. The International and heritage significance of Doctors Creek is related to... its setting as a macrotidal tropical semi-arid mangrove coast, its erosional patterns, its tide-dominated deltaic estuarine setting, and the fractal laboratory therein. As will be demonstrated below, the Doctors Creek basin represents a once-off globally unique and important system." (Semeniuk, 1997; 2).

1.2 Type site for geologic /ecologic research

Doctors Creek has a small (140 km2) catchment and no real source of sediment from inland. Rainfall run off and associated sediment transport occurs during extreme storms but this flux is low compared to the sediment flux into the creek from King Sound. Although Doctors creek appears stable, a comparison of aerial photographs taken over the past 30 years shows that significant erosion and deposition has occurred. (Derby Hydro Power, 1997; 31).
"Doctors Creek has become a type site for geologic/ecologic research into tidal flats in high- tidal, semi-arid deltaic areas. As such it has value in the future as an area of reference. This means it can serve as a laboratory to research natural processes within a "known" framework, and as a "benchmark" site for monitoring future change (e.g. those induced by Greenhouse Effect).

1.3 Geoheritage significance of the Doctors Creek system

"There are three aspects of the Doctors Creek system that have geoheritage significance. These are:

1. Stratigraphic type location of the Christine Point Clay
2. Relationship of the linear dunes to tidal flats
3. Interaction of hinterland freshwater with tidal flat hypersaline water

The Doctors Creek embayment, towards the mouth of Doctors Creek, is the stratigraphic type section of the location of the Christine Point Clay (Semeniuk, 1980c). This formation, in its stratigraphic context of King Sound, is the most southerly occurrence of the sedimentary unit known as the "Big Swamp" complex described by Woodroffe et al (1985). The "Big Swamp" phase of northern Australia records an early Holocene history of rapid sedimentation, with large extensive mangrove forests, and humid climate, unlike anything seen today in the region.

Embedded in this stratigraphic unit at Christine Point, therefore, is the history of this part of Australia in terms of sedimentation style, sedimentation rates, mangrove ecology, and climate.

Fairbridge (1961) described Quaternary red sand dunes descending beneath the Holocene tidal flat deposits of the Doctors Creek embayment and thus alerted scientists to the occurrence of this important climatic and stratigraphic relationship. This relationship occurs mostly and is best developed along the western edge of the Doctors Creek embayment.
Later, Jennings & Coventry (1973) and Jennings (1975) explored the relationship of these red dunes to the overlying tidal flat deposits, writing a paper on the history of the Holocene transgression into the red sand dune terrain.

As such, the work became an international classic in coastal stratigraphy. In this context, in the light of the works of Fairbridge (1961), Jennings & Coventry (1973) and Jennings (1975), this area has become **known internationally, and is of International geoheritage significance.**

In the future, this site will continue to be a site of stratigraphic and climatic research, as the basic work carried out by those authors is re-explored, refined, and amplified. It is therefore imperative that the terrain remains accessible as a site of Quaternary research.

The third matter relates to the interaction of hinterland freshwater with tidal flat hypersaline water. The configuration of the red sand dunes descending stratigraphically below the tidal flat sediments provides a conduit for freshwater seepage that discharges under the tidal flats. This seepage was detected by Jennings (1975) and by Semeniuk (1980a). Jennings (1975) documented "dune ghosts" outlined by strings of vegetation on the vegetation-free hypersaline tidal flat, where groundwater of lower salinity, resided in the buried dune fingers under the tidal flat. Semeniuk (1980a) documented groundwater hypersalinity diluted by this seepage within buried fingers of dune sand under the tidal flat. "These occurrences of sub-tidal flat seepage assume geoheritage significance." (Semeniuk, 1997; 14-15).

2. Global importance of Doctors Creek mangroves

2.1 Macrotidal setting in a global context

"Thus, King Sound and Broome, with 11 and 12 species of mangrove, respectively, are the most species rich macrotidal mangrove-vegetated tidal flat systems in the world; both have a tidal range in excess of 10m, but, the substrate type, the geomorphic setting, and the system of tidal creeks for these two areas are wholly incomparable, and the prevailing tidal range also is incomparable. In this context, it is obvious that the King Sound area in its own right is globally significant." (Semeniuk, 1997; 8).

