E1118 VOL. 18

PROJET ILMÉNITE

PLAN DE GESTION ENVIRONNEMENTALE SECTORIEL

PORT D'EHOALA – PHASE CONSTRUCTION

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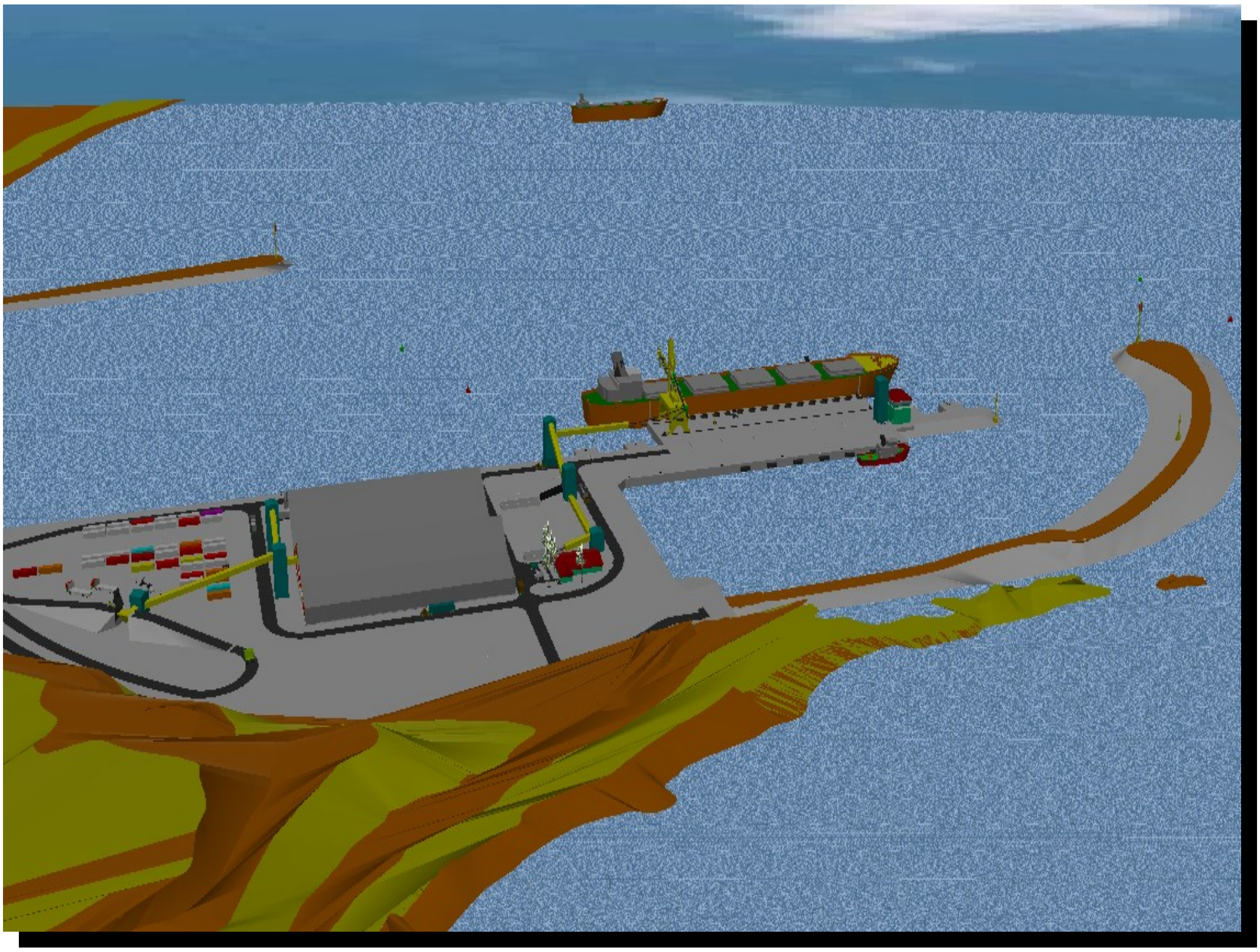

Déposé par QIT Madagascar Minerals S.A. (QMM S.A.) auprès de
l'Office national pour l'environnement de Madagascar
Mai 2006

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COMPLEXE PORTUAIRE D'EHOALA
PHASE CONSTRUCTION

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INTRODUCTION

Le Plan de gestion environnementale sectoriel (PGES) relatif à la construction du complexe portuaire d'Ehoala a été élaboré par QIT Madagascar Minerals S.A. (QMM) et constitue un outil de gestion permettant de rencontrer les exigences légales ainsi que les engagements pris par QMM dans son Plan de gestion environnementale du projet (PGEP) de novembre 2001.

Le présent PGES a pour objectif de présenter les mesures environnementales retenues pour éliminer, atténuer ou compenser les impacts potentiels des activités sur les milieux naturel et social, et ce, pour chacune des composantes constituant la phase construction du complexe portuaire d'Ehoala. **Pour ce qui a trait de la phase exploitation, un PGES sectoriel sera présenté ultérieurement.**

Pour la phase de construction, les sources d'impacts se résument aux activités habituelles de construction (préparation d'accès, terrassement, etc), aux activités de dragage et de dynamitage (s'il y a lieu), à la valorisation des déblais de dragage pour la mise en place d'un terre-plein, la construction des quais et la construction des installations visant à assurer le fonctionnement du port. À ces activités, s'ajoute l'achalandage routier engendré par les activités sur les chantiers, à la perturbation associée à la circulation routière à proximité des chantiers.

Les objectifs spécifiques de ce PGES sectoriel sont les suivants :

- assurer l'existence d'un Code de bonnes pratiques environnementales visant à minimiser et à surveiller les répercussions sur l'environnement;
- assurer la mise en place et la prise en compte des mesures d'atténuation, en particulier lorsque celles-ci sont soumises à des conditions d'approbation environnementale;
- exposer les responsabilités incombant à l'équipe de conception et de construction (Mandena Joint Venture) et aux entrepreneurs;
- fournir des exigences concernant la formation et la sensibilisation des différents intervenants à l'environnement;
- s'assurer de la compatibilité de ce PGES avec les engagements figurant dans le PGEP.

Le présent rapport est composé de cinq principales sections.

La section 1 présente la politique de Rio Tinto envers l'environnement, les engagements pris par QMM et les exigences adressées à l'équipe de conception et de construction (Mandena Joint Venture) et aux entrepreneurs.

La section 2 présente l'approche méthodologique préconisée pour élaborer les mesures environnementales. La section 3 présente une description technique des activités prévues pour la construction des infrastructures portuaires.

La section 4 présente les caractéristiques du milieu récepteur, les impacts potentiels et les mesures d'optimisation, d'atténuation ou de valorisation retenues relativement aux milieux naturel et social. Dans la section des mesures d'atténuation, le lecteur retrouvera les mesures spécifiques applicables à l'élément analysé. En ce qui a trait aux mesures de protection de l'environnement (bonnes pratiques environnementales) le lecteur est référé à la section 5.

La section 5 décrit les exigences environnementales, sous forme de Code de bonnes pratiques, que tout entrepreneur mandaté devra respecter pour garantir une bonne qualité d'exécution et la protection de l'environnement. Ces exigences environnementales seront intégrées au niveau des cahiers d'appel d'offre et feront partie intégrante du *Cahier des charges et devis généraux* de l'équipe de conception et de construction (Mandena Joint Venture) et de l'entrepreneur mandaté. Les bonnes pratiques environnementales sont présentées par éléments environnementaux (air, eau, etc.).

1. POLITIQUE DE RIO TINTO, ENGAGEMENTS ET EXIGENCES DE QMM

1.1 Politique de Rio Tinto

Rio Tinto s'est fixé des normes environnementales et communautaires rigoureuses pour la conduite de ses différentes activités et reconnaît qu'une excellente gestion de ses responsabilités en matière d'environnement est essentielle à son succès à long terme. Les différentes pratiques implantées par QMM sont en lien avec la politique de Rio Tinto. Elles visent à minimiser tout impact défavorable éventuel des activités de QMM sur l'environnement et à apporter une contribution positive à la vie des communautés locales.

1.2 Engagements de QMM

Dans la conduite de ses activités, QMM s'engage à se conformer aux exigences environnementales malgaches applicables à ses activités, de même qu'aux conditions d'exécution de son permis environnemental (PGEP). QMM s'engage à exceller en matière d'environnement par l'amélioration continue de ses connaissances, de sa compréhension des enjeux et de ses performances. La poursuite de l'excellence dans la gestion de ses responsabilités en matière de protection de l'environnement est essentielle à sa réussite à long terme et contribuera à l'atteinte du développement durable pour le bénéfice de l'ensemble des employés et des collectivités.

Pour maintenir ses engagements, QMM appuie ses pratiques sur les exigences d'un système de gestion basé sur la norme internationale ISO 14 001 pour l'environnement et celle de l'OHSAS 18000 en ce qui a trait à la santé et à la prévention des accidents. Ce système de gestion est en voie d'élaboration et une accréditation est prévue à la suite du démarrage de la phase d'exploitation du projet QMM.

1.2.1 Programme de surveillance et de suivi environnemental

Dans son PGEP, QMM s'est engagée à faire respecter les lois, les règlements, les directives, les codes et les clauses contractuelles relatifs à l'environnement sur les chantiers, et à tenir compte de l'environnement dans toutes les activités de conception et de construction au cours de cette période.

Le programme de protection de l'environnement et de suivi environnemental vise les objectifs suivants :

- assurer la protection de l'environnement durant la mise en place des infrastructures du complexe portuaire;
- vérifier la justesse des prévisions et des évaluations de certains impacts, particulièrement ceux pour lesquels subsistent des incertitudes dans l'étude d'impact;
- identifier les impacts qui n'auraient pas été anticipés, et le cas échéant, mettre en place des mesures environnementales appropriées;
- évaluer l'efficacité des mesures environnementales mises en œuvre;
- obtenir des informations et/ou des renseignements permettant d'améliorer les méthodes de prévision des impacts de projets similaires;
- produire des rapports qui seront diffusés publiquement.

QMM, par l'entremise d'une équipe de surveillance environnementale des opérations sur les chantiers de construction et d'une équipe de suivi environnemental relativement aux aspects sociaux et biophysiques, sera responsable de l'application et du suivi des mesures proposées tels que présentés à la sections 4 et des mesures de protection de l'environnement retrouvée à la section 5 du présent PGES.

Le tableau suivant décrit les principales activités environnementales liées à la construction du complexe portuaire d'Ehoala.

1.3 EXIGENCES DE QMM

Cette rubrique présente les responsabilités organisationnelles relatives à la mise en place du PGES. Elle permettra de guider les membres du personnel quant à leur rôle et leurs responsabilités concernant la gestion de l'environnement dans le cadre du projet. Des responsabilités spécifiques sont attribuées à QMM, à l'équipe de conception et de construction (Mandena Joint Venture) et aux entrepreneurs. L'établissement des rôles et responsabilités liés à la gestion de l'environnement permet à la fois d'améliorer la sensibilisation et d'augmenter la responsabilisation, notamment dans les prises de décisions.

1.3.1 RESPONSABILITÉS DE QMM

Afin d'assurer une gestion adéquate de l'environnement dans le cadre des activités de construction du complexe portuaire, QMM s'engage à :

- mettre sur pied une équipe responsable de la protection de l'environnement sur les différents chantiers de construction et une équipe responsable du suivi environnemental des aspects sociaux et biophysiques;
- faire respecter les engagements contenus dans le PGEP et le PGES approuvés par l'ONE;
- élaborer et mettre en application des procédures de protection de l'environnement sur les différents chantiers;
- contrôler au quotidien les travaux de chantier, les installations et les activités des entrepreneurs;
- surveiller la qualité d'exécution et l'approbation des travaux d'environnement (mesures d'atténuation, de compensation et de mise en valeur);
- supporter l'équipe de conception et de construction (Mandena Joint Venture) et les entrepreneurs en terme de conseil technique, d'information et de sensibilisation environnementale;
- gérer avec diligence les plaintes;
- délimiter et protéger les éléments sensibles;
- élaborer des programmes de suivi environnemental relatifs aux différentes composantes du milieu biophysique et sociales qui présentent des enjeux;
- produire un rapport de démarrage des chantiers comprenant entre autres les plans et devis de construction;
- produire un rapport relatif à la surveillance environnementale des chantiers de construction ainsi qu'au suivi environnemental des composantes biophysiques et sociales identifiées comme étant des enjeux et le transmettre à l'ONE et aux autres organisations impliquées (PIC, BM).

Principales activités environnementales liées à la construction du complexe portuaire d'Ehoala

PHASE PRÉPARATOIRE	PHASE DE CONSTRUCTION DES INFRASTRUCTURES	
Conception	Ingénierie détaillée	Mise en place des infrastructures
La gestion de l'environnement intégrée à l'ingénierie préliminaire du projet	La gestion de l'environnement intégrée à l'ingénierie détaillée du projet	La surveillance des travaux de construction des différentes infrastructures et la réalisation des travaux d'environnement
Études techniques, sociales, environnementales et économiques. Études d'impacts en vue de l'obtention des permis de mise en place et d'exploitation.	Optimisation de certains ouvrages et/ou de leurs modalités de réalisation. Vérification des plans et devis ainsi que des documents d'appels d'offres relativement aux clauses environnementales. Optimisation et préparation des plans et devis de toutes les mesures d'atténuation, de mise en valeur et de compensation devant être réalisées à la phase de construction du projet. Réalisation des études environnementales complémentaires s'il y a lieu. Suivi des composantes environnementales identifiées.	Contrôle quotidien des travaux de chantier, des installations et des activités des entrepreneurs. Réalisation des mesures d'atténuation, de mise en valeur et de compensation. Surveillance de la qualité d'exécution et approbation des travaux d'environnement. Suivi des composantes environnementales identifiées. Production du manuel d'exploitation intégrant les consignes environnementales.

1.3.2 RESPONSABILITÉS DE L'ÉQUIPE DE CONCEPTION ET DE CONSTRUCTION (MANDENA JOINT VENTURE)

L'équipe de conception et de construction est tenue de se conformer aux pratiques environnementales applicables aux activités de construction du complexe portuaire et s'engage à :

- intégrer aux plans et devis et aux documents d'appels d'offres les mesures environnementales énoncées dans les PGEP et PGES ayant une incidence sur les travaux de construction;
- s'assurer que l'ensemble du personnel de supervision et de gestion connaît et comprend ses responsabilités dans le cadre du présent PGES;
- s'assurer que le PGES est compris et mis en œuvre par l'ensemble du personnel travaillant sur les sites de construction et procédant à des activités;
- s'assurer que les différents entrepreneurs engagés respectent les clauses contractuelles de protection de l'environnement environnementales et la mise en place des mesures d'atténuation, de mise en valeur et de compensation prévues. Les clauses contractuelles sont en lien direct avec le Code des bonnes pratiques environnementales présenté à la section 5;
- contrôler au quotidien les travaux de chantier, les installations et les activités des entrepreneurs;
- rendre compte à QMM de tout incident ayant des répercussions sur l'environnement naturel et social.

QMM exige de l'équipe de conception et de construction (Mandena Joint Venture) la mise sur pied d'une équipe de surveillance technique des travaux constituée de personnes compétentes et expérimentées.

1.3.3 RESPONSABILITÉS DES ENTREPRENEURS

Pour s'assurer du respect par ses entrepreneurs des exigences environnementales qu'elle impose à elle-même et à son maître d'œuvre, QMM a élaboré un Code de bonnes pratiques qui devront être intégrées dans les contrats des entrepreneurs. Les règles contractuelles sont établies en fonction des aspects et des impacts environnementaux en cause, des exigences légales associées aux travaux et des autres exigences auxquelles QMM se conformera.

Les entrepreneurs seront tenus de respecter les spécifications relatives à l'environnement énoncées aux sections 4 et 5 du présent PGES. De plus, les entrepreneurs devront présenter et faire approuver par QMM, avant le début des travaux, les méthodes de travail, des plans de gestion environnementale et de santé et sécurité au travail. Les entrepreneurs devront préciser et décrire les actions nécessaires pour répondre, entre autres, aux préoccupations suivantes:

- la gestion des sols;
- la gestion de l'eau;
- la gestion des matériaux dragués;
- la gestion des déblais;
- la gestion des déchets domestiques et des matières résiduelles;
- la gestion des matières et déchets dangereux;
- la gestion du matériel roulant et la sécurité routière;

- la gestion des émissions atmosphériques;
- la gestion du bruit;
- la gestion des produits pétroliers (huile de combustion, lubrifiant, etc.;
- un programme d'intervention en cas d'urgence environnementale;
- la protection de la santé et de la sécurité des employés;
- la sécurité publique;
- la formation des employés en matière de santé, sécurité et environnement;
- la gestion des pratiques opérationnelles standardisées et conformes aux politiques de QMM;
- toutes autres préoccupations qui leur seraient soumises.

2. APPROCHE MÉTHODOLOGIQUE

La méthodologie retenue pour élaborer les mesures de protection de l'environnement des chantiers de construction et de suivi environnemental des composantes biophysiques et sociales propres à la construction du complexe portuaire tient compte des recommandations formulées par l'Office National pour l'Environnement relativement aux principes à adopter pour la rédaction des PGES afin de permettre, aux analystes, une appréciation plus objective des données fournies par le promoteur. Par ailleurs, la méthodologie est similaire à celle utilisée lors de la rédaction de l'étude d'impact environnementale sectorielle (EIES) et du PGEP déposés à l'ONE. Par conséquent les lecteurs peuvent établir la concordance entre les différents documents. Ainsi, le présent PGES comporte les étapes suivantes :

Étape 1 : une description technique des activités prévues pour la construction du complexe portuaire d'Ehoala;

Étape 2 : une description des milieux touchés par les activités prévues;

Étape 3 : une description des impacts potentiels, l'identification des bonnes pratiques environnementales et des mesures d'atténuations proposées et/ou des mesures de suivi;

Étape 4 : une évaluation des impacts résiduels;

Étape 5 : une identification des indicateurs de performance environnementale.

2.1 DESCRIPTION TECHNIQUE

Le projet d'exploitation des sables minéralisés, dans la région de Fort-Dauphin, nécessite la mise en place d'un complexe portuaire. Le port d'Ehoala sera utilisé par QMM pour l'exportation d'environ 750 000 t d'ilménite et 25 000 t de zircon annuellement. Ces volumes correspondent à environ deux expéditions de 35 000 t par mois.

Le présent PGES donne une description technique du projet. Les sources d'impacts reliées à la construction du complexe portuaire susceptibles d'avoir un effet direct ou indirect sur un ou plusieurs éléments des milieux social et environnemental sont identifiées.

2.2 DESCRIPTION DES MILIEUX

Les éléments des milieux social et environnemental (biophysique) retenus pour l'analyse des impacts reliés à la construction du complexe portuaire sont d'une part ceux qui ont été présentés dans l'EISE déposé à l'ONE et d'autre part, les nouveaux enjeux identifiés à la suite de relevés complémentaires ainsi que l'élaboration des aspects techniques du projet.

À l'aide de l'approche éco-socio-systémique, les interrelations possibles entre les différentes activités du projet et les éléments du milieu ont été analysées. Cette approche a permis de déterminer et décrire les répercussions du projet sur les différents éléments des milieux social et environnemental (naturel).

Pour chaque milieu, les éléments suivants sont visés, à savoir :

MILIEU	ÉLEMENTS
NATUREL	Sols (profil et pente d'équilibre, surface et qualité des sols); Eau (ruissellement et infiltration, hydrologie et hydrogéologie, qualité des eaux); Flore (milieu ouvert, milieu marin); Faune (milieu ouvert, milieu marin).
SOCIAL	Santé (émissions atmosphériques, environnement sonore, santé communautaire, sécurité publique, santé et sécurité au travail); Utilisation du territoire (bâtiments résidentiel, industriel, commercial et institutionnel, services publics, exploitation des ressources agricoles et pâturage, exploitation des ressources halieutiques, exploitation des ressources forestières, potentiel touristique); Culture et patrimoine (sites funéraires, lieux sacrés et à valeur patrimoniale, paysage d'intérêt); Activité économique (secteur informel, emplois locaux, foncier et immobilier, circulation et transport des biens).

2.3 DESCRIPTION DES IMPACTS ET IDENTIFICATION DES MESURES D'ATTENUATION

L'analyse des impacts associés au projet consiste à identifier, décrire et évaluer les impacts potentiels des différentes activités reliées à la construction et à l'exploitation du port sur les composantes identifiées à l'étape 2 (description des milieux).

Ayant identifié les impacts (éléments du milieu affecté par une activité du projet), ceux-ci sont par la suite caractérisés. Chacune des interrelations établies est par la suite évaluée en fonction de trois critères :

- l'intensité du changement;
- la portée;
- la durée.

Ces trois critères sont d'abord évalués séparément, puis agrégés en un indicateur synthèse – l'importance de l'impact – qui permet de porter un jugement sur les effets prévus d'une activité reliée à un ouvrage sur un élément du milieu. Ces effets sont « mineur », « moyen » ou « majeur ».

Selon le type auquel il appartient, un impact peut être positif (amélioration) ou négatif (perturbation). À noter que le terme « négatif » n'est pas repris quand il s'agit d'un impact négatif, afin d'éviter les répétitions inutiles. Toutefois, pour qualifier l'importance d'un impact positif, on joindra au qualificatif (mineur, moyen ou majeur) le mot « positif ».

Pour plus de détails sur la méthode utilisée pour déterminer l'importance de l'impact, on se reportera à l'annexe 1 du présent PGES.

Les mesures d'atténuation sont des actions qui visent à éliminer ou à minimiser les impacts négatifs. Elles visent également à bonifier un impact positif sur un élément du milieu. Toutes ces mesures ont pour objectif de permettre une meilleure intégration du projet dans le milieu.

L'élaboration des mesures relatives au projet de construction du port tient compte des lois et règlements de Madagascar, des normes de bonnes pratiques dans le secteur de la construction, et des standards internationaux reconnus pour les projets d'infrastructure marine et côtière. Par ailleurs, le présent PGES tient compte des directives environnementales de la Banque Mondiale, dans le contexte du Projet de Pôles Intégrés de Croissance (Environmental Assessments of Mining Projects No. 22 (MN 22 et International Finance Corporation, Operational Policies, Natural Habitats (OP. 4.04)).

Enfin, les avis émis par l'ONE et les populations vivant dans le secteur d'Ehoala et directement touchées par le projet, de même que ceux des différents intervenants locaux, régionaux, nationaux et internationaux ont également été considérés.

2.4 ÉVALUATION DES IMPACTS RÉSIDUELS

Les impacts résiduels du projet ont été évalués en tenant compte :

- de l'importance de l'impact;
- des résultats escomptés de l'application des mesures d'optimalisation, d'atténuation ou de valorisation.

L'évaluation finale des impacts du projet repose sur le jugement porté quant à l'importance des impacts résiduels, c'est-à-dire ceux qui demeurent après l'application ou la non-application des mesures d'atténuation. Ils sont aussi qualifiés de « mineur », « moyen » ou « majeur ».

2.5 IDENTIFICATION DES INDICATEURS DE PERFORMANCE ENVIRONNEMENTALE

Pour vérifier les impacts potentiels décrits précédemment et pour assurer l'efficacité des mesures d'atténuation et de bonification proposées, QMM est à identifier des indicateurs qui permettront d'évaluer la situation et de réajuster les actions si nécessaire.

Les principaux critères qui guideront le choix des indicateurs environnementaux relatifs aux éléments sociaux et biophysiques sont :

- l'indicateur doit fournir une image représentative de l'état de l'environnement;
- l'indicateur doit fournir une image représentative des pressions environnementales;
- l'indicateur doit être simples, faciles à interpréter et à communiquer;
- l'indicateur doit permettre d'illustrer les changements dans l'environnement;
- l'indicateur doit convenir à l'échelle du projet et de ses répercussions sur l'environnement social et biophysique;
- l'indicateur doit entraîner de faibles coûts d'acquisition;
- l'indicateur doit avoir le soutien d'une documentation et jouir de la reconnaissance de sa qualité;
- l'indicateur doit faire l'objet de mises à jour périodiques, selon des intervalles spatiaux et temporels, et selon des procédures de mesure et d'échantillonnage appropriés à l'échelle du territoire étudié.

Pour ce qui a trait à la surveillance environnementale des travaux (protection de l'environnement), des critères seront également définis. Ceux-ci feront référence aux aspects règlementaires ou Code de bonnes pratiques environnementales applicables aux activités de chantier.

Les indicateurs de suivi au niveau de la phase construction du port seront disponibles préalablement au démarrage des activités de construction.

3. DESCRIPTION DU PROJET ET DE SES COMPOSANTES

3.1 MISE EN CONTEXTE

L'exploitation minière projetée par QMM permettra, pendant environ 40 ans, d'extraire de l'ilménite et de produire du 'Zirsill' (mélange de zircon et sillimanite) à partir d'un gisement de sable minéralisé situé près de la côte sud est de Madagascar, dans la région de Fort-Dauphin. Le gisement minier est réparti sur trois secteurs : Petriky, Mandena et Sainte-Luce. La première phase du projet concernera le secteur de Mandena où près de 750 000 t/a d'ilménite seront extraits. Le minerai sera par la suite exporté pour être transformé. Pour se faire, une installation portuaire est nécessaire. En appui à ses opérations, QMM utilisera cette installation pour l'importation de carburant à un rythme annuel de plus de 30 000 tonnes. En outre, un volume non déterminé de trafic conteneurisé sera requis pour l'acheminement d'équipements, d'engins, de matériels et de pièces de rechange nécessaires au bon fonctionnement de l'exploitation minière.

Comme le nouveau port d'Ehoala sera de nature publique, il prendra la relève du port existant pour les exportations de sisal et de produits de la pêche de même que pour les importations des produits de première nécessité (riz, farine, etc.), les matériaux de construction (ciment, acier, etc.) et, possiblement à terme, le carburant dans le cadre d'une relocalisation du dépôt existant du site actuel près du lac Lanirano vers le nouveau port. De plus, le nouveau port pourra accueillir le trafic associé au tourisme de croisière. Le trafic actuel au port existant ne reflète pas le réel potentiel de la région. L'avènement de ce nouveau port en eau profonde, combiné à sa proximité d'une zone de développement industrialo-portuaire à fort potentiel de croissance, ouvrira la porte à une croissance économique de la région de l'Anosy.

La construction de cette installation portuaire, sur le promontoire d'Ehoala dans la Fausse Baie des Galions au sud de la ville de Fort Dauphin, nécessitera le transport d'environ 1,5 million de tonnes de roc entre la carrière d'Andriambe et le site du port. Les travaux de construction dureront environ trois ans.

La figure 3.1 présente la localisation du futur complexe portuaire d'Ehoala.

3.2 OPTIMISATION DU CONCEPT PORTUAIRE D'EHOALA

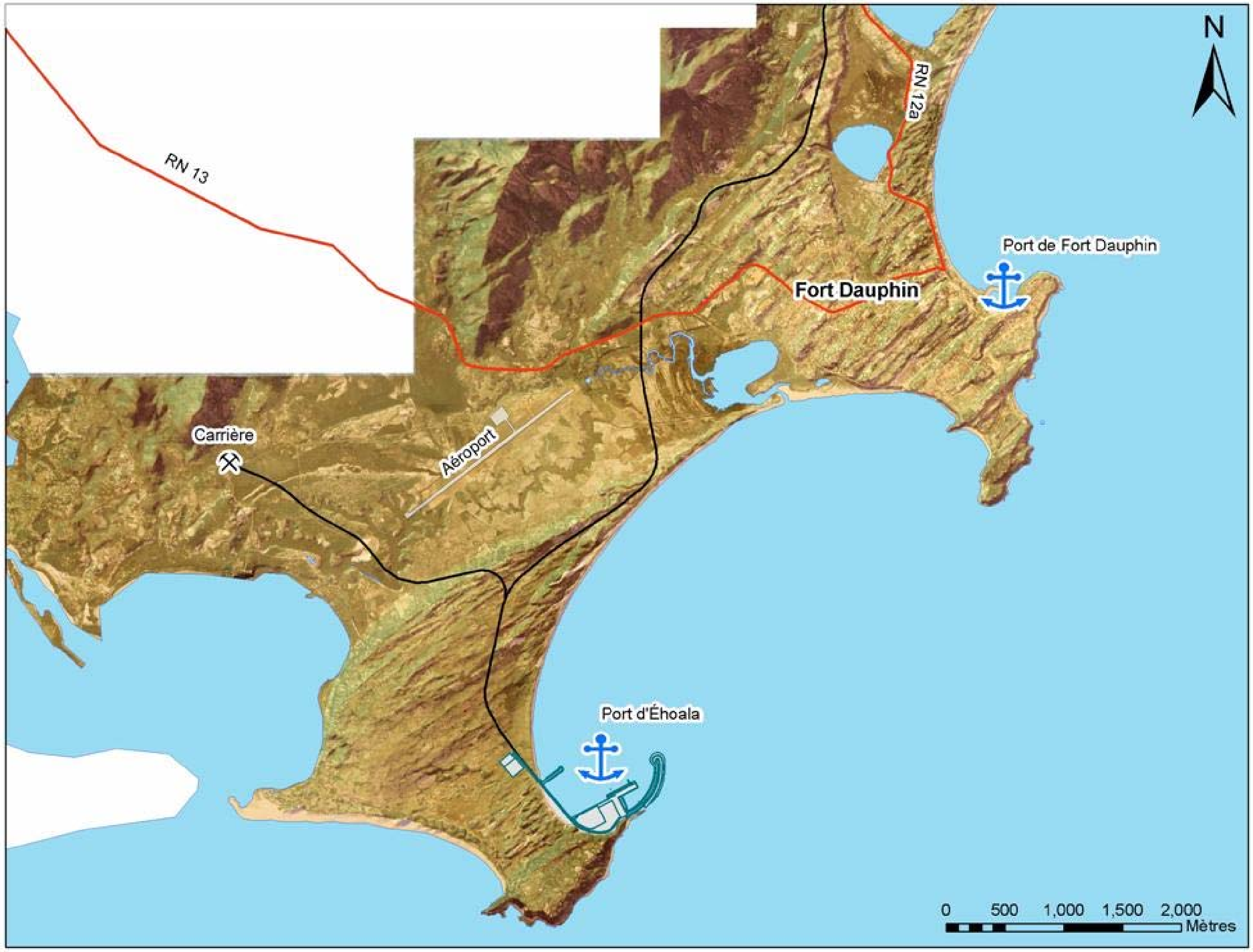
L'étude d'impact réalisée par QMM, en 2001 avait pour objet le projet d'exploitation minière proprement dite, y compris les infrastructures routière et portuaire associées.

L'infrastructure portuaire a fait l'objet d'études concernant le type de port (comparaison d'un quai protégé par un brise-lames vs une jetée non protégée et une bouée de corps-mort) ainsi que la localisation de ce port (comparaison des sites d'Ehoala avec Evatraha et Fort-Dauphin).

Les conclusions de ces études ont été présentées dans le rapport ÉISE déposé à l'ONE, en mai 2001. Les rapports techniques, ainsi que les études environnementales réalisées en appui au rapport de l'ÉISE, ont également été déposés à l'ONE sous forme d'annexes et de documents d'appui.

Les conclusions du rapport de l'ÉISE étaient à l'effet qu'un port protégé par un brise-lames situé sur le promontoire nord de la péninsule d'Ehoala représentait la meilleure alternative. Par la suite, dans le cadre des études de faisabilité du projet QMM, la nouvelle infrastructure portuaire a fait l'objet d'une optimisation. Ainsi, les travaux d'ingénierie réalisés en 2003 et 2004 ont permis d'apporter une

Figure 3.1 Localisation du complexe portuaire



meilleure définition au concept portuaire recommandé dans l'ÉISE de 2001. Cette optimisation a fait l'objet d'une revue, par l'ONE, de sa compatibilité avec le PGEP au début de l'année 2005. Également, dans le cadre de l'initiative de Projet de Pôles Intégrés de Croissance du Gouvernement de Madagascar (GdM) et de la Banque Mondiale, le concept portuaire proposé a fait l'objet d'une revue de sa conformité par rapport aux mesures de sauvegarde de la Banque Mondiale comme condition préalable à l'octroi d'un financement public pour l'infrastructure portuaire. Ce mandat de revue a été confié à une firme d'experts-conseils internationale, Tecsult.

Les conclusions de ces deux processus de revue ont confirmé, d'une part, la compatibilité du concept portuaire par rapport à l'ÉISE 2001, au Permis Environnemental et au Plan de Gestion Environnementale du Projet associé et, d'autre part, sa conformité par rapport aux mesures de sauvegarde de la Banque Mondiale.

3.3 DESCRIPTION DU COMPLEXE PORTUAIRE

QMM prévoit construire l'installation portuaire à Fausse Baie des Galions près de Fort Dauphin à Madagascar. Pour les besoins de QMM, le port servira à l'exportation d'ilménite en vrac, de 'Zirsill' ensaché par conteneurs, l'importation de carburants en vrac ainsi que la manutention de marchandises diverses en appui à l'exploitation minière. Dans le cadre de sa vocation publique, le nouveau port servira à l'exportation du sisal et des produits de la pêche ainsi qu'à l'importation des produits de première nécessité, des matériaux de construction, et du carburant pour les besoins de la région, de même qu'à l'accueil des navires de croisière.

L'installation portuaire consistera en :

- la construction d'un brise-lames en enrochement d'une longueur approximative de 600 m à la pointe d'Ehoala située à l'extrémité sud de la Fausse Baie des Galions;
- le dragage de 855 000 m^3 de substrat marin pour former un chenal d'accès (300m, -17.0m), un cercle de navigation des navires, et une zone d'approche au quai principal;
- la construction d'un quai polyvalent comprenant deux postes à quai :
  - un quai primaire de 275 m de longueur permettant l'accostage de navires allant jusqu'à 230 m de longueur, tels les vraquiers, les porte-conteneurs et cargos divers ainsi que des navires de croisière;
  - la construction d'un quai secondaire de 190 m de longueur situé dans une darse protégée par le brise-lames et pouvant accueillir les navires de cabotage côtiers faisant actuellement escale à Fort-Dauphin ainsi que les bateaux de service du port tels les remorqueurs et pilotine;
- la construction d'un épi d'enrochement pour restreindre le mouvement du sable littoral le long de la plage située au nord du port;
- l'aménagement de 11,5 hectares de terre-plein, derrière le quai, à partir des déblais de dragage. Ce terre-plein pourra ultérieurement être utilisé pour l'entreposage de conteneurs, de matériaux en vrac, et pourra accueillir des installations pour la manutention de marchandises, l'administration du port et des services portuaires, selon la demande pour ce genre d'installation;
- la construction de 1 500 m de murs de soutènement/digues pour la route côtière, de la route d'accès et de la zone de confinement des matériaux de dragage pour l'établissement du terre-plein;
- l'aménagement sur la péninsule d'Ehoala d'une zone nivelée d'environ 9 hectares pour la construction des réservoirs d'hydrocarbures, des bureaux et des entrepôts.

Les figures 3.2 et 3.3 présentent l'aménagement du complexe portuaire d'Ehoala.

Figure 3.2 Aménagement général du complexe portuaire d'Ehoala

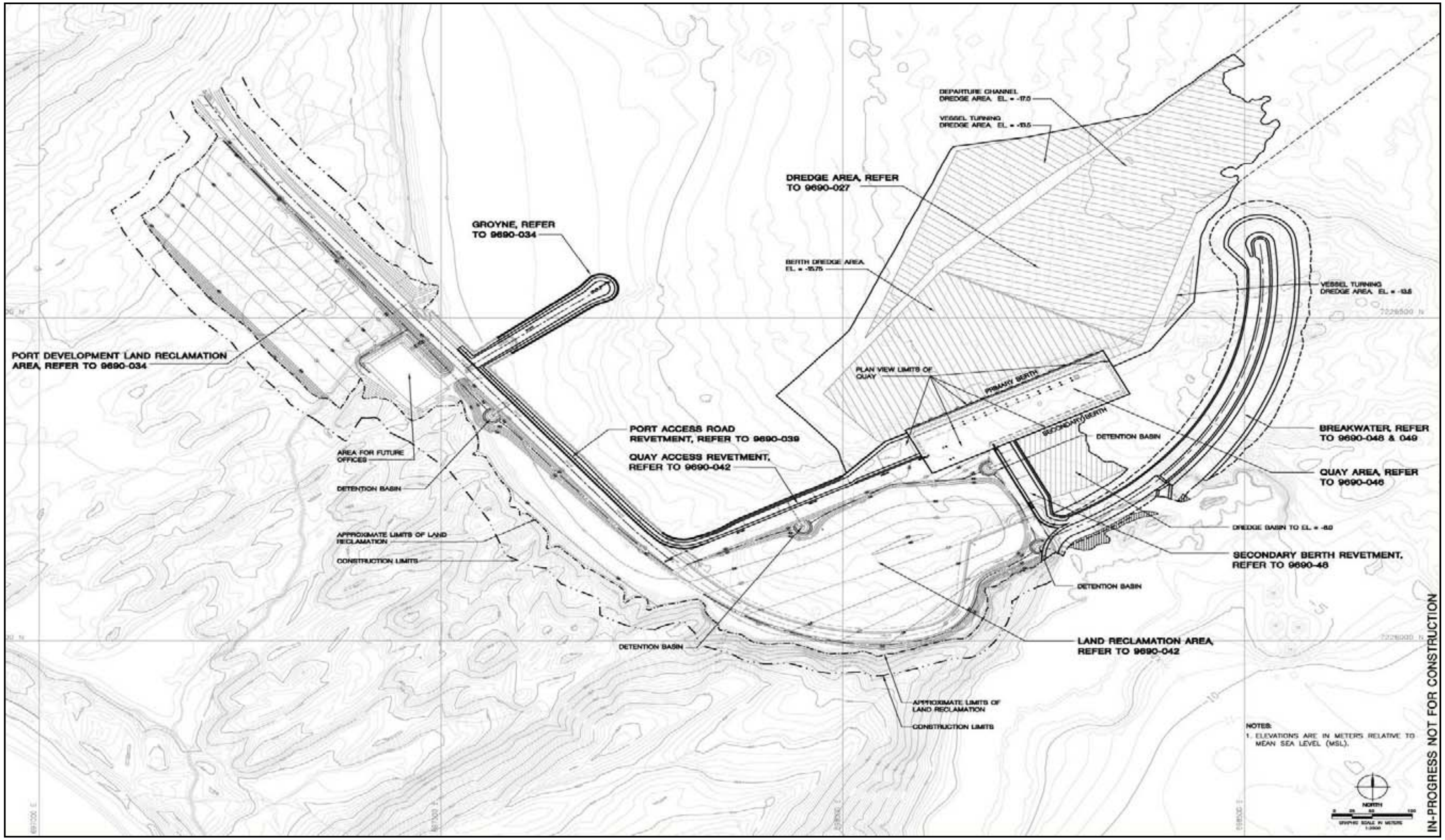
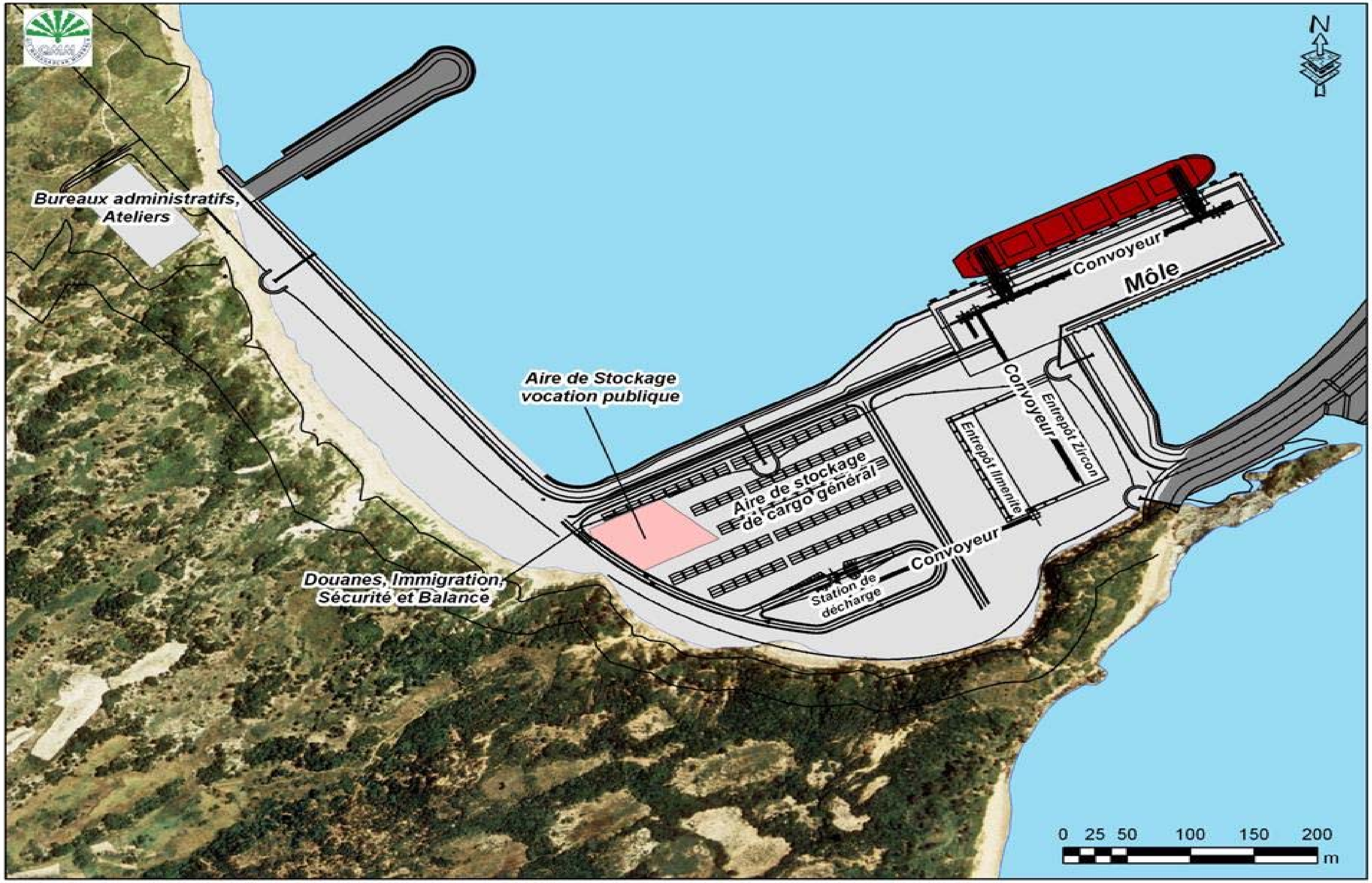


Figure 3.3 Aménagement des installations portuaires d'Ehoala



3.4 MÉTHODES DE CONSTRUCTION

3.4.1 PHASES ET ÉCHÉANCIER DE CONSTRUCTION

Dans le secteur de la Fausse Baie des Galions, la houle peut atteindre des hauteurs de l'ordre de 3 à 4 m. Dans ce contexte, la construction des principales structures portuaires devra être réalisée par étapes. Par exemple, les travaux de construction du brise-lames doivent être suffisamment avancés pour permettre de réaliser les travaux de dragage et d'établissement du terre-plein en toute sécurité.

La stratégie de construction du port, sera la suivante :

Phase 1 : Mobilisation des équipements au site de carrière et en débuter les opérations (travaux ayant déjà fait l'objet d'un PGES sectoriel et déposés à l'ONE);

Phase 2 : Construction d'un épi d'enrochement provisoire et la route d'accès côtière jusqu'au brise-lames; construire une hauteur initiale du brise-lames sur sa pleine longueur; construire les digues de soutènement qui serviront à contenir les déblais (zone de confinement des matériaux dragués);

Phase 3 : Dragage des surfaces requises pour construire le quai secondaire et ses approches, acheminement des déblais de dragage dans l'aire de confinement; construction du quai de la darse et amorce de la construction définitive de la route d'accès au quai;

Phase 4 : Construction du dernier poste à quai et la route d'accès côtière; finalisation du dragage et remise en état du terrain; finalisation du mur principal du quai et du remblai;

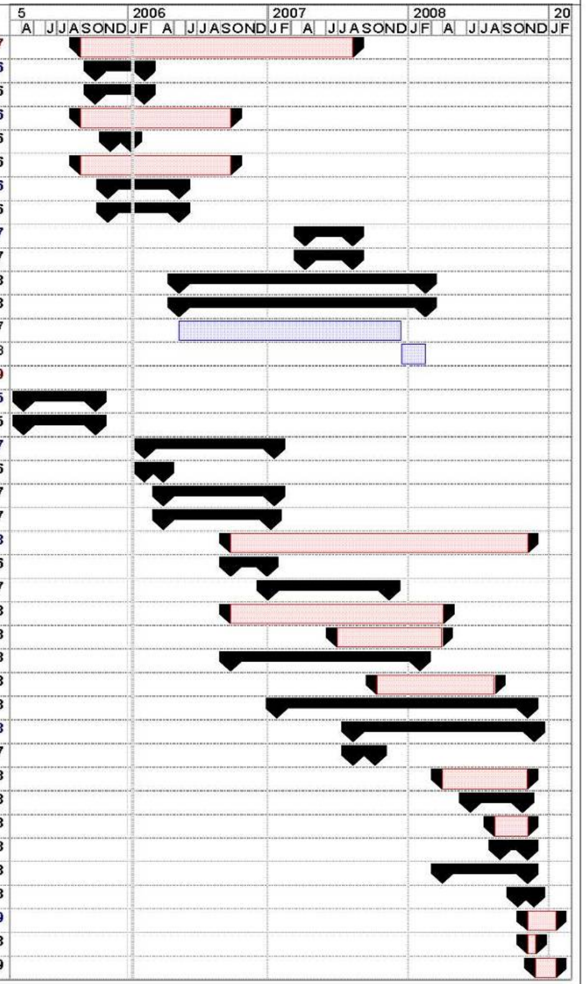
Phase 5 : Mise à la disposition de l'entrepreneur des infrastructures civiles du quai et de l'aire de terre-plein et au besoin, finaliser la mise en place de l'enrochement de protection couvrant le brise-lames.

L'achèvement des travaux portuaires est requis pour septembre 2008 (voir figure 3.4). Environ 260 personnes seront nécessaires pour la construction des infrastructures portuaires. De la main-d'œuvre étrangère sera probablement nécessaire. Celle-ci sera logée dans un campement temporaire installé à proximité de la carrière d'Andriambe. Ce campement sera pourvu des services requis pour le logement, l'approvisionnement en eau à partir de puits forés, l'électricité à l'aide d'une génératrice diesel, et le couvert pour nourrir la main-d'œuvre durant les travaux de construction du port, pour une durée estimée à près de trois ans. Un système de gestion des matières résiduelles et des eaux usées sera également mis en place. Les déchets domestiques seront collectés et acheminés vers un site d'élimination aménagé et situé à proximité du campement.

Figure 3.4 Échéancier des travaux de construction du complexe portuaire d'Ehoala

Port D'Ehoala
Updated 11th January 2006
DRAFT FOR REVIEW
Summary

ID	Task Name	Cal	Start	Dur	Finish
1	TENDER & AWARD CONTRACTS	D	2-09-2005	486d	10-08-2007
2	EARLY WORKS CONTRACT	D	10-10-2005	82d	14-02-2006
3	Tender & Award Contract	D	10-10-2005	82d	14-02-2006
10	PORT CONTRACT	D	2-09-2005	268d	26-09-2006
11	Prequalification	D	18-11-2005	27d	9-01-2006
14	Tender & Award Contract	D	2-09-2005	268d	26-09-2006
31	SHIP LOADER SUPPLY CONTRACT	D	11-11-2005	122d	15-05-2006
32	Tender & Award Contract	D	11-11-2005	122d	15-05-2006
39	PLANT BUILDINGS - PORT	D	9-04-2007	90d	10-08-2007
40	Tender & Award Contract	D	9-04-2007	90d	10-08-2007
47	PROCUREMENT	C	16-05-2006	543d	15-02-2008
48	SHIP LOADER PROCUREMENT	C	16-05-2006	543d	15-02-2008
49	Fabricate & Deliver Ship Loader	D	16-05-2006	404d	14-12-2007
50	Deliver Ship Loader	D	17-12-2007	35d	15-02-2008
51	CONSTRUCTION	C	7-04-2005	1166d	19-01-2009
52	PIONEERING CONTRACT	C	7-04-2005	160d	10-10-2005
53	CAMP CONSTRUCTION	C	7-04-2005	160d	10-10-2005
57	EARLY WORKS CONTRACT	C	15-02-2006	287d	18-01-2007
58	MOBILISATION	C	15-02-2006	42d	4-04-2006
60	HAUL ROADS	C	5-04-2006	245d	18-01-2007
66	QUARRY DEVELOPMENT	C	5-04-2006	237d	9-01-2007
74	PORT CONTRACT	C	27-09-2006	648d	7-11-2008
75	MOBILISATION	C	27-09-2006	80d	30-12-2006
79	QUARRY OPERATION	C	2-01-2007	270d	12-11-2007
85	MARINE ROCK STRUCTURES	C	27-09-2006	467d	2-04-2008
102	DREDGING	C	2-07-2007	229d	29-03-2008
111	CAISSON MANUFACTURE	C	27-09-2006	416d	1-02-2008
157	CAISSON INSTALLATION	C	12-10-2007	252d	13-08-2008
215	FINISHING WORKS & SHIP LOADER	C	25-01-2007	548d	7-11-2008
230	PLANT BUILDINGS - PORT CONTRACT	C	11-08-2007	392d	24-11-2008
231	MOBILISATION	C	11-08-2007	50d	8-10-2007
233	CIVIL WORKS	C	29-03-2008	183d	6-11-2008
238	STRUCTURE, MECHANICAL & PIPING	C	12-06-2008	112d	25-10-2008
242	ELECTRICAL & INSTRUMENTATION	C	14-08-2008	72d	7-11-2008
245	FIRE PROTECTION & DETECTION	C	28-08-2008	60d	7-11-2008
249	ADMINISTRATION BUILDINGS AND WORKSHOPS	C	31-03-2008	184d	7-11-2008
257	NAVIGATIONAL AIDS	C	14-10-2008	36d	24-11-2008
259	COMMISSIONING	C	8-11-2008	58d	19-01-2009
260	COLD COMMISSIONING	C	8-11-2008	18d	28-11-2008
262	HOT COMMISSIONING	C	29-11-2008	40d	19-01-2009



Flagstaff Consulting Group Pty Ltd   Page 1   FCG Madagascar Port Schedule - Updated 2005-01-11.mpp
Printed: 12-01-2006

3.4.2 Description des travaux

3.4.2.1 Route d'acces au port

La construction d'une route d'accès au brise-lames sera nécessaire. Cette section de la route de transport près de la côte aura une crête d'une hauteur variant de +4 m à +6 m NMM et nécessitera un matériau de protection servant à protéger la pente du remblai de la route contre l'action des vagues.

La figure 3.5 illustre l'emplacement et la longueur de la route d'accès au port, et la figure 3.6 illustre les sections transversales typiques de la route d'accès au port. Le tableau ci-dessous présente le volume de matériaux requis pour la route d'accès au port.