"Many of the other macrotidal systems outside Australia, for instance Mont St Michel, and the Bay of Fundy, also are anthropogenically modified, and in this context, the Doctors Creek system becomes important because it is pristine, and constitutes a macrotidal-flat wilderness, unique globally as being a terrigenous and erosional system with the largest tide for tropical mangrove setting. Within King Sound, the Doctors Creek system is part of the Fitzroy River estuary, a deltaic estuarine environment with a tide-dominated delta. The Doctors Creek basin represents the accumulation of deltaic sediments within a setting where deltaic sedimentation is interacting with an embayed and crenulate coast.

It is obvious, therefore, that the Doctors Creek system represents a unique and globally important system. It is located in a setting that has these features:
it is a semi-arid macrotidal coast that is species rich in terms of mangroves.

Other systems that are also macrotidal to this extent either lack mangroves (Bay of Fundy, St Helier, St Mont Michel, Puerto Galegos, etc.), or are depauperate in mangroves (Bhavnagar). This underpins the global significance of Doctors Creek."(Semeniuk, 1997; 9).

"As Doctor's Creek has extreme tides that generate high turbidity and is relatively protected from oceanic conditions, the assumption that it's fauna will be similar to that of the creeks around Broome and Cape Leveque which are influenced by the ocean, is hard to justify. Maybe a statement that more research is required would be more appropriate." (Morgan, Gill, White and Thorburn, 2002; Comment 22).

2.2 Global importance of the Doctors Creek mangroves

"Within King Sound there are relatively wide bands of mangroves occupying gentle gradients that exhibit clearly defined patterns of zonation (e.g. Christine Point). This is not the case in Doctors Creek. Within Doctors Creek, mangroves form complex mosaics and occur in relatively thin bands along steep creek banks where zonation is complicated by topography". (Derby Hydro Power,1997; 44). Of these complex mosaics, Paling (1997; 6) typified "20 different types of communities, mainly on the basis of their species composition and their location (upper and lower) in the two creeks... "(Paling, 1997; 22). Two of these Doctors Creek communities do not appear to be found anywhere else in the world, not even in King Sound.

"The mangroves of Doctors Creek in particular and of King Sound in general are of global significance, as will be discussed below. In general, to assess the global significance of mangroves in a given area, it is necessary to determine the species richness of the region and the variability of coastal style (habitat setting) where mangroves are located. In order to assess the global significance of mangrove formations specifically in Doctors Creek, the discussion that follows centres on two inter-related aspects: the species pool, and the erosion-generated habitats."

"However, Doctors Creek does provide two aspects of significance. The first is that the mangrove species Bruguiera parviflora occurring here is at its most southern limit, and given the differences in mangrove biogeography on the east and west coasts of Australia, this is of National significance. The second is that the mangroves are related to habitats generated by erosional processes."

"While globally most mangrove areas are viewed to be sites where mangrove habitation is linked to coastal accretion, the King Sound area was the first location where coastal erosion was described in detail to provide insight into tidal flat processes and mangrove responses. As such it stands as a global class-room for mangrove ecology in relationship to macrotidal coastal erosion.

In this context, even though the bulk of the mangroves in Doctors Creek are not rare or unusual species, the occurrence of mangrove assemblages along the eroding banks and headwaters here assume global importance because this embayment represents the extreme end of a spectrum of erosional forms. Thus, Doctors Creek represents Stage 6 of an intergradational series of tidal creek forms, noted by Semeniuk (1980b) as Stages 1-6. Erosion of tidal creek systems has nearly gone to completion in the Doctors Creek area, and the mangrove assemblages established there have formed in habitats in a Stage 6 erosional setting." (Semeniuk, 1997; 12-13).

3. Marine fauna of Doctors Creek

3.1 Traditional fishing ground.

The Aboriginal communities of Karmulinunga, Burrinunga, Djimung Nguda and Budulah are all located on the western shore of Doctors Creek. The combined population of these communities is about 200. Doctors Creek is their traditional fishing ground and the fishery forms a part not only of their culture, but of their fresh nutrition as well. They reliably catch mature barramundi, golden grunter, salmon, mangrove jack, catfish, bug-eye mullet, mud crabs, sharks, rays and sawfish. This is significant because most suffer from the typical socio-economic disadvantages of the Australian Aboriginal population. Doctors Creek plays an important role in their cultural, physical and economic wellbeing.

3.2 Marine breeding site

"The information Fisheries WA passed on to the EPA about the nature of the creek system was not based on scientific evidence, it was based on hearsay; that is, Dr. Eric Paling's (a consultant to the tidal dam proponent) remark to Fisheries WA, 'He indicated that Doctors Creek was a steep sided creek which drained significantly at low tide leaving minimal mangrove associated waters. From this observation it was speculated that: 'its contribution to (King Sound) as a shallow water mangrove breeding site could be minimal'" (Troy Sinclair, Fisheries WA Kununurra office, correspondence with Cheryl Grant 12/12/97).
Dr Paling's observation failed to include the fact that although Doctors Creek does indeed drain significantly, at low tide it nonetheless retains approximately 20 kilometres of deep pools populated with adult fish and connected by a strongly running river of water draining out of the mangrove forest. It also failed to include the fact that there are hundreds of tributary creeks in the mangrove forest, each retaining numerous minor pools filled with small fish, at low tide.
Logic is only as good as its premises: garbage in, garbage out. The Fisheries WA speculations based on Dr Paling's incomplete observations led the EPA to the false assumption that Doctors Creek empties completely at low tide, then on to an unfounded and risky conclusion about the unlikihood of unique species in the area (EPA Bulletin 942, p37 para 7).

This is the exact opposite of the more likely logical possibility that, because of:

a) the observed fact of significant water retained at low tide, including around the mangroves,
b) the highest tropical mangrove tidal range in the world,
c) unique, scientifically documented ecological and geological processes,

Doctors Creek may well contain unique species and also may be both a significant marine breeding and nursery area as well as a significant marine ecosystem. These points are reinforced by the EPA in Bulletin 942, Attachment 1 which states:

"In summary, a case can be developed for the protection of not just a type site of a geologic record, but more broadly an area that has been studied extensively from a geologic, geomorphologic and ecologic perspective. Had such broader criteria been applied by the Wilson review of marine/parks, it is possible that Doctors creek may have achieved protected status at an earlier time"

Doctors Creek is by far the largest creek close to the mouth of the Fitzroy River offering shelter to barramundi adults and juveniles, and therefore it may be important as a breeding and nursery site sustaining the barramundi stock in the Fitzroy" (Pillsbury, 2001).

3.3 Fisheries research

The findings on Doctors Creek from a survey conducted by Murdoch University's Centre for Fish and Fisheries Research in 2002 support the argument that Doctors Creek may be both a significant marine breeding and nursery area as well as a significant marine ecosystem.

"A total of 37 fish species were recorded in the 70 sites sampled during the project, with 23 of these species being principal freshwater species (i.e. they complete their life-cycle in freshwater) and 14 species being of either estuarine or marine origin that may spend some part of their life-cycle in freshwater" (Morgan, Allen, Bedford and Horstman 2002; 2).

"A proposal to build a tidal power station across the two branches of Doctor's Creek, King Sound, WA, has triggered the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), as three species of EA listed fish may inhabit the Creek. The fish are Glyphis sp. A (speartooth shark), Glyphis sp. C (northern river shark) and Pristis microdon (freshwater sawfish)" (Larson 2002; para 1)

"The northern river shark (Glyphis sp. C), which we captured in Doctor's Creek, is extremely rare, and had not previously been recorded in Western Australia. It was previously only known from a few specimens collected in the Adelaide River in the Northern Territory and from the Fly River in Papua New Guinea" (Compagno and Niem 1998) (Morgan, Allen, Bedford and Horstman 2002; 10).

Pristis microdon: "Listed by Environment Australia as Endangered, the results of the project, together with that of a concurrently run Murdoch University/CSIRO shark survey of the rivers of northern Australia, suggests that the Fitzroy River may be an extremely important refuge for this species" (Morgan, Allen, Bedford and Horstman 2002; 37).

"All the males captured in the Fitzroy River were immature... Require formal protection in W.A." (Morgan, Allen, Bedford and Horstman, 2002; 37).