Type de pierres	Volume (m^3)
Matériau de protection (Catégorie III) (2 000 kg – 6 000 kg)	10 600
Filtre (Catégorie IV) (750 kg – 2 000 kg)	5 500
Matériau du noyau (1 kg – 2000 kg)	117 800
Assise (Catégorie VI) (1kg – 75 kg)	5 100
Enrochement (500 kg – 2 000 kg)	8 900
Total	147 900

3.4.2.2 Construction d'un epi d'enrochement

Un petit épi d'enrochement sera construit jusqu'à une profondeur d'eau de - 0,5 m NMM immédiatement au nord de la zone du port (voir figure 3.5). Cet épi d'enrochement donnera accès à la plage et permettra le transfert du matériel de construction des barges jusqu'à la rive. La longueur initiale de l'épi sera d'environ 60 mètres. Le tableau ci-dessous présente le volume de roc requis pour construire l'épi.

Type de pierres	Volume (m^3)
Matériau de protection (Catégorie III) (2 000 kg – 6 000 kg)	3 500
Filtre (Catégorie IV) (750 kg – 2 000 kg)	1 100
Matériau du noyau (1 kg – 2 000 kg)	6 100
Assise (Catégorie VI) (1kg – 75 kg)	650
Total	11 350

Après la construction du port, l'épi sera prolongé jusqu'à une profondeur d'eau de - 2 m NMM, avec une longueur totale d'environ 200 mètres. Cet épi de rocher servira à empêcher la migration du sable vers le sud, dans les zones de dragage du poste à quai principal. Selon les résultats des suivis relatifs aux changements littoraux pendant la construction du brise-lames, la longueur de l'épi pourra être optimisée afin d'empêcher le sable de se déplacer autour de l'extrémité de l'épi. Le tableau ci-dessous présente le volume de roc anticipé pour construire l'épi définitif.

Type de pierres	Volume (m^3)
Matériau de protection (Catégorie III) (2 000 kg – 6 000 kg)	8 200
Filtre (Catégorie IV) (750 kg – 2 000 kg)	1 400
Assise (Catégorie VI) (1kg – 75 kg)	800
Matériau du noyau (1 kg – 2 000 kg)	23 400
Granulats	1 100
Total	34 900

Figure 3.5 Route d'accès au port et épi préliminaire

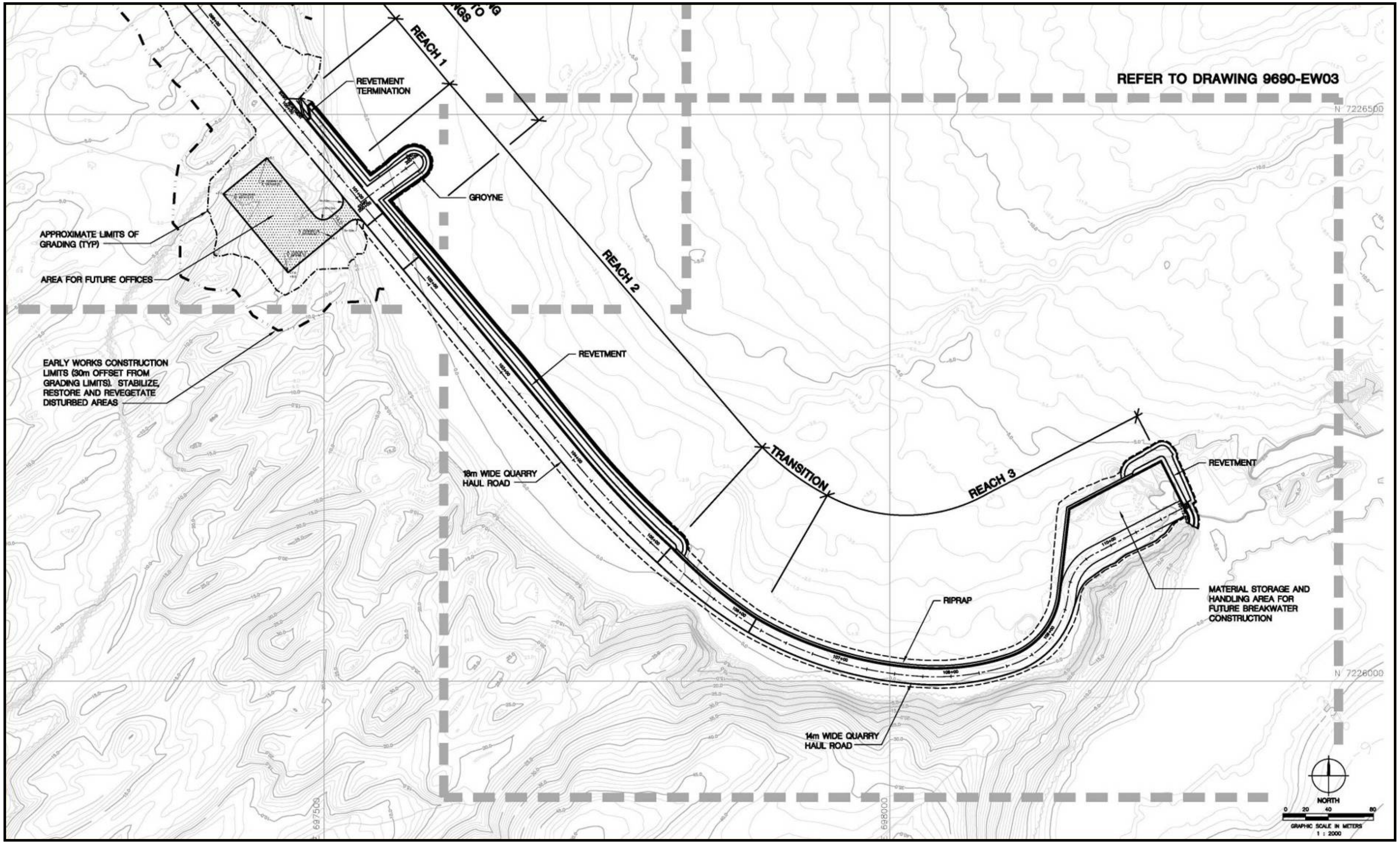
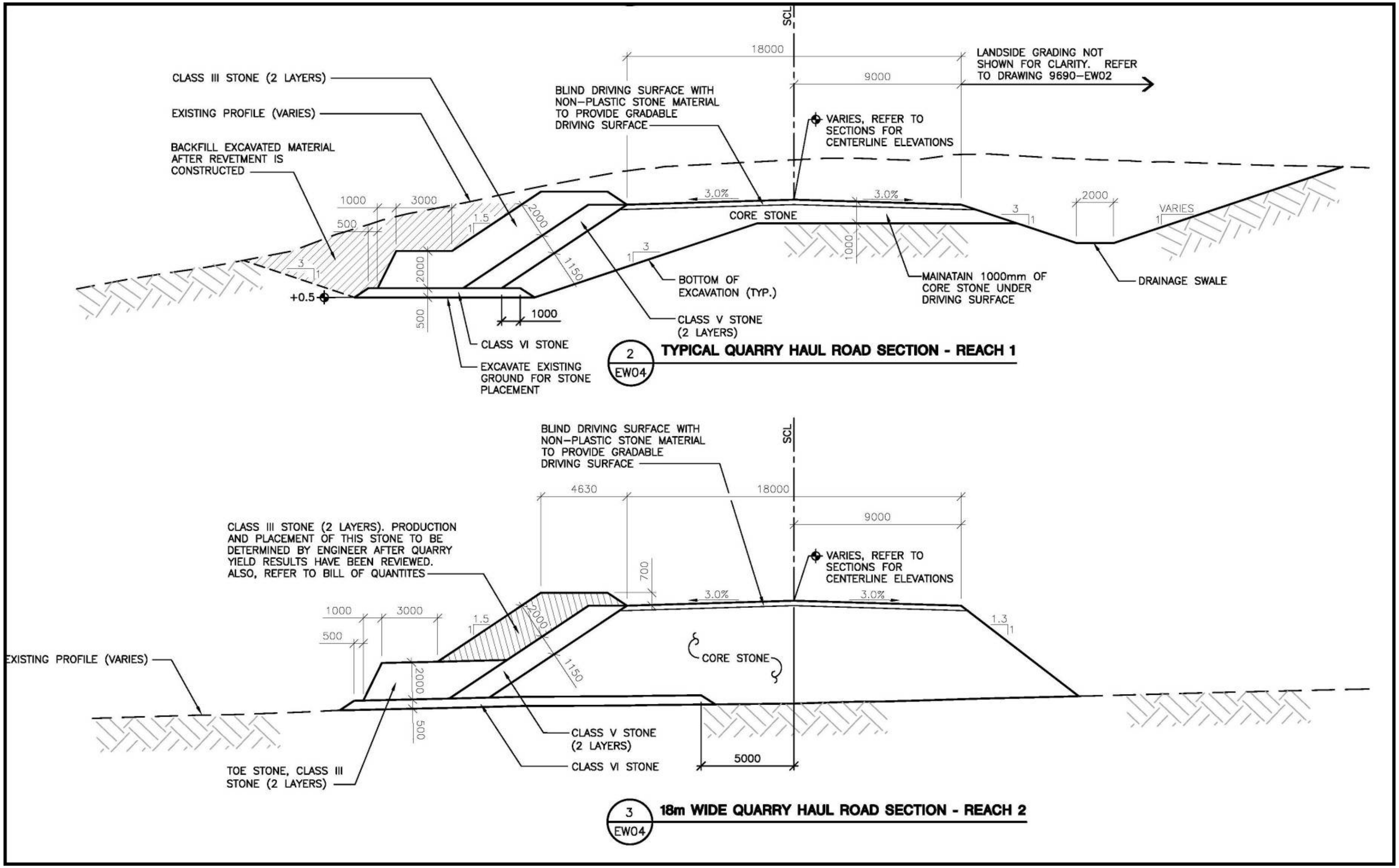


Figure 3.6 Sections transversales typiques de la route d'accès au port



Pour la construction de l'épi de rocher, l'entrepreneur utilisera des camions à benne d'une capacité d'environ 50 tonnes pour transporter, à partir du site de la carrière, les matériaux pour construire le noyau de l'épi et les matériaux de protection associée.

Dans la mesure du possible, les camions transportant les matériaux pour le noyau reculeront le long de l'épi et se déchargeront par l'arrière dans l'eau, ou aussi près que possible de l'extrémité de la construction de la structure. Un bouteur de dimension similaire à un Caterpillar D8 (70 tonnes) sera utilisé pour pousser les matériaux dans la mer.

Des blocs de protection seront poussés par des bouteurs, et au besoin positionnés par une excavatrice de 80 tonnes, afin de produire la section transversale requise de la structure.

3.4.2.3 BRISE-LAMES

Un brise-lames sera construit depuis la péninsule d'Ehoala vers le nord-nord-ouest, pour atteindre une longueur d'environ 600 m. Le brise-lames en enrochement de type « multi-calibres » sera constitué de plusieurs couches de roc de dimensions variées, tel que décrit au tableau suivant.

TYPE DE PIERRES	VOLUME (M^3)
Matériau de protection (Catégorie I) (12 000 kg – 18 000 kg)	67 000
Matériau de protection (Catégorie II) (6 000 kg – 12 000 kg	62 100
Matériau de protection (Catégorie III) (2 000 kg – 6 000 kg)	99 100
Matériau du noyau (1 kg – 2 000 kg)	305 900
Granulats	3 000
Total	537 100

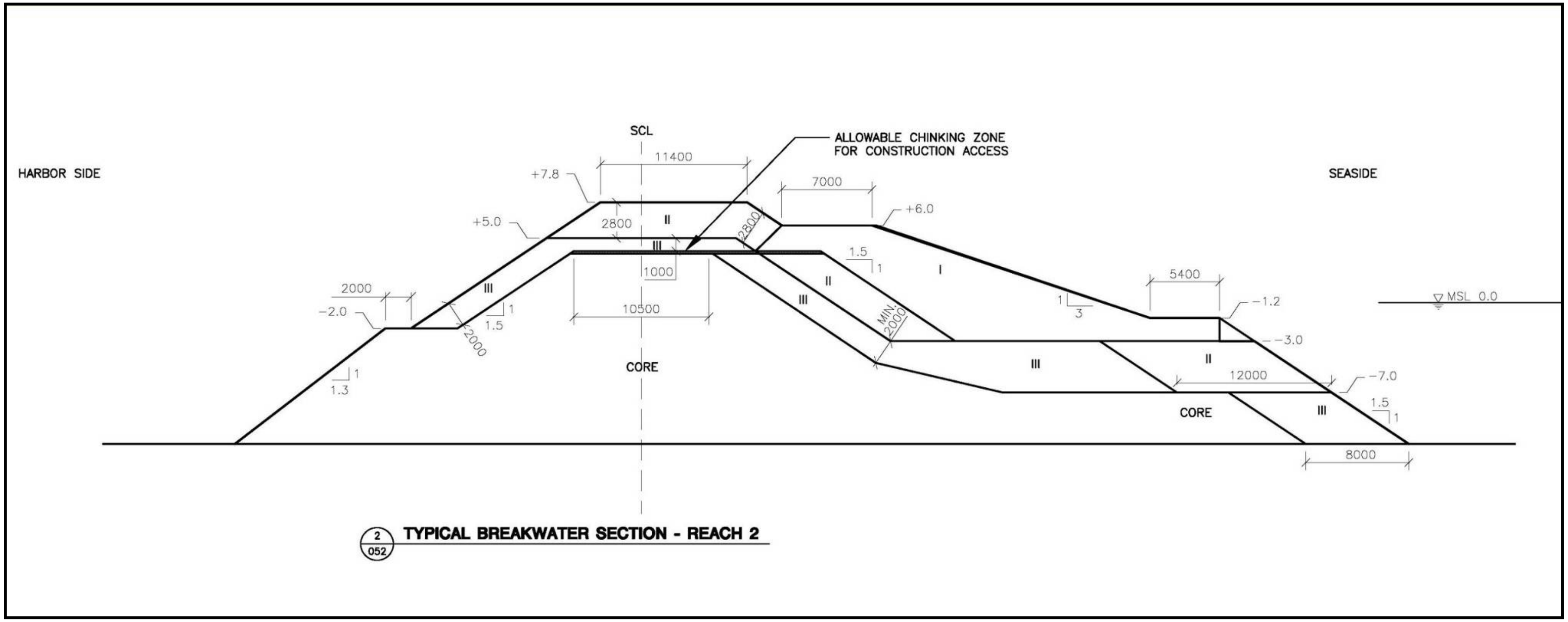
Le brise-lames doit être construit à un niveau définitif de +7,8 m NMM, avec une largeur de crête définitive de 11,4 m. La figure 3.2 présente une vue en plan de l'alignement du brise-lames, et la figure 3.7 présente une section transversale typique du brise-lames.

Les méthodes de construction qui seront utilisées pour la construction du brise-lames sont similaires à celles de l'épi de rocher, à l'exception que le brise-lames sera construit en deux étapes, et que le positionnement des matériaux de protection sera différent de celui du brise-lames. Pour les travaux, l'utilisation d'une grue sur chenilles de très grande dimension (d'une capacité de l'ordre de 300 tonnes) sera nécessaire afin de placer individuellement les gros blocs d'enrochement de protection.

Un bouteur et une excavatrice de grande dimension seront également utilisés pour les travaux de construction. La phase initiale de construction servira à protéger aussitôt que possible le brise-lames contre les intempéries. Afin d'élaborer rapidement le brise-lames, l'entrepreneur placera les matériaux du noyau et une quantité significative de matériaux de protection (roc de type 3) afin d'assurer une protection de l'ouvrage contre les tempêtes caractérisées par une période de récurrence de 10 ans. La conception finale du brise-lames a pour sa part été prévue pour un événement de tempête caractérisée par une période de récurrence de 100 ans.

Il est prévu que la construction intérimaire du brise-lames sera complétée en quatre à cinq mois, et que dix à douze mois additionnels seront nécessaires pour mettre en place le reste des matériaux de protection.

Figure 3.7 Vue d'une section transversale typique du brise-lames



3.4.2.4 DRAGAGE

Une fois le brise-lames complété, les travaux de dragage seront réalisés en respectant les profondeurs suivantes :

- chenal de départ des navires : jusqu'à – 17,5 m NMM;
- zone de manœuvre des navires : jusqu'à – 13,5 m NMM;
- zone d'accostage au quai principal : jusqu'à – 15,75 m NMM;
- tranchée de fondation du mur du quai principal : jusqu'à – 18,0 NMM;
- tranchée de fondation du mur du quai secondaire : jusqu'à –10,0 NMM;

Les matériaux dragués seront valorisés en les utilisant pour construire une surface de terre-plein derrière le quai pour fins de développement portuaire. Le tableau suivant donne une estimation des quantités de matériau à draguer.

EMPLACEMENT	VOLUME (M^3)
Zone d'accostage au quai principal, zone de manœuvre, chenal	681 000
Mur du poste à quai principal	88 000
Quai secondaire et zone de manœuvre	66 000
Mur du poste à quai secondaire	19 000
Total	854 000

Pour la réalisation des travaux il sera nécessaire de positionner des aides à la navigation pour identifier le chenal d'entrée, la zone de manœuvre et les secteurs d'accostage des postes à quai.

Le chenal d'accès mesurera 150 mètres de largeur par 700 mètres de longueur, incluant une zone de manœuvre et les secteurs d'accostage. Les matériaux à draguer seront principalement des dépôts de grès de plage, des dépôts de sable et des dépôts résiduels.

Il est anticipé que le dragage sera réalisé au moyen d'une drague aspiratrice de type désagrégeuse sans prétraitement (dynamitage). Ce type de dragage exige une drague de grande dimension dont la puissance excède 2000 chevaux-vapeur. Les matériaux seront broyés et les boues seront pompées à travers un pipeline et déversées directement dans l'aire proposée de confinement des matériaux dragués. Les boues séjourneront dans l'aire de confinement afin de permettre au sable et aux roches broyées de se déposer. L'entrepreneur devra s'assurer de minimiser le niveau de matières solides totales en suspension dans l'effluent du seuil déversoir. Il est prévu que le dragage durera environ quatre mois.

Par ailleurs, si des travaux de forage ou du dynamitage sont nécessaires, l'entrepreneur devra soumettre à l'approbation de QMM un Plan de surveillance environnementale relatif à la protection de l'environnement et plus particulièrement pour les espèces désignées dans la zone écosensible. Avant les travaux de dynamitage, l'entrepreneur exécutera un programme d'essais de dynamitage. De plus, il devra identifier des explosifs conçus spécifiquement pour l'utilisation sous-marine dans les zones écosensibles.

3.4.2.5 DIGUES DE RETENUE, AIRE DE CONFINEMENT DES MATERIAUX DRAGUES, TERRE PLEIN ET MURETS DE PROTECTION

Dans le cadre des travaux de dragage, aucune décharge de déblais au large des côtes n'est proposée puisque tous les déblais de dragage seront déposés dans l'aire de confinement et sur la berge. Ils seront décantés de manière conventionnelle à l'aide de cellules de sédimentation jusqu'au remplissage complet. L'eau, après décantation des sédiments, sera drainée et déversée dans la Fausse Baie des Galions. Les déblais de dragage seront compactés afin de produire un terre-plein derrière le quai qui soit utilisable, après son aménagement, pour y conduire des activités portuaires.

Le volume total de remblai pour fins de remise en état du terrain est estimé à 775 000 m^3. La zone de remise en état sera remplie généralement à un niveau de +5.95 m NMM et nivelée.

On prévoit initialement que la majorité des digues de retenue seront des structures en enrochement d'une hauteur de +2 mètres, délimitant entièrement les limites de la zone prévue de terre-plein. Au fur et à mesure de la déposition des matériaux dans la zone de confinement des matériaux dragués, ceux-ci seront poussés par des bouteurs afin d'accroître la hauteur des digues de retenue. L'entrepreneur devra maintenir la hauteur du sommet des digues de retenue à un minimum de 0,6 mètre au-dessus des boues décantées. Par ailleurs, les digues de retenue devront servir à confiner les matériaux dragués pour toute la durée du contrat. Les matériaux utilisés pour construire les digues seront caractérisés par une teneur en eau permettant leur compaction au moyen des équipements de transport et d'épandage.

Dans la zone de développement portuaire terrestre (localisée près de la berge), les digues de retenue seront construites avec des matériaux excavés de la zone même. Le décapage de tous les arbres et de la végétation sera effectué pour les zones de fondation des digues. Les digues de retenue seront construites avant le début des travaux de dragage. Avant tout travail de terrassement, l'entrepreneur devra soumettre à l'approbation de QMM un plan de prévention de l'érosion.

3.4.2.6 QUAI

Plusieurs structures de quai ont été analysées lors de la conception du port, y compris des structures en blocs, palplanches et des caissons. L'entrepreneur choisi proposera la méthode de construction du quai. Toutefois, l'entrepreneur devra rencontrer les exigences de QMM, soit une structure comprenant un poste à quai principal de 275 m de longueur ainsi qu'un poste à quai secondaire de 190 m de longueur dans la darse abritée par le brise-lames. Les figures 3.2 et 3.3 illustrent les postes à quai principal et secondaire associés à la darse.

La structure du quai a été positionnée pour s'étendre sur une crête d'éolianite. L'éolianite correspond à une formation de dune sableuse fossile, cimentée en surface et composée de sable de divers degrés de compaction. La base de la structure du quai au poste principal atteindra une profondeur d'environ -18,05 m NMM.

Dans l'éventualité de la construction de caissons, un chantier de bétonnage sera alors nécessaire. Le chantier de bétonnage contiendra plusieurs aires de coulage, dont une aire distincte pour la préparation de la base des caissons, alors que les autres aires seront utilisées pour les coffrages de ressaut ou des coffrages de murs coulissants.

Les caissons pourraient alors être mis à l'eau au moyen d'une plate-forme basculante ou d'un traîneau glissant sur une rampe. Les caissons seraient ensuite déposés sur le fond marin pour être remis à flot et remorqués ou hissés à l'aide d'un treuil vers l'endroit où ils seront installés. Les caissons seront ensuite guidés en position définitive à l'aide du caisson précédent afin d'assurer une localisation précise. Il sera nécessaire de mettre à l'eau les caissons pendant une période de mer calme.

Après la mise à l'eau des premiers caissons, une dalle de béton pré coulée sera insérée entre les structures de jonction des caissons. Dès que le placement des caissons sera suffisamment avancé, le remblayage pourra commencer. Cela pourrait être accompli en vidant le matériel de remblai par l'arrière et en l'épandant à l'aide d'un bouteur.

On pourra alors par la suite démarrer la construction des structures de recouvrement en béton, l'installation des supports de rail, des chevalets et des structures de convoyeur et de l'oléoduc.

3.5 SOURCES D'IMPACT

Pour la phase de construction, les sources d'impacts se résument aux activités habituelles de construction, aux activités de dragage et de dynamitage (s'il y a lieu), au confinement des matériaux dragués ainsi qu'au déplacement des embarcations.

Les composantes et activités suivantes, reliées à la construction du complexe portuaire sont susceptibles d'être des sources d'impacts :

- le déboisement, défrichage, décapage, remblai/déblai;
- la sécurisation et préparation du périmètre du port, de l'accès y conduisant et d'un périmètre pour l'aménagement des réservoirs de carburant et de l'entrepôt d'ilménite;
- la construction de l'accès au brise-lames, etc., pour la mise en place des infrastructures portuaires;
- le déversement de matériaux dans la mer pour la construction des infrastructures portuaires (brise-lames, épi de rocher, terre-plein);
- le dragage de la zone portuaire pour la création d'un chenal d'accès, d'une zone de manœuvre des navires etc. (à noter qu'aucun dynamitage du fond marin n'est prévu dans la planification actuelle);
- la production de béton à proximité du milieu marin et le coulage de béton (si nécessaire);
- la construction de quais;
- la mise en place d'un oléoduc sur près de deux kilomètres;
- la mise en place d'un convoyeur sur le quai pour le chargement de l'ilménite;
- le décapage, nivellement et travaux de drainage d'une zone pour l'aménagement des réservoirs de carburant, des bureaux administratifs et de l'entrepôt d'ilménite e QMM;
- la construction de réservoirs d'hydrocarbures, d'une capacité totale de neuf millions de litres;
- la construction d'un entrepôt pour l'ilménite d'une capacité de 50 000 t;
- la mise en place d'une génératrice pour l'approvisionnement en électricité des installations portuaires;
- la mise en place de l'éclairage sur le brise-lames;
- les déversements accidentels d'hydrocarbures dans ou près du milieu marin.

Ces activités et composantes sont visées par le présent PGES.

4. PHASE « CONSTRUCTION » - DESCRIPTION DU MILIEU RÉCEPTEUR, DES IMPACTS POTENTIELS ET DES MESURES D'ATTÉNUATION, DE COMPENSATION ET DE MISE EN VALEUR

4.1 IMPACTS SUR LE MILIEU NATUREL

4.1.1 PROFIL, PENTE D'ÉQUILIBRE, SURFACE ET QUALITÉ

Le complexe portuaire nécessitera la construction d'infrastructures sur la terre ferme ainsi qu'en milieu marin. La figure 4.1 présente le plan de masse du complexe portuaire.

4.1.1.1 ÉCOSYSTEME TERRESTRE

4.1.1.1.1 ÉTAT ACTUEL ET IMPACTS POTENTIELS

Pour les besoins des opérations relatives à l'exploitation de la mine et des infrastructures portuaires, près de 9 ha de terrain feront l'objet de travaux de décapage, d'excavation, de nivellement et de drainage. Cet aménagement sera utilisé en vue de la construction des bureaux administratifs et des réservoirs d'hydrocarbures d'une capacité totale de 9 millions de litres. Un oléoduc de près de 2 km sera aussi construit, pour le transport du carburant des pétroliers, jusqu'aux réservoirs situés sur la péninsule d'Ehoala.

Le secteur qui sera utilisé est caractérisé par la présence d'un sol sablonneux et de faible fertilité où les formations de graminées dominent le paysage dans une proportion de plus de près de 90 % (voir figure 4.2.

Les répercussions relatives aux activités de déboisement, débroussaillage, d'excavation, nivellement, terrassement, compactage et recouvrement du sol nécessaires à l'aménagement de la section terrestre du complexe portuaire seront potentiellement :

- la modification du relief local;
- la création d'ornières, d'ourlets et de monticules;
- la modification de la qualité des sols;
- la contamination des sols;
- l'augmentation de l'érosion.

4.1.1.1.2 MESURES D'ATTÉUATION PROPOSÉES

Diverses mesures d'atténuation peuvent être envisagées afin de réduire les impacts sur le relief, les sols et valoriser les abords des infrastructures terrestres. Les principales mesures seront :

- l'application de bonnes pratiques environnementales (voir section 5);
- la conservation dans la mesure du possible des sols organiques;
- le nettoyage des lieux;
- le contrôle de l'érosion;

- l'élaboration d'un plan d'urgence environnementale et décontamination des lieux;
- l'élaboration d'un programme de surveillance et de suivi environnemental.

4.1.1.1.2.1 BONNES PRATIQUES ENVIRONNEMENTALES

- l'application de bonnes pratiques environnementales permettra de réduire les risques d'incidents environnementaux (ex. déversements accidentels de produits pétroliers). La section 5 donne les différentes règles de bonnes pratiques environnementales applicables à la protection des sols ainsi que les différentes procédures environnementales de QMM applicables.
- l'entrepreneur devra déposer avant le début des travaux un plan de gestion environnementale et sera soumis à un devis de performance afin de s'assurer que ce dernier réalise les travaux conformément à la satisfaction de QMM et aux règlements environnementaux locaux et des directives applicables. La section 5 apporte des précisions relativement aux obligations de l'entrepreneur et l'annexe 2 fourni les informations relatives aux obligations de l'entrepreneur relativement aux volets santé, sécurité et environnement relatifs au projet (voir annexe 2 : Division 01 - General requirements section 01525 – Safety, Health and Environmental Management).
- le stockage des produits pétroliers requis pendant la construction sera effectué conformément aux pratiques internationales en ce domaine. L'entrepreneur devra, entre autres, se soumettre aux normes RAEDHL (réglementation d'aménagement et d'exploitation des hydrocarbures liquides);
- la construction des installations permanentes de stockage des produits pétroliers sera réalisée par une compagnie pétrolière qui se conformera également aux pratiques et normes décrites ci-haut;
- l'entrepreneur devra délimiter toutes les zones de travaux et de stockage avant toutes interventions. L'entrepreneur devra faire approuver ces limites par QMM et s'y conformer;
- l'entrepreneur devra identifier les secteurs d'entretien et d'approvisionnement des véhicules;
- l'entrepreneur doit prévoir sur place une provision de matières absorbantes ainsi que des récipients étanches bien identifiés, destinés à recevoir les résidus pétroliers et les déchets;
- l'entrepreneur s'assurera d'utiliser la machinerie adéquate pour les travaux de construction;
- la mise en place de structures de drainage qui permettront de canaliser les eaux de surface dans des bassins de rétention afin d'éviter l'érosion des sols lors des pluies et plus particulièrement lors des épisodes cycloniques;
- durant la période de construction, un responsable de l'entrepreneur ainsi qu'un surveillant environnement de QMM s'assureront que les directives et méthodes de travail préconisées pour la protection de l'environnement sont respectées.

4.1.1.1.2.2 CONSERVATION DES SOLS

- le stockage de la terre végétale (si existante) sera exigé de l'entrepreneur lors du décapage des zones. Les sols seront décapés selon les besoins et stockés à des endroits désignés par QMM.
- la terre végétale sera utilisée pour revégétaliser les secteurs affectés.
- la vérification des opérations de maintien de la bonne qualité du sol (revégétalisation des zones d'entreposage pour limiter le lessivage et éventuellement améliorer la qualité biologique du sol).
- l'érosion des empilements de terre arable sera empêchée par des mesures appropriées comme des barrières de sédiments, l'utilisation de membrane géotextile, l'ensemencement de végétaux, etc.

4.1.1.1.2.3 NETTOYAGE DES LIEUX

- les infrastructures temporaires de chantier seront démantelées à la fin des travaux et sorties du site. Les aires de rebuts, les chemins d'accès, etc. seront restaurés. Les lieux seront réhabilités selon les pratiques reconnues internationalement.
- les matières résiduelles reliées à la construction (bidons, carcasses métalliques, ferraille, etc.) et les déchets domestiques seront récupérés et dirigés vers des sites d'élimination autorisés.
- les matières résiduelles ne seront ni enfouis et ni brûlées sur place.
- l'entrepreneur procédera au régalage des lieux en assurant l'intégration au relief naturel et le drainage naturel des eaux.
- les dépressions seront comblées afin d'éviter la formation des zones où des eaux stagnantes peuvent être générées.
- les pentes des talus seront adoucies à un rapport minimum de 2,5H : 1V (ratio applicable pour les sols et non pour le roc);
- les sols seront recouverts de terre végétale (si disponible) récupérée et entreposée au début des travaux.

4.1.1.1.2.4 CONTRÔLE DE L'ÉROSION

- toute intervention sur le chantier pouvant causer le transport de sédiments devra être accompagnée simultanément de mesures de captation de sédiments (bassins, fossés, barrières géotextiles, fossés de dissipation, fosse de captation).
- la mise en place de buses, de ponceaux ou drains afin d'assurer un écoulement adéquat des eaux de surface et contrôler l'érosion des sols.
- Au besoin des bassins de sédimentation doivent être construits avant le début des travaux de terrassement et de drainage. Ceux-ci devront être nettoyés quand ils sont remplis à 50 %.

- au fur et à mesure de l'achèvement des travaux, tous les endroits remaniés doivent être stabilisés immédiatement et de façon permanente. si un délai est nécessaire, les moyens de contrôle de l'érosion doivent demeurer en place afin de capter tout matériau érodé.

- les talus en remblai ou en déblai doivent être ensemencés au fur et à mesure de leur construction.

- tout amoncellement temporaire de matériaux non consolidés (ex. tas de terre) et localisés à moins de 30 m d'un plan d'eau, pour une période de plus de 24 heures, doit être protégé contre l'érosion notamment à l'aide d'une barrière géotextile ou d'un filtre composé de matière filtrante, afin d'éviter le transport de sédiments vers le plan d'eau.

- les camions de transport et la machinerie ne pourront circuler en dehors des emprises et des accès prévus et autorisés pour la construction.

- lorsqu'il y a circulation sur les berges, les ornières causées par la machinerie doivent être bloquées ou détournées pour éviter le transport de sédiments vers le milieu hydrique.

4.1.1.1.2.5 PLAN D'URGENCE ENVIRONEMENTALE ET DÉCONTAMINATION DES LIEUX

- l'entrepreneur devra aviser immédiatement QMM de tout déversement de contaminants dans l'environnement, quelle que soit la quantité déversée.

- en cas de déversement accidentel majeur de contaminants, en milieu terrestre, l'entrepreneur devra procéder immédiatement, et à ses frais, aux interventions suivantes :
  - Assurer la sécurité des lieux;
  - Contrôler la fuite;
  - Vérifier l'étendue du déversement;
  - Appliquer la structure d'alerte;
  - Confiner le contaminant;
  - Récupérer le contaminant;
  - Excaver et remplacer le sol contaminé, s'il y a lieu;
  - Gérer les résidus contaminés en fonction du niveau de contamination observé;
  - Déposer les sols contaminés et le contaminant dans un lieu autorisé.

- les secteurs contaminés par des déversements accidentels d'hydrocarbures ou autres produits chimiques seront décontaminés et réhabilités. L'entrepreneur devra avant les travaux faire approuver par QMM son plan de réhabilitation des lieux incluant les analyses de sols démontrant qu'il n'y a plus de contamination.

4.1.1.1.3 ÉVALUATION DES IMPACTS RÉSIDUELS

Le secteur prévu pour la construction des infrastructures terrestres est caractérisé par un sol sablonneux et de faible fertilité. Par conséquent, la construction des bureaux, des ateliers et des réservoirs d'hydrocarbures n'aura qu'un **impact mineur** sur le profil et les pentes d'équilibre, ainsi que sur la surface et la qualité du sol. Des mesures d'atténuation visant à réhabiliter les abords de la propriété feront en sorte que l'**impact résiduel** sera **mineur.**

Le tableau présenté plus loin résume l'évaluation des impacts et les mesures d'atténuation qui seront mises en place pour atténuer les impacts.

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Figure 4.1 Plan de masse du complexe portuaire

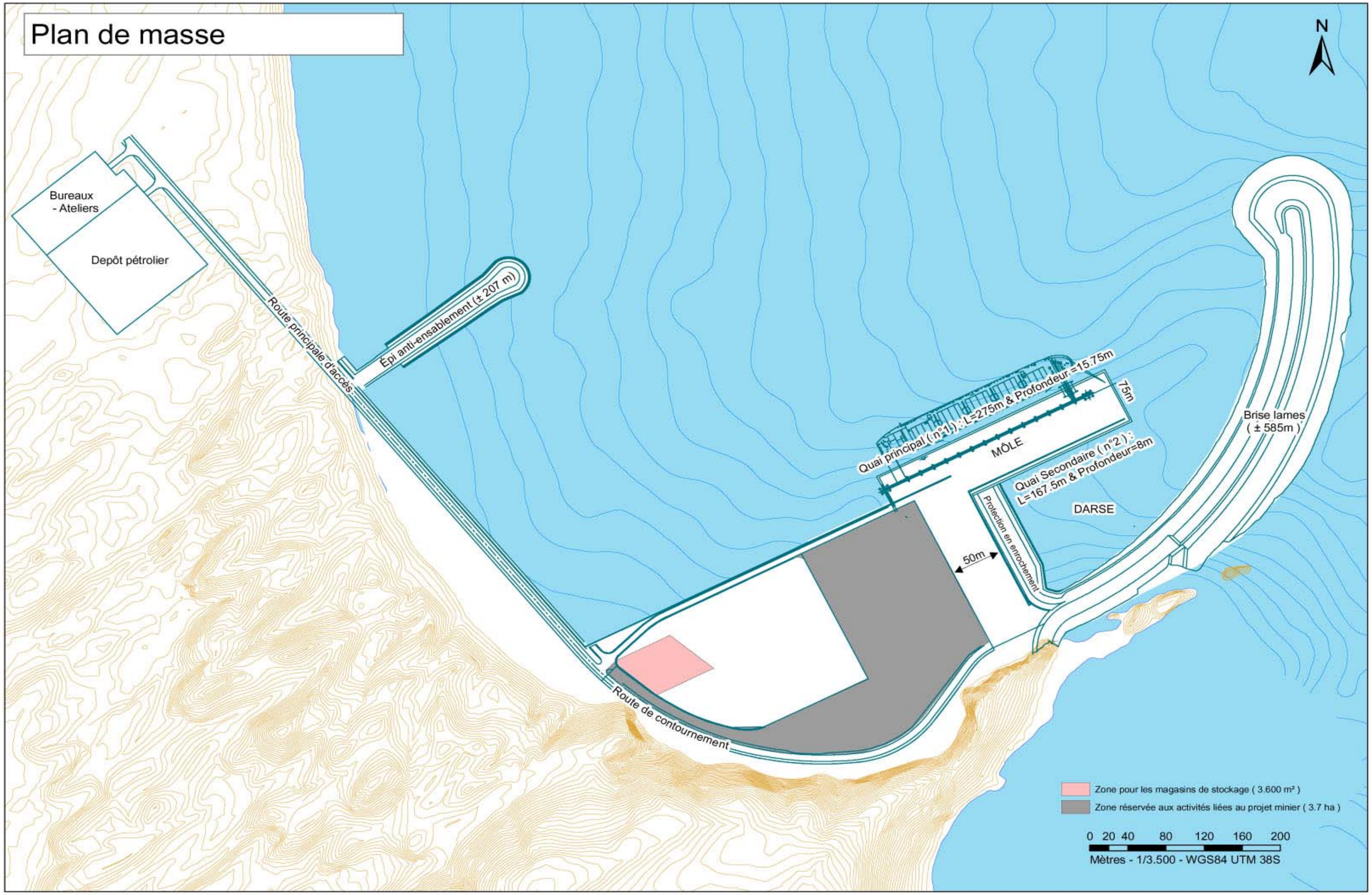
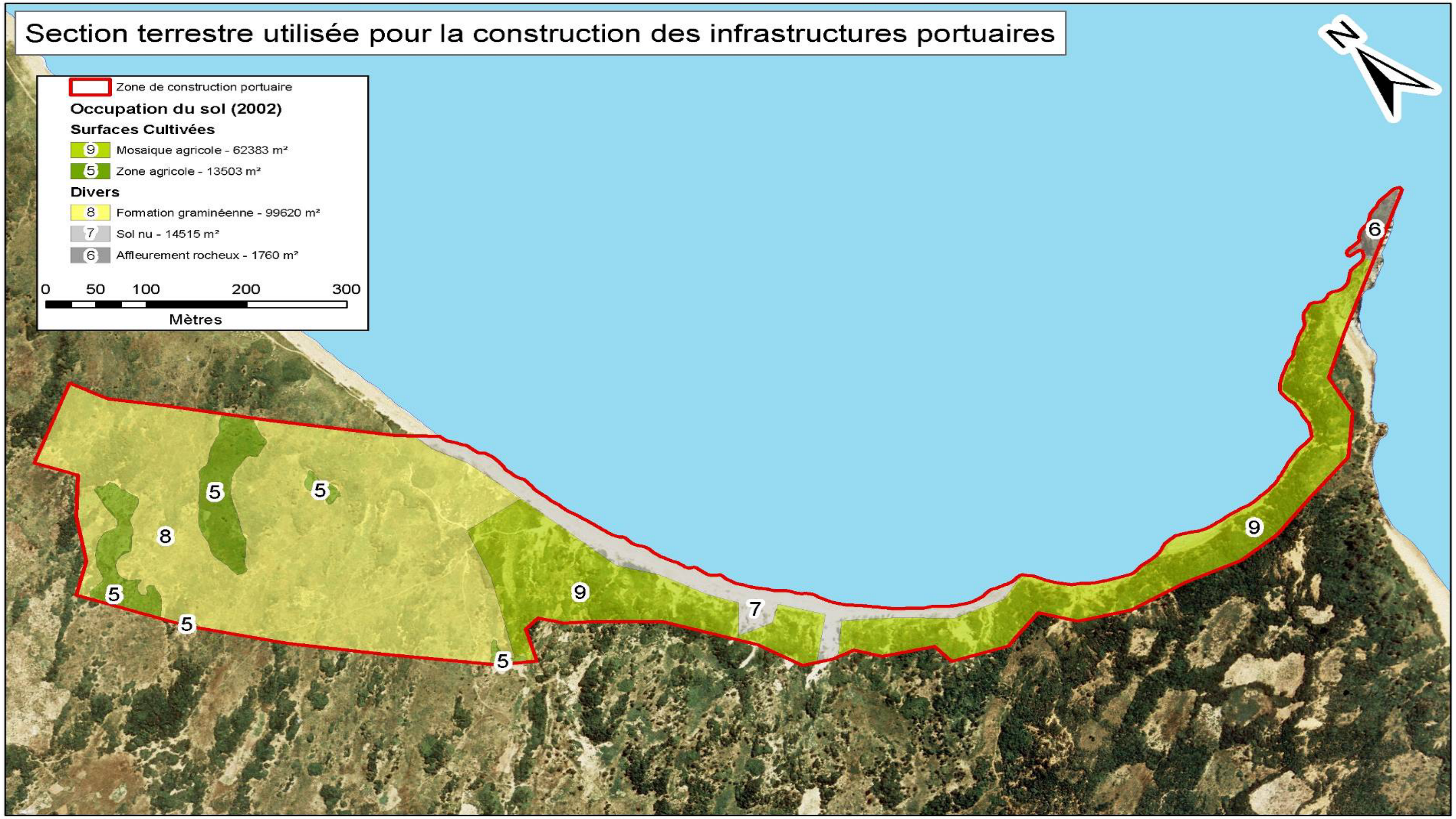


Figure 4.2 Occupation des sols



Évaluation des impacts et mesures d'atténuation relativement à l'élément sols (milieu terrestre)

MILIEU PHYSIQUE								
Identification de l'impact			**Évaluation de l'impact**				**Mesures d'optimisation, d'atténuation ou de valorisation**	**Impact résiduel**
Élément	Composante	Caractérisation	Intensité	Portée	Durée	Importance de l'impact		
Sols	Profil et pente d'équilibre, surface et qualité des sols	• Modification de la topographie locale; • Création d'ornières, d'ourlets et de monticules; • Modification de la qualité des sols; • Contamination des sols; • Augmentation de l'érosion.	Faible	Ponctuelle	Longue	Mineure	• Application de bonnes pratiques environnementales (voir section 5); • Conservation dans la mesure du possible des sols organiques; • Nettoyage des lieux; • Contrôle de l'érosion • Élaboration d'un plan d'urgence environnementale et décontamination des lieux; • Élaboration d'un programme de surveillance et de suivi environnemental.	**Mineur**

4.1.1.2 ÉCOSYSTEME MARIN

Les activités suivantes relatives à la mise en place des installations portuaires auront des impacts sur le milieu marin (pour plus de détails, vous référez à la description du complexe portuaire à la section 3.3 de ce document) :

- la construction d'un brise-lames rocheux d'une longueur approximative de 600 m;
- le dragage de 855 000 m^3 pour former un chenal d'accès (300m, -17.0m), une zone de manœuvre des navires, et un secteur d'accostage au quai principal;
- la construction d'un quai polyvalent comprenant deux postes à quai;
- la construction d'un épi d'enrochement;
- l'aménagement d'un terre-plein d'environ 11 hectares;
- la construction de 1 500 m de murs de soutènement/digues pour la route côtière, la route d'accès et le confinement du terrain pour la valorisation des déblais de dragage.

4.1.1.2.1 ÉTAT ACTUEL ET IMPACTS POTENTIELS

La zone littorale qui borde la péninsule d'Ehoala et la Fausse Baie des Galions est caractérisée par la présence d'un substrat solide composé d'éolianite et de grès de plage. On y retrouve également un substrat de gravier, de sable (de grosseur fine à moyenne) et de résidus de surface.

Pour ce qui a trait au substrat marin, un peu moins de la moitié de la zone est composée d'éolianite et de grès de plage, et le reste de gravier, de sable et de résidus de surface. La formation d'éolianite est une crête orientée nord-est/sud-ouest localisée dans la zone protégée du brise-lames proposé. Les résultats d'une excavation de 4 mètres de profondeur dans le secteur des travaux démontrent que la crête est composée d'une croûte d'éolianite de 30 cm d'épaisseur, suivie d'une couche non consolidée de 20 cm d'épaisseur de sables et de galets grossiers (calibre du grain 0,74 mm, 19 % de gravier et 38 % de $CaCO3$), d'une couche de 1,8 m d'épaisseur d'éolianite altérée et jointée de calibres moyen à fin ainsi que d'une couche tantôt altérée et tantôt non consolidée (calibre moyen du grain 0,15 mm, 1,6 % d'argile et limon et 2 % de $CaCO3$) avec une couche de cailloux et de galets au fond de l'excavation (voir figure 4.3).

Pour ce qui a trait au profil de plage, une comparaison de la position du rivage de l'ensemble de la Fausse Baie des Galions entre 1951 et 2004 indique qu'historiquement celui-ci serait relativement stable à l'exception d'un secteur d'érosion, au nord de la baie, près de la ville de Fort-Dauphin (voir les figures 2.3 à 2.5 de l'annexe 5 de ce rapport, Baird 2006). Toutefois, une analyse historique de l'évolution de ce même rivage pour une période plus récente, soit de 1989 à 2004, suggère qu'en plus de l'activité d'érosion au nord de la baie, un phénomène d'accrétion serait présent au sud de la baie, près de l'emplacement du futur port.

Il est fait l'hypothèse que ces phénomènes soient le résultat d'une variation à long terme de la morphologie de la baie associée à une fluctuation, également à long terme, des composantes du vent dominant du Nord Est et de la houle de longue période provenant du Sud.

Les recherches récentes sur les changements climatiques dans l'Hémisphère Sud concluent à une possible diminution dans la fréquence des tempêtes à l'origine de la houle de longue période provenant du sud depuis le début des années 1980. Ceci pourrait expliquer l'activité d'érosion au nord de la baie et le phénomène d'accrétion au sud de cette dernière.

Les calculs préliminaires de mouvement littoral de sable vers la partie sud de la baie de la Fausse Baie des Galions sont de l'ordre de 50,000 mètres cubes par an. Cependant, on observe également un phénomène important d'apport de sable du rivage vers les dunes sises sur le promontoire d'Éhoala estimé à près de 30,000 mètres cube par an, laissant un résiduel en accrétion de sable de l'ordre de 15 à 20,000 mètres cubes par an dans le secteur sud de la baie. L'augmentation ou la diminution du phénomène d'accrétion dans le future, sans considération à la présence du nouveau port, est difficile à prévoir étant donné les incertitudes associées au changement climatique future.

Les estimations de transport de sable dans la baie que ce soit par la houle où le vent, sont approximatifs, compte tenu de la complexité de ces phénomènes. Étant donné l'incertitude associée à la prévision du transport de sable dans la baie, un épi provisoire sera construit au début de la phase de construction du port pour fournir l'information sur le transport de sable et son potentiel taux d'augmentation contre l'épi de rocher. Un programme de suivi relatif à l'érosion des berges et du transport sédimentaire dans la baie a été amorcé par QMM avant la construction et continuera pendant la construction.

Les résultats du suivi de la mise en place de l'épi provisoire d'une longueur de 140 m permettront d'obtenir des informations sur le transport du sable et les taux d'ensablement contre celui-ci. Si le suivi montre que cet ouvrage permet de prévenir le transport de sable le long du rivage vers le port, un épi permanent de 200 m pourrait alors être construit. Les détails du programme de suivi du transport sédimentaire sont décrit en détails à l'annexe 5 (Baird, 2006) du présent rapport.

Pour ce qui a trait à la construction du brise-lames, de l'épi d'enrochement et des quais ainsi que de la zone de confinement des matériaux dragués, cela nécessitera le recouvrement du fond marin sur une superficie totale de 32,2 ha**.**

OUVRAGE	SUPERFICIE (HA)
Brise-lames	5,3
Épi temporaire	0,7
Quais	14,7
Zone de confinement des sédiments	11,5
Total	32,2

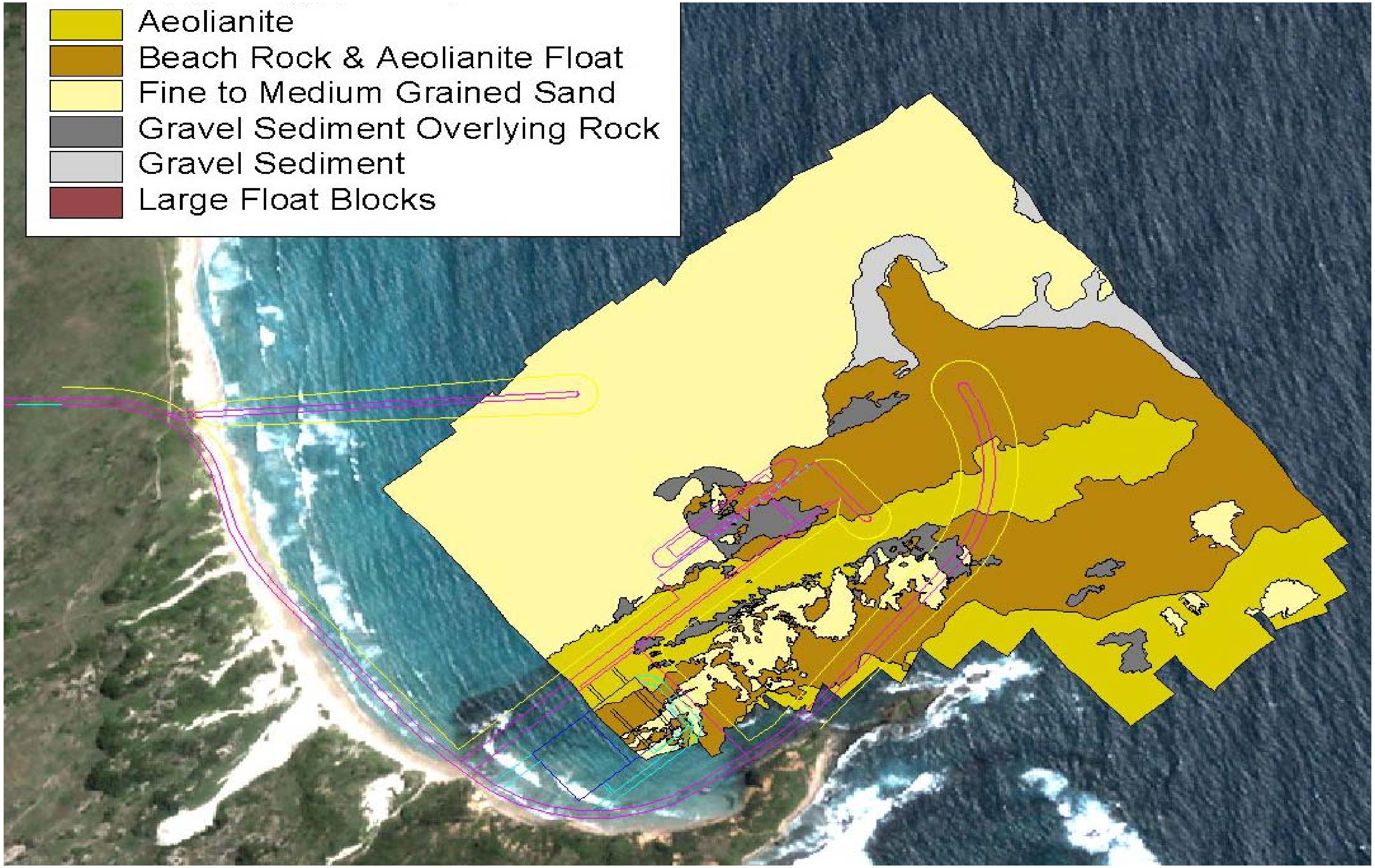
Le dragage, la mise en place de l'enrochement pour la construction des infrastructures et la construction du terre-plein entraîneront par conséquent une modification du fond marin.

Le dragage du chenal d'accès et de la zone portuaire nécessitera le prélèvement d'un volume estimé à 855 000 m^3 du fond marin**.** Selon une étude réalisée sur la qualité des sédiments, aucune contamination n'a été décelée dans les sédiments de la zone de dragage (Jacques Whitford, 2006 en préparation).

La construction du port (épi, brise-lames, route d'accès, terre-plein) pourrait entraîner la modification du profil de la plage, pouvant causer des phénomènes d'érosion et de sédimentation.

Figure 4.3 Caractéristiques de la géologie marine du secteur de construction des infrastructures maritimes

COMPOSITION DU FOND MARIN



Les répercussions relatives aux activités de construction et des travaux en milieu marin seront potentiellement :

- la modification du fond marin;
- la modification du profil de la plage dans le secteur ouest de la Fausse Baie des Galions suite aux travaux de construction de la route d'accès au port, du brise-lames et de l'éperon;
- l'accumulation de sédiment dans le secteur du quai et à l'est de la Péninsule Ehoala suite à la mise en place du brise-lames;
- le risque de contamination de l'environnement maritime suite aux déversements accidentels d'hydrocarbures et autres matières polluantes.

4.1.1.2.2 MESURES D'ATTÉNUATION PROPOSÉES

Diverses mesures d'atténuation peuvent être envisagées afin de réduire les impacts sur le milieu marin. Les principales mesures seront :

- l'application de bonnes pratiques environnementales (voir section 5);
- le nettoyage des lieux;
- l'application de mesures de contrôle de l'érosion et de la sédimentation;
- l'élaboration d'un plan d'urgence environnementale et décontamination des lieux;
- la mise en place d'un programme de surveillance et de suivi environnemental.

4.1.1.2.2.1 BONNES PRATIQUES ENVIRONNEMENTALES

- l'application de bonnes pratiques environnementales permettra de réduire les risques d'incidents environnementaux. La section 5 donne les différentes règles de bonnes pratiques environnementales applicables à la protection des sols;
- l'entrepreneur devra déposer avant le début des travaux un plan de gestion environnementale et sera soumis à un devis de performance afin de s'assurer que ce dernier réalise les travaux conformément à la satisfaction de QMM et aux règlements environnementaux locaux et des directives applicables. La section 5 apporte des précisions relativement aux obligations de l'entrepreneur et l'annexe 2 fourni les informations relatives aux obligations de l'entrepreneur relativement aux volets santé, sécurité et environnement relatifs au projet (voir annexe 2 : Division 01 - General requirements section 01525 – Safety, Health and Environmental Management);
- l'entrepreneur s'assurera d'utiliser de bonnes méthodes de travail et la machinerie adéquate pour les travaux de dragage (voir annexe 3 Division 02 - Site Work – section 02325, Dredging);
- durant la période de construction, un responsable de l'entrepreneur ainsi qu'un surveillant environnement de QMM s'assureront que les directives et méthodes de travail préconisées pour la protection de l'environnement sont respectées.

4.1.1.2.2.2 NETTOYAGE ET RESTAURATION DES LIEUX

- l'application des mesures identifiées au point précédent concernant les sols (section 4.1.1.1.2.3). Ces mesures sont applicables pour les sections de berge qui seront utilisées pour ériger des infrastructures temporaires.

4.1.1.2.2.3 CONTROLE DE L'EROSION ET DE LA SEDIMENTATION

- l'entrepreneur devra soumettre à l'approbation de QMM un plan de prévention de l'érosion avant l'amorce des travaux;
- l'entrepreneur devra installer des buses, des ponceaux ou des drains afin d'assurer un écoulement adéquat des eaux de surface et contrôler l'érosion des sols;
- l'entrepreneur devra délimiter toutes les zones de travaux et de stockage des matériaux de dragage avant toutes interventions. L'entrepreneur devra faire approuver ces limites par QMM et se conformer à ces limites et ne pas utiliser la périphérie de ces secteurs;
- les camions de transport et la machinerie ne pourront circuler en dehors des emprises et des accès prévus pour la construction;
- si nécessaire, l'entrepreneur construira des bassins de sédimentation qui permettront au sable et aux roches cassées de se déposer et de canaliser les eaux de surface afin d'éviter l'érosion des sols lors des pluies et plus particulièrement lors des épisodes cycloniques;
- l'entrepreneur devra prendre toutes les mesures nécessaires afin de protéger d'une inondation les terres adjacentes au secteur de valorisation des sédiments;
- l'entrepreneur devra prendre toutes les mesures nécessaires afin de s'assurer de contenir les particules fines dans le secteur de construction du noyau du brise-lames et de l'épi d'enrochement;
- la construction d'un épi d'enrochement.

4.1.1.2.2.4 PLAN D'URGENCE ENVIRONEMENTALE ET DÉCONTAMINATION DES LIEUX

- l'application des mesures identifiées au point précédent concernant les sols (section 4.1.1.1.2.5). Ces mesures sont applicables pour les sections de berge qui seront utilisées pour ériger des infrastructures temporaires;
- l'application des mesures spécifiques au milieu marin. Pour un déversement accidentel en milieu marin, l'entrepreneur devra préciser dans son plan d'urgence environnementale les interventions préconisées et le matériel qui sera mis en place en cas d'un déversement accidentel d'hydrocarbures. L'entrepreneur devra faire approuver son plan d'intervention par QMM avant le début de touts travaux en milieu marin. La procédure déversements d'hydrocarbures de QMM présenté à l'annexe 4 (**P-SPE-5001)** donne un aperçu de ce que l'entrepreneur devra fournir;

4.1.1.2.3 ÉVALUATION DES IMPACTS RÉSIDUELS

Pour le milieu terrestre, un **impact résiduel mineur** est anticipé à la suite de l’application des mesures d’atténuation relatives au profil et à la pente d’équilibre des sols. Le secteur où seront construites les infrastructures (bureaux, des ateliers et des réservoirs d’hydrocarbures) est caractérisé par des sols sablonneux et de faible fertilité.

Pour le milieu marin, l’application de mesures d’atténuation fera en sorte qu’un **impact résiduel moyen** est prévu pour la modification du fond marin, par le dragage et l’implantation des infrastructures relatives au complexe maritime.

Pour ce qui a trait à la modification du profil de la plage, le long du littoral de la Fausse Baie des Galions, à la suite de la construction des installations portuaires, un **impact résiduel mineur** est anticipé. Toutefois, une incertitude persiste et un programme de suivi a été élaboré afin de préciser les impacts de la construction des installations portuaires sur l’hydrodynamisme et le transport des sédiments dans la baie. À la lumière des informations relatives au suivi, l’épi d’enrochement provisoire pourrait être allongé pour assurer un contrôle de la sédimentation dans le secteur du port (voir annexe 5, Baird, 2006).

Un **impact résiduel mineur** est anticipé relativement à la contamination du fond marin, du littoral et de la plage à la suite d’un déversement accidentel.

Le tableau présenté plus loin résume l’évaluation des impacts et les mesures d’atténuation qui seront mises en place pour atténuer les impacts.

Il est à noter que pour évaluer les impacts potentiels décrits précédemment et pour assurer l’efficacité des mesures d’atténuation et de bonification proposées, divers programmes de suivi sont en cours de réalisation autant au niveau du suivi du profil de la plage (voir Baird, 2006 à l’annexe 5) qu’au niveau du suivi du milieu marin en tant que tel (voir Jacques Whitford, 2004 à l’annexe 6).

Évaluation des impacts et mesures d'atténuation relativement à l'élément sols (fond du milieu marin, littoral et plage)

MILIEU PHYSIQUE								
Identification de l'impact			**Évaluation de l'impact**				**Mesures d'optimisation, d'atténuation ou de valorisation**	**Impact résiduel**
Élément	Composante	Caractérisation	Intensité	Portée	Durée	Importance de l'impact		
Sols (substrats)	Profil et pente d'équilibre, surface	• Modification du fond marin par le dragage et l'implantation des infrastructures.	Moyenne	Ponctuelle	Longue	Moyenne	• Application de bonnes pratiques environnementales (voir section 5); • Nettoyage des lieux • Application de mesures de contrôle de l'érosion et de la sédimentation; • Élaboration d'un plan d'urgence environnementale et décontamination des lieux; • Élaboration d'un programme de surveillance et de suivi environnemental;	**Moyen**
		• Modification du profil de la plage et accumulation de sédiments le long du littoral de la Fausse Baie des Galions, à la suite de la construction des installations portuaires.	Moyenne	Ponctuelle	Longue	Moyenne		**Mineur (à confirmer)**
	Qualité des substrats	• Contamination du fond marin et du littoral ainsi que de la plage	Moyenne	Ponctuelle	Courte	Mineure		**Mineur**

4.1.2 EAU

4.1.2.1 QUALITE DES EAUX

4.1.2.1.1 ÉTAT ACTUEL ET IMPACTS POTENTIELS

4.1.2.1.1.1 RUISSELLEMENT ET INFILTRATION

Sur le promontoire d'Ehoala, le décapage d'environ 9 ha de terrain pour l'aménagement des infrastructures connexes (bureaux, entrepôts, réservoirs d'hydrocarbures) et de l'accès au brise-lames sur près de 2 km entraîneront une modification du drainage naturel. De même, la mise en place des matériaux de consolidation et des infrastructures modifieront aussi le ruissellement et l'infiltration dans ces secteurs. Les travaux pourront également entraîner la formation d'ornières et la compaction du sol en périphérie des aires utilisées.

4.1.2.1.1.2 QUALITÉ DES EAUX

Les résultats des différentes études réalisées par QMM indiquent que le milieu marin est très dynamique et présente une physico-chimie stable, et que la colonne d'eau est bien mélangée et homogène, relativement à la température (20,9 à 25,1°C) et à la salinité (31,9 à 35,8 g/kg), ce qui est typique des eaux côtières. Le pH est basique et varie de 8,1 à 8,5, ce qui est typique du milieu marin. Ce milieu est considéré comme un environnement oligotrophe, faible en éléments nutritifs (QMM, 2001).

Les mesures des taux de sédimentation à l'aide de trappes à sédiments ont permis de déterminer le flux vertical de particules dans le courant, et ainsi les échanges entre le fond de la mer et la colonne d'eau. Les taux de sédimentation mesurés en saison humide étaient de 2,3 g/jour à Ehoala et de 0,8 g/jour à Fort-Dauphin, indiquant que plus de particules sont transportées par la dérive littorale à Ehoala qu'à Fort-Dauphin. À la fin de la saison humide, pour la période allant de la fin mai à la mi-septembre, le taux de sédimentation était de 2,7 g/jour. En saison sèche, du 16 septembre au 15 octobre, le flux vertical moyen de particules était de 8 g/jour. Cette valeur élevée est vraisemblablement attribuable au fait que la période correspondante a été marquée par des vents forts et une mer agitée, ce qui a entraîné un retrait des plages et une exportation de sable vers le large. Ceci illustre le fait que le transport de masse de particules dans la colonne d'eau à l'intérieur de la dérive littorale est hautement variable, qu'il est fonction de la turbulence, donc du climat, et peut être relié aux échanges de sédiments entre la plage et les régions au large de la zone de déferlement. La figure 4.4 montre les facteurs qui influencent la dynamique sédimentaire du secteur à l'étude.

Lors de la réalisation des travaux de construction du brise-lames, de l'épi d'enrochement, du quai, de la mise en place de remblais dans la mer, les activités de dragage et de construction du terre-plein, engendreront une augmentation de la turbidité des eaux. La turbidité sera toutefois atténuée en partie par plusieurs facteurs :

- les matériaux non consolidés qui seront dragués contiennent peu de matières fines;
- les matériaux provenant de la carrière auront un faible pourcentage de matières fines;
- la protection offerte par le brise-lames favorisera le confinement partiel du panache de turbidité;
- la zone de confinement où sera déposée les déblais de dragage, sera localisée dans une zone complètement protégée par le brise-lames et les matériaux seront mis en place à l'intérieur de cellules de sédimentation (confinées à l'intérieur de digues);
- les eaux de ruissellement de la zone de confinement (zone endiguée) seront interceptées dans un bassin de rétention avant d'être déversées dans la Fausse Baie des Galions;

- le dispersement d'un panache de matières en suspension en dehors de la zone portuaire grâce aux forts courants qui caractérisent le secteur. La présence de forts courants marins (de 10 à 40 cm/s), dirigés vers l'est, entraînera les sédiments vers la pointe d'Ehoala, où la dérive littorale du sud-ouest prendra le relais et chassera les sédiments vers le large (CSSA, 2001)(voir figure 4.4).

La contamination de l'eau par la remise en suspension de contaminants dans les sédiments marins n'est pas anticipée. En effet, selon une étude préliminaire sur la qualité des sédiments réalisée récemment (Jacques Whitford, 2006), aucune contamination des sédiments n'a été décelée dans la zone de dragage.

Les répercussions environnementales anticipées relatives à la qualité de l'eau sont :

- le ruissellement des eaux de surface des aires des travaux dans le milieu maritime (création d'ornières, d'ourlets et de monticules aux différents sites de construction);
- la modification de la qualité de l'eau due à l'augmentation temporaire de la turbidité;
- le risque de contamination de l'environnement maritime suite aux déversements accidentels d'hydrocarbures et autres matières polluantes.

4.1.2.1.2 MESURES D'ATTENUATION PROPOSEES

Diverses mesures d'atténuation sont envisagées afin de réduire les impacts sur la ressource eau. Les principales mesures seront :

- l'application de bonnes pratiques environnementales (voir section 5);
- l'application de mesures de contrôle de l'érosion et de la sédimentation;
- la mise en place d'un programme de surveillance et de suivi environnemental.

4.1.2.1.2.1 BONNES PRATIQUES ENVIRONNEMENTALES

- l'application de bonnes pratiques environnementales permettra de réduire les risques d'incidents environnementaux (ex. déversements accidentels de produits pétroliers). La section 5 donne les différentes règles de bonnes pratiques environnementales applicables à la protection de la ressource eau;
- l'application des mesures d'atténuation prévues à la section sols;
- l'entrepreneur s'assurera d'utiliser de bonnes méthodes de travail et la machinerie adéquate pour les travaux de dragage (voir annexe 3 Division 02 - Site Work – section 02325, Dredging);
- l'entretien et le nettoyage de la machinerie terrestre ainsi que son ravitaillement en carburant et en lubrifiant doivent être effectués à une distance d'au moins 60 m de tout plan d'eau. S'il est physiquement impossible de respecter cette distance, une enceinte confinée sur coussin absorbant doit être aménagée pour permettre cette activité;
- aucun réservoir ou contenant d'essence ou d'huile ne doit être laissé sans surveillance à moins de 60 m d'un plan d'eau.

4.1.2.1.2.2 CONTROLE DE L'EROSION ET DE LA SEDIMENTATION

- l'application des mesures d'atténuation prévues à la section sols;

- l'entrepreneur disposera les déblais de construction dans des aires bien identifiées et approuvées par QMM. Des travaux de confinement devront être réalisés afin d'éviter le ruissellement des eaux de ces aires dans le milieu marin;
- l'entrepreneur utilisera pour la construction du brise-lames et de l'épi du roc ne contenant pas de sol et terre organique. L'enrochement pourrait cependant contenir des particules fines;

Diverses procédures environnementales envisageables pour minimiser les impacts environnementaux des activités de dragage incluront, sans s'y limiter :

- l'entrepreneur prendra toutes les mesures nécessaires afin de s'assurer que les sédiments ne soient pas véhiculés en dehors du site des travaux;
- l'entrepreneur devra avant le début des travaux de dragage faire accepter par QMM les méthodes de travail qui viseront à limiter et contrôler la dispersion des sédiments;
- l'exécution des travaux par un équipage expérimenté dans les travaux de dragage;
- le matériel dragué sera pompé directement dans un bassin de sédimentation construit dans la zone de confinement des matériaux de dragage;
- les méthodes de travail devront tenir compte des marées afin de réduire au minimum le temps de séjour des sédiments en suspension dans le secteur;
- l'entrepreneur s'assurera de mettre en place tous les moyens nécessaires relativement à une gestion des matières en suspension afin de conserver le milieu propice à la vie aquatique;
- l'entrepreneur devra s'assurer du bon fonctionnement des équipements de dragage et devra déposer à QMM son programme de contrôle et de maintenance des équipements de dragage;
- l'entrepreneur cessera les opérations de dragage dans le cas où un bri d'équipement est susceptible de générer un incident.

Diverses procédures environnementales seront également appliquées pour minimiser les impacts environnementaux relatifs à la gestion des matériaux dragués dans la zone de confinement, incluant :

- l'entrepreneur devra soumettre à l'approbation de QMM un plan de prévention de l'érosion avant l'amorce des travaux;
- l'entrepreneur devra délimiter toutes les zones de travaux et de stockage des matériaux de dragage avant toutes interventions. L'entrepreneur devra faire approuver ces limites par QMM et se conformer à ces limites et ne pas utiliser la périphérie de ces secteurs;
- l'entrepreneur devra prendre toutes les mesures nécessaires afin de protéger d'une inondation les terres adjacentes au secteur de valorisation des sédiments;
- le remplissage de la zone de confinement des sédiments sera contrôlé et se fera de façon graduelle afin d'éviter les débordements et le ruissellement dans le milieu maritime;
- les eaux de ruissellement du secteur de mise en dépôt seront dirigées vers des bassins de sédimentation. Le déversoir de ces bassins sera conçu de façon à permettre la réduction au minimum des matières en suspension dans le milieu marin.
- Si nécessaire, l'entrepreneur construira des bassins de sédimentation qui permettront au sable et aux roches cassées de se déposer et de canaliser les eaux de surface afin d'éviter l'érosion des sols lors des pluies et plus particulièrement lors des épisodes cycloniques;
- les matériaux fins confinés dans le secteur de mise en dépôt et susceptibles de générer des poussières et pouvant être transportées par les vents seront recouverts de matériaux plus grossiers ou arrosés.

4.1.2.1.3 ÉVALUATION DES IMPACTS RÉSIDUELS

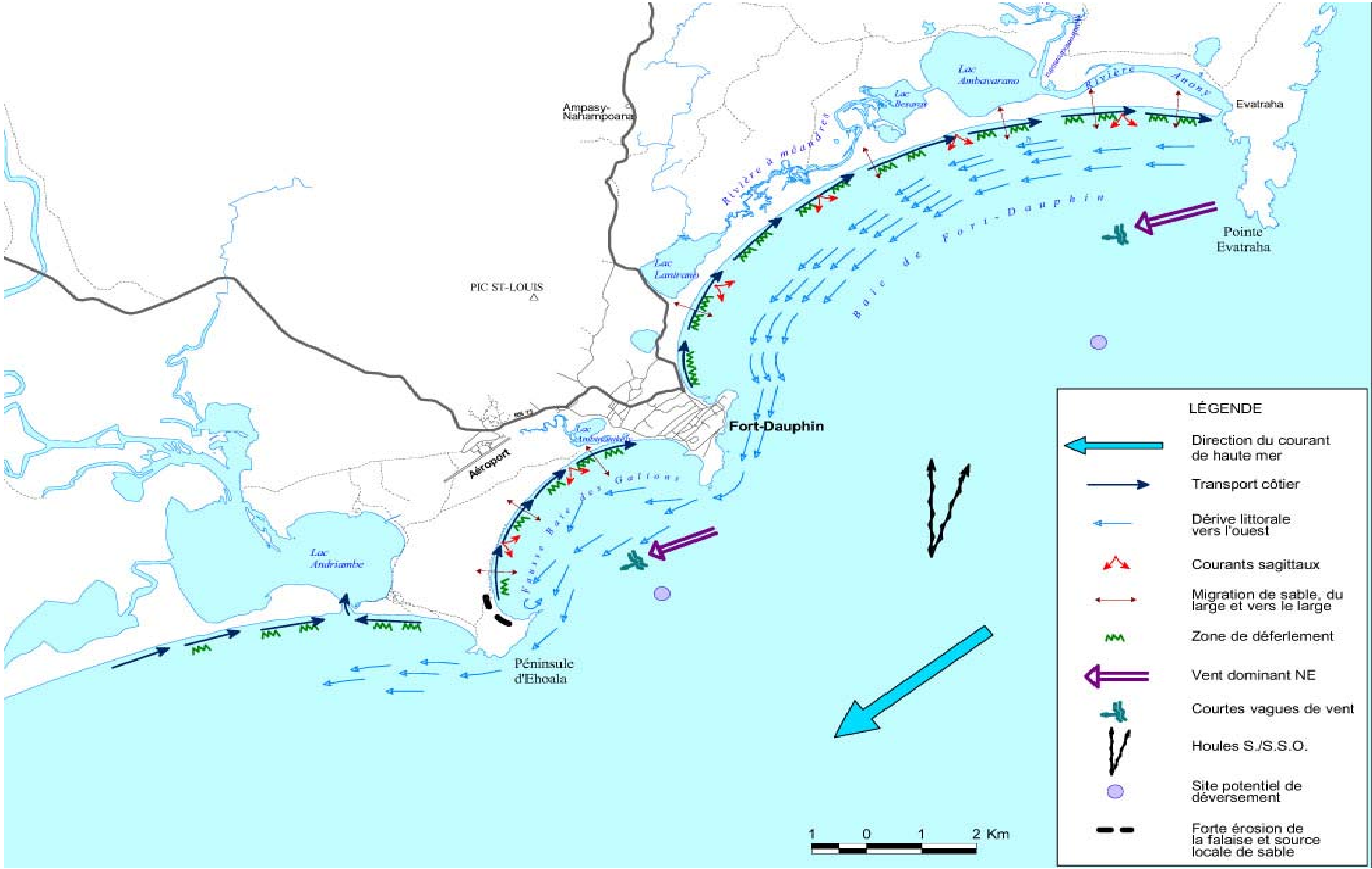
L'application de mesures d'atténuation fera en sorte qu'un **impact résiduel mineur** est prévu pour la modification de la qualité des eaux lors de la mise en place des blocs de roc pour la construction du brise-lames, et de l'épi d'enrochement, lors du dragage et de la mise en dépôt des sédiments dragués. Aucun impact résiduel n'est anticipé relativement à la modification du drainage naturel en milieu terrestre à la suite de la construction des infrastructures pour l'exploitation du port.

Le tableau présenté plus loin résume l'évaluation des impacts et les mesures d'atténuation qui seront mises en place pour atténuer les impacts sur la ressource eau.

Un programme de suivi a été élaboré afin de permettre la documentation des modifications de la qualité physico-chimique des eaux. Une attention particulière sera apportée aux matières en suspension générées par les travaux de dragage qui se réaliseront sur une courte période.

Le lecteur retrouvera en annexe 6 (Jacques Whitford, 2004), les détails d'un programme de suivi et les justifications de celui-ci. Ce programme sera optimisé en fonction des nouvelles informations recueillies au cours des dernières années.

Figure 4.4 Facteurs physiques impliqués dans la dynamique sédimentaire de la zone côtière de Mandena



Évaluation des impacts et mesures d'atténuation relativement à la qualité des eaux

Milieu physique								
Identification de l'impact			**Évaluation de l'impact**				**Mesures d'optimisation, d'atténuation ou de valorisation**	**Impact résiduel**
Élément	Composante	Caractérisation	Intensité	Portée	Durée	Importance de l'impact		
Eau	Ruissellement et infiltration	• Création d'ornières, d'ourlets et de monticules aux différents sites de construction.	Faible	Ponctuelle	Courte	Mineure	• Application de bonnes pratiques environnementales (voir section 5); • Application de mesures de contrôle de l'érosion et de la sédimentation; • Mise en place d'un programme de surveillance et de suivi environnemental;	**Aucun**
	Qualité des eaux	• Augmentation de la turbidité des eaux lors de la mise en place des blocs de roc pour la construction du brise-lames à la péninsule d'Ehoala. • Contamination par les hydrocarbures, produits chimiques, poussières, érosion.	Moyenne	Ponctuelle	Courte	Mineure		

4.1.3 FLORE

4.1.3.1 ÉCOSYSTEMES TERRESTRES

4.1.3.1.1 ÉTAT ACTUEL ET IMPACTS POTENTIELS

4.1.3.1.1.1 FORÊT LITTORALE, MILIEU MARÉCAGEUX ET MILIEU OUVERT

Le secteur prévu pour l'entreposage de l'ilménite et des hydrocarbures, à Ehoala est caractérisé par la présence de différentes entités phytoécologiques (voir figure 4.5). L'ensemble de la péninsule est actuellement couvert d'une mosaïque de végétation, dominée par des formations arbustives et herbeuses ainsi que des cultures sur sol sableux (voir annexe 7**).** Ces formations sont extrêmement dégradées par les activités anthropiques (incendie, agriculture itinérante). La plupart des fragments résiduels de groupements végétaux autochtones identifiés sont utilisés comme lieux d'aisance par la population riveraine. Toutefois, la présence des espèces de flore forestières, dispersées au sein des reliques de végétation arbustive constitue un bon indicateur de la présence, dans le passé, d'une formation forestière.

Vue d'ensemble du secteur proposé pour la construction de l'aire d'entreposage à la péninsule d'Ehoala

Dépôt de sable transporté par le vent (dune)

4.1.3.1.1.2 CARACTERISATION FLORISTIQUE DES ENTITES PHYTOECOLOGIQUES

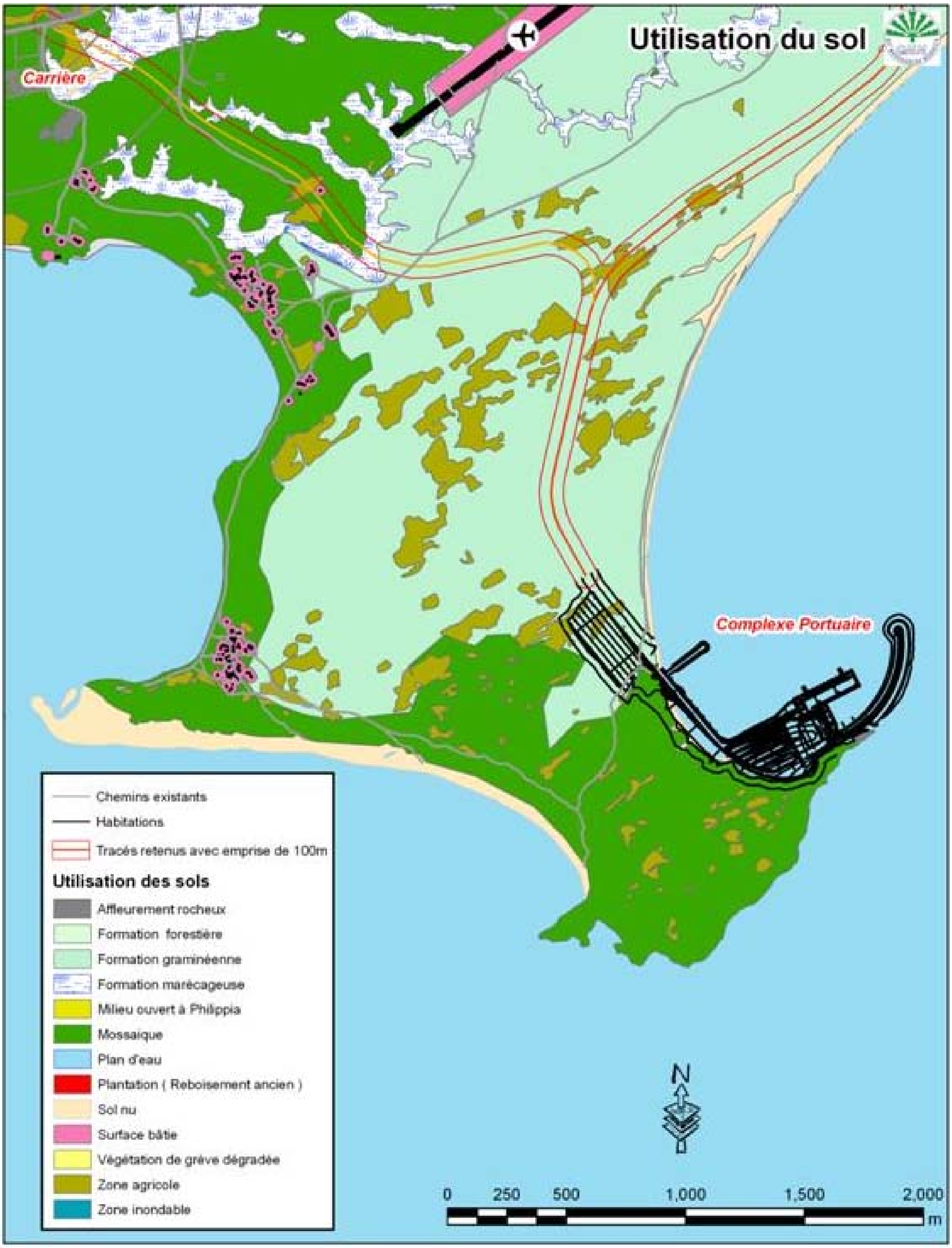
Mosaïque

Bien que la végétation dans le secteur de la pointe d'Ehoala soit fortement dégradée, une variation graduelle de la physionomie et de la composition floristique, due à l'influence du vent salin, est notée. Ainsi, d'est en ouest, la végétation passe d'une formation de plage, basse très rabougrie et rampante, constituée essentiellement de *Ipomoea pes-caprae* (Convolvulaceae), *Hydrophylax madagscariensis* (Rubiaceae) *Launaea bellidifolia* (Asteraceae) vers une formation plus haute constituée essentiellement d'espèces ligneuses adaptées au vent telle que *Scaevola taccada* (Goodeniaceae), *Flacourtia ramontchii*, *Tambourissa religiosa*, *Premna serratifolia* (Verbenaceae), *Mapouria eugleoides* (Rubiaceae)

Ainsi, sur les 123 espèces répertoriées, 23% sont des petits arbres et les 77% résiduels sont des arbustes, des herbes, des lianes et des épiphytes (voir annexe 7).

Aucune espèce inventoriée n'est endémique de la péninsule. Environ 41 % des espèces sont à large distribution (tropicale et cosmopolite), 52% sont des espèces communes aux différentes formations malgaches et 5% sont des espèces communes de la formation littorale. Aucune parmi les 2% d'espèces ayant une distribution restreinte (Petriky et Ehoala.) n'est menacée ni en danger (voir annexe 7).

Figure 4.5 Utilisation du sol à la Pointe d'Ehoala



VÉGÉTATION DE PLAGE

Aucune association végétale particulière et aucune espèce végétale rare ou menacée n'a été inventorié le long des plages. Du côté est, la variation graduelle de la ceinture longitudinale de végétation conditionnée par l'action du vent marin est bien visible. Ainsi, après la plage de sable blanc, la flore est constituée d'espèces caractéristiques de la côte est de Madagascar comme *Ipomoea pes-caprae* (Convolvulaceae), *Hydrophylax madagscariensis* (Rubiaceae), *Launaea bellidifolia* (Asteraceae), *Stephanotaphrum dimidiantum* (Poaceae), *Scaevola taccada* (Goodeniaceae), *Pandanus* (Pandanaceae). L'avancement de dune sur ce côté provoque un enfouissement d'une grande surface de végétation.

Du côté ouest, la ceinture longitudinale n'est pas visible et la composition végétale est essentiellement constituée de végétation arbustive formée de *Mimusops commersonii* (Sapotaceae), *Poupartia minor* (Anacardiaceae), *Brexia madagascariensis* (Celastraceae) où on retrouve des cultures de patates douces (*Ipomoea batatas*) et du maïs (Zea maïs). Ce côté est caractérisé par la présence de quelques domaines privés.

FORMATION ARBUSTIVE

C'est une formation disparate d'association de vestiges d'espèces arbustives dont la hauteur dépasse rarement 2 m**.** Constituée essentiellement de *Flacourtia ramountchii* (Salicaceae), *Poupartia minor* (Anacardiaceae), *Brexia madagascariensis* (Celastraceae), *Tambourissaa religiosa* (Monimiaceae), *Scutia maritima* (Rhamanaceae), *Strebulus dimepate* (Moraceae), *Strichnos spinosa* (Loganiaceae) cette formation forme une association avec les champs de patates douces (*Ipomoea batatas*) et de maïs (*Zea maïs*).

L'inventaire floristique réalisé indique qu'il n'y a aucun groupement végétal particulier et aucune espèce végétale rare ou menacée (voir annexe 7).

FORMATION GRAMINÉENNE

Toutes les surfaces dénudées sont colonisées par des espèces herbacées dominées par les graminées.

Ce sont surtout des espèces indicatrices de sol très pauvre telle que *Imperata cylindrica* et des espèces adaptées au sol sablonneux telles que *Stenotaphrum dimidiatum, Panicum parviflorum, Melinis repens, Dactyloctenium aegyptium, Ramirea maritima.*

L'inventaire floristique réalisé indique qu'il n'y a aucun groupement végétal particulier et aucune espèce végétale rare ou menacée (voir annexe 7).

MOSAÏQUE DE CULTURE

Avant de cultiver, les paysans brûlent d'abord la surface et puis, avant la saison de pluie, ils ensemencent à la main les graines. Ils abandonnent la surface cultivée après un cycle de trois ans et recommencent le même processus sur une surface située à proximité. Ce sont des cultures principalement constituées de maïs, du manioc et d'haricot. Les patates douces sont plutôt cultivées près du village.

En général, la production agricole de ces sites est faible et souvent détruite par des incendies d'origine anthropique.

SABLE NU

Après avoir été transporté par la houle (plage) ou par l'érosion éolienne (dune), les dépôts de sable se sont accumulés et ont formé des surfaces dénudées de couleur blanche.

Les répercussions des travaux de construction sur la flore terrestre seront potentiellement :

- la perte de couverture végétale naturelle (végétation de berge et terrestre);
- l'enfouissement de la végétation par les dépôts de sable;
- la prolifération des espèces invasives;
- la contamination à la suite du déversement accidentel d'hydrocarbures ou autres produits dangereux.

4.1.3.1.2 MESURES D'ATTÉNUATION PROPOSÉES

Diverses mesures d'atténuation peuvent être envisagées afin de réduire les impacts sur la végétation. Les principales mesures seront :

- l'application de bonnes pratiques environnementales (voir section 5);
- l'application des mesures énoncées aux sections sols et eau;
- la mise en végétation ou recouvrement des espaces dénudés par les travaux et exposés à l'action éolienne;
- la conservation de la couverture végétale sur les talus gréseux à la pointe de la péninsule (Cap Ranavalona) comme anti-érosion;
- le contrôle des espèces envahissantes lors des différents travaux de revégétalisation et stabilisation;
- la décontamination et la réhabilitation des lieux;
- l'élaboration d'un programme de surveillance et de suivi environnemental.

4.1.3.1.3 ÉVALUATION DES IMPACTS RÉSIDUELS

L'application des mesures d'atténuation permettra d'atténuer ou d'éliminer les impacts de la construction des infrastructures portuaires sur la végétation.

Aucune espèce végétale rare ou menacée n'a été inventoriée dans le secteur de la péninsule d'Ehoala. Les espèces caractérisant le milieu sont communes à Madagascar. Par conséquent, l'**impact résiduel** sur les milieux terrestres et riverain (berge) est qualifié d'**importance mineure.**

Le tableau présenté plus loin résume l'évaluation des impacts et les mesures d'atténuation qui seront mises en place pour les atténuer sur l'élément flore terrestre.

Évaluation des impacts et mesures d'atténuation relativement à l'élément flore terrestre et riveraine

MILIEU BIOLOGIQUE								
Identification de l'impact			Évaluation de l'impact				Mesures d'optimisation, d'atténuation ou de valorisation	Impact résiduel
Élément	Composante	Caractérisation	Intensité	Portée	Durée	Importance de l'impact		
Flore	Milieu ouvert	• Perte de couverture végétale; • Enfouissement de la végétation par les dépôts de sable (dune); • Prolifération des espèces invasives.	Faible	Ponctuelle	Longue	Mineure	• Application de bonnes pratiques environnementales (voir section 5); • Réhabilitation et remise en végétation des espaces exposés à l'action du vent; • Mise en végétation ou recouvrement des espaces dénudés par les travaux; • Conservation de la couverture végétale sur les talus gréseux à la pointe de la péninsule comme anti-érosion; • Contrôle des espèces envahissantes; • Élaboration d'un programme de surveillance et de suivi environnemental.	**Mineur**
		• Contamination des végétaux.	Faible	Ponctuelle	Courte	Mineure		

4.1.3.2 ÉCOSYSTEME MARIN

4.1.3.2.1 ÉTAT ACTUEL ET IMPACTS POTENTIELS

La zone d'Ehoala jusqu'à Faux Cap est connue par sa richesse en flore algale tel que *Gelidium madagascariensis, Gigartina radula, Hypnea musciformis, Plocamium sp, Rhabdonia africana, Haliptylon subulata, Peysonnelia sp, Botryocladia leptopoda, Galaxaura arborea, Pterocladia sp.*

Un inventaire floristique a été réalisé le long du littoral de la région de Fort-Dauphin, dont le secteur de la péninsule d'Ehoala. Un total de 43 espèces d'algues a été répertorié. Les algues vertes sont dominantes en termes de biomasse alors que les algues rouges sont prépondérantes en termes de diversité spécifique. Les algues brunes sont présentes en minorité.

Soulignons que *Gelidium madagascariensis* est une Gelidiaceae endémique de Madagascar. Elle pousse en abondance de Sainte Luce à Faux Cap (Andriamapandry, 1976).

Dans le secteur des travaux, des algues vertes, du type *Ulva*, et rouges peuplent un récif rocheux submergé, au sud du futur brise-lames et parallèle à celui-ci. Dans la zone immédiate de la construction de l'ouvrage de protection portuaire, soit à des profondeurs inférieures à 15 m, le fond marin est recouvert de sable et de blocs favorables aux colonies d'algues holothuries d'une abondance relative. Des inventaires réalisés dans le secteur de la péninsule d'Ehoala (CSSA, 2001) ont également révélé que les habitats favorables à la flore aquatique sont plus abondants au sud de la zone de construction du brise-lames (voir figure 4.6). La figure 4.7 présente également la distribution des ressources marines de la zone côtière où s'insère le projet.

Les répercussions des travaux de construction des infrastructures portuaires sur la flore marine seront potentiellement :

- la modification de la ressource *Gelidium madagascariensis* dans le secteur de dragage et de l'emplacement des infrastructures;
- la modification de la composition de la flore à l'emplacement des infrastructures et dans le secteur de dragage;
- la perte d'individus de la flore à l'emplacement des infrastructures et dans la zone de dragage;
- l'envasement des individus floristiques à la suite du transport des matières en suspension;
- le déversement accidentel de matières résiduelles pouvant être toxiques pour les espèces végétales marines.

Figure 4.6 Ressources marines dans le secteur de la péninsule d'Ehoala

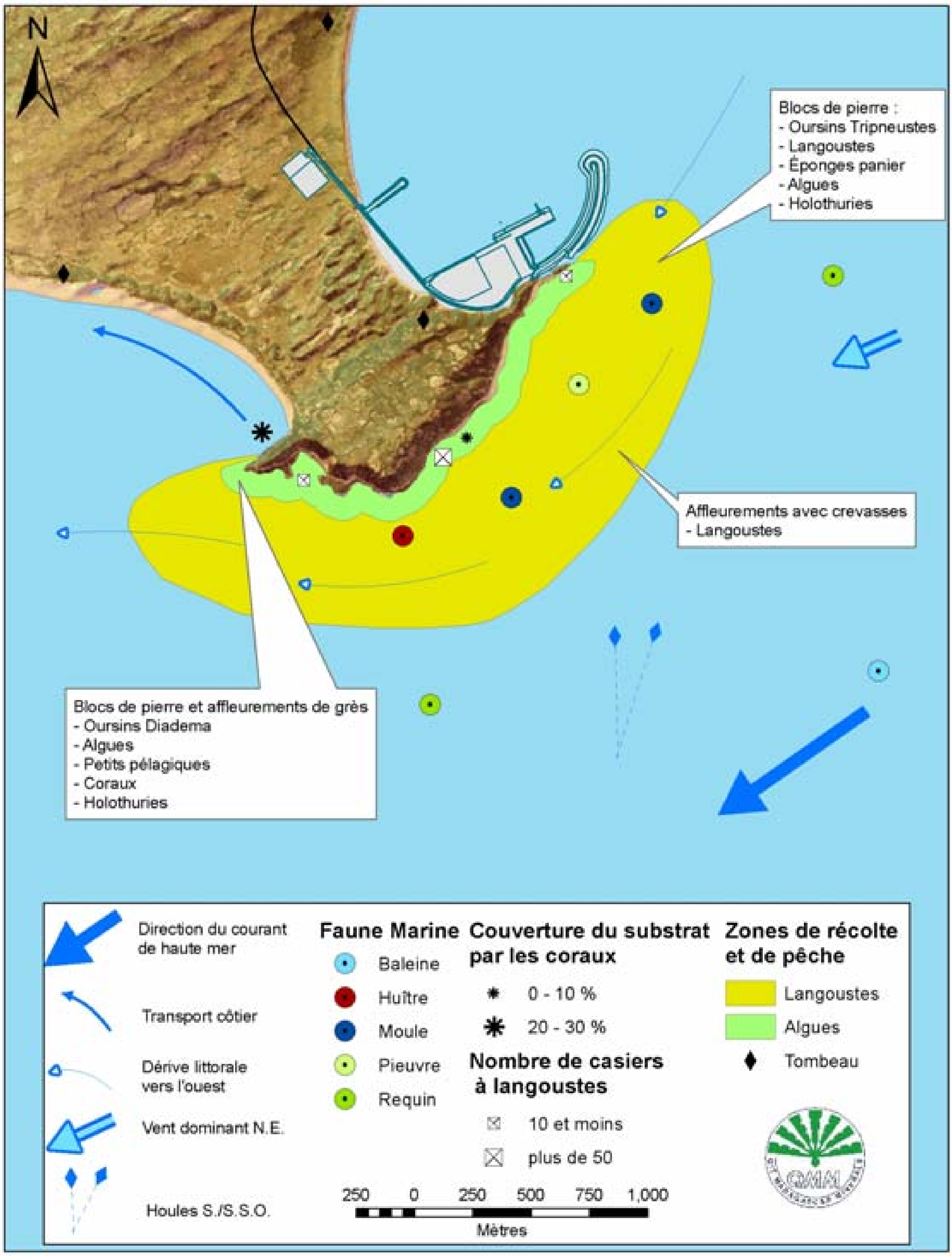
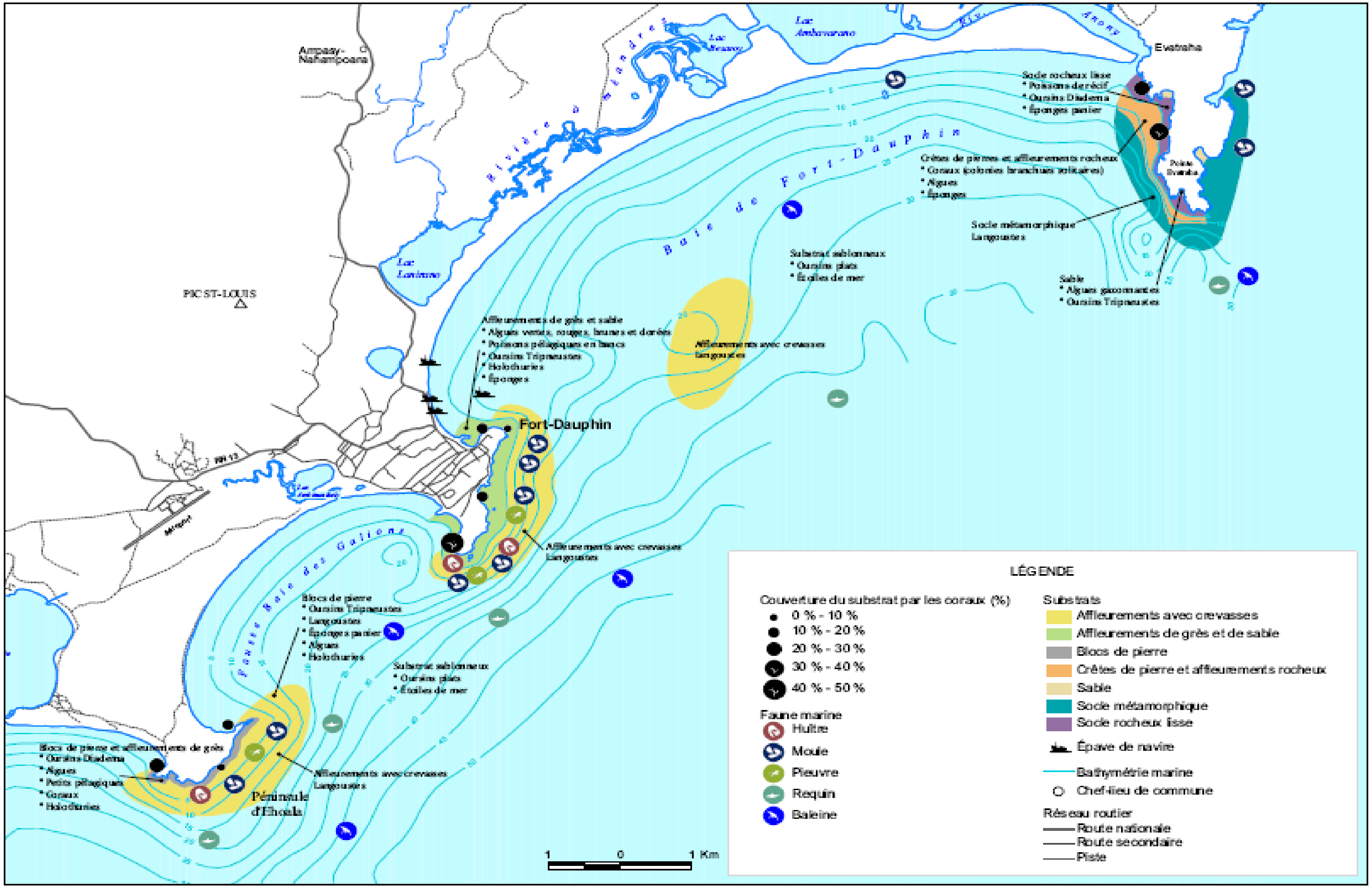


Figure 4.7 Distribution des ressources biologiques dans la zone côtière



Source : CSSA International Consultants, 2001

Figure 3.114 : Distribution des ressources biologiques inventoriées dans la zone côtière

4.1.3.2.2 MESURES D'ATTÉNUATION PROPOSÉES

Diverses mesures d'atténuation peuvent être envisagées afin de réduire les impacts sur la végétation marine. Les principales mesures seront :

- l'application de bonnes pratiques environnementales relatives à la protection du milieu hydrique (voir section 5) permettra de réduire les risques d'incidents environnementaux;
- l'application des mesures énoncées aux sections sols et eau;
- l'application des bonnes méthodes de dragage (ex. moment et vitesse) permettant un transport des matières en suspension par la marée et minimisant une stagnation aux sites des travaux;
- l'évacuation de façon appropriée en eau libre, des eaux de l'effluent en provenance du site de confinement des sédiments et en évitant les habitats marins sensibles;
- l'élaboration d'un programme de surveillance et de suivi environnemental.

Selon les différentes études réalisées dans le secteur de construction du brise-lames, il est peu probable que les modifications apportées au milieu marin soient préjudiciables à la flore. La turbidité engendrée par les dépôts de matériaux à la mer, au début de la construction du brise-lames, pourrait affecter les colonies d'algues à proximité du site de construction. Toutefois, les conditions hydrodynamiques qui prévalent dans ce secteur permettent de prévoir qu'il n'y aura peu d'impacts sur les colonies d'algues rouges. En effet, les courants marins favoriseront la dissipation rapide de la turbidité. De plus, ces algues ont également été repérées sur le côté sud et sud-est de la péninsule d'Ehoala.

Par ailleurs, à l'exception de *Gelidium madagascariensis* qui est endémique à Madagascar, aucune autre espèce en milieu marin n'est endémique, rare, menacée ou vulnérable. Par ailleurs, *Gelidium madagascariensis* est abondante de Sainte Luce à Faux Cap (Andriamapandry, 1976).

4.1.3.2.3 ÉVALUATION DES IMPACTS RÉSIDUELS

Un **impact résiduel d'importance mineure** est donc prévu pour la flore maritime. Par ailleurs, au terme de la construction du brise-lames, QMM est d'avis que l'infrastructure constituera un habitat potentiel pour la flore marine. Il est reconnu qu'un fond marin rocheux est plus propice, sous plusieurs aspects, à la colonisation par la flore marine.

Le tableau présenté plus loin résume l'évaluation des impacts et les mesures d'atténuation qui seront mises en place pour les atténuer sur l'élément flore maritime.

Un programme de suivi a été élaboré afin de permettre de documenter les modifications sur la flore marine. Le lecteur retrouvera en annexe 6 (Jacques Whitford, 2004), les détails d'un programme de suivi et les justifications de celui-ci. Ce programme sera optimisé en fonction des nouvelles informations recueillies au cours des dernières années.

Évaluation des impacts et mesures d'atténuation relativement à l'élément flore marine

MILIEU BIOLOGIQUE								
Identification de l'impact			**Évaluation de l'impact**				**Mesures d'optimisation, d'atténuation ou de valorisation**	**Impact résiduel**
Élément	Composante	Caractérisation	Intensité	Portée	Durée	Importance de l'impact		
Flore	Milieu marin	• Modification de la ressource *Gelidium madagascariense* dans le secteur de dragage et de l'emplacement des infrastructures; • Modification de la composition de la flore à l'emplacement des infrastructures et dans le secteur de dragage; • Perte d'individus de la flore à l'emplacement des infrastructures et dans la zone de dragage; • Envasement des individus floristiques.	Faible	Ponctuelle	Longue	Mineure	• Application de bonnes pratiques environnementales (voir section 5); • Application des mesures énoncées à la section sols et eau; • Application de bonnes méthodes de dragage; • Évacuation appropriée en eau libre des eaux de l'effluent du site de confinement des sédiments; • Élaboration d'un programme de surveillance et de suivi environnemental.	**Mineur**
		• Contamination de la flore algale et des autres groupes végétaux.	Faible	Ponctuelle	Courte	Mineure		

4.1.4 FAUNE

4.1.4.1 ÉCOSYSTEME TERESTRE

4.1.4.1.1 ÉTAT ACTUEL ET IMPACTS POTENTIELS

Un inventaire de la faune terrestre retrouvée dans le secteur du futur site portuaire a été réalisé afin d'identifier les espèces potentiellement présentes et les habitats utilisés.

La liste des espèces inventoriées est fournie à l'annexe 8.

Du point de vue biologique, le secteur proposé pour la construction des infrastructures portuaires est caractérisé par la présence de 58 espèces de vertébrés, dont 19 reptiles, 4 amphibiens, 29 oiseaux dont 6 sont des espèces marines mais fréquentent occasionnellement le rivage. Le milieu terrestre ne présente que de très faible valeur biologique par rapport aux sites adjacents dans la région compte tenu du fait que les milieux sont très dégradés. La plupart des espèces inventoriées sont ubiquistes et largement distribuées. L'inventaire réalisé au site portuaire d'Ehoala montre qu'aucun habitat sensible n'a été localisé. La biodiversité terrestre rencontrée est dominée par une communauté de faune de prairie ou de savane. On note toutefois, la présence d'une espèce endémique (*Heterixalus boettgeri*) de la région de l'Anosy. Son écologie est suffisamment connue et elle est bien adaptée aux milieux fortement dégradés voire même à proximité d'une zone d'habitation et en ville, à Fort Dauphin. Une espèce désignée (UICN), soit *Fossa fossana* une espèce de carnivore de la prairie est présente dans le secteur de la péninsule. Elle est aussi observée dans différentes localités de la forêt humide de l'est de Madagascar. Elle se réfugie en forêt et utilise occasionnellement la prairie pour se nourrir. Toutefois, le secteur des travaux n'est pas reconnu comme étant un secteur privilégié pour cette espèce.