"Comment 1
Paragraph 1, sentence 1, Glyphis sp. C and Pristis microdon are now known to occur in Doctor's Creek (Comment 2 & Comment 10 below and Figure 1), amend this sentence and the following paragraph accordingly.

Comment 2
Paragraph 2, sentence 1, It may be worth noting that Pristis microdon is listed as critically endangered by the IUCN. Although Pristis microdon is widely regarded to be restricted to freshwater and/or the lower salinity in estuaries, it is occasionally caught by gill net fishermen operating in the Arafura Sea (White, unpublished data) and has been found in a salinity of 35 ppt in the Robinson River just to the north of Doctor's Creek (Thorburn, unpublished data). Furthermore, whilst Pristis microdon is extremely common throughout the Fitzroy River (and has been found in 10 sites up to 450 km from the mouth) (see attached Figure I), none of the fish caught were mature (Max. total length 2.1 m) (Morgan et at., in prep.; Thorburn, unpublished data). In contrast, the local professional fisherman often catches large mature animals in and around Doctor's Creek (Bergman, pers. comm.)" (Morgan, Gill, White and Thorburn, 2002; 2)

"Comment 22
Paragraph 2, sentence 3, As Doctor's Creek has extreme tides that generate high turbidity and is relatively protected from oceanic conditions, the assumption that it's fauna will be similar to that of the creeks around Broome and Cape Leveque which are influenced by the ocean, is hard to justify. Maybe a statement that more research is required would be more appropriate" (Morgan, Gill, White and Thorburn, 2002; 6).

"Comment 25
It should also be noted that Ferdy Bergman, the commercial fisherman in Derby, has captured in addition to some of the above species, the easily identifiable narrow sawfish Anoxypristis cuspidatus, and other sawfish with teeth counts of between 16 and 30. If the latter count is correct it may indicate the first recording of the wide sawfish Pristis pectinata in Western Australia, this species is known to enter estuaries in southern Africa to give birth. Ferdy has also reported to us both the presence of running ripe barramundi in Doctor's Creek, and each year after the wet thousands of juvenile barramundi on the salt flats of the upper reaches of the southern branch of Doctor's Creek. Furthermore, he has told us of the presence of dugongs and dolphins in the Creek, the latter of which we can verify" (Morgan, Gill, White and Thorburn, 2002; 6).

4. Threats

4.1 Tidal barrages

Of the proposed Tidal Energy Australia Pty Ltd tidal barrage in Doctors Creek,
"... the EPA has concluded that the environmental impacts, uncertainties and risks associated with the proposal are significant and are of such a nature that the proposal should not be implemented."
(Western Australia EPA Bulletin 942, 1999; iv).

4.1.1 Mangroves

"Within King Sound there are relatively wide bands of mangroves occupying gentle gradients that exhibit clearly defined patterns of zonation (e.g. Christine Point). This is not the case in Doctors Creek. Within Doctors Creek, mangroves form complex mosaics and occur in relatively thin bands along steep creek banks where zonation is complicated by topography".
(Derby Hydro Power, 1997; 44).

"The Doctors creek system lies within a 130 sq km tidal mudflat, on the northern boundary of the Derby peninsula. It contains two blind creeks and there is no natural drainage system from inland into King Sound. The mudflat area is composed of hyper saline clays which are largely devoid of life for the majority of the 14 day tidal cycle. The average elevation is 4.3m AHD, which is some 700mm under the mean high water springs elevation of 5.0m AHD".
(Tidal Energy Australia (2001b; 3.3).

"Mangroves generally occur between Mean Sea Level (MSL) and Mean High Water Spring (MHWS). Estimates taken from the submergence curve associated with the new concept indicate that the new zones available to the mangroves are 2.6m to 4.1m AHD..."
(Tidal Energy Australia, 2001a; 7).

In the eastern arm of Doctors Creek there will be "...a loss of all mangroves".
(Derby Hydro Power, 1997; 45).

"Tidal inundation in the western arm of Doctors Creek will be restricted to a more narrow band at the upper end of the normal tidal elevation (from approximately 3 to 4.1m AHD). The majority of the mangrove associations within the creek occur between 2.84 and 4.79m. There is likely to be a contraction of the mangrove community width closer to the new level, with mortality occurring at the higher elevations due to lack of inundation and possibly at lower elevations due to flooding" (Paling, 1997; 23).

DISCUSSION

The maps and photographs of Doctors Creek show that most of the mangrove forest grows on the tidal flat close to the edge of the creek bank, which averages about 4.3m AHD (Tidal Energy Australia spot height map, 2002; 11, and Derby Hydro Power, 1997; Figure 6.4). This is the forest that will be destroyed when the barrages reduce MHWS in the high basin from 5.0m AHD to 4.1m AHD. The new tidal range of 2.6m AHD to 4.1m AHD is confined almost entirely within the steep sided creek channels. Significant recolonisation by mangroves within this range cannot then occur, owing to the steepness and instability of the creek banks (Derby Hydro Power, 1997; 44).

Submergence time calculations suggesting a possible enlargement in the area available for colonisation are not relevant because the increased submergence time will mostly be restricted to the narrow, steep and unstable creek banks, which are not suitable for mangrove growth (see photos 4 and 5 below, which show the denuded creek banks and the mangroves growing at their top edge).

In Figure 6.8, "Summary of Potential Mangrove Impacts" (Derby Hydro Power, 1997) the dark green and light green areas shown respectively as "Areas available for mangrove colonisation" and "Mangroves expected to be retained" are incorrect, as both areas are mostly well above the post-barrage Mean High Water Spring level required by mangroves.

Put simply, the water in the high basin after the barrages are built will be confined almost entirely within the existing banks of the creek. It is therefore impossible for most of the new mangrove colonisation illustrated by Tidal Energy Australia to occur. Most of the existing mangrove forest in the high basin will be destroyed, and will not be replaced by significant new colonisation. Figure 6.8 also shows that all of the existing low basin mangroves will be lost, although it is possible that mangroves will be able to recolonise parts of the exposed creek bed.

4.1.2 Marine fauna

"A second major area of concern with the CER relates to the larger fauna such as fish and reptiles that inhabit the system. Despite recording the presence of several species of fish that have commercial value, and of reptiles that have conservation value, the consultants apparently conclude that operation of the tidal power station will have no significant effect on them. I find that conclusion highly improbable" (Daborn, 1998; 8).

"Despite that, the CER provides information that suggests some large fish and reptiles (crocodiles are mentioned, but are there also any turtles?) inhabit the system. This immediately raises the problem of mortality in turbines.

I regret to say that some of the 'predictions' made on page 58 are so naive as to be almost laughable. For example, it is stated with (apparent) confidence that "larger fish will be prevented from entering the turbines through installation of an exclusion mesh". Such a statement suggests to me that the authors cannot have attempted to model the effects on flow of a screen with a mesh size small enough to exclude most commercial sized fish. They appear to be unfamiliar with the huge

amount of research that hydro power generating companies have carried out on this topic. Mesh screens simply reduce the cross-sectional volume to such an extent that they seriously impede flow. Consequently, the output of a generator is reduced. Furthermore, where exclusion screens actually are used (e.g. in the intake channels of power stations through which cooling water is drawn), they require a great deal of maintenance, are easily fouled, and become obstructed by fish impacted upon them. In estuaries, the biofouling community is extremely well developed, and any structure will become coated very quickly. In view of the large size of the intake tube, and the need for good flow through the turbine, exclusion screens are not really an option.

We must then assume that fish of varying sizes, and possibly reptiles, will end up passing through the turbine.

Fish passage through turbines has been extensively studied for the last half century, and is still a highly controversial topic. At Annapolis we have done some of the most relevant research in the past few years because it became clear right at the earliest planning stage that a mechanical barrier to prevent fish from entering the draft tube was simply not feasible. I can summarise the results of several years' work as follows:

Fish mortality is usually considerably higher than that predicted by traditional models.

Small fish are even more susceptible to being killed on passage through the turbine than large fish because of the sharp pressure drops to which they are subjected. This causes bursting of blood vessels in gills and eyes, pulping of body muscle, and occasionally shearing off of the head.

3. Experimental measurements of turbine mortality are extremely difficult to obtain with confidence. Handling and repeated catching of fish causes mortality in itself, and it is not easy to establish adequate controls so that the true effects of the turbine can be assessed.