Des observations ornithologiques ont surtout été réalisées sur le littoral et les dunes adjacentes. Quatre espèces ont été répertoriées (*Calidris alba, Larus dominicanus, Milvus migrans parasitus* et *Sternia caspia*). L'espèce *Milvus migrans parasitus* (le milan noir) est représentée par une sous-espèce qui est endémique à Madagascar. Cette espèce a été observée aux deux saisons. *Calidris alba* (le bécasseau sanderling) est une espèce migratrice qui hiverne à Madagascar; sa présence n'a été notée qu'en septembre. *Larus dominicanus* (le goéland dominicain) n'est représenté à Madagascar que par une petite population exclusive au sud du pays.

Les répercussions de la construction des infrastructures portuaires sur la faune terrestre seront potentiellement :

- la perte d'habitats;
- la détérioration d'habitats (ensablement par l'érosion éolienne de sites de nidification et refuges sur le littoral;
- la fragmentation des habitats;
- les risques d'accidents potentiels avec les véhicules;
- l'invasion des espèces introduites telle que les rats (*Rattus rattus*), les souris (*Mus musculus*) et les chiens (*Canis canis*).

4.1.4.1.2 MESURES D'ATTÉNUATION PROPOSÉES

Diverses mesures d'atténuation peuvent être envisagées afin de réduire les impacts sur la faune terrestre. Les principales mesures seront :

- l'application de bonnes pratiques environnementales relatives au milieu hydrique et permettra de réduire les risques d'incidents environnementaux (voir section 5;
- l'application des mesures énoncées aux sections sols et eau;

- la stabilisation et la revégétalisation des abords des talus et des fossés, en bordure de la surface de roulement et du site portuaire;
- l'élaboration d'un programme de surveillance et de suivi environnemental.

4.1.4.1.3 ÉVALUATION DES IMPACTS RÉSIDUELS

Un **impact résiduel** qualifié de **mineur** est identifié. La pérennité d'aucune des espèces de la faune terrestre inventoriées dans le secteur où seront construites les structures du port ne sera menacée. Les espèces caractérisant le milieu sont communes à Madagascar.

Le tableau présenté plus loin résume l'évaluation des impacts et les mesures d'atténuation qui seront mises en place pour atténuer les impacts sur la faune terrestre.

Un programme de suivi a été élaboré afin de documenter les modifications sur la faune terrestre des travaux de construction des infrastructures portuaires.

Le lecteur retrouvera en annexe 6 (Jacques Whitford, 2004), les détails d'un programme de suivi et les justifications de celui-ci. Ce programme sera optimisé en fonction des nouvelles informations recueillies au cours des dernières années.

Évaluation des impacts et mesures d'atténuation relativement à la faune terrestre et avifaune

MILIEU BIOLOGIQUE								
Identification de l'impact			**Évaluation de l'impact**				**Mesures d'optimisation, d'atténuation ou de valorisation**	**Impact résiduel**
Élément	Composante	Caractérisation	Intensité	Portée	Durée	Importance de l'impact		
Faune terrestre	Forêt littorale fortement dégradée et milieu ouvert (dune et plage)	• Perte d'habitats; • Fragmentation des habitats par formation d'une nouvelle barrière écologique; • Risques d'accidents avec les véhicules; • Invasion des espèces introduites telles que les rats (*Rattus rattus*), les souris (*Mus musculus*) et les chiens (*Canis canis*).	Faible	Ponctuelle	Longue	Mineure	• Application de bonnes pratiques environnementales (voir section 5); • Application des mesures énoncées à la section sols et eau; • Stabilisation et revégétalisation des abords des talus et des fossés, en bordure de la surface de roulement et du site portuaire; • Élaboration d'un programme de surveillance et de suivi environnemental.	**Mineur**
Avifaune	Milieu ouvert (dune et plage)	• Perte d'habitats; • Détérioration d'habitats (ensablement de la plage et autre site de nidification et refuge); • Risques d'accidents avec les véhicules; • Invasion des espèces introduites.	Faible	Ponctuelle	Longue	Mineure		

4.1.4.2 ÉCOSYSTEME MARIN

4.1.4.2.1 ÉTAT ACTUEL ET IMPACTS POTENTIELS

4.1.4.2.1.1 FAUNE BENTHIQUE

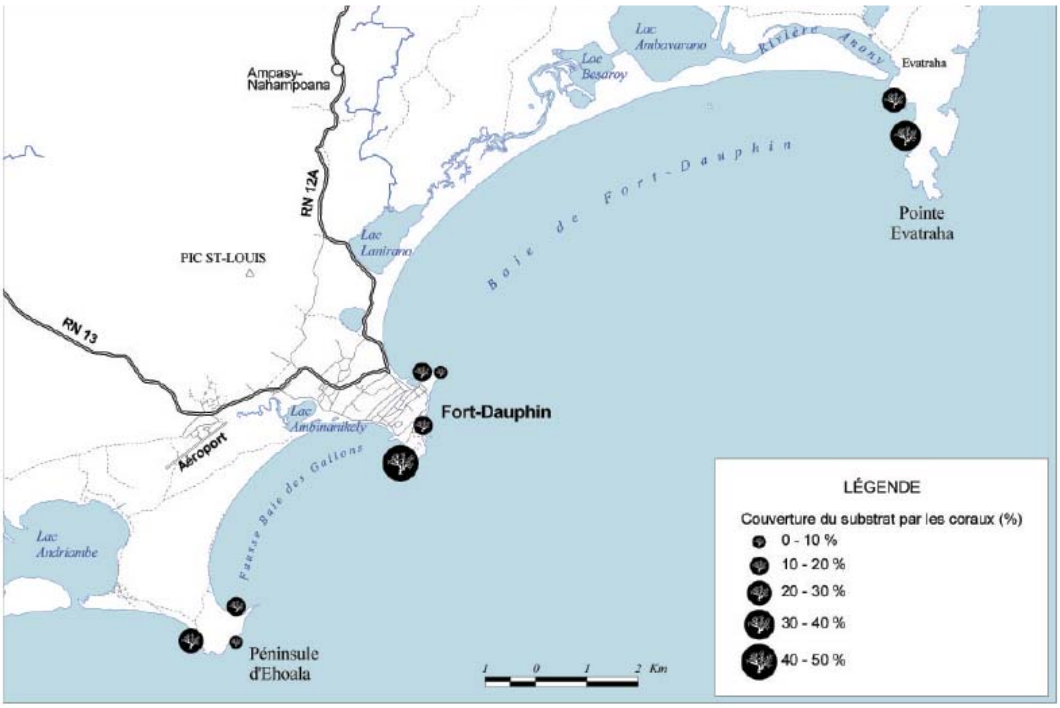
À des profondeurs de moins de 5 m et à proximité de la pointe et du promontoire d'Ehoala, l'habitat marin est dominé par les oursins *Diadema*. À partir de la pointe est du promontoire d'Ehoala, le fond de la mer est composé d'un amas de blocs de pierre qui descend en pente douce vers la baie d'Ehoala. Abondants, les oursins Tripneustes s'alimentent des algues. Des éponges encroûtantes, des éponges en panier, des coraux, des colonies solitaires de coraux branchus peuvent aussi être observés.

Le substrat du secteur d'implantation du brise-lames est caractérisé, entre le littoral et 15 m de profondeur, par du sable moyen à gros et des amas de blocs de pierre. Dans ce secteur les vagues sont fortes et seuls les substrats durs peuvent être colonisés, par des éponges, des oursins, des concombres de mer et des échinodermes. Des ondulations régulières, distantes de 1 m et hautes de 0,2 m sont formées sur le sable du fond, parallèlement à l'axe S.O./N.E. La vie marine y est peu diversifiée et peu abondante. On observe dans ce milieu des espèces tels les oursins plats et les étoiles de mer. On trouve aussi un récif submergé à l'intérieur de la baie d'Ehoala, parallèle à la pointe est du promontoire et à 200 m de celle-ci. Ce récif est le prolongement de la crête de grès. Ce dernier s'étend du rivage jusqu'à une profondeur d'environ 6 m et se trouve dans un environnement de forte houle, où la mise en suspension des sédiments est élevée. On ne voit que quelques éponges en panier (voir figure 4.6).

4.1.4.2.1.2 COLONIES DE CORAUX

Aucune colonie de coraux n'est identifiée jusqu'à environ 200 m de la zone des travaux. Les premières colonies importantes apparaissent à la pointe ouest de la baie de Fort-Dauphin (voir figure 4.8).

Figure 4.8 Localisation des colonies de coraux dans la zone d'étude



4.1.4.2.1.3 POISSONS

Dans le secteur à l'étude, un inventaire des espèces de poissons présentes dans le milieu marin ont permis d'y répertorier 39 espèces, dont 9 ont aussi été répertoriées en milieu estuarien. Aucune espèce identifiée dans le milieu marin n'a été retrouvée en milieu dulcicole. La liste complète des poissons est présentée à l'annexe 9.

Les espèces de poissons recensées sont toutes des espèces marines, océaniques ou côtières. Les juvéniles de quatre espèces migrent en milieu estuarien pour y poursuivre leur développement, mais retournent en milieu marin au stade adulte. Ce sont la Carangue têtue (*Caranx ignobilis*), le Vivaneau encrier (*Lutjanus ehrenbergii*), le Sargue doré (*Rhabdosargus sarba*) et le barracuda (*Sphyraena barracuda*).

Parmi la faune ichthyenne inventoriée, cinq espèces sont des grands migrateurs et font partie de l'Annexe I de la Convention sur le droit de la mer (1982). Ce sont la dorade coryphène (*Coryphaena hippurus*), la bonite à dos rayé (*Euthynnus affi nis*), la bonite à ventre rayé (*Katsuwonus pelamis*), le requin tigre commun (*Galeocerdo cuvier*) et le makaire bleu de la zone indo-Pacifique (*Makaira mazara*).

Aucune des espèces de poissons répertoriées en milieu marin n'est endémique à Madagascar.

4.1.4.2.1.4 MAMMIFÈRES MARINS

Dans la région de Fort-Dauphin, des dauphins, des marsouins et des baleines sont observés dans les eaux côtières (voir figures 4.6 et 4.7). Les espèces de dauphins fréquemment observés incluent, notamment, le dauphin à gros nez (*Tursiops truncatus*) et le dauphin à long bec (*Stenella longirostris*). La baleine à bosse (*Megaptera novaeangliae*) est le cétacé le plus fréquemment observé dans la zone d'étude.

La baleine à bosse est une espèce désignée vulnérable par l' IUCN. Elle est également protégée sous l'article 64 de la Convention sur les droits de la mer des Nations Unies (1982). La baleine à bosse migre de l'Antarctique vers Madagascar en quête d'eaux chaudes pour sa reproduction. Lors de ses déplacements, elle longe les régions côtières, incluant la région de Fort-Dauphin. Les groupes de femelles sont les premières à arriver, entre la mi-juin et le mois d'août. À leur arrivée, les baleines se maintiennent à une distance de 8 à 10 km de la côte en conditions de mer agitées, et nagent plus près de la rive à des profondeurs inférieures à 15 m, lorsque la mer est calme. Le voyage de retour, soit après la mise bas des baleineaux, s'effectue sur une période comprise entre le mois de septembre et la mi-novembre.

Selon les résultats d'un inventaire récent, aucune baleine n'a été observée à moins de 500 m de la zone de dragage prévue lors des travaux (Jacques Whitford, 2006).

4.1.4.2.1.5 CRUSTACÉS

Les espèces de langoustes retrouvées dans le secteur marin de la zone d'étude appartiennent à la famille des palinuridés, qui regroupe des langoustes marines retrouvées principalement dans les zones côtières, sur des hauts-fonds rocheux ou des bancs récifaux, à des profondeurs de 1 à 45 m. Pour ce qui a trait à la zone d'étude, de tels habitats se trouvent surtout dans la partie côtière des péninsules d'Ehoala, Fort-Dauphin et Evatraha.

La langouste rouge (*Panulirus homarus*) est l'espèce la plus abondante dans la région de Fort-Dauphin. Cette espèce grégaire occupe la zone de houle à une profondeur qui dépasse rarement 20 m. Elle préfère un substrat rocheux ou un récif de grès et évite le corail. Sa longueur dépasse rarement 31 cm. Elle se reproduit pendant toute l'année.

La langouste fourchette (*Panulirus. penicillatus*) est une espèce solitaire ou vivant en paire. Elle occupe la zone de houle, sur un substrat de grès ou un récif de corail et peut tolérer des eaux turbides. Sa longueur dépasse rarement 41 cm. Elle se reproduit entre mars-avril et septembre-octobre.

La Langouste dragon (*Panulirus. longipes*) est une espèce solitaire ou vivant en paire. Elle occupe le substrat de grès ou le récif de corail à une profondeur de 3 à 20 m et évite la zone de houle. Sa longueur dépasse rarement 30 cm Elle se reproduit entre mars-avril et septembre-octobre.

La Langouste ornée (*Panulirus. ornatus*) est une espèce solitaire ou vivant en paire. Elle préfère un substrat de grès ou les récifs de corail, à des profondeurs de 3 à 45 m. Cette espèce tolère les eaux turbides et évite la zone de houle. Sa longueur maximale est de 50 cm. Elle se reproduit entre mars-avril et septembre-octobre.

La Langouste bariolée (*Panulirus. versicolor*) est une espèce très grégaire. Elle préfère les récifs de corail et est parfois retrouvée sur un substrat de grès à des profondeurs de 3 à 20 m. Elle évite la zone de houle. Sa longueur maximale est de 40 cm. Elle se reproduit entre mars-avril et septembre-octobre.

Toutes les espèces retrouvées dans le secteur de la péninsule d'Ehoala sont nocturnes et se nourrissent de poissons morts, de vers, de bivalves et autres invertébrés marins. De jour, elles se cachent dans des trous ou des anfractuosités. Puisque la langouste a besoin des trous et des anfractuosités des roches et des récifs de coraux pour se cacher et se protéger, on ne la retrouvera pas sur des fonds sableux ou mous. Dans la zone d'étude, les habitats appropriés aux langoustes se trouvent essentiellement au sud de la péninsule d'Ehoala (voir figure 4.6).

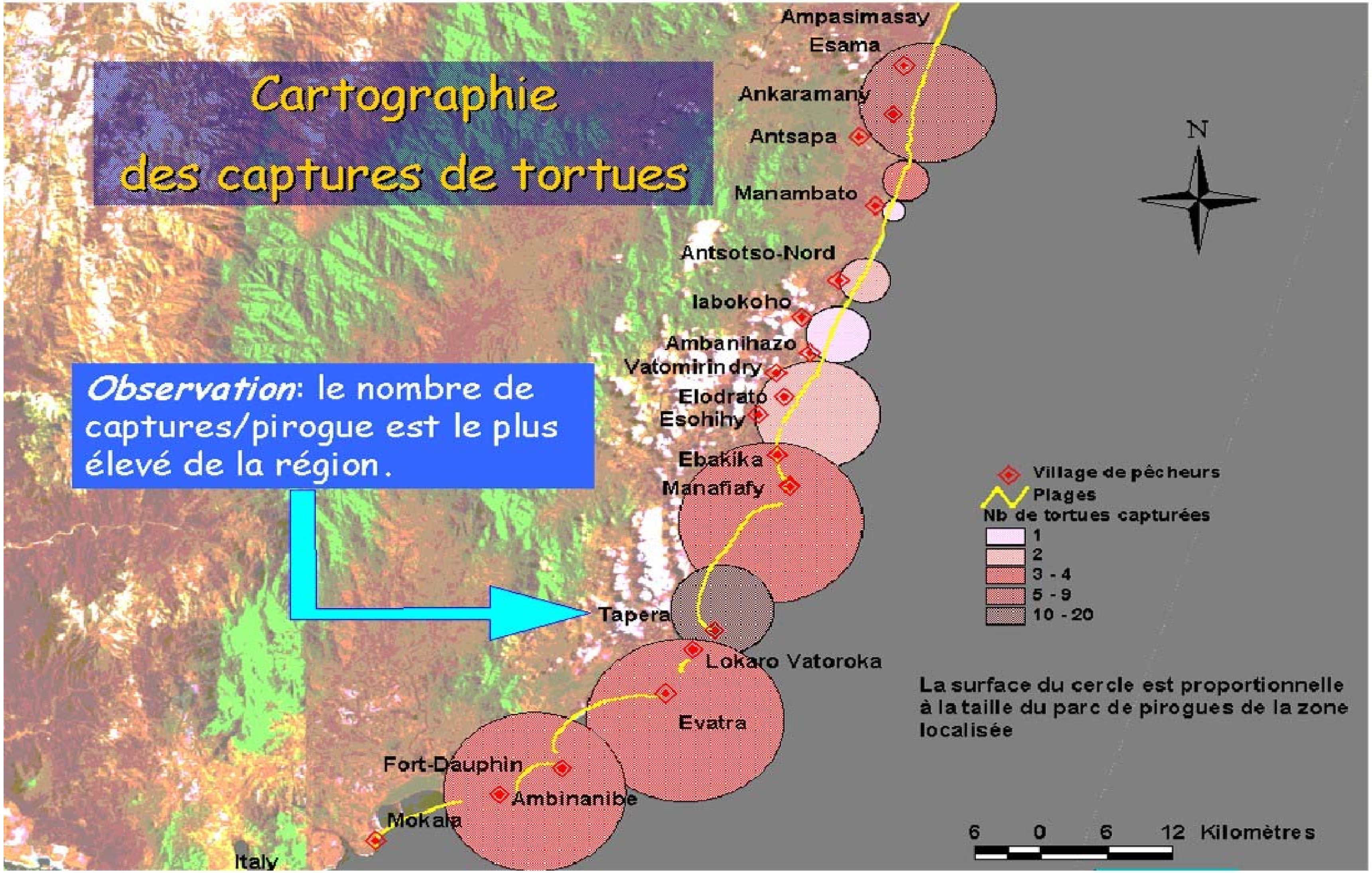
4.1.4.2.1.6 TORTUE MARINE

La présence de tortue est rarement observée dans le secteur de la Fausse Baie des Galions. Toutefois, récemment, un nid de tortue caouanne (*Caretta caretta*) a été inventorié dans la zone de l'établissement du port. Il s'agit d'une espèce menacée d'extinction au niveau mondial selon l' UICN. Au cours d'un suivi réalisé de janvier 05 à février 2006, une femelle de cette espèce a été observée sur la plage de la Fausse Baie des Galions pour pondre. Une autre a été repérée respectivement dans la Baie de Fort de Fort Dauphin et dans la Baie d'Ambinanibe. Selon les résultats du suivi en cours sur les différents sites utilisés par les tortues marines, il appert que ces sites ne sont utilisés qu'occasionnellement et plus particulièrement celui d'Ehoala.

Par ailleurs, selon les informations obtenues auprès de la population locale, les tortues observées à proximité des zones habitées sont généralement capturées par la population. La figure 4.9 présente la localisation des principaux sites de capture des tortues. On note qu'il y a très peu de tortues prélevées dans la zone d'étude.

Globalement, l'ensemble des espèces marines trouvées dans la zone d'insertion du brise-lames sont toutes présentes ailleurs dans les eaux qui entourent l'île de Madagascar et, pour la majorité d'entre elles, en Afrique. La zone marine où sera construit le brise-lames, à la péninsule d'Ehoala, n'est pas caractérisée par une faune aquatique différente de celles qui caractérisent les promontoires d'Evatraha et de Fort-Dauphin. Par ailleurs, à Ehoala, les habitats préférentiels des différentes espèces se trouvent principalement sur toute la partie sud et sud-est du promontoire, qui ne sera pas touchée par les travaux (voir figure 4.6).

Figure 4.9 Localisation des captures de tortue dans la zone côtière



Les résultats des différentes études biologiques réalisés depuis plusieurs années et suivis amorcés depuis quelques années dans le secteur d'étude ont révélé la présence :

- de la baleine à bosse *(Megaptera novaeangliae)*, espèce classée vulnérable, (UNEPWCMC, 2000);
- de cinq espèces de poissons grands migrateurs. Ces espèces sont visées par l'article 64 de la Convention des Nations Unies sur le droit de la mer (1982);
- d'une tortue caouanne (*Caretta caretta*), espèce menacée d'extinction au niveau mondial selon l'UICN.

Les répercussions de la construction des infrastructures portuaires sur la faune marine seront potentiellement pour :

- la faune benthique :
  - perte d'habitats;
  - modification de la composition à l'emplacement des infrastructures et dans le secteur de dragage;
  - perte d'individus à l'emplacement des infrastructures et dans la zone de dragage;
  - envasement des individus à la suite du transport des matières en suspension dans la baie;
  - contamination d'individus à la suite d'un déversement accidentel de matières résiduelles pouvant être toxiques pour la faune benthique;
- les poissons :
  - perte d'habitats;
  - dérangement potentiel par le bruit généré par les équipements de construction, le déversement de matériaux dans la mer (brise-lames, épi, quai, confinement des déblais de dragage) et du dragage pouvant entraîner un comportement d'évitement de la zone;
  - contamination d'individus à la suite d'un déversement accidentel de matières pouvant être toxiques pour les espèces de poissons;
  - invasion d'espèces non indigènes provenant des eaux de ballasts des navires;
- les crustacés :
  - perte d'habitats plus particulièrement pour les langoustes;
  - modification de la composition à l'emplacement des infrastructures et dans le secteur de dragage;
  - perte d'individus à l'emplacement des infrastructures et dans la zone de dragage;
  - dérangement potentiel par le bruit généré par les équipements de construction, le déversement de matériaux dans la mer (brise-lames, épi, quai, confinement des déblais de dragage) et du dragage pouvant entraîner un comportement d'évitement de la zone;
  - contamination d'individus à la suite d'un déversement accidentel de matières résiduelles pouvant être toxiques pour les espèces de crustacés;
- les mammifères marins :
  - perturbation du comportement des baleines, des dauphins et des marsouins;
  - risques d'accidents causés par une collision avec les embarcations et les équipements;
  - dérangement potentiel par le bruit généré par les équipements de construction, le déversement de matériaux dans la mer (brise-lames, épi, quai, confinement des

déblais de dragage) et du dragage pouvant entraîner un comportement d'évitement de la zone;
- déversement accidentel de matières résiduelles pouvant être toxiques pour les mammifères marins.

- la tortue marine caouanne :
  - perte d'habitats;
  - perte potentielle de sites de ponte sur les plages aux sites d'implantation des installations portuaires;
  - dérangement potentiel par le bruit généré par les équipements de construction, le déversement de matériaux dans la mer (brise-lames, épi, quai, confinement des déblais de dragage) et du dragage pouvant entraîner un comportement d'évitement de la zone;
  - risques d'accidents causés par une collision avec les embarcations et les équipements;
  - déversement accidentel de matières résiduelles pouvant être toxiques pour l'espèce.

4.1.4.2.2 MESURES D'ATTÉNUATION PROPOSÉES

Selon les différentes études réalisées dans le secteur de construction du brise-lames, il est peu probable que les modifications apportées au milieu marin soient préjudiciables à la faune marine de la région de Fort-Dauphin.

Toutefois dans le but de minimiser les impacts, diverses mesures d'atténuation d'ordre général pourront être appliquées, les principales sont :

- l'application de bonnes pratiques environnementales (voir section 5) lors des travaux;
- l'application des mesures d'atténuation préconisées pour les éléments sols et eau;
- le déversement des matériaux rocheux à la mer avec un débit contrôlé permettant à la plupart des espèces marines mobiles de s'échapper;
- l'application de bonnes méthodes de dragage (ex. moment et vitesse) permettant le transport des matières en suspension par la marée pour minimiser une stagnation et des impacts sur la vie marine;
- la limitation des déplacements des vaisseaux à l'intérieur ou autour de la zone de dragage aux vaisseaux autorisés durant les opérations pour minimiser les impacts liés au trafic;
- l'évacuation de l'eau en provenance du site de confinement des matériaux de dragage via un bassin de sédimentation afin de libérer les eaux de particules fines afin de réduire les effets sur les habitats marins sensibles;
- la relocalisation des espèces aquatiques piégées dans l'aire de confinement des matériaux de dragage;
- l'interdiction à tous navires de rejeter les eaux de ballasts ou toutes autres substances dans les eaux de la baie;
- la réalisation d'un programme de surveillance et de suivi environnemental.

4.1.4.2.3 ÉVALUATION DES IMPACTS RÉSIDUELS

L'application des mesures d'atténuation permettra d'obtenir un **impact résiduel** pour la faune benthique d'une importance **mineure** compte tenu du fait qu'une zone relativement restreinte d'habitats (oursins, éponges) sera touchée et aucune colonie de coraux. Les inventaires réalisés le long du littoral, entre les péninsules d'Evatraha et Ehoala, montrent que les habitats de ces différentes ressources sont abondants ailleurs. Pour la péninsule d'Ehoala, les habitats se trouvent principalement sur toute la partie sud et sud-est du promontoire, qui ne sera pas touchée par les travaux.

Aucune espèce de poisson répertoriée en milieu marin n'est endémique à Madagascar et aucune espèce rare, menacée ou vulnérable n'a été identifiée dans la zone d'étude. Aucune aire de frai ou habitats particuliers n'ont été recensés dans le secteur des travaux. Les différentes espèces pourraient perdre des sources d'alimentation et déserter le secteur durant la période de dragage. Un **impact résiduel** d'**importance mineure** est donc prévu pour le poisson.

La construction du brise-lames ne touchera qu'une partie restreinte des habitats de langoustes car les habitats se trouvent principalement sur la partie sud et sud-ouest du promontoire. De plus, les espèces trouvées dans la zone d'insertion du brise-lames sont communes aux eaux côtières de Madagascar. Par ailleurs, au terme de la construction du brise-lames, il est anticipé que l'infrastructure constituera un habitat potentiel pour la faune marine. En effet, de nombreux projets, études et programmes internationaux ont été et sont encore menés, afin d'évaluer la capacité des infrastructures artificielles, en particulier les récifs coralliens artificiels et certains types d'infrastructures maritimes, tels les brise-lames, à constituer un substrat favorable à la faune et à la flore marines. Il est reconnu qu'un fond marin rocheux est plus propice, sous plusieurs aspects, à la colonisation par la faune marine, particulièrement les crustacés. De ce point de vue, le brise-lames prévu à Ehoala pourrait devenir un support physique favorable aux crustacés présents dans les eaux locales. Ce pourrait être le cas en particulier des langoustes à haute valeur commerciale pour la région, représentées par les espèces *Panulirus homarus, Panulirus longipus et Panulirus versicolor*. Le brise-lames constituera une surface d'environ 2,5 ha sous la mer. Il est probable qu'une partie de la structure pourra être colonisée par différents organismes marins, dont les langoustes, et que la superficie de support artificiel potentiellement utilisable sera supérieure à celle du support actuellement disponible. En effet, le brise-lames d'Ehoala répond aux critères évoqués par Spanier (1994) selon lesquels les cavités et fissures qui seront laissées entre les blocs de roche et la diversité de leur taille sont autant d'éléments susceptibles de conditionner, entre autres, l'installation des crabes et des langoustes. Concernant ces dernières, il est établi que la mise à disposition d'abris artificiels de conception appropriée augmente les chances de survie et d'établissement local des juvéniles (Herrnkind, Butler et Hunt, 1997). La superposition de blocs de 3 à 20 t permettra donc de créer des abris propices au développement des langoustes.

Par conséquent, un **impact résiduel positif** et d'une **importance mineure** est anticipé relativement à la construction du brise-lames sur les crustacés et particulièrement les langoustes.

Pour certaines espèces comme la baleine à bosse et la tortue caouanne, des mesures spécifiques seront également appliquées.

Pour la baleine à bosse, les principales mesures seront :

- le maintien d'une zone tampon de 500 m entre la remorque/barge et toutes baleines. Celles présentes à l'intérieur de cette zone seront découragées de pénétrer dans la zone de dragage en utilisant un agent dissuasif tel que des carabines à air comprimé actionnées dans l'eau;
- les embarcations se déplaçant dans la zone tampon définie précédemment, devront prendre les actions appropriées pour éviter les collisions avec les baleines durant la période de migration (juin à novembre). Lorsque la visibilité est réduite, soit le soir, en présence de brouillard ou lors que l'état de la mer est supérieur à Beaufort 3, la remorque/barge ou l'opérateur de la drague devront ralentir leur vitesse à 5 nœuds ou moins si des baleines ont été observées dans la zone tampon dans les derniers 24 heures;
- l'entrepreneur responsable du dragage devra rapporter toute observation de baleine à bosse dans le secteur de Fort-Dauphin;

- l'entrepreneur devra contacter immédiatement QMM et le « NMFS Whale Stranding Network » si une baleine échouée/blessée/invalide est observée à l'intérieur de la zone de construction;
- la sensibilisation des pêcheurs à l'importance de rapporter toute observation de baleine dans le secteur de Fort-Dauphin;
- la réalisation d'un programme de surveillance des baleines à bosse et suivi de l'efficacité des mesures d'atténuation.

Les travaux de construction du brise-lames pourraient déranger les baleines qui utiliseront le secteur compris entre les péninsules d'Evatraha et Ehoala. Les baleines à bosse, comme les autres mammifères marins, sont sensibles aux perturbations du milieu marin. Le bruit généré par les divers équipements de construction et le déversement des roches dans la mer se propagera dans l'eau. Comme ils peuvent capter des sons à des distances relativement grandes, les mammifères marins se déplaceront vraisemblablement vers des zones plus propices à leurs activités, en dehors du secteur touché par les divers travaux d'aménagement. Par ailleurs, le secteur n'est pas reconnu comme une zone vulnérable ou un habitat particulier pour l'accouplement des baleines ou la parturition des femelles. De plus, on retrouve des baleines tout le long des côtes de Madagascar. Les activités de construction du brise-lames, à Ehoala auront par conséquent un **impact résiduel** d'**importance mineure** sur les baleines.

Pour la tortue marine *Caretta caretta*, les principales mesures seront :

- l'aménagement d'une barrière littorale pour prévenir l'utilisation de la plage par la tortue caouanne à l'emplacement de construction des quais, du brise-lames et de l'épi d'enrochement pour ainsi favoriser l'utilisation des espaces attenants pour la ponte;
- l'élaboration et mise en œuvre d'un programme de sensibilisation de la population locale sur la précarité de l'espèce et sur l'importance d'en assurer sa conservation;
- la réalisation d'un programme de suivi (utilisation du secteur, importance des individus, aire potentielle de ponte, etc.).

L'observation d'une activité de ponte au site de confinement des déblais de dragage est considérée comme un évènement isolé. Il existe peu de données existantes sur la nidification des tortues dans le secteur du futur port. Toutefois, après la construction du port, des sites favorables à la ponte de tortue pourraient être disponibles le long de la plage de sable, à l'est de l'épi d'enrochement. Par ailleurs, bien que cette espèce soit désignée comme étant une espèce menacée d'extinction au niveau mondial selon l'UICN, les travaux d'implantation d'une infrastructure portuaire à la péninsule d'Ehoala ne mettront pas en danger la pérennité de cette espèce. Des sites de ponte ont été observés ailleurs le long de la côte au nord de Fort Dauphin et un peu partout le long des côtes de Madagascar. Par conséquent, les activités de construction du brise-lames, à Ehoala auront un **impact résiduel** d'**importance mineure** sur la tortue marine caouanne.

Le tableau présenté plus loin résume l'évaluation des impacts et les mesures d'atténuation qui seront mises en place pour atténuer les impacts.

Un programme de suivi a été élaboré afin de permettre de documenter les modifications sur la faune marine du secteur à l'étude. Le lecteur retrouvera en annexe 6 (Jacques Whitford, 2004), les détails d'un programme de suivi et les justifications de celui-ci. Ce programme sera optimisé en fonction des nouvelles informations recueillies au cours des dernières années.

Évaluation des impacts et mesures d'atténuation relativement à la faune marine

MILIEU BIOLOGIQUE								
Identification de l'impact			Évaluation de l'impact				Mesures d'optimisation, d'atténuation ou de valorisation	Impact résiduel
Élément	Composante	Caractérisation	Intensité	Portée	Durée	Importance de l'impact		
Faune marine	Poissons (faune benthique)	• Modification de la composition des populations • Perte d'habitats et d'individus au site d'implantation des infrastructures portuaires et de la zone de dragage • Dérangement potentiel par le bruit généré par les équipements et les travaux • Envasement des habitats et des individus découlant d'une remise en suspension des sédiments dans la baie • Contamination des habitats et des individus à la suite d'un déverse-ment accidentel de matière dangereuse • Invasion d'espèces non indigènes provenant des eaux de ballasts des navires	Faible	Ponctuelle	Longue	Mineure	• Application de bonnes pratiques environnementales (voir section 5) • Application des mesures d'atténuation préconisées pour les éléments sols et eau • Déversement des matériaux rocheux en mer avec un débit contrôlé permettant à la plupart des espèces marines mobiles de s'échapper • Application de bonnes méthodes de dragage permettant le transport des matières en suspension par la marée pour minimiser une stagnation et des impacts sur la vie marine • Déplacements des vaisseaux à l'intérieur ou autour de la zone de dragage limités aux vaisseaux autorisés durant les opérations pour minimiser les impacts liés au trafic • Évacuation des eaux en provenance du site de confine-ment des matériaux de dragage via un bassin de sédi-mentation libérant les eaux de particules fines afin de réduire les effets sur les habitats marins sensibles • Relocalisation de la faune aquatique piégée dans l'aire de confinement des matériaux de dragage • Interdiction aux navires de rejeter les eaux de ballasts ou toutes autres substances dans les eaux de la baie • Réalisation d'un programme de surveillance et de suivi	Mineur

Évaluation des impacts et mesures d'atténuation relativement à la faune marine (suite)

MILIEU BIOLOGIQUE								
Identification de l'impact			Évaluation de l'impact				Mesures d'optimisation, d'atténuation ou de valorisation	Impact résiduel
Élément	Composante	Caractérisation	Intensité	Portée	Durée	Importance de l'impact		
Faune marine	Crustacés	• Perte d'habitats, particulièrement pour les langoustes • Perte d'individus à l'emplacement des infrastructures et dans la zone de dragage • Modification de la composition des populations à l'emplacement des infrastructures et dans le secteur de dragage • Dérangement potentiel par le bruit généré par les équipements et les travaux • Contamination des individus à la suite d'un déversement accidentel de matière dangereuse	Faible	Ponctuelle	Longue	Mineure	• Application de bonnes pratiques environnementales (voir section 5) • Application des mesures d'atténuation préconisées pour les éléments sols et eau • Déversement des matériaux rocheux en mer avec un débit contrôlé permettant à la plupart des espèces marines mobiles de s'échapper • Application de bonnes méthodes de dragage permettant le transport des matières en suspension par la marée pour minimiser une stagnation et des impacts sur la vie marine • Déplacements des vaisseaux à l'intérieur ou autour de la zone de dragage limités aux vaisseaux autorisés durant les opérations pour minimiser les impacts liés au trafic • Évacuation des eaux en provenance du site de confinement des matériaux de dragage via un bassin de sédimentation libérant les eaux de particules fines afin de réduire les effets sur les habitats marins sensibles • Relocalisation de la faune aquatique piégée dans l'aire de confinement des matériaux de dragage • Interdiction aux navires de rejeter les eaux de ballasts ou toutes autres substances dans les eaux de la baie • Réalisation d'un programme de surveillance et de suivi	Positif mineur

Évaluation des impacts et mesures d'atténuation relativement à la faune marine (suite)

MILIEU BIOLOGIQUE								
Identification de l'impact			Évaluation de l'impact				Mesures d'optimisation, d'atténuation ou de valorisation	Impact résiduel
Élément	Composante	Caractérisation	Intensité	Portée	Durée	Importance de l'impact		
Faune marine	Mammifères marins, principalement la baleine à bosse	• Perturbation du comportement des baleines à bosse • Risques d'accidents causés par une collision avec les embarcations et les équipements • Dérangement potentiel par le bruit généré par les équipements de construction, le déversement de matériaux dans la mer (brise-lames, épi, quai, confinement des déblais de dragage) et du dragage pouvant entraîner un comportement d'évitement de la zone • Contamination des individus à la suite d'un déversement accidentel de matière dangereuse	Faible	Ponctuelle	Moyenne	Mineure	• Application de bonnes pratiques environnementales (voir section 5) • Application des mesures d'atténuation préconisées pour les éléments sols et eau • Déversement des matériaux rocheux en mer avec un débit contrôlé permettant à la plupart des espèces marines mobiles de s'échapper • Application de bonnes méthodes de dragage permettant le transport des matières en suspension par la marée pour minimiser une stagnation et des impacts sur la vie marine • Déplacements des vaisseaux à l'intérieur ou autour de la zone de dragage limités aux vaisseaux autorisés durant les opérations pour minimiser les impacts liés au trafic • Évacuation des eaux en provenance du site de confinement des matériaux de dragage via un bassin de sédimentation libérant les eaux de particules fines afin de réduire les effets sur les habitats marins sensibles • Interdiction aux navires de rejeter les eaux de ballasts ou toutes autres substances dans les eaux de la baie • Maintien d'une zone tampon de 500 m entre la remorque/barge et toute baleine • Utilisation d'un agent dissuasif tel que des carabines à air comprimé actionnées dans l'eau pour éloigner les baleines de la zone des travaux • Surveillance accrue durant la période de migration (juin à novembre) afin d'éviter les collisions entre navires et baleines • Réduction de la vitesse des navires à 5 nœuds ou moins le soir et en présence de conditions météorologiques défavorables, si des baleines ont été observées dans la zone tampon dans les dernières 24 heures • Information à l'entrepreneur de toute observation de baleine à bosse dans le secteur de Fort-Dauphin • Signalement de toute baleine échouée/blessée/invalide observée à l'intérieur de la zone de construction • Réalisation d'un programme de surveillance et de suivi environnemental	Positif mineur

Évaluation des impacts et mesures d'atténuation relativement à la faune marine (suite)

Milieu biologique								
Identification de l'impact			**Évaluation de l'impact**				**Mesures d'optimisation, d'atténuation ou de valorisation**	**Impact résiduel**
Élément	Composante	Caractérisation	Intensité	Portée	Durée	Importance de l'impact		
Faune marine	Tortue marine caouanne	• Perte d'habitats • Perte potentielle de sites de ponte de la tortue • Dérangement potentiel par le bruit généré par les équipements et les travaux • Contamination des individus à la suite d'un déversement accidentel de matière dangereuse	Faible	Ponctuelle	Moyenne	Mineure	• Application de bonnes pratiques environnementales (voir section 5) • Application des mesures d'atténuation préconisées pour les éléments sols et eau • Déversement des matériaux rocheux en mer avec un débit contrôlé permettant à la plupart des espèces marines mobiles de s'échapper • Application de bonnes méthodes de dragage permettant le transport des matières en suspension par la marée pour minimiser une stagnation et des impacts sur la vie marine • Déplacements des vaisseaux à l'intérieur ou autour de la zone de dragage limités aux vaisseaux autorisés durant les opérations pour minimiser les impacts liés au trafic • Évacuation des eaux en provenance du site de confinement des matériaux de dragage via un bassin de sédimentation libérant les eaux de particules fines afin de réduire les effets sur les habitats marins sensibles • Aménagement d'une barrière littorale • Élaboration et mise en œuvre d'un programme de sensibilisation de la population locale sur la précarité de l'espèce et sur l'importance d'en assurer sa conservation • Réalisation d'un programme de surveillance et de suivi	Positif mineur

4.2 IMPACTS SUR LE MILIEU SOCIAL

4.2.1 SANTÉ

Cet élément comprend les événements reliés à l'environnement sonore, aux émissions atmosphériques, à la santé communautaire, à la sécurité publique et à la santé et sécurité au travail.

4.2.1.1 ENVIRONNEMENT SONORE

4.2.1.1.1 ÉTAT ACTUEL ET IMPACTS POTENTIELS

Lors des travaux de construction des infrastructures maritimes, l'environnement sonore du secteur des travaux, sur le promontoire d'Ehoala, sera modifié principalement en raison des équipements (grue, camion, bouteur, compresseur, etc.) utilisés pour forer, excaver et transporter les matériaux nécessaires à la construction de l'accès au brise-lames, du brise-lames lui-même, de l'épi et des quais ainsi que des infrastructures terrestres. Les activités de dragage généreront également du bruit.

Les niveaux de bruit prévus à la péninsule d'Ehoala varieront, dans les conditions les moins favorables, entre 90 et 93 dBA au centre de la zone de travaux comparativement à 74 dBA en conditions naturelles. Ce niveau de bruit est principalement associé aux vagues qui viennent se briser sur la côte, combinées à la vitesse du vent (SENES, 2001b).

Les répercussions relatives à l'environnement sonore seront potentiellement :

- le dérangement des résidents de la communauté villageoise d'Ambinanibe;
- le dérangement des résidents des communautés de Lohavoloka et de la ville de Fort-Dauphin;
- le dérangement des individus de la faune terrestre utilisant le secteur des travaux.

4.2.1.1.2 MESURES D'ATTÉNUATION PROPOSÉES

Diverses mesures d'atténuation peuvent être envisagées afin de réduire les impacts sur l'environnement sonore. Les principales mesures seront :

- l'application de bonnes pratiques environnementales (section 5);
- l'utilisation d'équipements de chantier et de camions en bon état de fonctionnement et conformes aux normes sur les émissions sonores;
- l'utilisation des équipements de protection (auditive) appropriés pour les travailleurs soumis à des niveaux de bruit élevés sur une base continue;
- l'élaboration d'un programme d'information auprès des intervenants et des villageois concernés;
- le suivi des plaintes;
- l'élaboration d'un programme de surveillance et de suivi environnemental.

4.2.1.1.3 ÉVALUATION DES IMPACTS RÉSIDUELS

Pour ce qui a trait à la communauté de Lohavoloka, située à plus de 2 km de la zone des travaux, cette dernière est séparée par la présence de dunes qui peuvent atteindre plusieurs dizaines de mètres de hauteur. Par conséquent, ces barrières naturelles contribueront à minimiser les impacts sur l'environnement sonore pendant la période de construction. Pour la ville de Fort-Dauphin, située à plus de 5 km de la zone des travaux, un **impact résiduel également** qualifié de **mineur** est anticipé pour cette communauté associé aux activités de construction de nuit pendant les périodes sans vent où la propagation des ondes sonores sur les eaux de la Fausse Baie des Galions pourrait atteindre Fort-Dauphin. Il est à noter cependant qu'étant donné la dominance de la direction du vent (en provenance du nord-est), cette situation n'est pas susceptible de se produire fréquemment. La figure 4.10 présente les niveaux sonores simulés à la péninsule d'Ehoala pour la phase construction. Les niveaux sonores seront généralement inférieurs à la norme de 45 dBA la nuit suggérée par la Banque mondiale (SENES, 2000).

Enfin pour la faune, un **impact résiduel** qualifié de **mineur** est anticipé. Les espèces pourront se déplacer dans des secteurs où le bruit est moindre ou quitter temporairement les lieux.

Le tableau relatif à l'environnement sonore présenté plus loin résume l'évaluation des impacts et les mesures d'atténuation qui seront mises en place pour atténuer les impacts sur l'environnement sonore.

4.2.1.2 QUALITE DE L'AIR

4.2.1.2.1 ÉTAT ACTUEL ET IMPACTS POTENTIELS

Les activités relatives à l'aménagement de l'aire d'entreposage d'ilménite et d'hydrocarbures, et la construction de l'accès au brise-lames et du brise-lames lui-même, ainsi que la construction de l'épi représentent différentes sources de mise en suspension de particules dans l'air, en raison du soulèvement des poussières qu'elles entraînent.

Le secteur des travaux est fortement influencé par la vélocité des vents. Les concentrations de polluants atmosphériques dans la zone d'étude peuvent également varier en fonction des conditions météorologiques et topographiques. Par exemple, des valeurs plus élevées de polluants sont généralement enregistrées, plus particulièrement dans les vallées, quand les conditions météorologiques sont stagnantes particulièrement dans les zones de feux de brousse. Les véhicules qui circulent dans la région affectent également la qualité de l'air, puisqu'ils ne sont pas munis de systèmes de contrôle des émissions atmosphériques.

Les répercussions des émissions atmosphériques relatives à l'environnement seront potentiellement :

- l'altération de la qualité de l'air dans les secteurs de construction des infrastructures maritimes et le dérangement des résidants urbains et villageois ainsi que des individus de la faune utilisant le secteur;
- l'altération de la qualité de l'air dans les secteurs de construction des infrastructures maritimes et le dérangement des individus de la faune utilisant le secteur.

4.2.1.2.2 MESURES D'ATTÉNUATION PROPOSÉES

Diverses mesures d'atténuation peuvent être envisagées afin de réduire les impacts des émissions atmosphériques sur l'environnement. Les principales mesures seront :

- l'application de bonnes pratiques environnementales (voir section 5);
- le défrichage et le nivellement uniquement selon les besoins des portions des secteurs de travaux;
- l'utilisation d'équipements de chantier et de camions en bon état de fonctionnement et conformes aux normes sur les émissions atmosphériques;
- l'arrosage (eau) pour limiter la mise en suspension des poussières;

- la réhabilitation et la remise en végétation le plus rapidement possible des secteurs affectés par les travaux et des abords de routes;
- le recouvrement, si jugé nécessaire, avec des bâches les déblais ou autres qui peuvent subir les effets d'une érosion éolienne;
- l'interdiction de brûler toutes matières résiduelles (déchets domestiques, matériaux secs) sur les sites des travaux;
- l'élaboration d'un programme d'information auprès des intervenants et des villageois concernés;
- le suivi des plaintes;
- l'élaboration d'un programme de surveillance et de suivi environnemental.

4.2.1.2.3 ÉVALUATION DES IMPACTS RÉSIDUELS

L'application de ces mesures d'atténuation permettra de limiter les impacts de la construction des infrastructures sur la qualité de l'air pour les résidants urbains et villageois ainsi que sur la faune utilisant le secteur. Par conséquent, **aucun impact résiduel** n'est anticipé pour ce qui a trait aux poussières et émissions générées par les camions et la machinerie. En effet, le nombre relativement réduit d'équipements motorisés aux divers sites de travaux, ne devrait pas contribuer à augmenter de façon significative les concentrations de polluants dans l'air. De plus, l'utilisation de véhicules munis de systèmes antipollution et, au besoin, l'arrosage permettront de diminuer l'importance de l'impact sur la qualité de l'air par l'apport de poussière.

Par ailleurs, l'emplacement du site de construction à la pointe d'Ehoala permettra une dissipation rapide des polluants, compte tenu de la vélocité des vents et de leur provenance (nord-est).

Le tableau relatif à la santé, présenté plus loin résume l'évaluation des impacts et les mesures d'atténuation qui seront mises en place pour atténuer les impacts des émissions atmosphériques sur l'environnement.

4.2.1.3 SANTE COMMUNAUTAIRE

4.2.1.3.1 ÉTAT ACTUEL ET IMPACTS POTENTIELS

En matière de santé communautaire, la situation actuelle est telle que la population de la région est touchée par un ensemble de pathologies liées à des conditions de pauvreté et d'insalubrité (pneumopathies aiguës ou toux chroniques, dermatoses, diarrhées, lèpre, infections oculaires ou annexes, choléra, etc.) ou liées au milieu tropical (paludisme). Par ailleurs, on observe depuis quelques années une augmentation importante du nombre de personnes à Fort-Dauphin qui souffrent de maladies sexuellement transmissibles (MST). Selon les sources, le taux de prévalence des MST dans la population varie de 20 à 50 % à Fort-Dauphin et en milieu rural (Raymond *et al.*, 2001; Maclean, 2001).

Madagascar ne partage pas avec l'Afrique continentale subsaharienne l'actuelle pandémie de VIH/SIDA, dont le taux de prévalence moyen est de 8,57 % sur le continent, et atteint même 20 % en Afrique du Sud et 35 % au Bostwana (Whiteside, s.d.). À Madagascar, le taux de prévalence du SIDA, en 1999, n'était que de 0,15 %. Dans la région de l'Anosy, le Ministère de la Santé ne rapportait qu'un seul cas officiel en 1996 (Maclean, 2001).

Pour la construction des infrastructures portuaires, le recours à un groupe de travailleurs spécialisés recruté hors de Fort-Dauphin et à des travailleurs recrutés localement sera nécessaire. Ainsi, la venue de travailleurs provenant de l'extérieur de Fort-Dauphin pour la construction du port est susceptible d'avoir un impact sur les conditions sanitaires déjà précaires de Fort-Dauphin, si des précautions ne sont pas prises.

Dans le secteur des travaux il n'y a aucune prise d'eau privée ou publique.

Les répercussions de l'aménagement des infrastructures portuaires sur la santé communautaire seront potentiellement :

- l'augmentation potentielle des problèmes de santé communautaire (MST, VIH/SIDA, etc.) découlant de la présence de travailleurs provenant de l'extérieur de la région.

4.2.1.3.2 MESURES D'ATTÉNUATION PROPOSÉES

Diverses mesures d'atténuation peuvent être envisagées afin de réduire les impacts sur la santé communautaire. Les principales mesures seront :

- l'éloignement du campement d'ouvriers, par rapport à Fort-Dauphin et aux villages environnants, permettra de minimiser les impacts négatifs de la présence de travailleurs sur les populations locales;
- le contrôle des entrées et sorties du campement en dehors des heures de travail;
- l'obligation de l'entrepreneur retenu et de ses employés de se soumettre à un code de conduite visant à assurer le respect des mœurs et coutumes des communautés locales environnantes. En ce qui concerne l'embauche locale, un programme a été mis en place visant à favoriser le recrutement de main d'œuvre dans les communautés environnantes;
- le contrôle médical des travailleurs avant leur arrivée au campement, à la fin de leur embauche et au besoin pendant l'embauche;
- la mise sur pied d'un programme régulier de suivi médical des employés;
- l'élaboration d'un programme de sensibilisation des travailleurs;
- l'élaboration d'une campagne de sensibilisation des populations à risque de Fort-Dauphin, avec l'aide des autorités médicales et des organismes communautaires concernés;
- l'élaboration d'un programme de suivi des dossiers médicaux;
- l'élaboration d'un programme de suivi des plaintes;
- l'élaboration d'un programme de surveillance et de suivi environnemental.

4.2.1.3.3 ÉVALUATION DES IMPACTS RÉSIDUELS

L'application de ces mesures d'atténuation permettra de limiter les impacts de la présence de travailleurs sur la santé communautaire des résidants urbains et villageois dans la région du projet. Un i**mpact résiduel d'importance mineure** relativement à la santé communautaire est anticipé.

Le tableau relatif à la santé présenté plus loin résume l'évaluation des impacts et les mesures d'atténuation qui seront mises en place pour atténuer les impacts sur la santé communautaire.

4.2.1.4 SECURITE PUBLIQUE

4.2.1.4.1 ÉTAT ACTUEL ET IMPACTS POTENTIELS

La construction des infrastructures portuaires représentera un risque d'accidents. Le fonctionnement des équipements lourds et la circulation des véhicules pourraient constituer un risque pour les personnes non autorisées qui voudraient accéder aux aires de travaux.