4. We have some convincing evidence from the Annapolis studies that the age distribution of the American shad has changed since the turbine came into operation. Prior to 1985, the oldest fish were 11-13 years of age; now we rarely get one that is more than 7 years. Nonetheless, the population still exists and spawns in the river. Our attempts to estimate population abundance have been confounded by other events that affect stock size.

5. "Experts" do not necessarily agree on the results of the studies. My friend and colleague, Dr. Mike Dadswell, who is the most experienced fisheries biologist in the area has conducted the major studies of mortality using adult and juvenile shad at Annapolis. I co-supervised the study using juvenile shad, and have supervised further juvenile work since that joint research. The results came out as follows; adult mortality was above 20%: juvenile mortality above 50% on each passage through the turbine. Mike Dadswell accepts those figures as real, whereas I argue that they are too confounded by methodological problems to be reliable. However we both agree that mortality is far higher than the predictions made by the consultants prior to the building of the station: less than 5% for adult shad and 0% for juveniles.

Turbine mortality is, I suggest, a potentially project-breaking factor for the Doctors Creek project. If the system is used by numbers of large fish and reptiles I see no likelihood that these can be prevented from entering the turbines. If the stocks have value for conservation (e.g. turtles, saltwater crocodiles, rare fish) or commerce, then the degree of risk must be assessed before a decision is made to proceed" (Daborn, 1998; 9-11).

4.1.3 "A" Class Nature Reserve 1326

Land Administration Reserve Diagram 845, Lots 263 and 87: 878 hectares, situated in the Doctors Creek headwaters (Dept of Land Administration Ref. 2649/975, 4 January 1999).

"A nature reserve is proposed for an area to the south east of the mudflats of Doctors Creek on Lots 263 and 87 (Figure 5). The proposed nature reserve has the objective if protecting within the conservation estate the vegetation communities of an area of land that is representative of the mudflats, remnant Pleistocene pindan (red sand) dunes and sub-coastal black-soil plain of the south-west Kimberley."

"The construction of the tidal power station would alter the mean tidal height in both creeks and reduce the maximum tidal height being reached on spring tides, affecting the inundation patterns at the most easterly part of the mudflats. The altered hydrology of the creeks may also change the groundwater salinity near the margins of the mudflats, potentially affecting the fringing vegetation."

"CALM expressed concern over the potential impact on the proposed nature reserve from changes in surface and groundwater flow patterns" (Western Australia EPA Bulletin 942, 1999; 28).

4.2 Port development

The West Kimberley Resource Development Study Group seminar held in Derby in July 2004 announced an option to develop a port facility and/or gas pipeline from the Browse Basin, to come onshore at Point Torment, which forms the eastern shore of Doctors Creek. Biological and chemical pollution from shipping and pipelines are both environmental risks.

4.3 Gas pipelines

Empire Oil & Gas has a proposal to develop the Point Torment gas field and run a pipeline 20km across Doctors Creek to supply the new Derby power station. (Empire Oil & Gas release to Australian Stock Exchange, 17/12/2003). Construction and maintenance activity and release of hydrocarbons from accidental rupture of the pipelines all carry significant environmental risks to the Doctors Creek ecosystem.

4.4 Aquaculture farms

Two aquaculture farms already exist in the Doctors Creek catchment, one located on the tidal mudflats on the eastern side of Doctors Creek and one on shore close to the western side of Doctors Creek. The EPA considered groundwater depletion and water pollution of sufficient concern to place conditions on its environmental approval for the Kimberley Prawn Company's proposed 650ha expansion of its prawn ponds on the tidal mudflats of Doctors Creek. (Western Australia EPA Bulletin 918, 1998; 27).

4.5 Residential developments

Residential developments occur within the Doctors Creek catchment along both the eastern and western margins of the embayment. Stormwater drains into the Doctors Creek catchment, carrying the risks of pollution. Domestic dogs and cats predate in the mangrove forest. Recreational vehicle use cuts up and destroys fragile foreshore soils and vegetation.