Les répercussions de la construction des infrastructures portuaires sur la sécurité publique seront potentiellement :

- les risques potentiels d'accidents avec les véhicules de chantier;
- le danger potentiel pour les villageois et le bétail aux différents sites de travaux;
- les risques potentiels d'accidents avec les équipements de dragage.

4.2.1.4.2 MESURES D'ATTÉNUATION PROPOSÉES

Diverses mesures d'atténuation peuvent être envisagées afin de réduire les impacts sur la sécurité publique. Les principales mesures seront :

- l'application de bonnes pratiques environnementales (voir section 5);
- la sécurisation et le gardiennage des secteurs potentiellement dangereux;
- l'élaboration d'une campagne de sensibilisation auprès des populations relativement aux dangers reliés à la construction des infrastructures portuaires;
- la réalisation des travaux aux différents sites de façon sécuritaire (chauffeur formé, respect des limites de vitesse, etc.);
- la mise en place d'une signalisation et infrastructures adéquates à la limitation de vitesse;
- le déménagement des aires d'entreposage des pirogues dans un secteur sécuritaire pour les pêcheurs;
- la mise en place et respect des procédures de gestion amiable des conflits potentiels créés par les accidents sur les personnes ou sur le bétail;
- le suivi des plaintes;
- l'élaboration d'un programme de surveillance et de suivi environnemental.

QMM considère la sécurité publique comme un enjeu important. Pour réaliser les travaux de construction d'une façon sécuritaire, QMM mettra en place des mesures appropriées, mais devra également pouvoir compter sur une collaboration entre l'ensemble des utilisateurs du secteur des travaux et les autorités concernées.

4.2.1.4.3 ÉVALUATION DES IMPACTS RÉSIDUELS

Après la mise en place des mesures préventives appropriées, un **impact résiduel mineur** est prévu en ce qui concerne la sécurité des populations et du bétail à proximité des sites de construction des infrastructures portuaires.

Le tableau relatif à la santé présenté plus loin résume l'évaluation des impacts et les mesures d'atténuation qui seront mises en place pour atténuer les impacts sur la sécurité publique.

4.2.1.5 SANTE ET SECURITE AU TRAVAIL

4.2.1.5.1 ÉTAT ACTUEL ET IMPACTS POTENTIELS

Les activités de construction des infrastructures portuaires (ex. fonctionnement des équipements lourds et de dragage, circulation des véhicules, transport et l'entreposage des hydrocarbures, déchargement des camions, etc.) dans le secteur des travaux pourraient représenter des risques potentiels pour les travailleurs.

L'environnement sonore sera modifié par la circulation des camions et autres véhicules, ainsi que par le fonctionnement des divers équipements de chantier. La qualité de l'air sur les chantiers sera également modifiée par la présence de poussières dues au décapage, terrassement, déblaiement, manipulation des agrégats, du roc, à la circulation des camions et autres véhicules, et par les rejets atmosphériques de polluants par les différents équipements de chantier.

Pour la construction des infrastructures, le recours à un groupe de travailleurs étrangers spécialisés et à des travailleurs recrutés à Madagascar sera nécessaire. Ces travailleurs seront logés dans un campement situé près de la carrière d'Andriambe.

Les répercussions de la construction du port sur la santé et la sécurité des travailleurs seront potentiellement :

- les risques d'accidents potentiels de différentes natures et gravités;
- les risques d'exposition à des matières dangereuses;
- les risques d'augmentation potentielle des problèmes de santé (maladies).

4.2.1.5.2 MESURES D'ATTÉNUATION PROPOSÉES

Diverses mesures d'atténuation peuvent être envisagées afin de réduire les impacts sur la santé et la sécurité des travailleurs. Les principales mesures seront :

- l'application de bonnes pratiques environnementales relativement à l'eau, l'air et les sols (voir section 5);
- l'application des mesures énoncées au volet santé communautaire;
- l'application des mesures énoncées aux volets environnement sonore et émissions atmosphériques;
- l'application du programme de santé et sécurité au travail répondant aux normes de Rio Tinto;
- la mise en service d'une clinique médicale;
- la mise en place d'un programme de formation en santé et sécurité au travail;
- le respect des mesures préventives et du code de conduite par les travailleurs;
- le respect par les entrepreneurs des normes de santé et sécurité en vigueur à Madagascar;
- le respect par les entrepreneurs des normes de santé et sécurité prescrites par QMM;
- la réalisation des travaux aux différents sites de façon sécuritaire (chauffeur formé, respect des limites de vitesse, etc.);
- la distribution de repas du midi aux travailleurs recrutés localement ;
- le suivi des plaintes;
- l'élaboration d'un programme de surveillance et de suivi environnemental.

4.2.1.5.3 ÉVALUATION DES IMPACTS RÉSIDUELS

L'application de ces mesures d'atténuation permettra de limiter les impacts de la construction des infrastructures portuaires sur la santé et la sécurité des travailleurs. Après la mise en place des mesures préventives appropriées, un **impact résiduel mineur** est prévu.

Le tableau relatif à la santé présenté plus loin résume l'évaluation des impacts et les mesures d'atténuation qui seront mises en place pour atténuer les impacts sur la santé et la sécurité des travailleurs.

Évaluation des impacts et mesures d'atténuation relativement à la santé

Milieu humain								
Identification de l'impact			**Évaluation de l'impact**				**Mesures d'optimisation, d'atténuation ou de valorisation**	**Impact résiduel**
Élément	Composante	Caractérisation	Intensité	Portée	Durée	Importance de l'impact		
Santé	Environnement sonore	• Dérangement des résidents de la communauté villageoise d'Ambinanibe	Faible	Locale	Courte	Moyenne	• Application de bonnes pratiques environnementales (voir section 5); • Utilisation d'équipements de chantier et de camions en bon état de fonctionnement et conformes aux normes sur les émissions sonores; • Utilisation des équipement de protection (auditive) par les; • Élaboration d'un programme d'information auprès des intervenants et des villageois concernés; • Suivi des plaintes; • Élaboration d'un programme de surveillance et de suivi environnemental.	**Mineur**
		• Dérangement des résidents des communautés de Lohavoloka de la ville de Fort-Dauphin	Faible	Locale	Courte	Mineure		**Mineur**
		• Dérangement des individus de la faune terrestre utilisant le secteur	Faible	Ponctuelle	Courte	Mineure		**Mineur**
	Qualité de l'air	• Altération de la qualité de l'air dans les secteurs de construction des infrastructures maritimes et dérangement des résidents urbains et villageois ainsi que des individus de la faune utilisant le secteur	Faible	Ponctuelle	Courte	Mineure	• Application de bonnes pratiques environnementales (voir section 5); • Défrichage et nivellement uniquement selon les besoins des portions des secteurs de travaux; • Utilisation d'équipements de chantier et de camions en bon état de fonctionnement et conformes aux normes sur les émissions atmosphériques; • Arrosage au besoin (eau) pour limiter la mise en suspension des poussières; • Réhabilitation et remise en végétation le plus rapidement possible des secteurs affectés par les travaux et des abords de routes; • Recouvrement, si jugé nécessaire, avec des bâches les déblais ou autres qui peuvent subir les effets d'une érosion éolienne; • Interdiction de brûler toute matière résiduelle sur les sites des travaux; • Élaboration d'un programme d'information auprès des intervenants et des villageois concernés; • Suivi des plaintes; • Élaboration d'un programme de surveillance et de suivi environnemental.	**Aucun**
		• Dérangement des individus de la faune utilisant le secteur	Faible	Ponctuelle	Courte	Mineure		

Évaluation des impacts et mesures d'atténuation relativement à la santé (suite)

MILIEU HUMAIN								
Identification de l'impact			Évaluation de l'impact				Mesures d'optimisation, d'atténuation ou de valorisation	Impact résiduel
Élément	Composante	Caractérisation	Intensité	Portée	Durée	Importance de l'impact		
Santé	Santé communautaire	• Augmentation potentielle des problèmes de santé communautaire (MTS, VIH/SIDA, etc.) découlant de la présence de travailleurs provenant de l'extérieur de la région	Moyenne	Locale	Courte	Moyenne	• Éloignement du campement, par rapport à Fort-Dauphin et aux villages environnants, permettant de minimiser les impacts négatifs de la présence de travailleurs sur les populations locales; • Contrôle des entrées et sorties du campement; • Obligation de l'entrepreneur retenu et de ses employés de se soumettre à un code de conduite visant à assurer le respect des mœurs et coutumes des communautés locales environnantes. En ce qui concerne l'embauche locale, un programme a été mis en place visant à favoriser le recrutement de main-d'œuvre dans les communautés environnantes; • Contrôle médical des travailleurs avant leur arrivée au campement, à la fin de leur embauche et au besoin pendant l'embauche; • Mise sur pied d'un programme régulier de suivi médical des employés; • Élaboration d'un programme de sensibilisation des travailleurs; • Contrôle des activités hors site en dehors des heures de travail; • Élaboration d'une campagne de sensibilisation des populations à risque de Fort-Dauphin, avec l'aide des autorités médicales et des organismes communautaires concernés; • Suivi des dossiers médicaux et des plaintes; • Élaboration d'un programme de suivi.	**Mineur**

Évaluation des impacts et mesures d'atténuation relativement à la santé (suite)

Milieu humain								
Identification de l'impact			**Évaluation de l'impact**				**Mesures d'optimisation, d'atténuation ou de valorisation**	**Impact résiduel**
Élément	Composante	Caractérisation	Intensité	Portée	Durée	Importance de l'impact		
Santé	Sécurité publique	• Risques d'accidents avec les véhicules de chantier; • Danger potentiel pour les villageois et le bétail des zones de travaux et d'activités aux différents sites de travaux; • Risques d'accidents avec les équipements de dragage;	Moyenne	Ponctuelle	Courte	Mineure	• Application de bonnes pratiques environnementales (voir section 5); • Sécurisation et gardiennage des secteurs potentiellement à risque; • Élaboration d'une campagne de sensibilisation auprès des populations relativement aux dangers reliés à la construction des infrastructures portuaires; • Réalisation des travaux aux différents sites de façon sécuritaire (chauffeur formé, respect des limites de vitesse, etc.); • Mise en place d'une signalisation et infrastructures adéquates à la limitation de vitesse; • Déménagement des aires d'entreposage des pirogues dans un secteur sécuritaire pour les pêcheurs; • Suivi des plaintes; • Mise en place et respect des procédures de gestion amiable des conflits potentiels créés par les accidents sur les personnes ou sur le bétail; • Élaboration d'un programme de surveillance et de suivi environnemental;	**Mineur**

Évaluation des impacts et mesures d'atténuation relativement à la santé (suite)

MILIEU HUMAIN								
Identification de l'impact			**Évaluation de l'impact**				**Mesures d'optimisation, d'atténuation ou de valorisation**	**Impact résiduel**
Élément	Composante	Caractérisation	Intensité	Portée	Durée	Importance de l'impact		
Santé	Santé et sécurité au travail	• Risques d'accidents de différentes natures et gravités; • Risques d'exposition à des matières dangereuses; • Risques d'augmentation des problèmes de santé (maladies).	Faible	Ponctuelle	Courte	Mineure	• Application de bonnes pratiques environnementales relativement à l'eau, à l'air et aux sols (voir section 5); • Application des mesures énoncées au volet santé communautaire; • Application des mesures énoncées aux volets environnement sonore et émissions atmosphériques; • Application du programme de santé et sécurité au travail répondant aux normes de Rio Tinto; • Mise en service d'une clinique médicale; • Mise en place d'un programme de formation en santé et sécurité au travail; • Respect des mesures préventives et du code de conduite par les travailleurs; • Respect par les entrepreneurs des normes de santé et sécurité en vigueur à Madagascar; • Respect par les entrepreneurs des normes de santé et sécurité prescrites par QMM; • Réalisation des travaux aux différents sites de façon sécuritaire (chauffeur formé, respect des limites de vitesse, etc.); • Distribution de repas du midi aux travailleurs recrutés localement Suivi des plaintes; • Élaboration d'un programme de surveillance et de suivi environnemental	**Mineur**

4.2.2 UTILISATION DU TERRITOIRE ET ASPECTS ÉCONOMIQUES

L'élément utilisation du territoire comprend les événements reliés aux bâtiments résidentiel, industriel, commercial et institutionnel, aux services publics, à l'exploitation des ressources agricoles et du pâturage, à l'exploitation des ressources halieutiques, à l'exploitation des ressources forestières et du potentiel touristique. En ce qui a trait aux aspects économiques, ceux-ci comprennent les événements reliés à la relocalisation des villageois et à certaines activités de ces derniers.

Ces éléments sont traités globalement dans le cadre du processus de déclaration d'utilité publique (DUP) conformément à l'ordonnance n° 62-023 du 19 Septembre 1962 et à son décret d'application portant le n° 63-030 du 16 Janvier 1963 et tel qu'autorisé par la Convention d'Établissement et qui stipule que les terrains nécessaires aux travaux de construction des infrastructures industrialo-portuaires de Taolagnaro, dont font partie les routes, sont déclarés d'utilité publique par le décret n° 2005-501 du 19 Juillet 2005 à la suite de la demande de QMM.

4.2.2.1 MISE EN CONTEXTE

Les principales étapes du processus de Déclaration d'Utilité Publique sont les suivantes :

- la préparation par le Gouvernement du Cadre de Politique de Réinstallation (CPR) et du Plan d'Action de Réinstallation (PAR) en conformité avec sa législation nationale et les meilleurs standards internationaux applicables, telles que les exigences de la Banque Mondiale, pour éviter autant que faire se peut qu'une personne ou propriété ne subisse des préjudices pendant et suivant la mise en œuvre du projet (rapport TECSULT – Février 2005). Les principes de base du Plan de Réinstallation reposent sur les points suivants :
    - éviter autant que possible qu'une personne ou une propriété ne subisse des préjudices pendant et suivant la mise en œuvre du projet;
    - des déplacements involontaires de population pourraient être inévitables. Le plan de réinstallation constitue un guide pour les opérations d'indemnisation et de réinstallation des personnes affectées par le projet (PAP);
    - les personnes affectées par le projet recevront une juste compensation établie sur la base des prix courants du marché et de valeurs non dépréciées pour les biens meubles et immeubles perdus, incluant les cultures, les arbres et les arbustes;
    - la compensation en nature est la méthode envisagée pour compenser la plupart des pertes. Le type de compensation sera cependant un choix individuel même si tous les efforts seront faits pour faire comprendre l'importance et la préférence d'accepter des compensations en nature.
- la préparation du chronogramme général de mise en œuvre du processus de déclaration d'utilité publique et un calendrier de libération des terrains ont été préparés avec les responsables locaux et du gouvernement.
- la mise en place par les Autorités locales à Fort-Dauphin, le 01 avril 2005, d'une commission locale pour la mise en œuvre du processus DUP où sont également représentés les représentants des villages touchés par le projet. Cette commission est dirigée par le Chef de région de l'Anosy.
- la préparation, en avril et juin 2005, des protocoles d'accord entre la Région de l'Anosy et QMM définissant les principes directeurs et les engagements qui régissent la coopération entre la Région, représentant l'État Malgache, et QMM.SA pour la mise en œuvre de travaux préparatoires, faisant suite à la réalisation de l'enquête commodo/ incommodo et de l'évaluation par la Commission Administrative d'Évaluation, dans le cadre du processus de Déclaration d'Utilité Publique permettant l'achat amiable des terrains ou l'expropriation, la compensation et le cas échéant le déplacement des populations, de

diverses parcelles de terrains nécessaires aux travaux de construction des infrastructures routière et industrialo-portuaire de Taolagnaro. Cette enquête réalisée par des consultants indépendants recrutés localement a permis de préciser les informations sur les terrains touchés par ces infrastructures : superficie, type d'occupation, propriétaires, usufruitiers traditionnels. Des affichages d'information sur différents lieux publics, des annonces à travers les médias locaux, des réunions publiques d'information et une tenue des registres des doléances sur les différents sites du projet ont été préalablement préparés par ces consultants;

- la sortie du décret N°2005-501 le 19 juillet 2005 déclarant d'utilité publique et classant dans le domaine public l'ensemble des terrains nécessaires aux travaux de construction des infrastructures industrialo-portuaires de Taolagnaro (la route reliant le gisement de Mandena et le port d'Ehoala, à partir de son croisement avec la RN13,,, la carrière, la route entre la carrière et le port d'Ehoala, la zone industrialo-portuaire d'Ehoala);
- la commission locale DUP a fait appel à une agence d'exécution ayant des expériences similaires en matière de DUP, le « Bureau des Projets, de Promotion et d'Aménagements des Régions » (BPPAR) pour assister la Commission Administrative d'Evaluation (CAE) dans l'information des Personnes affectées par le Projet sur leurs droits et obligations. Les rôles de BPPAR sont de :
  - assister la Commission Administrative d'Evaluation (CAE) dans l'information des Personnes affectées par le Projet sur leurs droits et obligations;
  - assurer le bon déroulement du processus d'expropriation et d'indemnisation;
  - assurer la conformité des activités de la CAE selon la législation malagasy et les meilleures pratiques internationales notamment les recommandations de la Banque Mondiale;
  - sensibiliser la CAE sur la politique OP.4.12 de la Banque Mondiale;
  - mettre à jour les fiches individuelles plus particulièrement l'identification des PAP
  - préparer les dossiers et saisine du Tribunal de Taolagnaro (ordonnance d'expropriation);
  - appuyer les services concernés pour la constitution des pièces de paiement.
- la Commission Administrative d'Evaluation (CAE) prévue à l'article 7 du décret N° 63-030 du 16 Janvier 1963 fixant les modalités d'application de l'Ordonnance sur l'expropriation publique relative à l'expropriation pour cause d'utilité publique a été constituée par l'arrêté N° 13 Rég/Anosy du 01 septembre 2005 du Chef de Région de l'Anosy et dont les rôles sont :
  - d'organiser une visite sur les sites touchés par les composantes du Projet de construction d'infrastructures routières – industrialo-porturaire qui ont été déclarés d'utilité publique par décret N° 2005-501 du 19 juillet 2005;
  - d'évaluer les terrains situés dans l'emprise;
  - de déterminer les indemnités et compensations à offrir aux personnes affectées par le Projet (PAP).
- en novembre/décembre 2005, la Commission Administrative d'Evaluation (CAE) a estimé les compensations des PAP sur la péninsule d'Ehoala. Ses procès-verbaux ont reçu le visa du Chef de service de la Conservation et des Documents Fonciers le 29 décembre 2005 et ont été approuvés par le Ministre de l'Économie, des Finances et du Budget le 16 janvier 2006.
- les PAP sont actuellement notifiés sur les estimations des compensations;
- l'implication de deux ONGs et d'un cabinet, en tant que parties neutres, pour :
  - la mise en place de projets d'accompagnement auprès des PAP;

- assurer le suivi/évaluation du processus auprès des PAP.

4.2.2.2 BATIMENTS RESIDENTIEL, INDUSTRIEL, COMMERCIAL, INSTITUTIONNEL ET ZONES AGRICOLES

4.2.2.2.1 ÉTAT ACTUEL ET IMPACTS POTENTIELS

IDENTIFICATION DES BIENS TOUCHÉS

Compte tenu de la spécificité du projet ilménite associé au Pôle Intégré de Croissance qui fait intervenir la Banque Mondiale dans le financement d'une partie du coût de construction du port, les opérations menées par la Commission Administrative d'Évaluation (CAE), chargée d'évaluer les indemnités d'expropriation et de la valeur des immeubles susceptibles d'être assujetties à la redevance de plus-value, ont été réalisées avec la participation et l'assistance d'autres organismes tels que le BPPAR, la commission locale de mise en œuvre du processus DUP et QMM.

Selon l'évaluation de la Commission Administrative d'Évaluation, le nombre total de personnes affectées par le site industrialo-portuaire d'Ehoala s'élève à 166. Les propriétés et édifices touchés comportent :

- Habitation **:**

  trois cases traditionnelles en bois constituées d'une seule pièce; ce sont des cases temporaires des gardiens.

- Cultures

  Les cultures présentes dans cette zone comportent :

TYPE DE CHAMPS	TERRAINS IMMATRICULÉS	TERRAINS DOMANIAUX À OCCUPATION TRADITIONNELLE
Rizière	0	0,00 ha
Cultures vivrières (manioc, patate douce, maïs)	0	13,15 ha
Autres cultures (sisal, pervenche, ananas)	0	5,20 ha
Terrain en jachère	0	87, 20 ha
Total	**0**	**105, 50 ha**

4.2.2.2.2 COMPENSATION DES BIENS AFFECTÉS

Les terrains ayant fait l'objet de Déclaration d'Utilité Publique sur la péninsule d'Ehoala sont des terrains domaniaux stériles exploités de façon itinérante par certains paysans d'Ambinanibe qui sont notamment des pêcheurs. Comme le sol est sableux et très pauvre, le rendement des cultures reste faible; après une saison de culture, les villageois laissent les parcelles en jachère pendant plusieurs années.

Cette zone ne comporte aucune aire de pâturage des zébus.

Les membres de la CAE ont estimé une compensation financière des cultures existantes et des terrains mis en jachère. Aucune compensation en nature des terrains n'est envisagée. Les trois cases temporaires existantes seront compensées en nature ou en argent selon le souhait des propriétaires;

comme ce ne sont que des cases temporaires de gardiennage ou d'abri, certains propriétaires ont souhaité la compensation monétaire.

Le principe de compensation se résume comme suit :

UTILISATEURS	NATURE DES BIENS	MODE DE COMPENSATION	OBSERVATIONS
Usufruitiers	Champs de culture	En argent	• Acte de vente administratif ou • Ordonnance d'expropriation ou • Compensation des cultures existantes
Propriétaire légal	Cases	En argent ou en nature (choix des propriétaires)	• Terrain de remplacement déjà disponible.

Si les propriétaires des cases souhaitent le remplacement, les nouvelles maisons seront construites suivant le modèle à une pièce qui a été bâti à titre de démonstration aux PAP touchés au site de la carrière. Les bénéficiaires auront le choix de terrain de relocalisation entre leur propre terrain dans le village d'Ambinanibe et celui fourni pour la relocalisation situé aux environs du village d'Ilafiatsinanana.

4.2.2.2.3 MODE DE COMPENSATION

Les personnes affectées par le projet sont déjà notifiées des montants de compensation selon l'estimation faite par la CAE et elles seront payées à partir du 14 mars 2006. La réclamation de certains PAP sur l'évaluation des pertes de biens a été recueillie par l'ONG du programme d'accompagnement et sera analysée par la Commission locale de mise en œuvre du processus DUP.

Les compensations seront payées en un seul versement et se feront :

- par l'intermédiaire d'une banque privée sur site en présence de
  - Représentant de l'État;
  - ONG « programme d'accompagnement »;
  - QMM.
- par la signature d'un Acte d'adhésion à signer par PAP juste avant le paiement.

4.2.2.2.4 MODE D'ACCOMPAGNEMENT DES PAP

Une ONG indépendante assurera, sous la supervision de la Commission locale de mise en œuvre du processus DUP, le programme d'accompagnement des PAP.

Les Termes de Référence de l'ONG pour ce programme d'accompagnement sont d'une manière très générale, les suivants :

- l'appui à la mise en place des mesures de compensation pour les PAP : nouvelles maisons, nouveaux champs;
- l'assistance aux PAP pour le maintien ou l'amélioration de leurs conditions de vie : sécurité alimentaire, restauration des champs, préparation des cultures. Cette assistance peut également inclure un appui technique, une formation professionnelle, un accès au micro crédit, un accès aux infrastructures de base (au moins équivalent à la situation avant la réinstallation);

- la consultation et communication avec les PAP pour les tenir informés de l'avancement de la mise en œuvre du Plan d'Action de Réinstallation.

L'ONG chargée de la mise en œuvre de ces mesures d'accompagnement devra notamment effectuer :

- l'identification des groupes vulnérables (confirmer la liste produite par le consultant recruté par le Gouvernement et la Banque Mondiale – Tecsult);
- la formation des comités au sein des PAP pour faciliter le processus de consultation et communication;
- la mise en place de cellules spécifiques pour le développement de projets;
- la production d'un rapport mensuel pour la commission locale DUP.

4.2.2.2.5 PROGRAMME DE SUIVI-ÉVALUATION DES PAP

Une autre ONG indépendante (différente de celle assurant le programme d'accompagnement) assurera, sous la supervision de Commission locale de mise en œuvre du processus DUP le programme de suivi et l'évaluation des PAP.

Les dispositions pour le suivi et l'évaluation visent à insérer les résultats de ce dernier dans le processus de gestion du projet et permettre la mise en place rapide des mesures appropriées.

Le suivi et l'évaluation du processus de déplacement et d'indemnisation seront réalisés : (i) par l'unité de gestion et d'exécution du projet (en l'occurrence BPPAR) désigné par la Commission locale et le Ministre de tutelle du PIC pour exécuter le Plan de réinstallation et (ii) par un organisme indépendant de l'unité de gestion et d'exécution, par exemple un bureau de spécialistes en réinstallation ou une ONG spécialisée en matière sociale

L'unité de gestion et d'exécution a identifié au préalable les indicateurs de résultats en matière de réinstallation des populations affectées par les projets concernés. Ces indicateurs devront porter, entre autres, sur le processus de réinstallation comme tel, sur le processus de participation des personnes affectées, et sur l'évaluation des impacts du processus de réinstallation au niveau de chaque foyer : niveau de vie (revenus et production agricole), qualité de vie etc. L'objet du suivi et de l'évaluation du processus de déplacement et d'indemnisation est de prendre les mesures spécifiques pendant la réalisation du projet pour résoudre les plaintes et de déterminer si les personnes affectées par le projet ont retrouvé ou non leur niveau de vie et des conditions de vie équivalentes ou meilleures à celles qu'elles avaient avant la réalisation des projets considérés, suite à la mise en œuvre du Plan de réinstallation.

Le suivi consistera alors à :

- l'évaluation du système de suivi et proposer des améliorations;
- la préparation des rapports d'une manière indépendante, suite à des suivis sur site;
- la définition des principales recommandations sur les mesures d'atténuation;
- la gestion de la base de données sur les PAP.

D'une manière non exhaustive, les activités consisteront en une vérification sur site et un rapport sur :

- le paiement des compensations, incluant la valeur et l'échéancier;
- l'aménagement des nouveaux terrains;
- la construction des nouvelles maisons;

- la mise en œuvre des mesures d'accompagnement (cf. termes de référence des mesures d'accompagnement);
- la mise en place des mesures de transition.

4.2.2.2.6 MESURES D'ATTÉNUATION PROPOSÉES

Diverses mesures d'atténuation peuvent être envisagées afin de réduire les impacts sur l'utilisation du territoire et les aspects économiques reliés aux bâtiments résidentiel, industriel, commercial, institutionnel et zones agricoles

Les principales mesures seront :

- l'engagement du Gouvernement de rendre disponibles les terrains pour permettre la construction de nouvelles maisons et l'aménagement de nouveaux champs de cultures;
- l'aménagement de nouveaux champs de culture avec l'appui d'experts et la contribution des PAP;
- la relocalisation des cases ou la compensation en argent selon les souhaits des PAP;
- la participation de représentants des PAP pour l'élaboration du concept de construction des habitations;
- la construction des maisons selon les exigences de la réglementation nationale et selon les pratiques culturelles et traditionnelles;
- la construction d'habitations plus confortables et plus sécuritaires;
- la construction d'habitations plus rigide et ne nécessitant qu'un entretien minimal;
- l'aménagement de puits cuvelés pour les groupes de maisons et la construction de toilettes collectives;
- le suivi et le contrôle de l'exécution des travaux de construction assurés conjointement par la Région de l'Anosy représentant la Commission Locale DUP en tant que Maître de l'ouvrage et QMM comme bailleur de fonds;
- l'appui d'organisations pour la mise en œuvre des mesures d'atténuation et de compensation;
- le suivi des plaintes;
- l'élaboration d'un programme de suivi.

4.2.2.2.7 ÉVALUATION DES IMPACTS RÉSIDUELS

L'application des mesures d'atténuation décrites ci-dessus permettra de limiter les impacts de la construction des infrastructures portuaires sur l'utilisation du territoire et les aspects économiques reliés. Cependant, malgré la mise en place de ces mesures, un **impact résiduel** jugé **moyen** demeure étant donné les conséquences négatives associées à un changement brusque de mode de vie causé par la relocalisation, lesquelles ne peuvent être entièrement compensées.

Le tableau présenté plus loin résume l'évaluation des impacts et les mesures d'atténuation et de compensation qui seront mises en place pour minimiser les impacts de la construction des infrastructures portuaires sur l'utilisation du territoire et les aspects économiques reliés aux bâtiments résidentiel, industriel, commercial, institutionnel et zones agricoles.

Évaluation des impacts et mesures d'atténuation relativement à l'utilisation du territoire et aux aspects économiques

MILIEU HUMAIN								
Identification de l'impact			**Évaluation de l'impact**				**Mesures d'optimisation, d'atténuation ou de valorisation**	**Impact résiduel**
Élément	Composante	Caractérisation	Intensité	Portée	Durée	Importance de l'impact		
Utilisation du territoire	Bâtiments résidentiels	• Déplacement de trois cases	Forte	Ponctuelle	Longue	Majeure	• Relocalisation des maisons dans la même zone que le terrain affecté; • Construction des maisons selon les exigences de la réglementation nationale et les pratiques culturelles et traditionnelles; • Construction d'habitations plus confortables et plus sécuritaires; • Construction d'habitations plus rigides et ne nécessitant qu'un entretien minimal; • Participation de représentant des villageois pour l'élaboration du concept de construction des habitations; • Réalisation de travaux de forage pour chacun des groupes de maisons de puits cuvelés et construction de toilettes collectives; • Suivi et contrôle de l'exécution des travaux de construction assurés conjointement par la Région de l'Anosy représentant la Commission Locale DUP en tant que Maître de l'ouvrage et QMM comme bailleur de fonds; • Appui d'organisations pour la mise en œuvre des mesures d'atténuation et de compensation; • Élaboration d'un programme de suivi (ONG, cabinet).	**Moyen**
	Exploitation des ressources agricoles et des pâturages (champs de culture et rizières)	• Perte de parcelles agricoles	Forte	Ponctuelle	Longue	Majeure	• Compensation des pertes de cultures; • Préparation des champs de culture par des experts avec la contribution des PAP – réalisation de travaux d'aménagement hydroagricole pour les nouvelles rizières; • Suivi et contrôle de l'exécution des travaux assurés par la Région de l'Anosy représentant la Commission Locale DUP en tant que Maître de l'ouvrage et QMM comme bailleur de fonds; • Appui d'organisations pour la mise en œuvre des mesures d'atténuation et de compensation; • Suivi des plaintes; • Élaboration d'un programme de suivi (ONG)..	**Moyen**

4.2.2.3 EXPLOITATIONS DES RESSOURCES HALIEUTIQUES

4.2.2.3.1 ÉTAT ACTUEL ET IMPACTS POTENTIELS

Un programme d'enquête réalisé en septembre-octobre 2000, aux péninsules d'Ehoala, Fort-Dauphin et Evatraha, a révélé que le nombre de casiers mouillés était supérieur à Ehoala. D'ailleurs, à la même période, 67 pirogues ont été comptées à l'est et à l'ouest d'Ehoala, et 60 au port de Fort-Dauphin, représentant respectivement 35 % et 31 % des 193 pirogues recensées aux différents sites de débarquement. Ces pirogues sont utilisées pour la pêche à la langouste et la pêche aux poissons de mer. Toutefois, l'effort de pêche à la langouste peut facilement se déplacer d'un endroit à l'autre sur les péninsules (CSSA, 2001). Il est à noter que l'accostage des pirogues se fait principalement (deux tiers du temps en moyenne) sur le côté Sud de la péninsule en fonction de la direction du vent (on se rappelle que la direction du vent dominant vient du Nord-Est).

Le secteur côtier de la Fausse Baie des Galions, à proximité de l'aire d'implantation des infrastructures portuaires permanentes à Ehoala, est fréquenté pour les activités traditionnelles de pêche et recèle des ressources halieutiques d'intérêt. Les principaux lieux de pêche aux poissons de mer se trouvent à environ 1 km de l'aire désignée pour la construction du brise-lames (voir figure 4.6).

Le village d'Ambinanibe, situé à moins de 3 km au sud-ouest de la péninsule d'Ehoala, compte trois types de pêcheurs. Selon les relevés effectués par QMM, une quinzaine de pêcheurs ne pêchent qu'en mer, 160 ne pêchent que dans la lagune d'Ambinanibe ou dans le lac Andriambe, et 115 pêchent dans les deux milieux.

Les répercussions des activités de construction sur l'exploitation des ressources halieutiques seront potentiellement :

- la perte de sites de récolte de ressources aquatiques dans les secteurs visés par les travaux de construction en milieu marin;
- la perte de la piste d'accès et du site d'accostage pour les pirogues de pêche du côté Nord de la péninsule d'Ehoala (côté de la Fausse Baie Galions).

4.2.2.3.2 MESURES D'ATTÉNUATION PROPOSÉES

Diverses mesures d'atténuation peuvent être envisagées afin de réduire les impacts sur l'exploitation des ressources halieutiques pendant la période de construction. Les principales mesures seront :

- l'amélioration du site d'accostage du côté sud;
- l'utilisation du site d'accostage du côté sud pendant la période de construction du port;
- l'élaboration d'un processus de consultation impliquant les pêcheurs affectés, les autorités et QMM avec pour objectif d'identifier une solution permanente à l'enjeu du site d'accostage nord;
- l'embauche prioritaire parmi la communauté de pêcheurs affectés;
- la mise en place d'un programme de suivi pour l'ensemble des mesures préconisées.

L'application de mesures d'atténuation appropriées pendant les activités de construction permettra de minimiser l'importance de l'impact sur l'exploitation des ressources halieutiques dans le secteur de construction des infrastructures portuaires.

L'application de mesures d'atténuation appropriées aux activités de construction permettra de minimiser l'importance de l'impact sur l'exploitation des ressources halieutiques dans le secteur de construction des infrastructures portuaires.

4.2.2.3.3 ÉVALUATION DES IMPACTS RÉSIDUELS

La construction du brise-lames affectera le site d'accostage au nord de la péninsule. Originalement, la mesure d'atténuation privilégiée était celle du déplacement du site d'accostage vers l'intérieur de la baie avec l'aménagement d'un accès piétonnier pour que les pêcheurs puissent rejoindre ce nouveau site. Cependant la mise en place du nouveau port à Ehoala avec la volonté commune exprimée (par QMM et les autorités portuaires nationales, l'APMF) que ce port se conforme à la nouvelle réglementation internationale en matière de sécurité portuaire, rend la faisabilité de la relocalisation du site de pirogues vers l'intérieur de la baie difficilement envisageable. L'aménagement d'un site d'accostage, d'une piste d'accès, le va-et-vient des villageois pêcheurs à l'intérieur du périmètre portuaire, sont autant d'éléments qui pourraient être jugés incompatibles avec la réglementation internationale portuaire en matière de sécurité.

Dans ces conditions, il est recommandé de n'utiliser que le site situé au sud en lui apportant des améliorations. Les mesures d'amélioration seront élaborées en collaboration avec la communauté de pêcheurs affectée, les autorités (locale, commune) et QMM préalablement au démarrage des activités de construction.

Un **impact résiduel mineur** est donc prévu dans le contexte de la perte d'accès au site d'accostage nord.

Pendant la construction, la circulation des équipements et les travaux d'aménagement du site portuaire (déversement de roc), ainsi que le dragage entraîneront la perte de sites de récolte de ressources marines au nord de la péninsule d'Ehoala. En effet, le dépôt du roc sur le fond marin et la modification des conditions hydrodynamiques locales entraîneront le déplacement des espèces mobiles et la perte des organismes fixes (crustacés et mollusques).

La turbidité causée par le dépôt des blocs et le dragage pourrait également affecter la productivité des colonies d'algues, plus particulièrement des algues rouges. Toutefois, les principaux secteurs potentiels de récolte d'algues sont situés surtout du côté sud et sud-ouest de la péninsule (figure 4.6). Les travaux envisagés du côté nord de la péninsule d'Ehoala devraient représenter un **impact résiduel moyen** sur les activités de pêche en mer, pendant la période de construction, malgré l'application des mesures. Cependant, au terme de la construction du brise-lames, QMM est d'avis que l'infrastructure constituera un habitat potentiel pour la faune marine qui contribuera, à moyen terme, à améliorer la pêche pour ces mêmes villageois.

Le tableau présenté plus loin résume l'évaluation des impacts et les mesures d'atténuation et de compensation qui seront mises en place pour minimiser les impacts de la construction des infrastructures portuaires sur l'exploitation des ressources halieutiques.

Évaluation des impacts et mesures d'atténuation relativement à l'exploitation des ressources halieutiques

MILIEU HUMAIN								
Identification de l'impact			**Évaluation de l'impact**				**Mesures d'optimisation, d'atténuation ou de valorisation**	**Impact résiduel**
Élément	Composante	Caractérisation	Intensité	Portée	Durée	Importance de l'impact		
Utilisation du territoire	Exploitation des ressources halieutiques	• Perte de sites de récolte de ressources halieutiques	Forte	Locale	Moyenne	Moyenne	• Amélioration du site d'accostage du côté sud; • Utilisation du site d'accostage du côté sud pendant la période de construction du port; • Embauche prioritaire parmi la communauté de pêcheurs affectés; • Mise en place d'un programme de suivi pour l'ensemble des mesures préconisées.	**Moyen**
		• Perte d'une piste d'accès à l'océan; • Perte du site d'accostage pour les pirogues de pêche du côté nord de la péninsule d'Ehoala (côté de la Fausse Baie Galions)	Faible	Ponctuelle	Longue	Mineure		**Mineur**

4.2.2.4 POTENTIEL TOURISTIQUE

4.2.2.4.1 ÉTAT ACTUEL ET IMPACTS POTENTIELS

Fort-Dauphin est reconnu comme une destination touristique, cependant cette vocation est actuellement freinée par de nombreux obstacles. En ce qui concerne les infrastructures, le mauvais état des routes limite l'accès à des sites potentiellement intéressants et enfin l'état du port de Fort-Dauphin limite la venue de bateaux de croisière. Le secteur des travaux du port n'est pas une zone d'activités touristiques en tant que telle. Les mouvements des véhicules et des engins s'effectueront principalement dans le secteur du promontoire d'Ehoala, de la carrière d'Andriambe et de la route reliant ces deux sites. Le site touristique le plus près est celui dit du Club Nautique Vinanibe. Étant donné sa proximité de la carrière, l'impact sur ce site a plutôt été traité dans le PGES Carrière.

La période de construction du port aura un impact positif sur l'industrie hôtelière locale étant donné l'achalandage généré par l'ensemble du personnel associé directement ou indirectement à sa construction (entrepreneurs, spécialistes, représentants des autorités, etc.)

Un impact **résiduel moyen positif** est donc prévu relativement aux travaux de construction des infrastructures portuaires sur le potentiel touristique.

Également, à terme, la mise en place des nouvelles infrastructures portuaires permettra de renforcer le pôle touristique de Fort-Dauphin par sa meilleure capacité d'accueil des croisiéristes.

4.2.3 CULTURE ET PATRIMOINE

Cet élément comprend les événements reliés aux sites funéraires, aux lieux sacrés et à valeur patrimoniale et au paysage d'intérêt.

4.2.3.1 SITES FUNERAIRES, LIEUX SACRES ET A VALEUR PATRIMONIALE

4.2.3.1.1 ÉTAT ACTUEL ET IMPACTS POTENTIELS

Trois tombeaux se trouvaient dans les limites de la zone industrialo-portuaire. Deux se trouvaient dans la zone des travaux et ont dû faire l'objet de relocalisation. Un troisième tombeau, présent à la limite ouest de la zone industrialo-portuaire d'Ehoala a plutôt fait l'objet d'un ajustement de la limite de la zone industrialo-portuaire afin de l'exclure de celle-ci, et n'a donc pas fait l'objet d'un déplacement (voir figure 4.11).

En ce qui concerne, les deux sites relocalisés, ces derniers ont d'abord fait l'objet de consultations préalables auprès des familles concernées pour discuter des différentes options acceptables par toutes les parties dans le but de minimiser les impacts des activités de construction et d'exploitation du port sur ces tombeaux. Il a été finalement convenu que la relocalisation constituait la meilleure option assurant la meilleure protection de ces sites. Ces consultations ont été réalisées par le biais de l'établissement d'un comité composé des représentants des familles concernées, des autorités locales (Région, Commune, Services publics concernés, PIC) et QMM. A la suite d'une approbation sur le principe par les familles concernées, les consultations se sont poursuivies afin de déterminer la localisation des nouveaux sites, la conception de ces derniers ainsi que le rituel à respecter selon les us et coutumes et le calendrier de relocalisation. Une fois une entente sur l'ensemble du processus finalisée, les travaux d'aménagement ont débuté et le processus de relocalisation c'est conclu par la conduite de la cérémonie de transfert de l'ancien au nouveau site. Ces deux sites ont été relocalisés en trois différents endroits : deux se trouvant dans le secteur d'Ambinanibe (voir Figure 4.11) et un dans la Commune de Manambaro (située à une vingtaine de kilomètres de Fort-Dauphin) suite à la décision d'une des familles concernées.

Bien que les sites funéraires aient fait l'objet d'ententes avec les familles concernées, il n'en demeure pas moins que la présence de travailleurs pourrait être une source de préoccupations pour les collectivités villageoises concernées.

Les répercussions potentielles indirectes de la construction des infrastructures portuaires sur la culture et le patrimoine pourraient être:

- la destruction de la stèle;
- la profanation du site;
- la perte de l'identité du milieu environnant « sense of place »;
- la perte de l'accès au site.

4.2.3.1.2 MESURES D'ATTÉNUATION PROPOSÉES

Diverses mesures d'atténuation ont été et seront mises en place afin de réduire les impacts sur les sites funéraires et sacrés. Les principales mesures sont :

Déjà mises en place :

- l'application par QMM des procédures prescrites par la législation malgache et directives de la Banque Mondiale;
- la concertation avec les villageois et familles concernés pour la relocalisation et/ou le maintien de l'accès aux sites funéraires et sacrés;

A venir :

- le contrôle des déplacements de la main-d'œuvre de construction;
- l'élaboration et la distribution d'un guide de comportement pour les employés;
- l'élaboration d'un programme de sensibilisation des travailleurs étrangers aux pratiques culturelles malgaches;
- l'application d'une directive de « tolérance zéro » relativement aux comportements jugés non acceptables;
- l'élaboration d'un programme d'information auprès des villageois concernés;
- le suivi des plaintes;
- l'élaboration d'un programme de suivi.

4.2.3.1.3 ÉVALUATION DES IMPACTS RÉSIDUELS

L'application de ces mesures d'atténuation permettra de limiter les impacts de la construction des infrastructures portuaires sur les sites funéraires et sacrés. Après la mise en place des mesures préventives appropriées, un **impact résiduel mineur** est prévu.

Le tableau relatif à la culture et au patrimoine présenté plus loin résume l'évaluation des impacts et les mesures d'atténuation et de compensation qui seront mises en place pour minimiser les impacts sur le site funéraire, lieu sacré et à valeur patrimoniale.

Figure 4.10 Localisation des sites sacrés

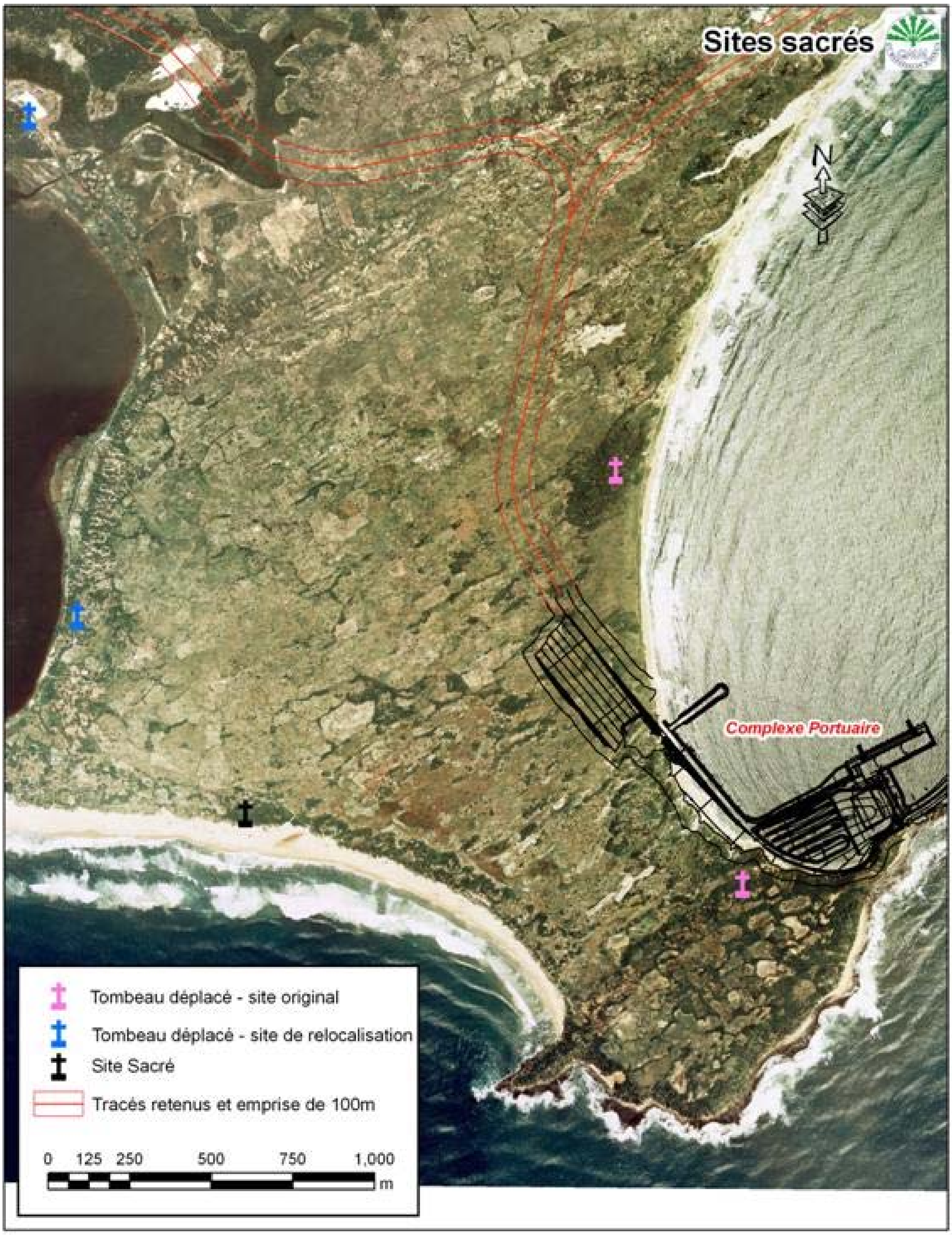


Figure 4.11 Relocalisation d'un site sacré dans le secteur d'Ehoala

Évaluation des impacts et mesures d'atténuation relativement aux sites funéraires, lieux sacrés et à valeur patrimoniale

MILIEU HUMAIN								
Identification de l'impact			Évaluation de l'impact				Mesures d'optimisation, d'atténuation ou de valorisation	Impact résiduel
Élément	Composante	Caractérisation	Intensité	Portée	Durée	Importance de l'impact		
Culture et patrimoine	Sites funéraire, lieux sacrés et à valeur patrimoniale	• Destruction des stèles; • Profanation du site; • Perte de l'identité du milieu environnant « sense of place »; • Perte de l'accès au site.	Moyenne	Ponctuelle	Courte	Moyenne	Déjà mises en place : • Application par QMM des procédures prescrites par la législation malgache et directives de la Banque Mondiale; • Concertation avec les villageois et familles concernés pour la relocalisation et/ou le maintien de l'accès aux sites funéraires et sacrés; A venir : • Contrôle des déplacements de la main-d'œuvre de construction; • Élaboration et la distribution d'un guide de comportement pour les employés; • Élaboration d'un programme de sensibilisation des travailleurs étrangers aux pratiques culturelles malgaches; • Application d'une directive de « tolérance zéro » relativement aux comportements jugés non acceptables; • Élaboration d'un programme d'information auprès des villageois concernés; • Suivi des plaintes; • Élaboration d'un programme de suivi.	**Mineur**

4.2.3.2 Paysage d'interet

4.2.3.2.1 État actuel et impacts potentiels

La construction du brise-lames, du quai, de l'oléoduc et des diverses composantes de l'aire d'entreposage, sur la péninsule d'Ehoala, ainsi que l'aménagement de l'accès routier qui longera la plage constituent un ensemble d'activités susceptibles d'affecter la qualité du paysage dans ce secteur de la Fausse Baie des Galions, au sud-ouest de Fort-Dauphin.

Ces altérations devraient être d'intensité limitée, étant donné la topographie des lieux et la distance (5 km) qui séparera le site portuaire des principaux points d'observation, à Fort-Dauphin. Une simulation visuelle a été réalisée à partir de la pointe du Miramar dans le but d'évaluer l'impact potentiel sur le paysage de la présence des ouvrages à la péninsule d'Ehoala (voir figure 4.12). Tel que montré à partir de la simulation visuelle, la distance qui sépare le site d'observation des ouvrages est suffisamment grande pour atténuer la perception visuelle des infrastructures. Il est également important de préciser que la présence de la haute dune séparant l'aéroport de Fort-Dauphin du promontoire d'Ehoala, fait en sorte qu'aucune des installations portuaires ne sera visible à partir du site de l'aéroport.

Les répercussions de la construction des infrastructures portuaires sur le paysage seront potentiellement :

- la circulation d'équipements lourds;
- la présence de poussières;
- la présence d'équipements de dragage;
- la construction des infrastructures.

4.2.3.2.2 Mesures d'atténuation proposées

Diverses mesures d'atténuation peuvent être envisagées afin de réduire les impacts sur le paysage. Les principales mesures seront :

- l'application de bonnes pratiques environnementales (voir section 5);
- l'élaboration d'un programme d'information auprès des villageois et opérateurs touristiques concernés;
- la plantation d'arbres le long de l'accès routier et en bordure des infrastructures portuaires;
- le suivi des plaintes;
- l'élaboration d'u programme de surveillance et de suivi environnemental.

4.2.3.2.3 Évaluation des impacts résiduels

L'application de mesures d'atténuation fera en sorte qu'un **impact résiduel mineur** sur le paysage est prévu, dans le cadre des travaux de construction des infrastructures portuaires.

Le tableau relatif au paysage d'intérêt présenté plus loin résume l'évaluation des impacts et les mesures d'atténuation et de compensation qui seront mises en place pour minimiser les impacts sur cet élément.

Évaluation des impacts et mesures d'atténuation relativement au paysage d'intérêt

Milieu humain								
Identification de l'impact			**Évaluation de l'impact**				**Mesures d'optimisation, d'atténuation ou de valorisation**	**Impact résiduel**
Élément	Composante	Caractérisation	Intensité	Portée	Durée	Importance de l'impact		
Culture et patrimoine	Paysage d'intérêt	• Circulation d'équipements lourds; • Présence de poussières; • Présence d'équipements de dragage; • Construction des infrastructures.	Faible	Locale	Courte	Mineure	• Application de bonnes pratiques environnementales (utilisation d'abat-poussières, si nécessaire) (voir section 5); • Élaboration d'un programme d'information auprès des villageois et opérateurs touristiques concernés; • Plantation d'arbres le long de l'accès routier • Suivi des plaintes; • Élaboration d'un programme de suivi.	**Mineur**

Figure 4.12 Simulation visuelle réalisée à partir de la pointe du Miramar

4.2.4 ACTIVITÉ ÉCONOMIQUE

Cet élément comprend les événements reliés au secteur formel, au secteur informel, aux emplois locaux et au foncier et immobilier. Ce volet traite des impacts économiques qui n'ont pas été mentionnés dans le volet utilisation du territoire.

4.2.4.1 ÉTAT ACTUEL ET IMPACTS POTENTIELS

Même si les retombées économiques du port se feront de plus en plus sentir suite à son démarrage, il n'en demeure pas moins que la phase de sa construction pourrait également contribuer à mettre en valeur les terrains situés dans le secteur de l'aéroport, en dehors du périmètre de la zone industrialo-portuaire.

Les répercussions de la construction des infrastructures portuaires sur l'économie seront potentiellement :

- les achats directs et indirects de biens et de services pouvant induire un risque d'inflation locale;
- la création d'emplois;
- la valorisation commerciale des terrains dans le secteur de l'aéroport;
- l'augmentation du potentiel d'extension urbaine au sud-ouest de Fort-Dauphin.

4.2.4.2 MESURES D'ATTENUATION PROPOSEES

Diverses mesures d'atténuation sur l'économie peuvent être envisagées. Les principales mesures seront :

- l'élaboration et la mise en place d'une politique d'achat favorisant les fournisseurs locaux à compétence égale et à prix concurrentiel;
- l'embauche de main-d'œuvre locale;
- l'appui aux entreprises et aux regroupements de fournisseurs locaux;
- l'appui aux programmes de formation de type « chantier-école »;
- l'appui aux services compétents pour élaborer les textes administratifs nécessaires en vue du contrôle des transactions domaniales par création de réserve foncière ou toute autre mesure administrative adéquate;
- l'élaboration d'un programme d'information auprès des intervenants et des populations concernées;
- l'appui au regroupement des fournisseurs locaux avec les organismes de micro-crédit;
- la diffusion des informations relatives aux besoins de QMM;
- le suivi des plaintes;
- l'élaboration d'un programme de suivi.

4.2.4.3 ÉVALUATION DES IMPACTS RESIDUELS

L'application de ces mesures d'atténuation permettra de favoriser l'économie locale. Après la mise en place des mesures préventives appropriées, un **impact résiduel majeur positif** est prévu.

Le tableau relatif à l'économie locale présenté plus loin résume l'évaluation des impacts et les mesures d'atténuation et de compensation qui seront mises en place.

Évaluation des impacts et mesures d'atténuation relativement aux aspects économiques

MILIEU HUMAIN								
Identification de l'impact			Évaluation de l'impact				Mesures d'optimisation, d'atténuation ou de valorisation	Impact résiduel
Élément	Composante	Caractérisation	Intensité	Portée	Durée	Importance de l'impact		
Économie	Secteurs formel et informel	• Achats directs et indirects de biens et de services pouvant induire un risque d'inflation locale; • Création d'emplois.	Forte	Régionale	Longue	Positive Majeure	• Élaboration et la mise en place d'une politique d'achat favorisant les fournisseurs locaux à compétence égale et à prix concurrentiel; • Embauche de main-d'œuvre locale; • Appui aux entreprises et aux regroupements de fournisseurs locaux; • Appui aux programmes de formation de type « chantier-école »; • Appui aux services compétents pour élaborer les textes administratifs nécessaires en vue du contrôle des transactions domaniales par création de réserve foncière ou toute autre mesure administrative adéquate; • Élaboration d'un programme d'information auprès des intervenants et des populations concernées; • Appui au regroupement des fournisseurs locaux avec les organismes de micro-crédit; • Diffusion des informations relatives aux besoins de QMM; • Suivi des plaintes; • Élaboration d'un programme de suivi.	**Positif Majeur**
	Foncier et immobilier	• Augmentation du potentiel d'extension urbaine au sud-ouest de Fort-Dauphin						

4.3 BILAN DE LA PHASE CONSTRUCTION

Cette section présente le bilan des principaux impacts et des mesures d'atténuation associées à la construction des infrastructures portuaires.

L'exploitation minière projetée par QMM permettra, pendant environ 40 ans, d'extraire de l'ilménite et de produire du 'Zirsill' à partir d'un gisement de sable minéralisé situé près de la côte sud est de Madagascar, dans la région de Fort-Dauphin. Le gisement minier est réparti sur trois secteurs : Petriky, Mandena et Sainte-Luce. La première phase du projet concernera le secteur de Mandena où près de 750 000 t/a d'ilménite seront extraits. Le minerai sera par la suite exporté pour être transformé. Pour ce faire, une installation portuaire est nécessaire.

Comme le nouveau port d'Ehoala sera de nature publique, il prendra la relève du port existant pour les exportations de sisal et de produits de la pêche de même que pour les importations de différentes marchandises. De plus, le nouveau port pourra accueillir le trafic associé au tourisme de croisière. L'avènement de ce nouveau port en eau profonde, combiné à sa proximité d'une zone de développement industrialo-portuaire à fort potentiel de croissance, ouvrira la porte à une croissance économique de la région de l'Anosy.

La construction de cette installation portuaire, sur le promontoire d'Ehoala dans la Fausse Baie des Galions au sud de la ville de Fort Dauphin, nécessitera le transport d'environ 1,5 million de tonnes de roc entre la carrière d'Andriambe et le site du port. Les travaux de construction dureront environ trois ans et consisteront principalement en la construction :

- d'un brise-lames en enrochement d'une longueur approximative de 600 m;
- le dragage de 855 000 m^3 de substrat marin pour former un chenal d'accès (300m, -17.0m), un cercle de navigation des navires, et une zone d'approche au quai principal;
- d'un quai polyvalent comprenant deux postes à quai;
- d'un épi d'enrochement pour restreindre le mouvement du sable littoral le long de la plage située au nord du port;
- l'aménagement de 11,5 hectares de terre-plein;
- la construction de 1 500 m de murs de soutènement/digues pour la route côtière, de la route d'accès et de la zone de confinement des matériaux de dragage pour l'établissement du terre-plein;
- l'aménagement sur la péninsule d'Ehoala d'une zone nivelée d'environ 9 hectares pour la construction des réservoirs d'hydrocarbures, des bureaux et des entrepôts.

Pour la construction des infrastructures portuaires, de la main-d'œuvre extérieure sera nécessaire. Celle-ci sera logée dans un campement temporaire d'une capacité d'environ 260 personnes localisé à proximité au nord-est de la carrière d'Andriambe.

L'évaluation des impacts montre que la majorité des répercussions relatives à la construction des infrastructures portuaires seront dans l'ensemble faible à la suite de l'application de mesures d'atténuation, de compensation et de valorisation.

Les principaux impacts potentiels de construction des infrastructures portuaires sont associés au milieu humain en relation à l'utilisation du territoire (perte de ressources halieutiques, de parcelles agricoles, déplacement de résidences) ainsi qu'aux activités économiques (dans ce cas il s'agit d'un impact positif associé à l'achat de biens et services et à la création d'emplois).

Enfin, pour le milieu biophysique, un seul impact moyen est enregistré. Cet impact concerne la modification du fond marin à la suite du dragage dans le secteur de la Fausse Baie des Galions. Pour ce qui a trait au transport sédimentaire dont l'impact résiduel est qualifié de mineur, le programme de suivi en cours combiné à la mise en place d'un épi de rocher provisoire durant la construction, permettra d'appuyer cette évaluation.

Le tableau suivant présente un résumé des principaux impacts identifiés.

BILAN DES PRINCIPAUX IMPACTS RELATIFS À LA CONSTRUCTION DES INFRASTRUCTURES PORTUAIRES (SOCIAL)

Identification de l'impact			Impact initial	Mesures d'atténuation, d'optimisation ou de valorisation	Impact résiduel
Élément	Composante	Caractérisation			
Utilisation du territoire	Bâtiments résidentiels	• Déplacement de cases	Majeur	• Relocalisation des maisons dans la même zone que le terrain affecté; • Construction des maisons selon les exigences de la réglementation nationale et les pratiques culturelles et traditionnelles; • Construction d'habitations plus confortables et plus sécuritaires; • Construction d'habitations plus rigides et ne nécessitant qu'un entretien minimal; • Participation de représentant des villageois pour l'élaboration du concept de construction des habitations; • Réalisation de travaux de forage pour chacun des groupes de maisons de puits cuvelés et construction de toilettes collectives; • Suivi et contrôle de l'exécution des travaux de construction assurés conjointement par la Région de l'Anosy représentant la Commission Locale DUP en tant que Maître de l'ouvrage et QMM comme bailleur de fonds; • Appui d'organisations pour la mise en œuvre des mesures d'atténuation et de compensation; • Élaboration d'un programme de suivi (ONG, cabinet).	**Moyen**
	Exploitation des ressources agricoles et des pâturages (champs de culture et rizières)	• Perte de parcelles agricoles	Majeur	• Compensation des pertes de cultures; • Préparation des champs de culture par des experts avec la contribution des PAP – réalisation de travaux d'aménagement hydroagricole pour les nouvelles rizières; • Suivi et contrôle de l'exécution des travaux assurés par la Région de l'Anosy représentant la Commission Locale DUP en tant que Maître de l'ouvrage et QMM comme bailleur de fonds; • Appui d'organisations pour la mise en œuvre des mesures d'atténuation et de compensation; • Suivi des plaintes; • Élaboration d'un programme de suivi (ONG). .	**Moyen**
	Exploitation des ressources halieutiques	• Perte de sites de récolte de ressources halieutiques	Moyen	• Élaboration d'un processus de consultation impliquant les pêcheurs affectés, les autorités et QMM avec pour objectif d'identifier une solution permanente à l'enjeu du site d'accostage nord; • Embauche prioritaire parmi la communauté de pêcheurs affectés; • Mise en place d'un programme de suivi pour l'ensemble des mesures préconisées.	**Moyen**

BILAN DES PRINCIPAUX IMPACTS RELATIFS À LA CONSTRUCTION DES INFRASTRUCTURES PORTUAIRES (SOCIAL)

Identification de l'impact			Impact initial	Mesures d'atténuation, d'optimisation ou de valorisation	Impact résiduel
Élément	Composante	Caractérisation			
Économie	Secteur formel, secteur informel, emplois locaux, foncier et immo-bilier	• Achats directs et indirects de biens et services; • Création d'emplois	Majeur Positif	• Élaboration et la mise en place d'une politique d'achat favorisant les fournisseurs locaux à compétence égale et à prix concurrentiel; • Embauche de main-d'œuvre locale; • Appui aux entreprises et aux regroupements de fournisseurs locaux; • Appui aux programmes de formation de type « chantier-école »; • Appui aux services compétents pour élaborer les textes administratifs nécessaires en vue du contrôle des transactions domaniales par création de réserve foncière ou toute autre mesure administrative adéquate; • Élaboration d'un programme d'information auprès des intervenants et des populations concernées; • Appui au regroupement des fournisseurs locaux avec les organismes de micro-crédit; • Diffusion des informations relatives aux besoins de QMM; • Suivi des plaintes; • Élaboration d'un programme de suivi.	**Majeur Positif**

BILAN DES PRINCIPAUX IMPACTS RELATIFS À LA CONSTRUCTION DES INFRASTRUCTURES PORTUAIRES (BIOPHYSIQUE)

Identification de l'impact			Impact initial	Mesures d'atténuation, d'optimisation ou de valorisation	Impact résiduel
Élément	Composante	Caractérisation			
Sols (fond marin)	Profil et pente d'équilibre, surface et composition du substrat	• Modification du fond marin par le dragage et l'implantation des infrastructures	Moyen	• Application de bonnes pratiques environnementales (voir section 5); • Nettoyage général des lieux; • Application de mesures de contrôle de l'érosion et de la sédimentation; • Élaboration d'un plan d'urgence environnementale et décontamination des lieux; • Élaboration d'un programme de surveillance et de suivi environnemental.	**Moyen**

5. BONNES PRATIQUES ENVIRONNEMENTALES

5.1 GÉNÉRALITÉS

En période de construction, une attention particulière sera apportée aux éléments présentés au tableau ci-dessous.

Les différentes règles de bonnes pratiques environnementales applicables aux éléments retenus s'appliquent spécifiquement à la phase construction. Bien que ces règles seront appliquées en phase exploitation, QMM élaborera un Manuel de procédures spécifiques pour les différentes activités reliées à l'exploitation de la mine et au transport du minerai.

ÉLÉMENTS	ASPECT / IMPACT POTENTIEL
Air	Risque d'émissions de poussières causées par le transport, la préparation du site, le stockage de sable, terre, agrégats
Sols	Gestion des sols, risque de contamination par des déversements accidentels de matières dangereuses, érosion, compactage, modification du relief
Eau	Risque de contamination des eaux par des déversements accidentels de matières dangereuses ou par les poussières et par un mauvais drainage des eaux de surface
Produits dangereux, déchets dangereux et produits pétroliers	Présence de matières dangereuses et déversements accidentels
Matières résiduelles	Génération de déchets de construction et domestiques
Bruit et vibrations	Gêne reliée aux activités de construction, dynamitage et transport à proximité des zones habitées et fréquentées
Urgence environnementale	Déversements accidentels de matières dangereuses
Sécurité publique	Risque d'accidents sur les chantiers et en périphérie

Le principal objectif du Code de bonnes pratiques est d'intégrer une gestion responsable de l'environnement dans le cycle complet des activités de construction, de réduire les impacts environnementaux et de contribuer au principe de l'amélioration continue. Le Code servira de guide à tous les entrepreneurs et établira une référence pour les méthodes de gestion en matière d'environnement pour la phase construction des infrastructures portuaires.

L'entrepreneur choisi pour la réalisation des travaux de construction des infrastructures portuaires devra suivre les règles de bonnes pratiques environnementales ici énoncées lorsque les travaux visés sont susceptibles d'avoir des impacts environnementaux. À cet effet, on peut se reporter aux différentes analyses des éléments naturels et sociaux présentés à la section 4 qui traite des répercussions potentielles pour chacune des activités reliées à la construction du port.

De plus, l'entrepreneur devra prendre les mesures nécessaires afin que ses employés et ceux de ses sous-traitants respectent le Code ainsi que les lois et règlements en vigueur.

À cet effet, l'entrepreneur en construction devra participer, avant le début des travaux, à une réunion de démarrage du chantier afin d'être informé des exigences spécifiques en matières d'environnement relatives au contrat. Il devra également prendre les mesures nécessaires afin que ses employés et ceux de ses sous-traitants participent, au début des travaux, à une séance d'accueil au chantier.

L'entrepreneur sera aussi tenu d'informer tout nouvel employé qui se joindra à son personnel au fur et à mesure de l'avancement de ses travaux.

L'entrepreneur devra, préalablement à la mise en place des équipements et infrastructures temporaires, soumettre pour approbation à QMM son plan de gestion environnementale et le plan des installations temporaires. Le type d'installation visée comprend ce qui suit sans s'y limiter : système d'approvisionnement d'eau potable (si distinct de celui du site du campement temporaire), système de traitement des eaux usées (si distinct de celui du site du campement temporaire), parc à carburant, aire d'entreposage des matières dangereuses et des déchets dangereux, gestion des matières résiduelles, etc.

Le présent Code **ne remplace pas et ne se substitue pas** à la réglementation sur l'environnement en vigueur à Madagascar. Ce dernier vient en appui à la législation existante et se compose des points suivants :

- Air
- Sols
- Eau
- Matières dangereuses
- Matières résiduelles
- Bruit et vibrations
- Urgence environnementale
- Sécurité publique
- Santé et sécurité au travail
- Installations et produits pétroliers

5.2 AIR

L'entrepreneur devra suivre les règles de bonnes pratiques suivantes en matière de contrôle des émissions atmosphériques lorsque les travaux visés sont susceptibles d'émettre des polluants dans l'air ambiant.

N°	AIR
5.2.1	**FONCTIONNEMENT DES CAMIONS ET DES ÉQUIPEMENTS** • Les équipements utilisés doivent toujours être en bon état de fonctionnement. • L'installation de dispositifs anti-pollution est requise sur les véhicules ou les équipements susceptibles d'émettre des polluants dans l'atmosphère tels que les émissions de particules, d'hydrocarbures, de monoxyde de carbone et d'oxyde d'azote. • L'entrepreneur doit effectuer un entretien périodique des véhicules et équipements afin de contenir, voire diminuer toute source possible de contamination de l'atmosphère. • L'entrepreneur doit maintenir un registre d'entretien des équipements et véhicules. Le registre sera vérifié périodiquement par QMM.
5.2.2	**ABATS POUSSIÈRES** • L'entrepreneur doit niveler et entretenir les voies de transport pour minimiser l'émission de particules dans l'air. • Si requis, l'entrepreneur devra épandre de l'eau en vue de prévenir le soulèvement de poussières reliées aux activités de construction, à la circulation routière ou à toute autre activité pouvant émettre des poussières dans l'environnement. • Si un abat-poussière autre que l'eau est utilisée, l'entrepreneur devra fournir la fiche signalétique et faire approuver par QMM l'utilisation du produit.
5.2.3	**BÂCHES** • Lorsque l'émission de poussière émise pendant le transport en camion de matériaux est importante, l'entrepreneur doit empêcher les envols en installant des bâches sur les bennes des camions ou en utilisant des véhicules fermés.

5.2.4	**CIRCULATION - LIMITES DE VITESSE**
	• Afin de protéger les travailleurs présents sur le chantier et de réduire le plus possible l'émission de poussière, l'entrepreneur devra contrôler la circulation de ses véhicules.
	• L'entrepreneur devra déposer, avant les travaux, à QMM un plan de circulation indiquant, entre autres :
	- la limite de la vitesse et le mouvement des véhicules.
	- la localisation et la dimension des voies de circulation.
	- la signalisation
	- la pose des panneaux de signalisation et des vitesses maximales permises décrites ci-après suivant le secteur :
	  - 15 à 20 km/h sur les ponts métalliques et cimentés de la RN13 respectivement;
	  - 30 km/h dans la ville de Fort-Dauphin (et ses agglomérations) et
	  - 40 km/h à la sortie de la ville;
	  - 60 km/h sur le RN13.
	• Consulter la procédure P-P-6401 de QMM – Limite de vitesse des véhicules.

5.3 GESTION DES SOLS

N°	SOLS
5.3.1	**GÉNÉRAL** • La terre végétale doit être excavée et entreposée à proximité de façon à pouvoir la récupérer pour la stabilisation des sols. • Le décapage pour récupérer la terre végétale doit être fait de manière à éviter de la contaminer par des matériaux sous-jacents de composition différente. • L'entrepreneur doit mettre en réserve toute la terre végétale nécessaire à ses travaux et doit la mettre en réserve sur des emplacements spécifiques. • Si jugé requis, des barrières pour contrôler l'érosion seront mises en place avant le début des travaux pour contrôler l'érosion seront mises en place avant le début des travaux. • Les terres excavées seront stockées à une distance sécuritaire des cours d'eau et seront surveillées par des dispositifs de contrôle des sédiments. • L'entrepreneur devra s'assurer que lors du transport des matériaux excavés, celui-ci se fasse de manière sécuritaire, en minimisant la dispersion. • Minimiser les zones à déboiser. • Établir des zones tampons pour permettre de maintenir l'intégrité écologique des habitats terrestres locaux. • Limiter l'introduction potentielle d'espèces invasives en nettoyant et inspectant régulièrement les équipements.
5.3.2	**STABILISATION ET RÉHABILITATION** • Pour tous travaux de stabilisation, l'entrepreneur doit déposer et faire approuver par QMM son plan de travail. • Lorsqu'une mise en végétation est prévue pour les sites affectés, les plans de revégétalisation (espèces, densité, etc.) doivent être déposés et être approuvés par QMM. • Revégétalisation des zones avec des espèces indigènes.
5.3.3	**NETTOYAGE DES SITES** • L'entrepreneur doit débarrasser le site de son matériel, des matériaux, des installations provisoires et éliminer les déchets, les décombres et les déblais dans les sites autorisés à cet effet, et cela, au fur et à mesure des travaux. • Les sables contaminés aux hydrocarbures ou aux produits dangereux doivent être récupérés et évacués dans un lieu autorisé. • Lors d'une découverte imprévue de sols présentant des indices de contamination (odeurs, couleur, etc.), l'entrepreneur doit aviser sans délai QMM. • L'entrepreneur doit déposer un plan de fermeture de son chantier à QMM avant le début des travaux.

5.4 EAU

L'entrepreneur doit suivre les bonnes pratiques suivantes en matière de gestion des eaux de surface, souterraines, usées et potables lorsque les travaux visés sont susceptibles d'avoir un impact sur ces éléments.

N^{o}	EAU
5.4.1	**GÉNÉRAL** • L'entrepreneur doit déposer et faire approuver par QMM son plan de gestion des eaux avant d'amorcer ces travaux. • Les travailleurs doivent avoir reçu une formation adéquate pour comprendre les enjeux et les méthodes de travail reliés à la gestion de l'eau.
5.4.2	**DRAINAGE** • L'entrepreneur doit respecter le drainage naturel du milieu et prendre toutes les mesures appropriées pour permettre l'écoulement normal des eaux. • Lors de l'aménagement de fossés temporaires, l'entrepreneur doit réduire, au besoin, la pente du fossé en y installant, à intervalles réguliers, des obstacles qui permettront d'éviter l'érosion (par exemple : sacs de sable, roche, etc.) • L'entrepreneur ne doit exécuter aucun travail susceptible de modifier le régime des eaux de surface, lequel pouvant modifier ou non le régime de ces derniers, ni effectuer de dérivation des eaux d'un cours d'eau en les enlevant momentanément ou définitivement de leurs cours sans autorisation. • Minimiser la sédimentation en adoptant des mesures de contrôle de l'érosion et de la sédimentation en évitant le relâchement de sédiments dans les cours d'eau. • Afin de protéger les rivières, les étangs, et autres cours d'eau, l'entrepreneur ne doit pas jeter ou disposer à proximité des matières insalubres ou d'objets quelconques susceptibles d'entraîner une dégradation quantitative et qualitative de la ressource en eau. • L'entrepreneur devra prendre toute mesure appropriée pour faire disparaître les causes d'insalubrité de manière à assurer la protection de la ressource en eau, la commodité du voisinage, la santé et la sécurité de la population, la salubrité publique, l'agriculture, la protection de la nature et de l'environnement et la conservation des sites et des monuments. • L'exécution des travaux de drainage doivent être placés sous surveillance et être approuvés par QMM.
5.4.3	**PÉRIODES DE PLUIES ABONDANTES** • L'entrepreneur doit, lors de l'influence d'un cyclone dans la région ou en période d'averses abondantes, faire cesser toute activité qui risque d'entraîner une dégradation du milieu.
5.4.4	**NETTOYAGE DES COURS D'EAU** • L'entrepreneur devra prendre toutes mesures appropriées pour enrayer ou prévenir le danger constaté ou présumé, relié aux différents travaux qui pourraient entraîner une dégradation du milieu relativement aux activités d'usage et pour la vie aquatique. • L'entrepreneur devra prendre toutes les actions nécessaires afin de restaurer le milieu endommagé (lit d'un cours d'eau, de ses berges ou contaminé) ou décontaminer le milieu.

Nº	EAU
5.4.5	**<u>EAUX SOUTERRAINES</u>** • Généralités : - Les eaux souterraines font partie du domaine public et sont constituées par les eaux contenues dans les nappes aquifères et les sources. - Elles ne peuvent faire l'objet d'appropriation privative que dans les conditions fixées par les dispositions de droit civil de la matière ainsi que des servitudes qui y sont attachées en vigueur sur le territoire de Madagascar. - Les prélèvements d'eaux souterraines ne peuvent être faits sans autorisation, sauf pour des usages personnels ne dépassant pas un volume seuil fixé par décret et ne présentant pas de risques de pollution de la ressource. Les conditions d'obtention des autorisations seront fixées par décret sur proposition de l'Autorité nationale de l'eau et de l'assainissement (ANDEA). L'entrepreneur, avec l'assistance de QMM, sera tenu de faire la demande auprès des autorités concernées pour les besoins qu'il juge nécessaire.
5.4.6	**<u>EAUX DE SURFACE</u>** • Généralités : - Les eaux de surface sont constituées par l'ensemble des eaux pluviales et courantes sur la surface du sol, des plans d'eau ou canaux, les fleuves et rivières, les canaux de navigation et rivières canalisées, certains canaux d'irrigations, les étangs salés reliés à la mer. Les lacs, étangs et assimilés, les marais, les zones humides. Les eaux de surface font partie du domaine public. - Une autorisation délivrée par l'Agence des Bassins, structure décentralisée de l'Autorité nationale de l'eau et de l'assainissement (ANDEA) est requise si les prélèvements d'eaux de surface dépassent le seuil de volume fixé par décret. L'entrepreneur, avec l'assistance de QMM, sera tenu de faire la demande auprès des autorités concernées pour les besoins qu'il juge nécessaire. • L'entrepreneur devra préserver les écoulements de surface existants en évitant la formation de zones d'eau stagnantes et la pollution de ces écoulements en pratiquant de dérivations adéquates autour des sites des travaux.
5.4.7	**<u>EAUX POTABLES</u>** • Généralités - Une eau potable est définie comme une eau destinée à la consommation humaine qui, par traitement ou naturellement, répond à des normes organoleptiques, physico-chimiques, bactériologiques et biologiques fixées par décret. *LES CRITÈRES DE 1998 DE L'ORGANISATION MONDIALE POUR LA SANTÉ (OMS) SERONT APPLIQUÉS POUR LA QUALITÉ DE L'EAU POTABLE :* ▪ *FER (FE) < 0,3 MG/L* ▪ *TURBIDITÉ < 1 (U.T.N.)* ▪ *COULEUR < 15 (U.C.V.)* ▪ *CHLORE RÉSIDUEL < 0,5 MG/L* ▪ *PH 6,5 - 8,5* • Interdiction d'utiliser les puits d'eau potable à des fins de travaux. • Protection des puits et des sources d'eau naturelles localisée dans les zones immédiates de travaux. • Une surveillance des travaux est requise à proximité des points d'eau à risque et où un risque d'altération de la qualité de l'eau potable est possible

N°	EAU

5.4.8	**<u>EAUX USÉES / EAUX SANITAIRES</u>**
	• Généralités :
	  - Les critères pour les rejets des eaux usées sont les suivants :
	    - Coliformes fécaux (moyenne géométrique) < 1000 u.f.c./100mL
	    - Demande biochimique d'oxygène (DBO_5) < 60 mg/L
	    - Demande chimique en oxygène (DCO) < 75* mg/L
	    - Ammoniaque < 5 mgN/L
	    - Nitrates/nitrites < 15 mgN/L
	    - Nitrogène total Kjeldahl (NTK) < 15 mgN/L
	    - Ortho-phosphate < 10 mgP/L
	    - Matière en suspension (MES) < 25 mg/L
	    - pH 5,5 – 9,5
	• Tout déversement d'eaux usées, autres que domestiques, dans les égouts publics doit être préalablement autorisé par la collectivité à laquelle appartiennent les ouvrages.
	• Les eaux usées domestiques du campement temporaire seront traitées avant leur rejet.
	• Les eaux huileuses seront stockées dans des réservoirs sécurisés et recueillies par une entreprise spécialisée.
	• L'évacuation des eaux de toutes natures doit être rejetée dans des conditions qui respectent les objectifs fixés pour le maintien et l'amélioration de la qualité des milieux récepteurs.

5.4.9	**<u>LAVAGE DE VÉHICULES ET DES ÉQUIPEMENTS</u>** • Généralités : - Les eaux usées venant d'un lavage de véhicule ou d'équipement peuvent contenir des sédiments, des métaux, des teneurs élevées d'huiles et de graisses et d'autres produits pouvant contaminer les milieux aquatiques. • Aucun le lavage de véhicules ou d'équipements ne sera permis sur les sites non autorisés par QMM. • Les véhicules ou les équipements devront être lavés dans les zones prévues à cette fin, identifiées « zone de nettoyage des véhicules », construites selon les codes en vigueur et où les eaux usées seront séparées de l'huile ou de la graisse résiduelle. Si les équipements de séparation d'huiles et graisses ne sont pas disponibles, l'entrepreneur devra aménager une aire de nettoyage sur des matériaux adéquats et s'assurer que les eaux de lavage sont acheminées vers un bassin de sédimentation avant leur rejet en milieu naturel. Les bassins devront être vidangés quand ils seront remplis à 50 % de leur capacité. • L'utilisation des produits nettoyants biodégradables, à faible teneur en phosphates et à base d'eau sont recommandés. Les nettoyants à base de produits halogénés, des hydrocarbures aromatiques, des hydrocarbures chlorés, des nettoyants à base de pétrole ou de composés phénoliques doivent être évités. L'utilisation de nettoyants à pH compris entre 5,5 et 9,5 est suggéré pour minimiser la dissolution des métaux. • Si possible, ne pas utiliser un boyau pour nettoyer les surfaces asphaltées ou bétonnées si l'eau n'est pas dirigée vers un séparateur eau-hydrocarbures ou dans une aire aménagée tel que décrit précédemment. Utiliser plutôt un balai ou essuyer le déversement avec des chiffons ou le nettoyer avec des absorbants. • Inspecter le terrain et les installations chaque jour pour déceler tout type de contamination. Déversement. En présence d'une contamination ou d'un déversement de produits pétroliers ou dangereux hors site des travaux l'entrepreneur devra aviser QMM. • Interdiction de déposer ou de déverser des débris ou des produits utilisés pour le travail dans le milieu naturel, sur des terrains privés ou dans des fossés.

N°	EAU
5.4.10	**MILIEU MARIN** • Généralités : - L'entrepreneur doit installer et opérer, s'il doit installer des équipements d'entreposage ou de transbordement près de l'océan, des dispositifs de contrôle de la pollution potentielle de l'eau. - L'entrepreneur doit déposer et faire approuver par QMM un plan d'urgence en cas de déversement de produits pétroliers pendant les travaux et s'assurer d'avoir le matériel nécessaire pour la récupération rapide de tout déversement accidentel. Le matériel doit être disponible sur les lieux et bien identifié. • Toute ravitaillement des véhicules et équipements roulant à moins de 60 m du milieu marin est interdit. • Afficher une interdiction de jeter les déchets sur le littoral et dans la mer. • Interdire le dégazage et le rejet des huiles dans le milieu marin. • Mettre en place un système de collecte des eaux usées et un système de traitement approprié pour les installations de chantier.

5.5 MATIÈRES DANGEREUSES (PRODUITS DANGEREUX ET DÉCHETS DANGEREUX)

Les règles s'appliquant à la conception et à la localisation des lieux d'entreposage (réservoirs, entrepôts) ne sont pas couvertes par cette section.

Un produit ou un déchet est dit dangereux lorsqu'il présente l'une des propriétés suivantes : comburante, corrosive, explosive, gazeuse, inflammable, lixiviable, toxique ou radioactive. Les principaux produits et déchets visés sont les huiles et graisses, les objets contaminés aux huiles et aux graisses, les tubes fluorescents, les aérosols, les accumulateurs, les piles, les gaz comprimés, les peintures, les solvants, les pesticides, les produits de nettoyage divers, les seringues (déchets biomédicaux), les carcasses d'animaux et les sols contaminés. Il est à noter que l'utilisation de produit d'amiante n'est pas autorisée sur les sites du projet.

N°	MATIÈRES DANGEREUSES
5.5.1	**GÉNÉRAL** • L'entrepreneur doit déposer et faire approuver son plan de gestion des matières dangereuses par QMM avant le début des travaux.
5.5.2	**ENTREPOSAGE ET COLLECTE DES PRODUITS ET DÉCHETS DANGEREUX** • L'entrepreneur doit entreposer les produits dangereux dans un lieu bien aéré et aménagé de manière à protéger son contenu de toute altération que peuvent causer l'eau et la chaleur. • L'entrepreneur doit en tout temps assurer l'accessibilité du bâtiment aux services d'urgence. • L'entrepreneur doit s'assurer que le site d'entreposage est protégé par un moyen quelconque (clôture ou cloison) et qu'il est accessible seulement aux employés autorisés à y accéder. • Le plancher, imperméable et sans fissure, doit être terminé de chaque côté par un muret formant un bassin étanche pouvant contenir le plus élevé des volumes suivants : 25 % de la capacité totale de tous les contenants entreposés ou 125 % de la capacité du plus gros contenant. • Tout drain doit être obturé hermétiquement en tout temps pour empêcher l'évacuation des produits ou déchets dangereux ou être relié à un réseau qui en assurera l'évacuation dans un système pouvant assurer la récupération. • Des substances absorbantes (trousse d'intervention en cas de déversement) doivent être conservées à proximité des matières dangereuses liquides. La trousse doit être bien identifié.
5.5.3	**ENTREPOSAGE ET COLLECTE DES PRODUITS ET DÉCHETS DANGEREUX (suite)** • Les bâtiments, remises, armoires, etc., où des matières résiduelles dangereuses sont entreposés doivent être identifiés par des affiches appropriées sur les lieux mêmes d'entreposage ainsi que sur les plans des installations. • Lors de l'entreposage, l'entrepreneur doit tenir compte de l'incompatibilité de chaque produit afin d'éviter toutes réactions physiques ou chimiques (à l'aide des fiches signalétiques). Pour cela, les contenants de matières incompatibles doivent être entreposés dans des aires distinctes ou dans des conteneurs différents. L'entrepreneur doit s'assurer que son personnel a eu une formation relativement à la manipulation des matières dangereuses. • Les contenants de produits dangereux doivent être fermés hermétiquement et étiquetés en indiquant la date de début d'entreposage de la matière et le type de matière. • L'entrepreneur devra fournir l'inventaire (type, quantité, lieu d'élimination) à QMM à tous les mois. • Un contrôle périodique du site d'entreposage des déchets doit être effectué par l'entrepreneur et les fiches d'inspection conservées. • Dans le cas d'observation d'une fuite dans un des conteneurs, l'entrepreneur devra immédiatement signaler ce déversement à QMM et procéder au nettoyage des lieux.

N°	MATIÈRES DANGEREUSES
	• Les déchets dangereux doivent être entreposés dans des récipients, sauf dans les cas suivants : - Récipients vides contaminés; - Cylindres de gaz; - Matières solides à 20ºC mises en vrac à l'intérieur d'un bâtiment dans une aire aménagée pour recevoir de telles matières; - Objets contaminés qui, en raison de leur dimension, ne peuvent être placés dans un contenant ou un conteneur. Dans un tel cas, ces objets doivent être placés soit dans un bâtiment, soit sous un abri, soit à l'extérieur dans un bassin étanche qui est compatible avec les objets déposés et que l'on doit recouvrir d'une toile imperméable dont les extrémités sont fixées aux rebords du bassin. - Aucun produit ou déchets dangereux ne doit être entreposé dans un récipient ayant servi à l'entreposage de matière qui lui est incompatible, lorsque le récipient n'a pas été préalablement nettoyé. - Huiles usées : collectées dans des barils ou citernes munis d'un bouchon sur le dessus. - Piles et cellules électrochimiques usées : collectées dans des barils à couvercle amovible. Ces matières peuvent être mélangées. - Batteries ou accumulateurs de voiture : déposés sur des palettes à l'intérieur d'un lieu d'entreposage conforme. - Canettes d'aérosol et bonbonnes de propane : collectées dans des barils à couvercle amovible. Ne pas mélanger les canettes d'aérosols avec des bonbonnes de propane ou des gaz de calibration. - Filtres à l'huile, graisse usée, équipements contaminés par ces matières : collectés dans des barils à couvercle amovible. Chaque matière doit être collectée séparément. - Guenilles souillées et absorbants : collectées dans des barils à couvercle amovible. - Matières liquides ou semi liquides (peinture, solvants, antigel, méthanol, acide) : Même principe d'entreposage que pour les huiles usées. Ne pas mélanger ces matières ensembles, les collecter dans des contenants distincts.
5.5.4	**EAUX D'ACCUMULATION** • Les accumulations d'eau dans l'aire d'entreposage des produits dangereux ou non biodégradables doivent être recueillies et séparées des polluants avant rejet ou récupérées et entreposées pour être acheminées vers un lieu autorisé.
5.5.5	**FORMATION** • Les travailleurs doivent avoir reçu une formation adéquate relativement à la gestion des matières dangereuses.
5.5.6	**PLAN D'ACTION EN CAS D'URGENCE**
	• L'entrepreneur doit produire et faire approuver un plan d'urgence à entreprendre en cas de déversements ou d'incendie de déchets dangereux.
	• L'entrepreneur doit conserver sur les lieux les équipements de sécurité nécessaires pour répondre à une urgence environnementale.
	• Le plan doit contenir des informations relatives aux procédures d'urgence en cas d'incendie et les mesures recommandées pour éteindre ces incendies, pour minimiser la propagation de la suie et nettoyer les surfaces contaminées.

5.6 MATIÈRES RÉSIDUELLES

Les matières résiduelles non dangereuses (déchets) comprennent toutes matières non classées dangereuses. Des exemples de déchets solides non dangereux sont le papier-carton, le verre, le plastique, les pneus, la ferraille, le bois, le textile, les encombrants, les résidus organiques (alimentaires, feuilles, herbes), les résidus de construction, etc.

Des bonnes pratiques supplémentaires seront fournies lorsque les détails du site d'élimination de déchets domestiques seront connus.

N°	MATIÈRES RÉSIDUELLES
5.6.1	**GÉNÉRAL** • Application dans la mesure du possible du principe des 3R (réduire, réutiliser et recycler) sur l'ensemble des activités du site afin de réduire les volumes acheminées au site d'enfouissement. • Récolter quotidiennement et trier les différents déchets générés. Si des déchets solides sont potentiellement contaminés, les déchets doivent être traités comme matières dangereuses. • L'entrepreneur ne doit pas mélanger ou diluer des déchets non dangereux à d'autres matières dangereuses. • Interdiction de brûler ou d'enfouir des matières résiduelles sur le site. • L'entrepreneur doit présenter et faire approuver par QMM son plan de gestion des matières résiduelles avant d'amorcer les travaux.
5.6.2	**ENTREPOSAGE** • Placer les amas de matières résiduelles dans une enceinte du chantier ou dans un conteneur et de façon à éviter l'éparpillement par le vent. • Ne pas stocker des matières résiduelles à proximité dune zone sensible ou d'un plan d'eau. • Séparer les matières résiduelles par catégorie et classer celles-ci dans des conteneurs différents (bois, métal, etc.)
5.6.3	**PNEUS HORS D'USAGE** • Entreposer les pneus mis aux rebuts dans un seul et même endroit et éloigner de tout autre matériel combustible. • Interdiction de bruler des pneus sur les sites de construction où ailleurs sur le territoire.
5.6.4	**FERRAILLE** • La ferraille doit être entreposée de façon à ne pas contaminer les eaux de surface et les eaux souterraines. Son entreposage à long terme doit aussi être évité afin de ne pas entraîner de contamination du sol. • Privilégier l'entreposage de la ferraille dans un conteneur pour en faciliter la gestion.
5.6.5	**DÉCHETS DOMESTIQUES** • S'assurer que les déchets domestiques sont collectés et stockés dans des conteneurs fermés avant leur acheminement au site d'enfouissement pour ne pas attirer les animaux sauvages. • Les déchets domestiques doivent être acheminées régulièrement au site d'enfouissement autorisé.

5.7 Bruit et vibrations

5.7.1 Nuisances sonores

Tout exploitant exerçant une activité pouvant générer du bruit doit respecter les critères suivants en fonction du zonage du terrain et du lieu de la prise de mesure. Les limites acceptables pour protéger la santé et la sécurité des travailleurs sont présentées dans le document « programme de santé et sécurité de QMM ».

<table>
<tr><th>N^o</th><th>Nuisances sonores</th></tr>
<tr><td>5.7.1.1</td><td><u>Critères d'émission de bruit</u>
• Généralités :
- Les activités menées par les entrepreneurs doivent respecter les niveaux de bruit suivants auprès des communautés, ou ajouter au plus 3 dB(A) au bruit ambiant actuel
<table>
<tr><th rowspan="2">Secteur</th><th colspan="2">Niveau maximum permis en dB(A)</th></tr>
<tr><th>Jour (7 h – 22 h)</th><th>Nuit (22 h – 7 h)</th></tr>
<tr><td>Zone résidentielle et institutionnelle</td><td>55</td><td>45</td></tr>
<tr><td>Zone industrielle et commerciale</td><td>70</td><td>70</td></tr>
</table>
Lignes directrices énoncées par la Banque Mondiale
- Les bruits à tonalité doivent être inférieurs à 30 % du temps de fonctionnement de l'activité.
• Afin d'atteindre les valeurs guides, l'entrepreneur doit, avant le début des travaux, déposer un plan de contrôle du bruit et faire accepter celui-ci par QMM. Ce plan doit présenter les mesures de mitigation et les pratiques retenues pour minimiser les émissions de bruit pendant les activités.</td></tr>
<tr><td>5.7.1.2</td><td><u>Règles de travail</u>
• Lorsque possible, éviter le travail de nuit près des zones sensibles en optimisant la planification des travaux (réaliser les activités bruyantes le jour).
• Apporter une attention aux alarmes de recul particulièrement la nuit.
• Réduire le bruit de la circulation, notamment par le contrôle de la vitesse.
• Arrêter les équipements quand ils ne sont pas utilisés et éviter de faire tourner les moteurs inutilement. Laisser les capots antibruit fermés quand les équipements fonctionnent.
• Vérifier les caractéristiques du bruit de l'équipement avant son utilisation. Si nécessaire, ajuster un équipement trop bruyant, assurer son bon fonctionnement et son entretien.
• Ne pas produire de bruit inutile ou en réduire l'émission (ex. : réduire la hauteur de chute des matériaux à partir des camions ou du lieu d'exploitation, réduire la distance entre le chargement et le déchargement, utiliser des revêtements caoutchouteux pour amortir les bruits de chute).
• Aménager des structures antibruit additionnelles si nécessaire comme des écrans acoustiques avec les déblais en périphérie des ouvrages.
• Port d'équipement auditif de protection pour les travailleurs qui sont soumis régulièrement à des niveaux de bruit élevé.</td></tr>
</table>

5.7.2 ONDES SISMIQUES – VIBRATIONS

N°	ONDES SISMIQUES ET VIBRATIONS
5.7.2.1	**CRITÈRES** • L'entrepreneur doit déposer un plan de gestion des ondes sismiques et le faire approuver par QMM avant les travaux si ces derniers peuvent avoir un impact non négligeable. • Les ondes sismiques impulsives ou discontinues émanant de l'exploitation de la carrière ne doivent pas excéder 4 cm/seconde lorsqu'elles sont évaluées à moins de 30 mètres de toute construction ou de tout puits artésien.

5.8 URGENCE ENVIRONNEMENTALE

Un plan général d'urgence environnementale, incluant la gestion des déversements de matières dangereuses, devra être fourni par l'entrepreneur et accepté par QMM avant le début des travaux.

N°	URGENCE ENVIRONNEMENTALE
5.8.1	**GÉNÉRAL** • Au début des travaux, l'entrepreneur doit présenter à QMM un plan d'intervention en cas de déversement accidentel de contaminants. L'entrepreneur doit s'assurer que le plan d'intervention contient, au minimum, un schéma d'intervention et une structure d'alerte, et qu'il est placé dans un endroit facile d'accès et à la vue de tous les travailleurs. • L'entrepreneur devra s'assurer que les équipements d'intervention sont suffisants et en bon état de fonctionnement et inspectés régulièrement. • Un surveillant de chantier en environnement de QMM devra faire partie de l'équipe d'intervention.
5.8.2	**FORMATION** • L'entrepreneur doit s'assurer d'avoir une équipe formée sur tous les quarts de travail pour les interventions d'urgence environnementale de déversements accidentels.
5.8.3	**TROUSSE D'INTERVENTION** • L'entrepreneur doit mettre sur le site des travaux une trousse d'intervention. Elle doit contenir des produits adaptés aux particularités du lieu de travail. Le contenu doit être présenté et accepté par QMM. • Une trousse d'urgence pour un déversement autre qu'en milieu marin doit contenir, sans être limité : - 1 baril ou boite contenant le matériel d'intervention en cas de déversement - 10 coussins absorbants en polypropylène de 430 cm^3 de dimension - 200 feuilles absorbantes en polypropylène - 10 boudins absorbants en polypropylène - 2 couvercles en néoprène de 1 m^2 pour couvrir un regard d'égout - 5 sacs de 10 litres de fibre de tourbe traitée pour absorber les hydrocarbures - 10 sacs en polyéthylène de 6 mm d'épaisseur et de 205 litres de grandeur pour déposer les absorbants contaminés • Le matériel d'intervention doit être accessible en tout temps, à proximité des travaux et bien identifié.
5.8.4	**INTERVENTIONS** • L'entrepreneur doit aviser QMM immédiatement de tout déversement de contaminants dans l'environnement, quelle que soit la quantité déversée. • L'entrepreneur doit présenter un bilan mensuel des déversements accidentels ainsi que la quantité et les lieux d'entreposage des sols contaminés ou autres matières contaminées. • L'entrepreneur est tenu de faire réaliser à la fin des travaux sur un chantier des analyses de sols afin de démontrer que le site n'est pas contaminé. Si ce dernier est contaminé il devra prendre les mesures nécessaires pour faire décontaminer les lieux.
5.8.5	**PRINCIPALES ETAPES D'INTERVENTION** • Évaluer la situation, identifier les produits en cause, localiser la source de la fuite et délimiter un périmètre de sécurité • Arrêter ou maîtriser la fuite • Confiner le déversement ou contenir le produit (éviter de diriger le produit vers un réseau d'égouts ou un milieu aquatique) • Aviser QMM et les autorités compétentes • Récupérer les matières déversées pour restreindre la migration ou l'étalement • Excaver et remplacer le sol contaminé, s'il y a lieu • Éliminer en toute sécurité les matières et déchets contaminés • Préparer un rapport d'incident, transmis à QMM et aux autorités compétentes

5.9 SÉCURITÉ PUBLIQUE

N^{O}	EXIGENCES – SÉCURITÉ PUBLIQUE
5.9.1	**GÉNÉRAL** • Les aires de travaux seront circonscrites et sécurisées. • Les équipements de chantiers et camions seront en bon état de fonctionnement. • Les camions se déplaceront en convois sécurisés lorsque possible. • Les routes et toutes les zones où circulera la machinerie lourde seront entretenues. • Les chauffeurs de camions seront formés et sensibilisés aux problématiques de circulation locale. • Les chauffeurs respecteront les limites de vitesse. • La signalisation routière et les limites de vitesse seront adéquates et visibles. • Les sites es chantiers seront gardés en tout temps.

5.10 SANTÉ ET SÉCURITÉ AU TRAVAIL

Les différentes règles de santé et de sécurité pour les entrepreneurs sont décrites dans le document intitulé « Programme de santé et sécurité de QMM » portant le numéro de référence T-SPE-6201, et par conséquent, ne font pas partie de ce présent rapport.

5.11 INSTALLATIONS ET PRODUITS PÉTROLIERS

Par produits pétroliers, on entend l'essence, le diesel, le mazout, les huiles usées issues d'un véhicule à moteur ou d'un équipement hydraulique ainsi que tout mélange d'hydrocarbures utilisés comme carburant ou combustible.

Les mesures suivantes s'appliquent à la manipulation des produits pétroliers. Elles ne couvrent pas les règles de conception ni d'installation des systèmes de stockage. Ceux-ci doivent être réalisés selon les normes d'aménagement internationales avec, si nécessaire, la construction de cuvette de rétention.

N^{O}	INSTALLATIONS ET PRODUITS PÉTROLIERS
5.11.1	**GÉNÉRAL** • Les équipements de chantier et camions-citernes doivent être gardés en bon état de fonctionnement pour éviter des déversements de produits pétroliers. • Un inventaire de tous les produits pétroliers (pétrole, huiles, lubrifiants) présents et stockés sur les chantiers doit être tenu à jour. • Le conducteur de camion-citerne devra effectuer une vérification visuelle quotidienne de son véhicule et remédier sans délai à une fuite ou à un dommage. L'entrepreneur doit consigner toutes les inspections dans un registre. • Interdiction de fumer partout où cela constitue un risque d'incendie ou d'explosion. • Les systèmes de stockage doivent être protégés contre les dommages résultant du trafic routier par des butoirs ou des barricades de béton placées à au moins 1,5 mètre du périmètre de confinement pour empêcher le passage des véhicules.
5.11.2	**CHARGEMENT / DÉCHARGEMENT DE PRODUITS PÉTROLIERS** • Le personnel affecté aux opérations de chargement et de déchargement des produits pétroliers doit être formé et testé en matière de procédures d'urgence et de méthode d'extinction des incendies. En outre, il doit également recevoir une formation sur l'emplacement et le rôle des clapets de l'équipement de protection contre les incendies et des clapets d'urgence. • Le chargement ou le déchargement de toute citerne doit s'effectuer dans une aire spécifique permettant de contenir tout déversement accidentel et où aucune matière incompatible n'est présente à proximité de l'aire. • Un chargement ou un déchargement ne doit jamais être sans surveillance. • Tout réservoir de stockage, sur les chantiers ou aires d'entrepreneur doit faire l'objet d'un jaugeage régulier et les informations conservées et être disponibles sur demande de QMM. • Toutes manipulations et tous ravitaillements de carburant, d'huile ou d'autres produits pétroliers doivent être effectués à plus de 60 mètres d'un plan d'eau et autres éléments sensibles. Dans le cas de matériel stationnaire contenant des hydrocarbures situé à moins de 60 mètres d'un plan d'eau ou autres éléments sensibles, un aménagement doit permettre de contenir tout déversement et être préalablement approuvé par QMM.
5.11.3	**DÉVERSEMENT** • Généralité : - La gestion des déversements de produits pétroliers sera couverte dans le plan d'urgences environnementales avec la mise en place des équipements de protection et de secours nécessaires pour toutes situations d'urgence. • Les sols et matériaux contaminés seront récupérés et disposés dans un lieu autorisé. • Une protection adéquate de toutes les zones du système de stockage susceptibles d'être touchées par un déversement doit être présente. S'assurer également qu'aucune fuite ou déversement n'atteigne un cours d'eau ou un réseau d'eau.
5.11.4	**CONTRÔLE ET SURVEILLANCE DU LIEU D'ENTREPOSAGE** • Les lieux d'entreposage des produits pétroliers au sens large, incluant les hydrocarbures, doivent être aménagés de manière à empêcher toute intrusion. • L'entrepreneur doit mettre en place un plan de sécurité incendie qui doit être approuvé par QMM. Ce plan doit être révisé tous les ans.

N^o	INSTALLATIONS ET PRODUITS PÉTROLIERS
	• L'entrepreneur doit utiliser dans le lieu où sont entreposées des matières inflammables soit un système permettant de détecter automatiquement les gaz inflammables ou une alarme qui se déclenche automatiquement lors de l'arrêt du système de ventilation. • L'entrepreneur doit mettre sous surveillance le lieu d'entreposage; dans le cas contraire, il doit relier tout système de détection d'incendie ou d'intrusion à un poste extérieur de contrôle d'alarme grâce à un équipement de transmission d'alarme. • Les systèmes de détection d'incendie et les systèmes de détection d'intrusion doivent être installés et entretenus au moins une fois par année et les preuves de ce suivi doivent être conservées sur le lieu d'entreposage. • Tout système de détection d'incendie doit comprendre un avertisseur d'incendie.
5.11.5	**SIGNALISATION** • Les signalisations appropriées seront requises sur les équipements de transport et sur tous les sites de manutention et d'entreposage de matières inflammables.