DISCUSSION

The International and Heritage Significance of Doctors Creek

> **"In summary, a case can be developed for the protection of not just a type site of a geologic record, but more broadly an area that has been studied extensively from a geologic, geomorphologic and ecologic perspective. Had such broader criteria been applied by the Wilson review of marine/parks, it is possible that Doctors Creek may have achieved protected status of an earlier time" (Professor B.G. Thom, in Western Australia Environmental Protection Authority Bulletin 942; 1999, Attachment 1.)**

Geology

Doctors Creek (so named because its tidal mudflat was used by the Royal Flying Doctor Service as the original landing ground for its Derby base) is found in King Sound in the Kimberley region of Western Australia. It is trapped in an embayment between the Derby peninsula on the west and the Point Torment peninsula on the east. The embayment's catchment area is so small that there are no rivers or even significant streams to carry sediment into it.

The Doctors Creek basin represents a once-off globally unique and important system. This is because the natural force that shapes it is the largest tidal range for tropical mangroves in the world. The massive 12 metre tides cause the most extreme coastal erosion known to science as they scour out the soft muds of the estuary. The narrow mouth to the 130 square kilometre system isolates the embayment from the huge wet season replacement sediments flooding into the rest of King Sound from the Fitzroy, May and Meda rivers. For this reason no other tidal creek system in the world, or even in King Sound, is known to show the extreme end stage erosion exhibited in Doctors Creek. Combined with three other unusual geologic features:

-stratigraphic type location of the Christine Point Clay;
-relationship of the linear dunes to tidal flats;
-interaction of hinterland freshwater with tidal flat hypersaline water;

the extreme erosion qualifies Doctors Creek as a place of International geoheritage significance.

Mangroves

The extreme erosion forces the dense tropical mangrove forest growing above the banks of the creek (see photos 4 and 5) to retreat from the sea, rather than advance into it as is usual with mangroves. Normal, advancing tropical mangrove forests have a simple structure of a few species growing in lineal zones along the shoreline. The 11 mangrove and six samphire species growing in the retreating Doctors Creek forest have been shown to possess one of the most complex and rapidly evolving mangrove structures (20 species associations) ever recorded. Some of these species associations are not known to occur anywhere else in the world, not even in King Sound.

Other systems that have huge tides either lack mangroves (Bay of Fundy, St Helier, Mont St Michel, Puerto Galegos), or have only a few species (Bhavnagar). This underpins the global significance of the Doctors Creek forest.

Marine fauna

The richness of the Doctors Creek fishery is demonstrated by its status as a culturally important traditional fishing ground for Derby's Aboriginal people, who reliably catch barramundi, golden grunter, salmon, mangrove jack, catfish, bug-eye mullet, mudcrabs, sharks, rays and sawfish in its waters. The fishery plays an important role in both their fresh nutrition and their household economies.

The heavily eroded channels and the complex mangrove forest in Doctors Creek provide by far the largest, deepest and most sheltered estuarine habitat in the vicinity of the Fitzroy River mouth. The Fitzroy River itself contains the largest and most diverse assemblage of fish fauna in Western Australia. Many of those fish have a life cycle that includes Doctors Creek as an important part of their breeding and nursery habitat. Other marine fauna relying on Doctors Creek include protected species such as dugongs, Irrawaddy dolphins, crocodiles and green turtles (with nearby nesting sites), the extremely rare and critically endangered northern river shark (not previously recorded in Western Australia), the rare and endangered spear tooth shark and the critically endangered freshwater sawfish.

The richness of the fishery, with its cultural and ecological significance, defines Doctors Creek as a prime candidate for protection.

Threats

The need to consider Doctors Creek for protection is particularly urgent in light of the number of threats facing it.

Tidal power dam

The most severe threat is the proposed tidal power dam. There are three essential problems:
1. The first problem is that the dam will almost completely destroy the globally important mangrove forest, stripping the estuary of the basis of its food chain, the foundation of its habitat and its only protection from the extreme erosion.

2. The second problem is that the dam will create what is in effect a giant fish trap. Most of the fish move in and out with each tide. The dam will let them in but when the gates close at high tide, the only way out will be through the turbines. Many years of research on the Bay of Fundy tidal station have shown that about 20% of adult fish and about 50% of juvenile fish are killed or severely maimed on each pass through the turbines.