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PROJET ILMÉNITE

PLAN DE GESTION ENVIRONNEMENTALE SECTORIEL

PORT D'EHOALA – PHASE CONSTRUCTION

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Déposé par QIT Madagascar Minerals S.A. (QMM S.A.) auprès de
l'Office national pour l'environnement de Madagascar
Mai 2006

ANNEXE 1

MÉTHODOLOGIE D'ÉVALUATION DES IMPACTS

1 L'évaluation des impacts

Le projet d'exploitation de l'ilménite, dans la région de Fort-Dauphin, nécessite la mise en place de plusieurs ouvrages (port, routes, drague et séparateur flottant, usine de séparation des minéraux, centrale électrique, carrières, campement ouvrier, etc.). Aussi, la réalisation de l'étude d'impacts doit prendre en compte tous les éléments du milieu social et biophysique susceptibles d'être affectés par les différentes composantes du projet.

L'analyse du projet comporte quatre grandes étapes, soit :

- Détermination des sources d'impacts associées aux différents ouvrages, selon les phases de réalisation (préparation, construction, exploitation et fermeture), et détermination des interrelations entre les sources et les éléments du milieu social et environnemental;
- Évaluation de l'importance des impacts (positifs ou négatifs) de chacun des ouvrages sur les éléments du milieu, en fonction des interrelations définies;
- Détermination des mesures d'atténuation qui auront pour objectif d'éliminer ou de minimiser les impacts négatifs ou de bonifier les retombées positives du projet sur un élément du milieu;
- Évaluation de l'importance des impacts résiduels des différentes sources d'impact sur un élément du milieu social ou environnemental. À cette étape seront présentées certaines mesures de compensation des impacts. Lorsque ces mesures ne pourront être déterminées immédiatement, ce sont les principes d'élaboration et les procédures d'application qui seront présentées.

Les lignes qui suivent présentent les définitions utilisées pour décrire les impacts, ainsi que la démarche méthodologique détaillée.

1.1 Évaluation de l'importance des impacts

La méthode utilisée consiste à déterminer, par la combinaison des critères d'intensité, de portée et de durée, l'importance de l'impact sur les milieux social et biophysique. Le texte qui suit décrit chacun des critères utilisés pour déterminer les impacts.

1.1.1 Les critères

1.1.1.1 L'intensité

L'intensité du changement généré par une source d'impact varie de forte à faible, selon le degré de modification de l'élément du milieu social ou environnemental étudié. Pour définir l'intensité, on a recours aux critères suivants :

- **Changement de forte intensité** : *La source d'impact affecte de façon importante un élément du milieu, en modifie l'intégrité, ou en diminue (ou augmente) fortement l'utilisation, le caractère particulier ou la qualité (ex. perte d'un habitat faunique essentiel, disparition d'une population végétale ou animale classée, perte d'une ressource utilisée pour une activité économique, sociale ou culturelle). La source d'impact améliore grandement l'élément ou en augmente fortement la qualité ou l'utilisation;*

- **Changement d'intensité moyenne** : *La source d'impact modifie le caractère particulier ou la qualité d'un élément et en restreint l'utilisation (ex. perte ou modification d'une portion d'un habitat, d'une ressource ou d'une activité), sans en modifier de façon importante l'intégrité ou l'utilisation d'une façon importante. La source d'impact améliore ou augmente légèrement la qualité ou l'utilisation de l'élément;*

- **Changement de faible intensité** : *La source d'impact modifie de façon limitée un élément du milieu, ou en diminue (ou augmente) légèrement l'utilisation, le caractère particulier ou la qualité (ex. perte ou modification d'une portion négligeable d'un habitat, d'une ressource ou d'une activité). La source d'impact améliore ou augmente de façon limitée la qualité ou l'utilisation de l'élément.*

1.1.1.2 La portée

Cet indicateur mesure une superficie ou une proportion de population. Il correspond au rayonnement spatial du changement ou au nombre d'individus susceptibles de percevoir ce changement dans la zone d'étude.

On a recours, pour définir la portée, aux critères suivants :

- **Portée régionale** : *La source d'impact modifie une portion importante ou la totalité d'un élément du milieu dans la zone d'étude principale (ZEP) ou la région de l'Anosy. L'élément affecté est utilisé, ou les effets du changement sur celui-ci peuvent être perçus par l'ensemble de la population humaine ou animale de la ZEP ou de la région de l'Anosy;*

- **Portée locale** : *La source d'impact modifie une portion de l'élément du milieu située dans le secteur des travaux et dans des espaces immédiatement adjacents. L'élément affecté est utilisé, ou les effets du changement sur celui-ci peuvent être perçus par la collectivité de quelques villages ou hameaux, ou par une population animale située dans l'aire circonscrite par le secteur des travaux ou dans des espaces immédiatement adjacents;*

- **Portée ponctuelle** : *La source d'impact modifie une portion de l'élément du milieu située dans le secteur des travaux. L'élément affecté est utilisé, ou les effets du changement sur celui-ci peuvent être perçus par une petite portion de la collectivité de quelques villages ou hameaux ou une portion d'une population animale située dans l'aire circonscrite par le secteur des travaux.*

1.1.1.3 La durée

Pendant la mise en place des différentes infrastructures, la nature des changements variera en fonction des phases de réalisation de différentes activités. Ces périodes se distinguent par leur durée et par la nature des changements qu'elles peuvent induire. Ainsi, la durée du changement renvoie à l'évaluation de la période pendant laquelle l'effet d'une activité d'une composante du projet se fera sentir.

On distingue quatre phases qui seront caractérisées par des modifications du milieu social et environnemental, soit :

- La phase de préparation qui regroupe les activités nécessaires à la mise en place des infrastructures nécessaires à l'exploitation de la mine (environ 15 ans);

- La phase de la construction, qui comprend l'ensemble des activités nécessaires à la mise en place des composantes du projet (environ trois ans);

- La phase de l'exploitation des infrastructures, qui regroupe les activités permettant l'exploitation de l'ilménite et du zircon (environ 25 ans);

- La phase de la fermeture, qui regroupe les activités nécessaires à la restauration, au nettoyage, à la démobilisation de la machinerie, à la démolition, et à la rétrocession d'une infrastructure ou d'un site exploité).

On répartira en trois classes la durée de l'impact :

- **Longue durée** : *La longue durée s'applique à un impact dont l'effet est ressenti de façon continue ou de façon intermittente, mais régulière, pendant toute la vie des infrastructures et même au-delà (plus de 25 ans); on considère également les effets comme irréversibles;*

- **Durée moyenne** : *La durée moyenne s'applique à un impact dont l'effet est ressenti de façon continue ou intermittente, mais régulière, pendant une période inférieure à la durée de vie des infrastructures, soit quelques années (3 à 25 ans);*

- **Courte durée** : *La courte durée s'applique à un impact dont l'effet est ressenti sur une période de temps limitée, correspondant généralement à la période de construction des infrastructures ou d'exploitation d'une aire de dragage (1 à 36 mois), ou à une période inférieure (quelques jours) à celle-ci.*

1.1.2 L'importance de l'impact

Pour déterminer l'importance du changement sur le milieu social et biophysique, les résultats de l'analyse des indicateurs décrits ci-dessus ont été intégrés dans une grille d'évaluation (voir à la fin de l'annexe). Cette grille permet toutes les combinaisons possibles d'indices pouvant être accordés aux trois critères d'intensité, de portée et de durée. Selon Fecteau (1997), les classes de chaque critère doivent correspondent aux niveaux d'importance du changement et doivent être considérés comme équivalentes l'une de l'autre, ou d'un même niveau de " gravité ". Les différents critères sont ainsi mesurés sur une échelle commune, ce qui facilite leur agrégation. Cela permet également d'accorder le même poids à chacun des critères déterminant l'importance de l'impact.

L'évaluation de l'importance de l'impact est fonction de la combinaison des différents indicateurs définis ci-dessus, la corrélation établie entre chacun des indicateurs permettant d'établir la classification suivante :

- **Impact d'importance majeure** : *Un impact d'importance majeure signifie que l'intégrité de la nature d'un élément et son utilisation sont modifiées de façon importante; l'impact met en danger la vie d'individus ou la survie d'une espèce animale ou végétale;*

- **Impact d'importance moyenne** : *Un impact d'importance moyenne signifie que l'intégrité de la nature d'un élément et son utilisation sont modifiées partiellement; l'impact ne met pas en danger la vie d'individus ou la survie d'une espèce animale ou végétale;*

- **Impact d'importance mineure** : *Un impact d'importance mineure signifie que l'intégrité de la nature d'un élément et son utilisation sont modifiées légèrement.*

1.2 Élaboration des mesures d'atténuation

L'application de mesures dites d'atténuation a pour objectif d'éliminer ou de minimiser les impacts négatifs, et de bonifier les retombées positives des activités ou des ouvrages du projet sur le milieu social et biophysique. Dans certains cas où la situation ne peut être corrigée ou améliorée, certaines actions du projet permettront d'améliorer les conditions environnementales dans un milieu donné. On parlera alors de mesures de valorisation, et ces mesures ne seront pas nécessairement appliquées dans la zone perturbée.

Le classement des mesures est le suivant :

- **Les mesures d'atténuation** : *Les mesures d'atténuation sont utilisées pour éliminer la source d'impact ou en réduire l'intensité, afin que les répercussions soient acceptables sur les plans social et environnemental. Ces mesures seront appliquées dans l'aire immédiate des zones perturbées ou dans les secteurs qui subiront directement les effets des changements induits par les travaux;*

- **Les mesures de valorisation** : *Les mesures de valorisation sont utilisées pour améliorer les conditions sociales ou environnementales existantes qui ne sont pas directement affectées par le projet. De telles mesures peuvent être implantées en dehors de la zone des travaux..*

1.2.1 Détermination des objectifs relatifs au choix des mesures d'atténuation et de valorisation

Les mesures proposées ont été définies à la suite de la détermination des répercussions potentielles du projet. Elles ont été élaborées en tenant compte d'objectifs à atteindre.

Les principaux objectifs retenus pour l'élaboration de mesures relatives aux répercussions potentielles sur un élément du milieu social et environnemental sont :

Objectifs généraux
Respecter les lois, directives, normes et règlements du gouvernement malgache Répondre aux grands principes du développement durable Respecter les normes de bonnes pratiques de l'industrie minière Répondre aux objectifs de la politique environnementale de Rio Tinto Atténuer les impacts négatifs et valoriser les aspects positifs

Les composantes du milieu	**Les objectifs spécifiques des mesures**
Le milieu social	
L'occupation du territoire	Réduire les conflits d'utilisation Minimiser les expropriations
Santé et sécurité	Minimiser les émissions atmosphériques Favoriser un environnement sonore acceptable dans les environs des zones de travaux; Viser l'élimination totale de la contaminantion par les minéraux radioactifs Rendre sécuritaires les aires de travaux Rendre sécuritaire la circulation piétonnière Favoriser le maintien de l'eau potable en quantité et en qualité

Les composantes du milieu	Les objectifs spécifiques des mesures
La culture	Préserver les sites sacrés et les sépultures Minimiser les conflits culturels Favoriser la protection du patrimoine historique Favoriser le maintien des activités traditionnelles Minimiser les impacts sur le paysage Favoriser la valorisation des ressources des forêts et des marécages dans la zone d'exploitation
Les activités économiques	Favoriser le développement économique de la région Minimiser les impacts sur les activités agricoles Minimiser les impacts sur les activités récréatives et touristiques
Le milieu physique	
L'air	Minimiser les émissions de poussières Minimiser les impacts sur l'environnement sonore dans la région des travaux et de l'exploitation
L'eau	Favoriser le maintien de la quantité et l'amélioration de la qualité de la ressource Ne pas contaminer les eaux
Les sols	Ne pas contaminer les sols
Le milieu biologique	
La flore	Restaurer les milieux perturbés Appuyer la conservation d'une certaine superficie (x ha) de forêt littorale
La faune	Favoriser la restauration des habitats perturbés dans l'aire des travaux

1.3 Évaluation des impacts résiduels

Les impacts résiduels sont ce qu'il reste des impacts après l'application du processus décrit ci-dessus. L'évaluation des impacts résiduels est donc fonction de l'importance de l'impact et des mesures d'atténuation proposées pour minimiser ou corriger l'impact.

On peut classer les impacts résiduels de la manière suivante :

- **L'impact résiduel fort** : *Les caractéristiques d'un impact d'importance majeure demeurent. Aucune mesure d'atténuation n'est applicable;*

- **L'impact résiduel moyen** : *Les caractéristiques d'un impact d'importance moyenne demeurent, même après l'application de mesures d'atténuation. Un impact d'importance majeure devient moyen après l'application de mesures d'atténuation;*

- **L'impact résiduel faible** : *Les caractéristiques d'un impact de faible importance demeurent, même après l'application de mesures d'atténuation. Les caractéristiques d'un impact d'importance moyenne sont atténuées par l'application de mesures d'atténuation;*

- **L'impact résiduel nul** : *Les mesures d'atténuation neutralisent ou éliminent complètement l'impact.*

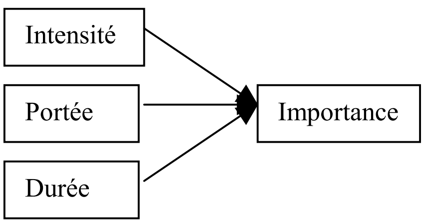
Enfin, des mesures sont proposées pour compenser les répercussions sur un élément social ou environnemental qui ne peuvent être atténuées ou lorsque l'impact résiduel demeure important.

Ces mesures peuvent se définir ainsi :

- **Mesures de compensation** : *Les mesures de compensation sont proposées pour compenser les incidences sur le milieu social et environnemental qui ne peuvent être atténuées ou qui ne le sont que partiellement. Les mesures de compensation peuvent être, par exemple, une aide pour la construction d'une infrastructure, d'aménagements physiques ou autres, etc.*

Grille d’évaluation de l’importance des impacts sur le milieu social et environnemental

Critères			**Importance absolue**
Intensité	***Portée***	***Durée***	**Importance**
Forte	Régionale (ZEP)	Longue	Majeure
		Moyenne	Majeure
		Courte	Majeure
	Locale	Longue	Majeure
		Moyenne	Moyenne
		Courte	Moyenne
	Ponctuelle	Longue	Majeure
		Moyenne	Moyenne
		Courte	Mineure
Moyenne	Régionale (ZEP)	Longue	Majeure
		Moyenne	Moyenne
		Courte	Moyenne
	Locale	Longue	Moyenne
		Moyenne	Moyenne
		Courte	Moyenne
	Ponctuelle	Longue	Moyenne
		Moyenne	Moyenne
		Courte	Mineure
Faible	Régionale (ZEP)	Longue	Majeure
		Moyenne	Moyenne
		Courte	Mineure
	Locale	Longue	Moyenne
		Moyenne	Moyenne
		Courte	Mineure
	Ponctuelle	Longue	Mineure
		Moyenne	Mineure
		Courte	Mineure



ANNEXE 2

SAFETY, HEALTH AND ENVIRONMENTAL MANAGEMENT, DIVISION 01 – GENERAL REQUIREMENTS, SECTION 01525, INTEGRATED GROWTH POLES PROJECT H320555-C003A-E, PORT OF EHOALA PROJECT, MARCH 20, 2006

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DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01525

SAFETY, HEALTH AND ENVIRONMENTAL MANAGEMENT

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SECTION 01525

SAFETY, HEALTH AND ENVIRONMENTAL MANAGEMENT

PART 1 GENERAL

1.1 SCOPE

This Section covers the requirements of a Safety Health and Environmental Management Plan that the Contractor shall apply during the entire construction period, beginning on the Date of Commencement.

1.1.1 Leadership and Commitment

The Contractor acknowledges the Employer's strong commitment to Environment, Health and Safety ("SHE") and the Contractor affirms that it has a written SHE management policy that has been signed and is actively supported and endorsed by the Contractor's management. The Contractor represents that its written policy is widely disseminated and understood among its employees, its policy is printed in English as well as such other local languages as are required and its written policy includes a description of the Contractor's organization, procedures and methods of communication to and from personnel. The Contractor shall provide copies of its policy and policy statement to the Employer with its bid submission.

1.2 REFERENCES

- Applicable Madagascar laws pertaining to Safety, Health and the Environment
- Rio Tinto Standards for Safety, Health and Environmental
- Pre-task Hazard Assessment
- Engineering Manual 385 – Safety and Health Requirements
  US Army Corps of Engineers
  Nov 3, 2003
  http://www.usace.army.mil

The Contractor acknowledges that the Employer has provided it with a copy of the Employer's Environmental Health and Safety Policy and Standards. The Contractor shall also download a copy of the EM 385 as referred to on the Attachments listed at the end of this section. Applicable EM 385 requirements shall relate to all marine construction activities and those land based construction activities near or at the waterline. The Contractor warrants that it shall comply with the requirements of this Section, the Employer's Policy and Standards, and the EM 385 in carrying out the construction of the Works.

1.3 LEGAL REQUIREMENTS AND REGULATIONS FOR SHE

The Contractor warrants that it is familiar with the contents and implications of all applicable SHE laws, regulations, codes of practice, guidelines and standards applicable to the services to be provided including, but not limited to, those set out in the sections below and the SHE Rules.

The Contractor shall ensure that its personnel and its Sub-Contractor's personnel have been informed of all such laws, regulations, codes of practice, guidelines and standards.

The Contractor shall comply and shall ensure that its personnel and its Sub-Contractor's personnel comply with all applicable SHE laws, regulations, codes of practice, guidelines and standards (whether international, national, regional or local) and shall take all necessary SHE precautions related to or arising out of the performance of this Contract in order to protect the Work, as well as the personnel and property of the Employer, the Contractor and all third parties.

The Contractor further agrees that in the event that any of its personnel or any Sub-Contractor's personnel violates any SHE requirement, such violation shall be corrected promptly, steps shall be taken to avoid recurrence, and any person or persons responsible for the violation shall be removed from the site upon the Employer's direction.

1.3.1 Contractor's General Requirements for SHE

The Contractor shall be fully responsible for the safety of all persons employed by it or its Sub-Contractors or any other person on the Site for any purpose relating to the Contractor carrying out its obligations under this Contract.

The Contractor shall initiate and maintain safety precautions and programs to conform with all applicable health and safety laws or other requirements, including requirements of any applicable Governmental Instrumentality wherever the Work is performed, that are designed to prevent injury to persons or damage to property on, about, or adjacent to the Site. The Contractor shall, at its own cost and risk, during the duration of and for the purposes of this Contract:

- Erect and maintain safeguards for the protection of workers and the public.
- Eliminate or abate all reasonably foreseeable safety hazards created by or otherwise resulting from performance of the Work.
- Provide all things and take all measures necessary for maintaining proper personal hygiene, ensuring safety of persons and property and protecting the environment at or near the Site;
- Avoid unnecessary interference with the passage of people and property at or near the Site;
- Prevent nuisance and excessive noises and unreasonable disturbances in performing the construction of the Work;
- Be responsible for construction of the Works the stability and safety of all its site operations, irrespective of any acceptance of approvals from the Employer or any Government Body.
-

1.3.2 SHE Pre-Start Meeting

The Contractor shall, prior to Work commencing, participate in a Pre-Start SHE review with the Employer. The purpose of this review shall be to compare the contents of the Contractor's SHE Management Plan and the Employer SHE Management Plan to facilitate a consistent approach to SHE issues.

The Contractor's CEO or equivalent shall attend the above meeting. The meeting that shall be conducted prior to the Contractor commencing activities on the site.

The Contractor shall not commence work activities until written approval is obtained from the Employer accepting the Contractor's SHE Management Plan.

1.3.3 Permits and Authorizations

The Contractor shall obtain all needed permits or licenses related to Safety, Health and Environmental. The Contractor shall be responsible for implementing the terms and requirements of the appropriate permits as needed and for payment of all fees.

In addition to the above, the Contractor shall comply with all requirements under the terms and conditions set out in the following permit(s) and authorization(s) obtained by the Employer listed below. These permit(s) and authorization(s) are available for review by contacting the Employer.

1.4 SUBMITTALS

The following shall be submitted in accordance with the provisions of this Section and Section 01330.

1.4.1 Contractor's SHE Management Plan

The Contractor shall prepare a Contractor's SHE Management Plan and submit it to the Employer for review within 30 days of the Commencement Date. The SHE Management Plan must comply with this Contract, and applicable law relating to the environment and workplace, health and safety.

The contents of the Contractor's SHE Management Plan should address the elements listed below as applicable:

1.4.1.1 Management Commitment and Involvement

- Contractor's SHE Policy;
- Project SHE consultative processes;
- Contractor senior management involvement with the Employer's staff in consultative processes;
- Visible and Proactive SHE Leadership by Contractor's senior personnel;
- Assignment of safety responsibilities to different roles within the organization;
- Identification of role of Safety Adviser, if applicable;
- Project SHE goals;
- Proposals for team building between Contractor and the Employer to meet project goals;
- Legislative compliance;
- Contractor's senior management project reviews

1.4.1.2 Audits and Inspections

- Proposed project SHE performance measures, both proactive and reactive;
- SHE system audits;
- Unsafe act auditing;
- Daily site SHE inspections;
- Nomination of personnel to carry out safety inspections;
- Audit schedule to ensure compliance with the SHE Management plan;
- Record keeping, including details of what is kept and for how long;

1.4.1.3 Awareness and Communication

- Safety awareness promotions;
- Introduction of Behaviour Based Safety
- Minuted toolbox meetings – frequency and content;
- SHE communications and meetings;
- SHE committee;
- Personal improvement and discipline;
- Assessment of Sub-Contractor’s, including requirements for safety plans;
- Control of service Contractor’s;
- Liaising with other Contractors on-site;

1.4.1.4 Training

- Project SHE training needs assessment;
- Competency assessments for designated skills;
- Work activity training:
- Inductions;
- Supervisor training, especially newly promoted supervisors;
- Evaluation of the effectiveness of training;

1.4.1.5 Risk Assessment

- Workplace hazard management;
- Identification of job specific hazards – Risk Assessments, Pre Hazard Task assessments;
- Work Method Statements;
- Hold points for hazard studies in design, if applicable;
- Hazard elimination programs;
- Construction Safety Studies;

1.4.1.6 Hazardous Materials

- Hazardous materials management;
- Storage and transportation of fuels, oils and other hazardous materials;

1.4.1.7 Occupational Health and First Aid

- Occupational Health and Hygiene including provision for monitoring employee exposures to chemicals, noise, dust, etc;
- Hygiene and workplace facilities;
- First aid and First Aid Facilities;
- Procedure for first-care treatment in case of injury;
- Rehabilitation procedures which encourage an early return to work;

1.4.1.8 Accident and Incident Reporting

- Accident/incident reporting, recording, investigation and analysis which ensures that corrective action is taken and this action is communicated to report initiators;

1.4.1.9 PPE

- Personal Protective Equipment

1.4.1.10 Emergency Response

- Emergency preparedness and response including - planning, training and drills;

1.4.1.11 Inspection of Plant and Equipment

- Inspection of plant, tools and equipment prior to introduction to site and regularly thereafter;

1.4.1.12 Environment

- Environmental considerations, including but not limited to - Waste Management, Operational Impact, Legislative compliance;
- SHE Records; and
- Site Specific SHE Handbook.

1.4.1.13 Specific Policies Mandated by the Employer

The Contractor must include in his SHE Management Plan specific policies covering the following:

- Fitness for Work;
- Working with electrical equipment;
- Isolation of energy sources;
- Vehicles and Driving;
- Working at heights;
- Work in confined spaces;
- Cranes and Lifting;
- Diving;
- Floating plant and marine activities;
- Blasting;
- Working near airports.

1.4.1.14 Disciplinary Code

The Contractor must include in his SHE Management Plan details of its Disciplinary Code, which as a minimum must align with the Employer's Disciplinary code and Employee Relations Policy.

1.4.2 Contractor's SHE Management Handbook

The Contractor shall develop an SHE Management Handbook that will summarize the requirements of the Contractor's SHE Management Plan. The document shall be in a hard copy format that can be issued to all Contractor office and field staff and labourers at inductions and prior to them commencing work on site, and shall be maintained for reference by these employees. The Employer shall review the format and contents of the Handbook prior to its issue.

The Contractor shall ensure that each employee acknowledges receipt of the Contractor's SHE Management Handbook by way of signature. The Contractor shall be responsible for producing these records at the time of audits.

1.4.3 Contractor's Safety Management Plan

The Contractor shall provide both electronic and hard copies of its Project Specific Safety Management Plan, including safety manuals, policies and procedures to the Employer. The Contractor shall forward to the Employer any updates or revisions to its safety manuals, policies or procedures in both electronic and hard copy formats.

1.4.4 Safety Statistics

The Contractor shall complete and submit a Contractor Monthly Safety Performance Report as shown in Attachment A, or as amended by the Employer, within two working days of the end of each month, covering the Contractor and each of the Contractor's Sub-Contractor's.

1.4.5 Safety Management Records

The Contractor shall submit to the Employer for review a schedule of the specific records he intends to maintain for the Contract. As a minimum records shall be retained by the Contractor as specified by local legislation. Copies of such records shall be provided to the Employer if requested.

1.4.6 Traffic Management Plan

The Contractor shall prepare at a traffic management plan that is a sub-set of the Site Plan as described in Section 01500. The traffic management plan shall include a drawing(s) and a comprehensive written document that describes:

a. routes of material supply to the sites

b. locations of crossings with existing vehicle routes and foot paths

c. traffic control devices, such as gates, crossing guards, flagmen, signage, and underpasses

d. expected frequency of traffic and maximum speeds

e. modifications to the existing haul road, if any

The Contractor shall be responsible for the repair of any damage to roads caused by construction operations.

The Contractor shall erect and maintain temporary barricades to limit public access to hazardous areas. Such barricades shall be required whenever safe public access to areas such as roads, walking paths or parking areas is prevented by construction activities or as otherwise necessary to ensure the safety of both pedestrian and vehicular traffic. Barricades shall be securely placed, clearly visible with adequate illumination to provide sufficient visual warning of the hazard during both day and night. Flagmen shall be deployed by the Contractor to maintain the operation of the barricades.

1.4.7 Environmental Protection Plan

Within 60 calendar days after the Date of Commencement, and prior to the start of construction, the Contractor shall submit an Environmental Protection Plan for review and acceptance by the Employer, and an electronic copy shall be submitted on site for distribution. The EPP will be based in part on the Sectoral Environmental Protection Plan for the port (Plan de Gestion Environmental Sectoriel – Port de Éhoala). The Employer will consider an interim plan for the first 30 days of operations. However, the Contractor shall furnish an acceptable final plan no later than 30 calendar days after receipt of Date of Commencement. Acceptance of the Contractor’s plan shall not relieve the Contractor of his responsibility for adequate and continuing control of pollutants and other environmental protection measures. Acceptance of the plan is conditional and predicated on satisfactory performance during construction. Environmental surveillance will be performed by the client with the objective of making sure all commitments to the state or to the lending agencies are being carried out. The Employer reserves the right to require the Contractor to make changes to the Environmental Protection Plan or operations if the Employer determines that environmental protection requirements are not being met. No physical work at the site shall begin prior to acceptance of the Contractor’s plan or an interim plan covering the work to be performed. The Environmental Protection Plan shall include but not be limited to the following:

a. A list of laws, regulations, and permits concerning environmental protection, pollution control, and abatement that are applicable to the Contractor’s proposed operations and the requirements imposed by those laws, regulations, permits or conditions of the lending agency.

b. Methods for protection of features to be preserved within authorized work areas. The Contractor shall prepare a listing of methods to protect resources needing protection, i.e., trees, shrubs, vines, grasses and ground cover, landscape features including sensitive sand dunes, air and water quality, fish and wildlife, soil, historical, archeological, and cultural resources. The Contractor will also respect commitments of the Employer with regarding local land use (fishing activities, recreational activities etc).

c. Procedures to be implemented to provide the required environmental protection and to comply with the applicable laws and regulations. The Contractor shall provide written assurance that immediate corrective action will be taken to correct pollution of the environment due to accident, natural causes, or failure to follow the procedures set out in accordance with the environmental protection plan.

d. A permit or license for the location of the solid waste disposal area.

e. Drawings showing locations of any proposed temporary excavations or embankments for haul roads, stream crossing, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials.

f. Environmental monitoring plans for the job site, including land, wildlife (marine mammals), water, air, and noise monitoring.

g. Methods of protecting surface and ground water during construction activities.

h. Spill prevention. The Contractor shall specify all potentially hazardous substances to be used on the job site and intended actions to prevent accidental or intentional introduction of such materials into the air, ground, water, wetlands, or drainage areas. The plan shall specify the Contractor’s provisions to be taken to meet laws and regulations regarding labeling, storage, removal, transport, and disposal of potentially hazardous substances. The Spill prevention plan will be in accordance with the Employer requirements.

i. Spill contingency plan for hazardous, toxic, or petroleum material. This should include information on applicable regulations, containment/recovery/cleaning measures, transportation of dangerous goods, organizational chart of spill control, human and physical resources for implementing the plan, notification of the Employer and of the authorities, waste treatment and disposal.

j. Work area plan showing the proposed activity in each portion of the area and identifying the areas of limited use or nonuse. Plan should include measures for marking the limits of use areas.

k. Plan of borrow quarry area(s).

l. Recycling and Waste Management Plan. No vegetation should be burned or buried. Mulching, composting, and other uses for vegetation should be considered and coordinated locally. Recycling and waste minimization efforts shall also be incorporated into this plan.

m. A Certification Letter must be signed acknowledging the Contractor has a copy of all permits applicable to the project and understands the conditions in the permit. The Certification Letter shall be attached to the Environmental Protection Plan. The letter must also acknowledge that the Contractor is aware of commitments of the Employer with the lending agency regarding environmental protection and will implement associated measures.

n. Construction activities shall be conducted in a manner as to not impact migratory birds or affect their nesting.

1.4.8 Airport Safety Plan

Submit plans to the airport operator on how to comply with the safety requirements of the project also ref Section 01354.

1.5 MEASUREMENT AND PAYMENT

There will be no measurement for the Work described in this Section. The Work shall be incidental to the cost of Mobilization as described in Section 01270.

PART 2 PRODUCTS

(Not Used)

PART 3 EXECUTION

3.1 SAFETY

3.1.1 Adherence to Contractor’s Safety Management Plan

The Contractor shall ensure that its personnel shall, at all times, strictly observe and comply with the procedures set out in the Contractor’s Safety Management Plan as well as safety procedures requested by the Employer from time to time, applying to the area of operations.

The Employer shall require the Contractor, from time to time, to supplement its safety manual, policies and procedures with guidelines and/or operating standards provided to the Contractor by the Employer. The Contractor shall comply with such request. The Contractor shall give prompt, written notice to the Employer of any objection to the Contractor to the requested supplement, including the reasons for objection. The Employer’s rights under this Clause are not intended, and shall not be construed, to relieve the Contractor from any obligations to ensure compliance with all provisions of this Contract.

3.1.2 Audit by the Employer

The Employer shall have the right to conduct audits/inspections of the Contractor’s Safety Management Plan implementation, operations, equipment, emergency procedures, etc at any time, and the Contractor shall fully cooperate with the Employer during such audits/inspections. The Employer’s rights under this clause shall not relieve the Contractor of its own obligations to conduct audits and reviews of its own Health and Safety performance.

Where such audits/inspections reveal deficiencies in the Contractor’s procedures, drills, training or equipment, or non-conformities with the Contractor’s accepted project Safety Management Plan, of a minor nature (Risk Rating of 6 or less), the Contractor shall investigate the cause of the nonconformity and initiate corrective and preventive action to rectify such deficiencies and non-conformities and prevent recurrence as soon as practicable.

Where such audits/inspections reveal deficiencies of a major nature (Risk rating of 7 or greater), the Contractor shall stop work on the operation/activity concerned, immediately investigate the cause of the nonconformity, and initiate corrective actions to rectify such deficiencies and non-conformities and to prevent recurrence. These corrective action plans shall be submitted to the Employer for review and comment within 24 hours of the audit finding.

Where such deficiencies include an unsafe practice or a breach of the statutory or the Contract's requirements, the Employer may in accordance with the General Conditions of Contract suspend the work associated with the unsafe practice or breach until the deficiency is rectified.

The Employer will establish a schedule of regular field safety audits, which will be based on an audit tool aligned to the Contractor's Safety Management Plan and site operations and activities. The Contractor's audit conformance will be assessed as a percentage and where conformance is better than 90% it will be considered satisfactory and the Contractor shall develop and implement an action plan within 4 weeks, to be reviewed at the next regular audit. Where the Contractor's level of conformance is between 75 – 90 %, a corrective action plan will be required to be developed and implemented within 2 weeks, and a follow up audit will be carried out. Where the Contractor's conformance is less than 75% the Contractor shall stop work until an investigation of the cause/s has been completed and corrective actions have been developed and implemented by the Contractor.

The Contractor shall provide to the Employer, at a time to be agreed, a regular status report on all outstanding corrective actions until they are successfully closed out.

3.1.3 Unsafe Act/Condition Auditing

The Contractor shall implement a system to recognize, correct, and report unsafe acts/conditions associated with all Contractor activities.

3.2 INVOLVEMENT, COMMUNICATION AND MOTIVATION

The Contractor's and Sub-Contractor's workforce shall, through their supervision, safety notice boards, toolbox meetings and daily pre-start meetings be kept aware of all safety related matters.

3.2.1 Safety Meetings

Contractor shall hold regular safety meetings on site such that all Contractor's and Sub-Contractor's personnel attend such meetings on a regular basis. Copies of minutes and action items arising from such meetings shall be submitted or otherwise made available for review by the Employer.

3.2.2 Safety Review Meetings

A Contractor's Representative shall take part in periodic safety review meetings between the Contractor and the Employer, as may be required by the Employer, which shall be held at least monthly or more frequently, if required by the Employer.

The Contractor shall attend all project safety meeting/s as outlined in the Project Safety Management Plan.

3.2.3 Pre-start Safety Briefings

The Contractor shall hold job start safety briefings with each work team before the start of each shift. Attendance records and brief topic notes shall be kept for auditing and record purposes.

3.2.4 Health & Safety Representative

The Contractor shall ensure that sufficient elected and/or appointed Health and Safety representative/s represent all workers employed by the Contractor. Each Health and Safety Representative shall be required to attend an accredited Health and Safety Representatives training course, at the expense of the Contractor, in accordance with the provisions of the applicable legislative requirements.

The Contractor shall ensure that Health and Safety Representatives execute their functions as under the provisions of applicable legislation.

An appropriate sticker is to be issued by the Contractor and affixed to the helmet to identify each Health and Safety Representative.

3.2.5 Traffic Safety Officer

The Contractor shall provide a dedicated Traffic Safety Officer (TSO). The TSO shall be employed on a full-time basis throughout the duration of the Contract, and his duties shall relate solely to the establishment, maintenance, management, and implementation of a traffic management plan. He shall have a minimum of one assistant provided by the Contractor, as required, or as directed by the Engineer.

The TSO shall liaise daily with the Engineer in order to maintain proper traffic arrangements.

The TSO will be required to perform the following duties and this list shall not be deemed to be comprehensive. He shall:

a. Be responsible for keeping the traffic management plan in compliance 24 hours a day, 7 days a week.

b. Compile and maintain a complete daily record of traffic signs installed and the traffic signs sequence at each location during the duration of the Contract.

c. Inspect and report to the Engineer on the state of all required road signs as often as the Engineer may require, but in any event not less than once a day or at such other intervals as may be specified.

d. Exercise control in terms of traffic safety over the safe movement of personnel, visitors, and plant on site including the wearing of high visibility clothing, the operation of amber flicker lights, and the display and cleanliness of “construction vehicle” signs, all as specified.

e. Be responsible for keeping all road signs and traffic cones clean and visible at all times. The Contractor shall remove all bituminous and other foreign matter from road signs and traffic cones or provide new road signs and traffic cones all at the Contractor’s own cost, and all as directed by and to the satisfaction of the Engineer.

f. Compile complete records of traffic accident scenes, which are in any way connected with construction activities, and draw up accident reports (including amongst other photographs).

g. Attend to the training and performance of flagmen and all other personnel involved in the control of traffic.

h. Attend to all complaints and claims form the public with regard to the traffic safety and report on such matters to the Engineer.

3.2.6 Marine Patrol

The Contractor shall work with the local maritime authority to reduce the risk of collisions between construction activity involving marine plant and construction and local vessels such as fisherman, wind surfers and other boats.

This will involve the Contractor making multiple, daily checks of marine traffic to ensure vessels not related to the port construction are kept well outside the working area. Report all encounters with non-construction vessels to the Engineer and keep a log of all patrols, including time, date, weather conditions, vessels encountered and action taken.

3.2.7 Dredge Discharge Supervision

The Contractor shall provide staff to act as a supervisor for dredging discharge operations. The supervision shall, in addition to duties assigned by the Contractor, be responsible for mandatory safe working practices around the discharge area. This may include monitoring the stability of the discharged material for the purposes of supporting equipment and preventing workers from coming unsafe distance from the discharge point.

3.3 SUBCONTRACTOR MANAGEMENT

3.3.1 Sub-Contractor’s Safety Management Plan

The Contractor shall ensure that all its Sub-Contractors have written Safety Management Plans in place, which are of a standard suitable for the type of activity being undertaken, and which address the hazards involved with the particular work activity.

3.3.2 Working Together for a Safe Site

The Contractor and its sub-Contractors shall actively participate in any programs and/or activities designed to improve the SHE performance on the project.

3.4 TRAINING AND COMPETENCY

3.4.1 Competency and Qualifications

Prior to the commencement of the Work the Contractor shall provide documentation to the satisfaction of the Employer that the Contractor’s personnel are competent and have the appropriate qualifications, job skills and training as required by this Contract and applicable laws.

3.4.2 Contractor Personnel Competency and Responsibility for SHE

The Contractor represents and warrants that its supervisors are responsible, and have been advised in writing that they are responsible, and have accepted and acknowledged such responsibilities in writing, for ensuring that the Work is performed in accordance with all applicable laws, rules and regulations, good working practices, and any additional guidelines and/or operating standards provided to the Contractor by the Employer. The Contractor shall at the Employer’s request, provide the Employer with organization charts, specifying the areas of safety responsibility of supervisors.

3.4.3 Legal Requirements

The Contractor shall ensure that all its employees and the employees of its Subcontractors working on-site are adequately trained in the type of work to be performed and are trained in relevant procedures and have the appropriate qualifications, certificates and tickets and are under competent supervision. Records are to be maintained of appropriate training and qualifications.

The Contractor’s employees must be the holders of current relevant Government Department certificates or permits where the operation being performed requires such certification, for example:

- Welders
- Crane and Hoist Drivers
- Crane Chasers and Dogmen
- Riggers
- Scaffolders
- Plant Operators
- Shot Firers
- Winch Drivers
- Explosive Tools
- Demolisher
- Electricians
- Plumbers
- Gasfitters
- First Aid Providers and Medics
- Divers
- Marine Operators

The actual list shall depend on the applicable regulations regarding competency.

Copies of all such certificates shall be logged in a Register maintained by the Contractor. The Contractor shall provide electronic copies of such Register/s to the Employer upon request.

3.4.4 General Requirements for Training in SHE

Any person expected to spend in excess of 3 days on site in any one month must complete all necessary inductions and general training requirements.

Before starting Work the Contractor shall at its own expense ensure that its personnel have received all training regarding SHE survival and job skills required by law, as well as training under the Contractor’s own safety policy and procedures, that is necessary to enable them to perform the Work in a manner that is safe and without risk to health. The Contractor shall provide certificates of the training to the Employer upon request.

The Contractor shall also prepare and present to all its employees a site-specific induction which shall as a minimum consist of an introductory briefing explaining the nature of the Work, the general hazards which may be encountered during the operation, and the particular hazards attached to their own function within the operation.

The Contractor shall ensure that no employee of the Contractor or its Sub-Contractor’s shall proceed to enter the Site or any of the Employer’s client’s sites until they have received all necessary site inductions required by the Employer or the Client.

The Contractor shall ensure that all its personnel and those of its Sub-Contractor’s receive a copy of the Contractor’s SHE Training manuals or handbooks relevant to their jobs which shall detail SHE code and conduct, personal safety protection, emergency SHE response and personal health conduct.

Training manuals, handbooks and other relevant literature shall be published in all relevant languages for all areas of operations.

The Contractor shall, if requested, provide the Employer with details of ongoing training programs and shall provide the Employer with all related revisions during the term of this Contract.

3.4.5 Visitors

The Contractor shall ensure that no visitors of the Contractor or of its Sub-Contractor’s shall proceed to enter the Employer’s site, the Work site or the Employer’s operations unless they have completed all necessary visitor entry requirements and must at all times be accompanied by a person who has completed all necessary general training requirements.

The Employer must approve all visitor entry.

3.4.6 Emergency Procedures

The Contractor shall ensure that all personnel on the site, including visitors, are properly instructed in the site emergency response procedures.

3.5 HAZARD IDENTIFICATION AND RISK MANAGEMENT

3.5.1 Contractor Procedures

Prior to the commencement of the Work, the Contractor shall demonstrate to the satisfaction of the Employer that the Contractor has performed hazard and risk assessment of the Work, and of the associated equipment and facilities, to meet the requirements of this Contract. The Contractor is responsible and accountable for ensuring that effective procedures and assessment systems are in place so as to mitigate risks or hazards to as low a level as is reasonably practicable, and to meet all the SHE management requirements under this Contract.

3.5.2 Training of Contractor’s Personnel

The contractor shall organize and run suitable courses for all Management and Supervisory personnel in the Hazard Identification and Risk management to ensure that all of these personnel are equipped and capable to carry out risk assessments.

3.5.3 Hazard Assessment Workshop

The Contractor shall participate, with appropriate personnel, in any Hazard Assessment Workshop or Construction Safety Studies that may be conducted. The Contractor shall, prior to this, identify the detailed methodology of the site installation (crane positions, lift sizes, Work at Height etc.), in particular for hazardous activities. The Contractor’s Representative and personnel directly involved, the Employer and any other relevant representatives shall attend the Workshop. At these workshops the Contractor’s methodology may be reviewed task by task, potential hazards identified, and actions agreed on to mitigate risk.

3.5.4 Work Method Statement

The Contractor shall submit to the Employer a Work Method Statement for Work under the Contract at least 24 hours prior to the Work commencing.

Acceptance of the Work Method Statement by the Employer shall not relieve the Contractor of responsibility for ensuring full compliance with Contract specifications and conditions.

3.5.5 Job Hazard Analysis

Prior to the commencement of each work activity, or as requested by the Employer, a Job Hazard Analysis (JHA) or similar shall be completed and documented. The purpose of the JHA is to identify all potential hazards associated with the Work and the Work environment, assess the risk these hazards present and then to provide risk control action that deals with those hazards, as well as providing to the workforce involved in the particular work activity, details of any hazards and the proposed controls.

The Contractor shall propose the JHA process and record format to be used, considering the requirements below. The documented JHA and/or resulting

Work Instruction shall be completed by the work crew and job supervisor, and at least one team member must be skilled and experienced in the JHA / risk assessment process. Completed JHAs must be available for review by the work crew and the Employer upon request.

The JHA shall:

- Describe the operation to be performed in the sequence of the basic job steps;
- Identify the hazards or potential hazards at each step;
- Assess the risk the hazard presents;
- Describe how the hazard shall be controlled such that the residual risk is as low as reasonably practicable (ALARP) and is acceptable to the work crew;
- Identify the related Work Instruction if appropriate;
- Be reviewed prior to each shift;
- List any necessary permits that may be required prior to commencement of work;
- Be acknowledged by way of signature of all personnel involved in the work activity.

3.5.5.1 Pre Task Hazard Assessment (PTHA)

For individual tasks and when tasks change during implementation, a PTHA must be carried out. The Contractor must propose the format of the PTHA to be used taking into account the Employer recommendation as laid out in Attachment E hereto.

3.5.6 Hierarchy of Controls

The Contractor shall ensure that all risk and hazard controls are applied in accordance with the ‘Hierarchy of Control’ methodology.

Control measures to eliminate or minimise the risk shall be considered and implemented in the following order of priority:

1. Elimination of the hazard is the main objective;

If this is not possible, prevent or minimise exposure to the risk by one or a combination of:

2. Substitution - substituting a less hazardous material, process or equipment;
3. Isolation - isolating the hazard from the person or the person from the hazard;
4. Engineering - redesigning equipment or work processes;
5. Administration - introduce administrative controls;

As a last resort, when exposure to the risk is not (or can not be) minimised by other means:

6. PPE - identify and use appropriate personal protective equipment

3.5.7 Unsafe Operations

If the Contractor believes that the Work cannot be safely undertaken or that continuance of the Work may result in extra hazardous conditions, it shall immediately cease work and notify the Employer. The Contractor shall at all times make every effort to control or overcome the cause, or minimize the effect of, any extra hazardous condition.

3.5.8 Management of Change

The Contractor shall develop a procedure and system to manage the change process. This procedure and system shall address the required processes to ensure that proposed changes do not give rise to unacceptable risk to health, safety, assets and/or the environment.

The change management process shall aim to ensure the following:

- changes are identified and recognised;
- careful consideration is given to managing the Risks associated with any change;
- due diligence can be shown to have taken place;
- a reduction in the number of unsatisfactory or unnecessary changes;
- involvement of the right people in the change process; and
- all statutory requirements are met.

The change management controls shall apply having regard to the fact that change may be planned, sudden or gradual.

3.5.9 Hazardous Materials

Contractor shall set out its policy for the use, transportation, handling and storage of fuel and hazardous materials.

Contractor shall ensure that all hazardous materials and waste products are disposed of in accordance with applicable laws and regulations, with any procedures published by the Employer and in the absence of any relevant law, regulation or procedures, in accordance with sound safe practice.

3.5.10 Risk Assessment of Plant and Equipment

Risk assessments of plant and equipment shall be undertaken and documented before arrival at site and after major service, after modification, and before use in an unusual operating mode. They must be undertaken by a suitably qualified and experienced person and must be reviewed and signed by the Contractor Project Manager or Equipment Supervisor.

Such risk assessments for equipment mobilising to Site must be reviewed and accepted by the Employer prior to the equipment arriving at Site, and shall consider, where applicable, potential for entanglement in moving parts, crushing or striking by moving or falling objects, cutting or stabbing by sharp objects, high pressure fluids, electrical shock or burns, burns from hot or cold surfaces, slips, trips and falls, ergonomic design of access and egress (3 points of contact to be maintained), seating, vibration, noise, exhaust fumes, etc. The identification of hazards should consider normal operations, abnormal or unusual operations, maintenance and servicing operations. Particular attention shall be given to fall protection attachment points when there is a requirement to work over 1.8 metres above the ground (servicing earthmoving equipment for example).

3.6 DESIGN AND SYSTEM SAFETY

3.6.1 Design Requirements

Safety Health and Environmental aspects must be considered in any design performed by the Contractor.

Design of all plant and equipment is to consider safe construction erection methods to minimise the risk to erection personnel during construction.

Construction methods shall ensure the Hierarchy of Control methodology is maintained as far as is practicable in design, such as facilitating modularised erection to eliminate and/or minimise the exposure of personnel to work at heights.

The Contractor shall ensure HAZOP and risk assessment are conducted in accordance with statutory requirements and to ensure all plant and equipment can be safely operated and maintained.

3.6.2 Hazard Assessment During Design

The Contractor shall ensure that all design responsibilities, as required by the engineering design phase of the Contract, consider risk mitigation by means of a documented formal hazard and risk assessment process.

Measures identified in the hazard assessments and as required by QMM shall be used as a basis for design tasks. Hazard studies shall be scheduled as appropriate for the Contract.

A key SHE objective is to meet the Engineering design criteria. Actions shall be taken so that risks of injury or damage are at an acceptable level, ALARP, to meet the Project objective of zero harm.

Designing for SHE compliance shall be achieved through the application of the following sequential steps for the design aspect of the Contract:

1. evaluate the hazards in the preliminary hazard register and develop design criteria;
2. describe the designing for health, safety, environment and community process in the Design Plan, including how the design process shall eliminate or mitigate the risks associated with the hazards in the preliminary hazard register. This shall include hazard studies such as HAZOP, Fire Safety Studies, and Construction Safety Studies (HAZCON);
3. update hazard identification and evaluation, which includes a detailed assessment of any additional hazards that have been identified during the detailed design phase for each design package. Any new hazards shall be added to the Project’s hazard register; and on completion of the detailed design, undertake a

formal design HSE verification process to ensure that all hazards identified during the course of the design have been eliminated or the associated risk mitigated to ALARP.

3.7 INCIDENT MANAGEMENT

3.7.1 Incident Reporting

The Contractor shall have an accident and incident reporting system that is compatible with the Employer’s standards and all applicable statutory requirements. Any incident or “near miss” involving the Employer, the Contractor, its subcontractor’s or any third party’s personnel, property, plant or equipment, shall be verbally reported immediately to the Employer, whether or not injury to personnel or damage to property or equipment resulted. A brief written report stating the known facts and conditions and including a preliminary assessment of most likely consequence potential of the incident in the circumstances, shall be provided to the Employer by the end of the shift.

3.7.2 Serious Incidents

For any serious incident involving a fatality, or permanent disability, the incident scene must be left untouched until witnessed by a representative of the Police, or the Division of Workplace Health and Safety or other Government Agency that has sufficient authority to make decisions and take action. This requirement does not preclude immediate first aid being administered and the scene made safe.

3.7.3 Incident Report and Close Out

The Contractor shall investigate the causes of all work accidents and significant incidents and shall provide the Employer with the results of the investigation and recommendations on how to prevent a recurrence. A formal root cause investigation process for all high potential incidents must be followed.

The written report shall include:

- Date, time and place of non-conformance;
- Description of non conformance;
- Type of injury (if any);
- Medical treatment provided (if any);
- Persons involved;
- Corrective action to prevent recurrence.

The Employer shall have the right to designate a representative to participate in the investigation at the Employer’s discretion.

Where the results of any investigation are not completed and issued to the Employer within 24 hours from the time of occurrence, the Contractor shall supply to the Employer a written update every 24 hours, of the progress and results of the investigation until such time as the incident report has been fully completed and issued to the Employer.

Where required by Statutory Requirements the Contractor shall be responsible for incident reporting to the appropriate Authority.

3.7.4 Corrective Action

The Contractor shall:

- ensure all hazards, incidents and accidents, including near misses, are investigated fully and documented;
- take corrective action to eliminate the cause of the incident or accident to prevent recurrence; and
- review inspection and audit reports to identify areas of improvement.

For the purposes of this specification, a SHE incident shall be taken as an incident involving harm or potential harm to any employees of the Contractor, the community, subcontractor and/or the work environment, or where the physical well being of a person, the community or the work environment has been placed at risk, e.g. a near miss.

3.8 SAFETY EQUIPMENT

3.8.1 Personal Protective Equipment (PPE)

The Contractor shall, at its own expense, supply its personnel and its subcontractor’s personnel, including transport and delivery contractors entering the site delivering materials and /or equipment, with adequate protective clothing and other protective equipment, which shall be maintained in good condition or replaced, and which shall be worn on all relevant occasions as indicated by notices, instructions and good practice. The Contractor shall ensure that all senior personnel and visitors wear protective garments and equipment in the appropriate circumstances, even if not actively engaged in the work. Minimum Personal Protective Equipment (PPE) required for the Site is set out below. The Contractor shall ensure that all employees and subcontractors, including transport and delivery contractors entering the site delivering materials and /or equipment, receive adequate training for the use, management and maintenance of all PPE equipment. PPE shall comply with relevant Legislation and industrial clothing shall be of fire resistant material.