The suggested use of an exclusion mesh does not solve the problem as it will still let all the juveniles through to be injured or killed, but will permanently trap the adults and have an effect on their breeding cycles. Given the number of extremely rare, critically endangered and protected species using the estuary and its significance as a fishery and nursery for the Fitzroy River fauna, this is not acceptable.

3. The third problem is that although the dam will impound water in a lagoon inside the steep banks of the creek, it will at the same time permanently lower the average height of the flooding spring tides inside the dam by nearly a meter. This happens because of the constricted entry of water through the dam gates on the incoming tide and the 24-hour off take of water through the turbines to generate power. The result is that 130 square kilometres of tidal mudflats will never be flooded again. They will dry out into a fine saline dust, which the prevailing winds will blow straight

into Derby. Everyone who lives in Derby has experienced the heavy dust storms that come off the mudflats even when the spring tides flood them normally, 13 times a year. The enormity of the problem when the mudflats dry out because of the tidal dam is difficult to imagine.

Another cost of lowered tidal heights will be damage to the proposed "A" class nature reserve in the headwaters of the creek. The altered surface and groundwater flow patterns following the loss of the spring tide flooding will compromise the survival of the flora and fauna in the reserve.

Port development

The West Kimberley Resource Development Study Group announced in July 2004 an option to develop a port facility and/or gas pipeline from the Browse Basin gas field to come onshore at Point Torment, which forms the eastern shore of Doctors Creek. Biological and chemical pollution from shipping, port infrastructure and pipelines all constitute environmental risks.

Gas pipelines

Empire Oil & Gas has a proposal to develop the Point Torment gas field and run a pipeline 20km across Doctors Creek to supply the new Derby power station. Construction and maintenance activity and release of hydrocarbons from accidental rupture of the pipelines all carry significant environmental risks to the Doctors Creek ecosystem.

Aquaculture farms

The Environmental Protection Authority considered groundwater depletion and water pollution of sufficient concern to place conditions on its environmental approval for the Kimberley Prawn Company's proposed 650ha expansion of its prawn ponds on the tidal mudflats of Doctors Creek.

Residential developments

Residential developments occur within the Doctors Creek catchment along both the eastern and western margins of the embayment. Storm water and groundwater drains it, carrying pollution. Domestic dogs and cats predate in the mangrove forest. Careless recreational vehicle use cuts up and destroys delicate foreshore soils and vegetation.

It is my hope that this description of the unique, globally significant geologic and biologic forces at work in Doctors Creek will help all those concerned with the environment to understand, enjoy and protect the remarkable natural phenomenon on Derby's northern shore.

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Derby
Wednesday, 9 February 2005

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PHOTOGRAPHS

1. Small pool near top of tidal creek some distance inland from the edge of the Doctors Creek mangrove forest (in background). It has a permanent population of several species of crabs and gobioid fishes (mud skippers) that survive the few days a month when it dries out during neap tides by burying themselves in the mud.

2. Medium-sized permanent tidal pool on inland edge of the mangrove forest. A large school of bug-eye mullet can be seen shoaling at the near right hand edge of the pool.

3. Large permanent tidal pool (approximately 2 metres deep, 3 metres wide and 40 metres long) inside the mangrove forest. Note the school of bugeye mullet along the shore. A rare Great-billed Heron fishes this pool.

4. The main channel of West Doctors Creek, 11km up the 14km long tidal creek. This photograph was taken 2 hours after extreme low tide, approximately an hour before the tide returned to this point, and shows the strongly flowing river that runs permanently between the high tides and connects the numerous deep pools in the main channel.

5. Deep permanent tidal pool in the main channel of West Doctors Creek (approximately 10 metres wide by 1.5km long, depth unknown; located 10km up the 14km long creek). Such pools are common throughout most of the combined 26km length of the two branches of Doctors Creek. The traditional owners catch barramundi, golden grunter, salmon, mangrove jack, catfish, bug-eye mullet, mud crabs, sharks, rays and sawfish in these pools.

These five photographs of Doctors Creek were taken by Derby resident James Pillsbury in 2001 when the tide was out. The photographs are of typical small, medium and large permanent pools. There are thousands of such pools in the Doctors Creek mangrove forest.