Minimum personal protective equipment shall be:

- Safety head protection
- Safety footwear with steel toe protection
- Safety glasses with side shields
- Hand Protection(as required)
- Long trousers
- Long-sleeved shirts with cuffs and collars
- Hearing and respiratory, protection (as required).

3.8.2 Safety Equipment

The Contractor shall ensure that all its safety equipment is regularly maintained and tested and that it is always in a serviceable condition and the Contractor’s personnel and Sub-Contractor’s personnel are instructed, trained, competent and, where required, certified in the use of such safety equipment. The safety equipment shall comply with all applicable laws, rules, and regulations.

3.9 EMERGENCY RESPONSE

3.9.1 Emergency Response Manual

The Contractor shall provide the Employer with both electronic and hard copies of the Contractor’s Emergency Response Manual that sets out its procedures for fire spill response, rescue from heights, adverse wind, wave and water level condition, and other relevant emergency response procedures. Those procedures must be made compatible with the Employer’s emergency response procedures for the Site prior to commencing Site activities. Unforeseen conflicts between the Employer’s policies and those of the Contractor shall be addressed and resolved by a direction from the Employer prior to the Contractor commencing the work.

3.9.2 Emergency Drills

The Contractor shall conduct emergency response drills (including, but not limited to, fire, rescue and spill drills) to test the effectiveness of its emergency procedures and equipment, and the knowledge and proficiency of all response personnel. The timing of such drills shall be agreed and shall be the responsibility of the Contractor after consultation with the Employer. The Contractor shall report the test results to the Employer, if requested and as required by any regulatory agency.

3.9.3 Fire Fighting

The Contractor shall prominently publish, in all relevant languages for all areas of operation under its control, the procedures to be carried out in the event of fire.

The Contractor shall train all employees in the procedures to be followed in the event of a fire and/or a fire alarm.

Contractors shall familiarize themselves with locations of fire equipment in the vicinity of their work site. Work areas must be clear, at all times, of any smouldering material which could fuel a fire. A thorough inspection must be made of the area at the end of any working period to ensure that no smouldering material is left at the work site or any situation left in such a manner that a fire or accident could result.

Electric welding, oxy-welding or cutting, or any other fire hazardous equipment is not to be used inside electrical switch rooms, control rooms, cable ducts or adjacent to any electrical switch room, control room, cable duct or adjacent to any electrical equipment, cables or conveyor belts without the permission of the Employer.

The Contractor shall supply all fire extinguishers for its work as required by the statutory regulations governing the Site. Fire extinguishers are not to be used for any purpose other than their intended use.

3.10 GENERAL

3.10.1 Tools and Equipment

The Contractor shall ensure that all plant, equipment, power and hand tools and equipment brought onto the Site by the Contractor or its Subcontractors are:

- Appropriate for the type of work to be performed;
- Approved, inspected, tested and tagged (if appropriate) in accordance with Health and Safety statutory regulations (and where no regulations exist in accordance with Employer's requirements), before importation onto Site;
- Are maintained in operable condition; and
- That users of the plant, tools and equipment are trained, competent, experienced and, where necessary, licensed and certified.

Specifically, the risk controls to be implemented by the Contractor will include ensuring that:

- Personnel are adequately guarded from all rotating or moving parts of all tools and equipment so that accidental contact is prevented.
- Every power-driven machine is provided with adequate means, immediately accessible and readily identifiable to the operator, of stopping it quickly and of preventing it from being started again. In the case of hand-held power tools, this shall be of an automatic or emergency shutdown "dead man-switch" type.
- The Contractor should specifically note that for truck mounted cranes, the Employer has defined a range of mandatory risk controls.

Tools and equipment, including electrical leads and electrical equipment, rigging and lifting gear and harnesses, shall be inspected and tagged every three months by an authorised inspector. An appropriate colour coded tag shall be attached in accordance with the coding following:

- January - March Red
- April – June Green
- July – September Blue
- October – December Yellow

3.10.2 Lifting Equipment

The Contractor shall maintain a register of all lifting equipment and lifting tackle. The Contractor shall provide certification prior to mobilisation for all cranes. Fall testing for lifting slings and lifting tackle before the equipment is permitted to be used on Site and/or shall carry out such tests and inspections as are requested by applicable regulatory authorities and the Employer. Safe working load (SWL) and radius charts shall be available for all lifting equipment and shall be marked on the equipment.

3.10.3 Maintenance

All equipment and structures both fixed and temporary are to receive regular maintenance, at intervals no longer than that recommended by the manufacturer, under a planned maintenance system to ensure the safety of personnel who are responsible for operating the equipment.

The Contractor shall maintain copies of all current tests and maintenance certificates relating to cranes, lifting beams, pulley blocks, lifting gear and slings, and shall make them available to the Employer upon request. No lifting beam or spreader bar shall be used unless a current Certificate of Inspection is available and the SWL is stamped on the equipment.

3.10.4 Defect Reporting and Correction

Where defects are identified during any routine inspection, pre-start check or during operation or use of any tools, equipment, motor vehicle, structure, etc it shall be immediately reported for repair and the tools, equipment, etc appropriately tagged to identify the defect and to limit further use until repairs have been completed and re-inspection carried out. Such defect reports shall be in writing.

3.10.5 Weather Precautions

In the event of impending adverse weather or other conditions, the Contractor shall, in consultation with the Employer, decide whether to institute precautionary measures in connection with the carrying out of the Work.

3.10.6 Photographs

It is the Employer’s policy that unauthorized persons are not permitted to take photographs on the Site.

The Contractor shall submit to the Employer any request to take photographs. Such requests shall state the purpose for which the Contractor intends to use the photographs. Permission to publish photographs will not be unreasonably withheld.

3.10.7 Personnel Search

As a condition of entering the Site, the Contractor voluntarily consents to searches by the Employer of the Contractor’s personnel and items or equipment in their possession. The Contractor shall provide written consent forms executed by each of its employees, and by each employee of any Sub-Contractor hired by the Contractor, acknowledging the Employer’s right to conduct searches in accordance with other terms of the Contract. Any person who refuses to be searched or is found to be in possession of a prohibited item or substance shall be directed to leave the premises.

3.10.8 Contractor’s Motor Vehicles

The Contractor’s vehicles shall be registered at all times and shall be maintained in a condition of roadworthiness acceptable for registration.

The Contractor shall ensure that its employees are licensed to drive the type of vehicle of which that employee is in control and under no circumstances are unlicensed persons permitted to control vehicles on the Site.

In the event of an accident in which a Contractor’s employee is involved, the employee shall remain at the scene until the Employer arrives on the scene or until the Employer authorizes the employee to leave the scene, unless the employee needs medical attention.

Private vehicles will not be permitted to enter the Site except those of the Contractor’s Senior Supervisory personnel who may be permitted entry upon application to, and approval by, the Employer.

The Contractor shall attach identification markers provided by the Employer to all of its vehicles permitted to enter the Site.

3.10.8.1 Pre Start Checklist

At the start of every shift a vehicle checklist must be carried out to ensure that all equipment and operating systems of the vehicle are in good order. The Contractor must propose the format of the checklist and establishes a system of recording the checklists and actions to be taken in the event of non-compliance.

3.10.8.2 Driver Training

The Contractor must ensure that all drivers undertake Defensive Driving Training applicable driving to conditions in the region and that records are kept of all such training.

3.10.8.3 Seat Belts

All vehicles used on site, including vehicles delivering goods and equipment to the site, must be fully equipped with seat belts. Seat belts must be worn at all times by the driver and all passengers in the vehicle. Failure to comply wit this regulation is a serious breach of procedures and will be treated as a Disciplinary Offence.

3.10.8.4 Carrying of Passengers

Passengers may only travel in vehicles in properly fitted seats complete with seat belts. Passengers may not travel in the load tray of a light vehicle, nor in the back of a truck unless proper provision has been made in terms of this clause. Failure to comply with this regulation is a serious breach of procedures and will be treated as a Disciplinary Offence.

3.10.9 Speed limits

Contractors and their employees who have permission to drive cars or trucks on the Site shall at all times drive at a safe speed; they shall not exceed the maximum speed permitted on the site or lower speeds as indicated by signs on roadways.

3.10.10 Commencement of Work

Prior to the commencement of any on-site Work, the Contractor shall consult with the Employer regarding the availability of and access to the item or area of the Works to be worked on and regarding instructions relating to any safety procedures that are to be followed.

The Contractor shall not commence Work on a particular item or area of the site until the Employer gives approval and until an Authority to Work Permit(s) has been issued.

3.10.11 Housekeeping

The Contractor shall maintain all Work and storage areas in a tidy state, free of debris and rubbish.

3.11 NOTIFICATIONS

3.11.1 Electrical Work

The Contractor shall submit to the Employer, in writing, notification of completion of any electrical Work prior to power being supplied. No further Work shall be undertaken without the written approval of the Employer. All electrical Work shall be carried out in accordance with the relevant statutory requirements.

3.11.2 Plumbing Work

The Contractor shall submit to the Employer, in writing, notification of completion of any plumbing Work prior to water being supplied. No further Work shall be undertaken without the written approval of the Employer. All plumbing Work shall be carried out in accordance with the relevant statutory requirements.

3.11.3 Completion Inspection

On completion of any on-site Work the Contractor shall notify the Employer to ensure that all items and areas of plant are left in a safe and operational condition.

On handover of the Site, the Contractor shall provide any requested report sheets to the Employer for counter signature as well as the Authority to Work Permit(s) for signing off.

3.12 OCCUPATIONAL HEALTH AND HYGIENE

3.12.1 Fitness For Duty

3.12.1.1 Health Assessments and Health monitoring

The Contractor shall ensure that all the Contractor’s personnel are healthy and medically fit for their respective assignments and shall certify the same to the Employer if so requested. The Contractor shall be responsible for pre-placement and exit medicals and ongoing health assessments.

The Contractor’s attention is drawn to Part 3, Section VII, Clause 6.7. In addition to the requirements stated in this reference, the Contractor shall also:

a. take precautions to prevent mixing Contractor personnel with local population

b. encourage workers to seek medical assistance if they are concerned

c. provide weekly reminders of AIDS prevention

Proof of vaccinations must be provided by all Contractor personnel for the following diseases:

a. Typhoid – valid for 3 years

b. Polio/Tetanus/Diphtheria – Valid for 10 years

c. Cholera – valid for 2 years

d. Hepatitis A – only if individuals have not had Hepatitis A or yellow jaundice

e. Hepatitis B

The evidence shall clearly state the vaccination date and type of vaccinations.

3.12.1.2 Alcohol and Other Drugs

The Contractor shall ensure that personnel under its control and authority do not at any time, during the performance of the work, take or work under the influence of any alcoholic and/or other drug other than for bona fide medical reasons or other proper reasons that have been approved in advance and in writing by the Contractor. The measures to be taken by the Contractor shall include Alco-testing prior to all personnel starting work on the site. The Contractor shall ensure that personnel under its control and authority comply with the Project site program of random testing for alcohol and other drugs. The Contractor will comply with the Employer’s Disciplinary code with regard to levels of Alcohol and/or drugs.

3.12.1.3 Medical Welfare

The Contractor shall be responsible for the medical welfare of its own employees. Also refer to Section 01500.

3.12.2 Hygiene

3.12.2.1 Sanitary Facilities

The Contractor shall provide at its own expense all toilet and hand washing facilities and shall be responsible for maintaining them in proper order. Installation of such facilities shall be in accordance with requirements established by the Employer. Also refer to Section 01500.

3.12.2.2 Smoking

The Contractor shall not permit smoking at the Site except within designated smoking areas selected in accordance with applicable laws, rules, regulations, and policies.

3.12.2.3 General Hygiene

The Contractor shall ensure that its personnel and Sub-Contractor’s personnel shall maintain high standards of hygiene in connection with the performance of the Work.
The Contractor shall maintain all Work areas in a clean and tidy state and shall promptly and appropriately dispose of waste material.

Meal rooms shall be kept in a clean and tidy manner to the satisfaction of the Employer and any statutory requirements.

3.12.3 General

3.12.3.1 First Aid Services

The Contractor shall provide and maintain, as a minimum, First Aid facilities at the Quarry and at the port construction site to a first world standard.

The Contractor is responsible for the establishment of arrangements for all off-site medical treatment. Also refer to Section 01500.

3.12.3.2 Sun Protection

The Contractor shall ensure that all personnel are protected in sunlight by the use of long sleeve shirts, long trousers; brims to safety helmets, UV factored sunscreen and shade structures.

The Contractor shall conduct training and awareness sessions with its workforce, advising on the risks of working in the heat and dehydration and the precautions to be taken including an acceptable fluid intake depending on conditions. The Contractor shall ensure that adequate water shall be available to its workforce at all times.

3.12.3.3 Working Hours

The Contractor shall be responsible for the administration of the working hours of its employees and subcontractors. Maximum working hours per day and minimum rest times between shifts shall be specified in the Contractor’s Health and Safety Management Plan and shall comply with the requirements for the project site unless specifically reviewed by the Employer.

3.12.3.4 Malaria

The Contractor is responsible for providing advice and all necessary medical protection to its employees and its subcontractors employees for protection against Malaria. The Employer has carried out extensive studies into protection against the disease and will provide information or advice requested. The Employer provided accommodation will be equipped with mosquito nets and all residents must make use of these facilities.

3.12.3.5 Cleaners, Solvents and Hazardous Materials

No chemical, which is potentially hazardous, shall be brought onto the site without the prior acceptance of the Employer.

The Contractor shall submit to the Employer a Materials Safety Data Sheet (MSDS) with its request for acceptance of each hazardous substance the Contractor proposes to use at the site.

The Contractor shall ensure that all necessary transport, storage and usage precautions are taken and that safety equipment, including antidotes, if necessary, is available on the site.

3.12.3.6 Injury Management

The aim of injury management is to ensure appropriate and adequate medical treatment is provided to injured employees to enable a quick and efficient return to the workplace.

A Project doctor has been nominated for the Project to which the Project medical staff will refer all injured employees requiring medical assistance in the first instance. If the Contractor does not wish to utilise the services of the Project doctor the Contractor shall make alternative arrangements and the Employer is to be notified in writing of the doctor to be used. The treatment of injured personnel will not be compromised and the immediate needs will be referred as required by the Project paramedics.

The Project doctor shall be briefed on the commitment by the Contractor to injury management, alternative duties, and early return to work programs and rehabilitation.

Effective injury management must commence immediately after the accident has occurred and is to include:

- counselling of the patient;
- referral to the nominated medical practitioner via the Project Clinic;
- follow up, including personal off Site visits by the Contractor;
- provision of off Site personal, family and social assistance where required;
- formal assessments of employee capabilities prior to return to work; and
- provision of alternate meaningful duties, where appropriate.
- provision or medical evaluation if necessary

3.13 ENVIRONMENT

3.13.1 Commitment and Policy

The Contractor shall take appropriate actions to protect air, water, animal and plant life from adverse effects of the Contractor’s activities, and to minimize any nuisance which may arise from such operations, in accordance with all applicable laws and, where applicable, the Environmental Requirements.

The Contractor shall ensure that the Contractor’s and Sub-Contractor’s personnel are briefed and understand the Employer’s policy on environmental protection, and that such personnel shall act accordingly.

The Contractor shall adhere to existing statutory regulations concerning environmental damage resulting from the performance of the Work.

The Contractor acknowledges its environmental obligations in relation to the Work under all Environmental Requirements and warrants that the Contract Price incorporates all costs and expenses associated with complying with such obligations.

The Contractor further acknowledges that the Employer has a strong commitment to the protection of the environment and, without limiting the Contractor’s specified obligations under this Contract, the Employer requires the Contractor to do all things necessary to construction of the Works in a way so as not to harm the environment.

3.13.1.1 Environmental Control Officer

The Contractor shall appoint, at their cost, for the duration of the construction period, an Environmental Control Officer (ECO) to be responsible for the overall implementation of the environmental portion of the SHE Management Plan in accordance with the requirements of the Contract. The ECO will oversee the planning, design and construction phases of the project on the ground, and sure that all environmental specifications and SHE requirements are met at all times. There shall be an approved ECO on the site at all times. It may be necessary to have more than one ECO.

The ECO will be responsible for the monitoring, reviewing and verifying of compliance with environmental requirements of the SHE. The ECO’s duties in this regard will include, inter alia, the following:

- Ensuring that all the environmental authorisations and permits required in terms of the applicable legislation have been obtained prior to construction commencing.
- Monitoring and verifying that the environmental portion of the SHE Management Plan is adhered to at all times and taking action if specifications are not followed.
- Monitoring and verifying that environmental impacts are kept to a minimum.
- Reviewing and approving construction methods in order to ensure that the environmental specifications contained within this SHE are adhered to.

- Keeping accurate and detailed records of all activities on site.
- Inspecting the site and surrounding areas on a regular basis regarding compliance with the environmental portion of the SHE Management Plan.
- Coordinating environmental awareness training for all new personnel on site.
- Ensuring that activities on site comply with all relevant environmental legislation.
- Keeping a register of complaints on site and recording community comments and issues, and the actions taken in response to these complaints.

The ECO must have:

- A good working knowledge of all relevant environmental policies, legislation, guidelines and standards;
- The ability to conduct inspections and audits and to produce thorough, readable and informative reports;
- The ability to manage public communication and complaints;
- The ability to think holistically about the structure, functioning and performance of environmental systems; and
- Proven competence in the application of the following integrated environmental management tools:
  - Environmental Impact Assessment
  - Environmental management plans/programmes
  - Environmental auditing
  - Mitigation and optimisation of impacts
  - Monitoring and evaluation of impacts
  - Environmental Management Systems and Sectoral Environmental Management Plans

3.13.2 Care of the Site

The Contractor shall ensure that the Works on the Site are left in a condition that complies with all environmental laws, requirements of any authorities having jurisdiction in relation to matters concerning the environment or the Site, and the Environmental Requirements.

3.13.3 Waste Disposal and Spillage

The Contractor shall take precautions to prevent contamination of the environment from the Work activities.

The Contractor shall be responsible for ensuring that the handling, storage, treatment, transportation, and disposal of waste is executed in an environmentally acceptable manner and is in accordance with all applicable legislation and any additional Employer requirements.

The Contractor shall take all the proper precautions to minimize the impact of discharge of water containing any matter in solution or suspension which may damage the environment, including, without limitation, visible suspended matter into waterways and adjacent to the Site. This obligation applies, without limitation, to water used for hydrostatic testing.

The Contractor shall take all precautions necessary to prevent the discharge into waterways of any oils or similar materials or of any foaming or non-biodegradable detergents. All plant and equipment maintenance must be carried out in a suitably contained area, the draining from which shall be provided with approved oil separation traps before discharge into any waterway. The Contractor shall be responsible for regular removal of deleterious matter from such traps and its disposal by approved methods.

The Contractor shall be responsible for obtaining, preparing and maintaining waste permits and manifests for transporting and disposing of wastes generated by the Contractor. All procedures must meet with the Employer's approval.

The Contractor shall be responsible for providing and maintaining spill control and clean-up equipment according to legal requirements.

Solid wastes (excluding clearing debris) shall be placed in containers that are emptied on a regular schedule. All handling and disposal shall be conducted to prevent contamination. Solid waste materials shall be hauled to an approved solid waste disposal site designated by the Employer. The Contractor shall comply with all regulations pertaining to the use of the solid waste disposal site.

The Contractor shall prevent oil, fuel, or other hazardous substances from entering the air, ground, drainage, local bodies of water, or wetlands. This shall be accomplished by design and procedural controls. All oil or fuel spilt or leaking from any item of plant or equipment which is likely to cause a nuisance, shall be cleaned up immediately, if necessary by excavation of impregnated soil and its removal to an approved disposal area. If oils or any materials as a result of the Contractor's failure to comply with the requirements of this Clause contaminate any waterway, the Contractor shall, at the Contractor's expense, comply with all directions given by any relevant Government Agency to clean up the contaminated areas and to prevent any further contamination. In the event that a spill occurs despite the design and procedural controls, the following shall occur:

(1) Immediate action shall be taken to contain and cleanup any spill of oil, fuel or other hazardous substance.

(2) Spills shall be immediately reported to the Employer.

(3) Spill contingency planning shall be strictly in accordance with the applicable regulations and with standard practices of the Employer.

(4) To control the spread of any potential spill, absorbent materials shall be readily available and capable of absorbing the contents of the single largest tank.

(5) To control the spread of any potential spill, the Contractor shall provide a written certification of commitment of manpower, equipment, and materials required to expeditiously cleanup and dispose of spill materials.

a. Spill Preventive Systems: System design and installation requirements have been discussed elsewhere in this Section. Temporary or portable tanks shall conform to applicable requirements and shall not be placed where they may be affected by storm, flooding, or washout. Diversionary structures for spills shall be put in place in advance where practical. Both spill preventive systems and any deviations from associated requirements must be approved by the Employer prior to implementation.

b. Fuel, oil, and lubricants shall be managed so as to prevent spills and evaporation. To prevent spills, fuel dispensers shall have a 1.5 metre square, 16-gauge metal pan with borders banded up and welded at corners right below the bib. Edges of the pans shall be 3 cm minimum in depth to ascertain that no contamination of the ground takes place. Pans shall be cleaned by an approved method immediately after every dispensing of fuel and wastes disposed of offsite in an approved area. Should any spilling of fuel occur, the Contractor shall immediately recover the contaminated ground and dispose of it offsite in an approved area. Petroleum waste generated shall be stored in marked corrosion-resistant containers and recycled or disposed of in accordance with local regulations.

3.13.4 Noise and Vibration

The Contractor shall conform to the provisions of the statutory regulations of the Government relating to transporting of material, noise control during construction, with particular reference to transporting of material, piling, drilling, blasting, abrasive blasting, excavation and earth moving plant, compressors and pumps, fabrication areas, workshops, concrete aggregate batching and mixing plants and all other construction equipment, including vehicles.

The Contractor shall comply with all provisions of the Specification relating to noise and vibration control when carrying out activities that cause noise and vibration, including compaction and blasting.

The Contractor shall take all reasonable steps, to the satisfaction of the Employer, to minimize vibration, shock and noise arising from construction activities for the Work.

3.13.5 Air Pollution

Without derogating from the Contractor’s responsibilities as set out in this Contract, the Contractor shall comply with the statutory requirements of Government concerning air pollution.

The Contractor shall ensure that all construction facilities erected on the Site of the Works by the Contractor and of his Sub-Contractors are designed and operated to prevent the emission of smoke, dust, cement dust and other objectionable matter into the atmosphere.

Without derogation from the Contractor’s responsibilities as set out in this Contract, the Contractor shall take all proper precautions to minimize any nuisance arising from dust caused by construction activities. Such precautions may include, but shall not be limited to, spraying roads with water or other suitable liquids and the removal of mud tracked onto roads by construction equipment.

3.13.5.1 Particulates

Particulates, such as dust, shall be controlled at all times, including weekends, holidays, and hours when work is not in progress. The Contractor shall maintain excavations, dredge disposal areas, stockpiles, haul roads, permanent and temporary access roads, plant sites, spoil areas, borrow areas, and work areas within or outside the project boundaries free from particulates that would cause air pollution standards to be exceeded or that would cause a hazard or nuisance. The Contractor shall have the necessary equipment and approved methods to control particulates as the work proceeds and before a problem develops.

3.13.5.2 Burning

All burning shall be subject to applicable regulations, including requirements for burn permits and bans during certain conditions such as droughts.

3.13.5.3 Odors

Odors shall be controlled at all times for all construction activities.

3.13.6 Hazardous Waste and Materials

The Contractor shall ensure that hazardous wastes are stored and disposed of in accordance with applicable regulations. The Contractor shall ensure that hazardous wastes are packed, labeled, and transported in accordance with applicable regulations.

The Contractor shall ensure that hazardous materials are labeled, stored, and transported in accordance with applicable regulations.

3.13.6.1 Notification

The Employer will notify the Contractor in writing of any observed noncompliance with the aforementioned laws or regulations, permits, lending agency requirements and other elements of the Contractor’s environmental protection plan. The Contractor shall, after receipt of such notice, inform the Employer of proposed corrective action and take such action as may be approved. If the Contractor fails to comply promptly, the Employer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No time extensions shall be granted or costs or damages permitted to the Contractor for any such suspension.

Additionally, the Contractor shall notify the Employer, in writing, of the absence or occurrence of environmental incidents, as required on the Project Environmental Summary Sheet, copy appended to the end of this Section. The Contractor will complete a monthly monitoring report to be presented to the Employer during the Project Progress Meeting.

3.13.6.2 Protection of Environmental Resources

For Contract work, the Contractor shall comply with all applicable laws and regulations and lending agency requirements. The environmental resources within the project boundaries and those affected outside the limits of permanent work under this Contract shall be protected at least during the entire period of this Contract. The Contractor shall confine his activities to areas defined by the Drawings and Specifications. Deviations from Drawings or Specifications (e.g., proposed alternate borrow areas, disposal areas, staging areas, and alternate access routes) could result in the need for the Employer to reanalyze and re-approve the project from an environmental standpoint. Environmental protection shall be as stated in the following subparagraphs.

3.13.6.3 General Project Environmental Design and Installation Criteria

Some project sites have features that shall not be impacted in any way, including cultural, historic, or archeological features. At all sites, project plans should minimize disturbance to existing features at the site to the extent possible, including vegetative, topographic, and drainage pattern features. Wetland impacts (temporary access, detours, staging areas, and other work area impacts) to project sites should be avoided and may require separate permitting action. Any wetlands temporarily impacted shall have its soil restored upon project completion. Expansion of previously permitted project footprints may likewise require separate permitting action.

In all cases, the design and/or installation of a project system shall provide for protection of the environment during handling, installing, storing, utilizing, transporting, servicing, testing, refilling, transferring, pumping, processing, removing waste products, repairing and maintaining systems and their components. Necessary design protection shall also be considered that would prevent contamination of the environment from impacts to the system caused by storm water runoff and flooding. Retrofit of connected systems on project sites to modern environmental protection design standards shall also be considered.

In the event environmental protection measures fail, the Contractor shall implement procedures to control and correct environmental damage.

3.13.6.4 Petroleum-Based Systems Environmental Design and Installation Criteria

For petroleum-based systems, a statement of site suitability shall be provided and shall include what would be necessary to prevent adverse impact to water quality; natural resources; habitat; historic, cultural, and archeological sites; and fragile local resources in the event of a fuel spill. Human error and mechanical/electrical failure of components without human intervention shall also be considered in the design with regard to spills. Additionally, appropriate noise and emissions controls shall be incorporated into the design, including vapor and exhaust controls.

At a minimum, environmental protection design requirements shall also include the following: (1) stationary tanks and piping shall have secondary containment features; (2) approved materials and corrosion protection systems shall be utilized; (3) system leaks shall be readily detected and contained without human intervention; and, (4) overfill containment systems shall be provided.

Applicable Government regulations and internationally recognized best practices and requirements shall be strictly adhered to in the design. Best Management shall be adhered to in the design.

3.13.6.5 Sewage-Based Systems Environmental Design and Installation Criteria

In general, there shall be no waste or debris discharges of any kind for a project unless authorized by the Employer. This shall include the Contractor's providing sufficient temporary sanitary equipment and facilities for the project. The design and/or installation of temporary or permanent sewage systems shall ensure that waters will be free of effects of sewage discharges. Requirements regarding sewage shall be strictly adhered to in the design. Best Management Practices from the applicable agencies shall also be adhered to in the design.

3.13.7 Disposal of Other Materials

Other materials than previously discussed (Construction and Demolition, vegetative waste, etc.) shall be handled as directed.

3.13.8 Contractor to Prevent Waste

The Contractor, Sub-Contractors and employees shall at all times take all necessary actions to ensure that no electricity, water or other the Employer-provided services or materials are wasted.

3.13.8.1 Rubbish Removal

The Contractor shall be responsible for the removal from the Work Site of all construction and other debris and waste generated under this Contract. The Contractor shall provide sufficient industrial disposal bins for collection of waste and ensure that all such bins are emptied on a regular basis to prevent overfilling.

Suitable collection equipment shall be provided for the collection of flammable waste, and of any hazardous substances shall be disposed of in accordance with statutory requirements. All waste shall be disposed of in accordance with the requirements of any statutory bodies.

3.14 PROTECTION OF LAND RESOURCES

Prior to the beginning of any construction, the Contractor shall identify all land resources to be preserved or avoided within the Contractor's work area. Materials displaced into uncleared areas shall be removed. The Contractor shall not remove, cut, deface, injure, or destroy land resources including trees, shrubs, vines, grasses, topsoil, and land forms without special permission from the Employer. The Contractor shall engage a qualified tree surgeon to perform all tree surgery. The Contractor shall be responsible to repair injuries to bark, trunk, branches, and roots of protected trees by dressing, cutting, and painting immediately as occurrences arise. No ropes, cables, or guys shall be fastened to or attached to any trees for anchorage unless specifically authorized. Where such special emergency use is permitted, the Contractor shall provide effective protection for land and vegetation resources at all times as defined in the following subparagraphs.

3.14.1 Work Area Limits

Prior to any construction, the Contractor shall mark the areas that are not required to accomplish all work to be performed under this Contract. Isolated areas within the general work area which are to be saved and protected shall also be marked or fenced. The Contractor shall protect from damage all existing trees designated to remain. Protection of tree roots shall be provided against noxious materials in solution caused by run-off or spillage. Fires shall be located outside the canopy of protected trees. No materials, trailers, or equipment shall be stored within the drip line of any protected tree. Monuments and markers shall be protected before construction operations commence. Where construction operations are to be conducted during darkness, the markers shall be visible. The Contractor shall convey to his personnel the purpose of marking and/or protection of all necessary objects.

The Contractor shall thoroughly clean all construction equipment and tools at the prior job site in a manner that ensures all residual soil is removed and that egg deposits from plant pests are not present. In addition, if this Contract involves the identification, shipping, storage, testing, or disposal of soils from such a quarantined area, the Contractor agrees to comply with the provisions of all applicable laws and regulations. The Contractor agrees to assure compliance with this obligation by all subcontractors.

3.14.2 Contractor Facilities and Other Work Areas

The Contractor’s field offices, staging areas, stockpile storage, and temporary buildings shall be placed in areas designated on the Drawings or as directed by the Employer. Temporary movement or relocation of Contractor facilities shall be made when approved by the Employer. Borrow and fill areas shall be managed to minimize erosion and to prevent sediment from entering nearby watercourses, wetlands, or lakes. Spoil areas shall be managed and controlled to limit spoil intrusion into areas designated on the Drawings and to prevent erosion of soil or sediment from entering nearby watercourses, wetlands, or lakes. Spoil areas shall be developed in accordance with the grading plan indicated on the Drawings. Temporary excavation and embankments for plant and/or work areas shall be controlled to protect adjacent areas from despoilment. If there is suspicion that sediment may be unsuitable for disposal at a specified location, the Contractor shall immediately take measures to contain the suspect sediment and notify the Employer.

3.15 PROTECTION OF WATER RESOURCES

The Contractor shall keep construction activities under surveillance, management, and control to avoid pollution of surface, ground waters, and wetlands. The Contractor shall plan his operation and perform all work necessary to minimize adverse impact or violation of the water quality standard. Special management techniques as set out below shall be implemented to control water pollution by the listed construction activities which are included in this Contract. The Contractor’s construction methods shall protect wetland and surface water areas from damage due to mechanical grading, erosion, sedimentation and turbid discharges. There shall be no storage or stockpiling of equipment, tools, or materials within wetlands or along the shoreline within the littoral zone unless specifically authorized.

3.15.1 Washing and Curing Water

Waste waters directly derived from construction activities shall not be permitted to enter water areas. These waste waters shall be collected and placed in retention ponds where suspended materials can be settled out or the water evaporates so that pollutants are separated from the water. Analysis shall be performed and results reviewed and approved by Employer staff before water in retention ponds is discharged.

3.15.2 Monitoring of Water Areas

Monitoring of water areas affected by construction activities shall be the responsibility of the Contractor. All water areas affected by construction activities shall be monitored by the Contractor.

3.16 PROTECTION OF FISH AND WILDLIFE RESOURCES

The Contractor shall keep construction activities under surveillance, management, and control to minimize interference with, disturbance to, and damage of fish and wildlife. Species that require specific attention along with measures for their protection shall be listed in the Contractor's Environmental Protection Plan prior to the beginning of construction operation.

3.16.1 Endangered Species Protection

The Contractor shall instruct all personnel associated with the project of the potential presence of whales in the area, and the need to avoid collisions with and harming these animals.

1) During the period November through June, barges or dredges moving through the designated critical habitat of the humpback whale shall take the following precautions. During evening hours or when there is limited visibility due to fog or sea states greater than Beaufort 3, the tug/barge or dredge operator shall slow down to 5 knots or less when traversing between areas if whales have been spotted within 15 nautical miles (nm) of the vessel's path within the previous 24 hours. Humpback whale sightings will be immediately communicated by marine radio to the dredging Contractor's dredge. In addition, the tug/barge or dredge operator shall maintain a 500 metre buffer between the vessel and any whale. The area designated as critical habitat in the Fausse Baie des Galions from the headland line out to 5 nm.

   If a stranded/injured/incapacitated whale is observed within the construction site, the Contractor is requested to immediately contact the NMFS Whale Stranding Network.

   It is important to note that the Employer will be discussing protection measures for whales and other endangered species with the ONE and the lending agency. Additional measures (if any) will be communicated to the Contractor with conditions of implementation.

3.16.2 Report Submission

The Contractor shall maintain a log detailing all incidents, including sightings, collisions with, injuries, or killing of whales occurring during the Contract period. The data shall be recorded on forms provided by the Employer.

3.17 PROTECTION OF SOUND INTRUSIONS

The Contractor shall keep construction activities under surveillance and control to minimize damage to the environment by noise.

3.18 POSTCONSTRUCTION CLEANUP

The Contractor shall clean up any area(s) used for construction.

3.19 PRESERVATION AND RESTORATION OF LANDSCAPE AND MARINE VEGETATION DAMAGES

The Contractor shall restore all landscape features and marine vegetation damaged or destroyed during construction operations outside the limits of the approved work areas. Such restoration shall be a part of the Environmental Protection Plan as defined in subparagraph “Environmental Protection Plan”. This work shall be accomplished at the Contractor’s expense. Special attention should be directed toward protecting fossilized dunes systems.

3.20 MAINTENANCE OF POLLUTION CONTROL FACILITIES

The Contractor shall maintain all constructed facilities and pollution control facilities and devices for the duration of the Contract or for that length of time construction activities create the particular pollutant.

3.21 GENERAL

3.21.1 Termination and Suspension for Breach of SHE

The Employer and the Contractor agree that the provisions of this Section are of the utmost importance, and any relevant violation of them shall be considered to be a material and substantial breach of this Contract.

The Contractor shall not cause, permit, or tolerate a hazardous, unsafe, unhealthy or environmentally unsound condition or activity over which it has control at the Site. If the Contractor becomes aware of any hazardous, unsafe, unhealthy or environmentally unsound condition, including a violation of any of the SHE Requirements, it shall immediately notify the Employer and take whatever steps are necessary and as shall be agreed between the Employer and the Contractor to eliminate, terminate, abate, and rectify the condition. If remedial action is not implemented within the agreed term, the Employer has the right to stop Work forthwith.

If the Contractor fails to take the necessary steps to cure that breach or violation promptly or to otherwise comply with this Clause, the Employer may exercise its rights of termination according to the default provisions of this Contract.

Should the Employer observe an unsafe act or become aware of a planned unsafe act, the Employer may direct the Contractor to cease, or not to proceed with, the unsafe Work. The Contractor shall, at the Contractor's own cost and risk, modify its Method of Work in order to work safely.

3.21.2 Conflict Between Standards

Where any conflict exists between the requirements of this Document, the Site Rules or Statutory Requirements/Regulations the higher standard shall apply unless such conflict is brought to the attention of the Employer and a direction provided. The Contractor shall be deemed to have allowed for the higher standard.

3.21.3 Rio Tinto Standards

All the procedures and standards that are to be prepared by the Contractor are to comply with the Rio Tinto SHE standards attached to this document as a minimum requirement. Should the Legislative or any other standard prescribed be of a higher standard, then that Procedure or Standard shall be applied.

-- End of Section --

ATTACHMENTS
A Contractor Monthly Safety Performance Report
B Rio Tinto Safety Standards (As applicable)
C Rio Tinto Health Standards (As applicable)
D Rio Tinto Environmental Standards (As applicable)
E Pre Task Hazard Assessment
F Engineering Manual 385 – Safety And Health Requirements
Us Army Corps Of Engineers
November 3, 2003
http://www.usace.army.mil Click on Publications

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Attachment A

Contractor Monthly Safety Performance Report

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ATTACHMENT A

CONTRACTOR MONTHLY
SAFETY PERFORMANCE REPORT
(To be reported by the end of second (2nd) day of the month for the previous month)

The following information relates to injuries which occur to Contractor's/Sub-Contractors' employees while working at a the Employer controlled site or office.

Month: ______________________ Year: ____________________
Contractor Name: ____
Contact Number: __________________ Facsimile: _______________

	Statistics
Total number of hours worked: (Hours Exposed)	
Total number of reported injuries, including Medical Treatments and Lost Time Injuries: (All)	
Number of Lost Time Injuries: (LTI)	
Number of Working Days lost due to Lost Time Injuries:	
Number of Serious Incidents:	
Total Number of Working Days due to be Worked:	
All-In-Injury Frequency Rate: AllFR = $\frac{\text{[All]}}{\text{Hours worked}}$ x 200,000	
Lost Time Injury Frequency Rate: LTIFR = $\frac{\text{[LTI]}}{\text{Hours worked}}$ x 200,000	
Severity Rate: Severity Rate = $\frac{\text{[Days Lost]}}{\text{Hours Worked}}$ x 200,000	

COMPLETED BY: ________________________________ Date: ____________
(Please Print)

____

(Signature)

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Attachment B

Rio Tinto Safety Standards
(As Applicable)

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A. MANAGEMENT SYSTEMS

A1. GENERAL SAFETY SYSTEMS

1.0 Scope

1.1 In order to satisfy this standard, a system must be:

(a) Documented in a clear and auditable form;
(b) Practical; and,
(c) Working effectively.

And it must also:

(d) Include procedures for periodic review and revision.

1.2 **Manager** means any person with the authority to assign work to another person.

2.0 Minimum requirements: performance management system

2.1 As part of the annual plan, every business, site and department must have in place a <u>safety improvement action plan</u> for eliminating all injuries in its operations.

2.2 Every employee must have:

(a) Targets setting out how they are expected to contribute to the <u>safety improvement action plan</u>.
(b) A formal meeting at least once a year with their managers in which these targets are agreed and documented; and,
(c) A formal meeting at least once a year with their managers in which their performance against targets is reviewed and an appropriate action plan agreed and documented.

2.3 Safety work behaviour must form part of an employee's performance review. If there is a variable compensation scheme in place, it must be designed so that safety cannot be compromised in order to maximise the financial reward.

2.4 There must be in place a fair and rigorous system for identifying and correcting inadequate safety performance.

3.0 Minimum requirements: safe work systems

3.1 There must be a system, based on risk assessment, for ensuring that effective controls and safe work procedures exist for all hazardous activities, including the safe handling and storage of hazardous substances and including emergency procedures.

3.2 There must be a system for ensuring that employees are trained and equipped to carry out their work according to the applicable safe work procedures, and that their competence has been tested.

3.3 There must be a system for ensuring that activities requiring technical certification are carried out only by suitably certified people.

3.4 There must be a system for ensuring the risks associated with aviation operations are controlled in accordance with the Rio Tinto Aviation Safety Guidelines.

3.5 There must be a system for practising emergency procedures.

3.6 There must be a system of first-party auditing carried out by line management, which verifies that all employees:

(a) Are competent, trained, equipped and, if required certified, to carry out their work in compliance with safe work procedures; and,
(b) Do in fact carry out their work in accordance with the applicable safe work procedures.

3.7 The first-party audit system must include:

(a) The collection, monitoring and analysis of audit data;
(b) The identification of the causes of unsafe acts and conditions; and,
(c) The implementation of actions to correct these causes.

4.0 Minimum requirements: safety incident investigation

4.1 A <u>safety incident</u> is an event or act, which results in an occupational injury, or illness or damage to physical assets or which might have done so. These safety incidents must be reported on the shift on which they occur.

4.2 There must be a system for risk evaluation of all <u>safety incidents</u>. Subsequent investigation of incidents must ensure that:

(a) A manager responsible for the activity or area in which the incident occurred carries out the investigation. S/he will involve other employees to ensure that all causal factors have been identified.
(b) The <u>root</u> causes of the incident are identified.

(c) The controllable causes are corrected so as to prevent recurrence.
(d) Details of the incident and the lessons from it are communicated and learnt.
(e) There is a process to confirm that (c) and (d) have been carried out.

5.0 Minimum requirements: safety organisation and communication system

5.1 There must be a safety organisation structure with the following elements:

(a) A safety committee which supports line management in developing and overseeing the safety improvement action plans.
(b) A structure of divisional and/or departmental safety committees which ensure coverage of all areas of the operation; and,
(c) A system to promote safety awareness and general communication such as a pre-shift safety briefing/huddle.

5.2 There must be a system for encouraging, collecting, evaluating, documenting, archiving and (as appropriate) implementing safety suggestions.

5.3 There must be a system for ensuring that relevant incidents, which have been reported by other operations on the Rio Tinto Safety Web Site, are communicated internally.

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A2 MANAGEMENT SYSTEMS

A2. CHANGE MANAGEMENT

1.0 Scope

1.1 Every business must have in place a system for ensuring that change does not cause injury to people or damage to physical assets. The business must define areas of high potential risk with respect to change, having regard to the fact that the change may be:

(a) Planned or unplanned; and,
(b) Sudden or gradual.

1.2 The system will include changes to:

(a) Plant and equipment.
(b) Processes.
(c) Operating procedures.
(d) Design and construction.
(e) Maintenance procedures.
(f) Materials used, their composition and properties.
(g) Feedstock used.
(h) Organisation structures and responsibilities.
(i) Personnel training or competency requirements.
(j) Programmable Electronic System software.
(k) Layout/architecture of mines/pits.
(l) Individual roles and responsibilities.
(m) Mine planning and ground control.
(n) Departure of contractors and hand over to Rio Tinto.

2.0 Identifying change

2.1 All employees and contractors must be trained and competent to identify what constitutes a change and how to initiate the change management procedure.

3.0 Proposals for change

3.1 There must be a system for approving proposed changes at the appropriate level in the organisation (see 4.1.(a))

3.2 All proposals for change must clearly identify:

(a) The current situation;
(b) The purpose of the change;
(c) The expected outcome from the change;
(d) The system to be used to test results of the change.

4.0 Assessment of proposals

4.1 All proposals for change must be assessed by a process including:

(a) Authorisation of the change by at least the same level of authority as authorised the original procedure;
(b) An appropriate level of technical expertise; and,
(c) The involvement of the workforce impacted by the proposed change.

4.2 The assessment must identify:

(a) All hazards associated with the proposed change;
(b) Control mechanisms to eliminate or minimise the risks;
(c) Standards to be used;
(d) Controls to be required;
(e) Further studies to be carried out, e.g. hazard studies;
(f) Regulatory requirements that must be met; and,
(g) If a change is subject to trial the duration and measures for the trial.

5.0 Implementation of change

5.1 Appropriate information on the change should be released and training provided related to the change to all those effected.

5.2 Prior to handing over a physical change for normal use, an acceptance check shall be carried out to ensure:

(a) The changes have been carried out in accordance with the authorised change proposal;
(b) All actions from the review process, including any studies called for have been satisfactorily completed and all outcomes included; and,
(c) The physical change has not introduced any unforeseen risks.

5.3 A formal review should be carried out in order to assess the actual impact of the change against the intended impact and the reasons for any deviation.

5.4 A system exists which allows for the revision of drawings, operating procedures, maintenance and emergency procedures.

6.0 Emergency Change Procedure

6.1 There must also be a contingency procedure to cover situations in which proposed changes cannot be subject to the full procedure. Such a procedure must incorporate the approval of the site manager or his/her designated deputy.

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A: MANAGEMENT SYSTEMS

A3. CONTRACTOR MANAGEMENT

1.0 Scope

1.1 For the purposes of this standard, contractors fall into three categories:

Cat. 1 Individuals engaged on temporary contracts to work within existing operations.

Cat. 2 Companies or individuals engaged for a discrete project.

Cat. 3 Companies or individuals engaged under contract to carry out specific tasks or provide specified services within existing operations areas.

1.2 In this standard, the company employing the contractor is referred to as the Owner.

2.0 Rules that apply to all contractors

2.1 For all contractors there must be an on site manager who is responsible for ensuring the effectiveness of the contractor safety management system in relation to that contract.

2.2 Before work begins on any contract all contractor personnel must be given appropriate orientation and induction training including emergency procedure drills. It must be confirmed that all tools and equipment to be used are in a safe condition.

3.0 Rules that apply to Category 1 contractors

3.1 Category 1 contractors are to be treated in all aspects of safety as if they were employees.

4.0 Rules that apply to Category 2 contractors

4.1 Category 2 contractors are engaged in projects, which will be carried out in a designated area that is separate from existing operations. Contractors within this category are independent of the Owner and are responsible to the Owner for carrying out their contracted work safely and in compliance with applicable regulatory requirements. They must have in place appropriate systems and supervision. The Owner's responsibility is to ensure that the contractor's safety duties are embedded in the contract and to use an audit process to see that the contractor carries out its safety duties in accordance with the contract and with applicable regulatory requirements.

4.2 For Category 2 contractors, the Owner must have a contractor safety management procedure that contains, as a minimum, provisions for the following elements:

4.2.1 **Pre-qualification of Contractor.** Wherever practical, the Owner should prepare a list of contractors whose safety performance warrants their being placed on a pre-qualified list of suitable contractors.

4.2.2 **Pre-bid Meeting/Discussions.** The Owner must conduct a pre-bid meeting with contractors to inform them of the scope of the project or contract and to discuss the potential HSE hazards it may involve.

4.2.3 **Bid Documents.** Contractors' bid documents must include a site-specific safety plan that identifies and addresses safety hazards.

4.2.4 **Selection.** The bid assessment must include consideration of the contractor's safety plan and its ability to implement the plan. Safety considerations shall receive no less weight than other considerations such as costs and technical capabilities.

4.2.5 **Contract Terms.** The contract document must contain provisions covering safety including such provisions as the contractor's responsibility to comply with the owner's safety policy, rules and procedures, all applicable laws, demonstration of adequate levels of insurance for worker's compensation and general liability, indemnification agreement and termination clause or penalties for lack of performance in safety.

4.2.6 **Pre-job Conference.** The Owner must conduct a pre-job conference with the successful bidder to review safety expectations and other requirements based on the site-specific HSE plan including the reporting of injuries or incidents.

4.2.7 **Monitoring and Evaluation.** The Owner must monitor the contractors' work and carry out formal reviews with them that include safety performance. Action plans will be agreed and documented to correct areas of under-performance.

4.2.8 **Feedback.** Safety performance records must be kept and used in future selection processes. The on going validity of the retained data needs to be assessed before it is used.

5.0 Rules that Apply to Category 3 Contractors

5.1 The tasks or services carried out by Category 3 contractors involve working in existing operations areas. The responsibility of the Owner varies according to the nature of the work and its location. Consequently, the Owner must apply the rules set out in section 4.0 as appropriate. In addition, where the contractor(s) are carrying out hazardous work or working in hazardous areas, there must be a permit to work system.

5.2 The permit to work must:

(a) Set out the work to be done, the hazards identified and the required safe work procedures;
(b) Be reviewed every shift and reissued if a change in conditions or work scope has occurred;
(c) Be signed by a designated manager for the current shift who is the person with responsibility for the geographical area or task in which the contractors are to work and/or by a designated competent authority if in a specialised field such as CO gas management.

5.3 The designated manager must:

(a) Ensure that, where practical, the contractor's work area is clearly demarcated;
(b) Ensure that the permit to work is available for inspection at the workplace;
(c) Monitor the contractors' work to check compliance with the permit conditions;
(d) Record and report any safety incidents as for employees in the area; and,
(e) Capture and act on safety improvement ideas.

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B: RECORDING AND REPORTING

B1. INJURY AND INCIDENT RECORDING AND REPORTING

1.0 Scope

1.1 This standard sets out:

- The Rio Tinto definitions of injuries, injury rates and incidents; and,
- Requirements for recording and reporting of injuries or incidents involving employees (permanent and temporary) and contractors.

2.0 Rio Tinto Definitions

2.1 **Lost time injuries** (LTIs) are the sum of lost day injuries and restricted work duty injuries.

(a) **A lost day injury** (LDI) is an occupational injury that results in one or more days away from work. A fatal injury is counted as a lost day injury.

(b) **A restricted work duty injury** (RWDI) is an occupational injury where, as a result, (1) the employee was assigned to another job on a temporary basis, or (2) the employee worked at a permanent job less than full time, or (3) the employee worked at his or her permanently assigned job but could not perform all the duties normally connected with it.

Restricted work activity occurs when the employee, because of the job-related injury, is physically or mentally unable to perform all or any **part** of his or her normal assignment during **all or any part** of the normal workday or shift.

2.2 **A medical treatment case** (MTC) is an occupational injury which is not classified as a lost time injury, but which results in loss of consciousness or medical treatment other than first aid.

2.3 **All injuries** (AI) are the sum of lost time injuries and medical treatment cases.

2.4 **Shifts/days lost** are the ACTUAL number of shifts/days a person was unable to work due to an occupational injury i.e. the sum of days away from work (DAW) and those on restricted work duties (RWD). If a person is unable to return to his normal job after two years, the injury is considered a permanent injury and no further "shifts/days lost" are recorded. The injury is reclassified as Permanent Damage Injury (PDI). There will be no shifts/days lost accumulated for a fatality or PDI.

2.5 A **Permanent Damage Injury (PDI)** is any occupational injury:

(a) From which there has not been, or is not expected to be, full recovery after two years.

(b) Which has substantial negative consequences for the individual e.g. prolonged hospitalisation, prolonged inability to work, loss of ability to continue normal social and home life, major damage to body or body function. All amputations are PDIs.

2.6 The **Hours of Exposure** is the total number of hours worked by all employees (permanent or temporary) and contractors in the reporting period.

2.7 **Lost Time Injury Frequency Rate (LTIFR)** is the rate of occurrence of LTIs per 200,000 hours worked:

$$\frac{\text{Number of LTIs x 200,000}}{\text{Hours of exposure}}$$

2.8 **Lost Time Injury Severity Rate (LTISR)** is the rate at which normal rostered workdays or shifts are lost as a consequence of LTIs per 200,000 hours worked:

$$\frac{\text{Number of lost shifts x 200,000}}{\text{Hours of exposure}}$$

2.9 **All Injury Frequency Rate (AIR)** is the rate of occurrence of All Injuries per 200,000 hours worked:

$$\frac{\text{Number of All Injuries x 200,000}}{\text{Hours of exposure}}$$

2.10 A **Significant Incident** is any incident which has actual or potential health, safety (or environmental) consequences that are of a serious nature and have the possibility to cause actual or potential material or reputational damage to the operation or to Rio Tinto.

2.11 **Rio Tinto Injury Statistics** are the monthly returns of:

(a) Fatalities
(b) Lost Time Injuries
(c) Medical Treatment Cases
(d) Permanent Damage Injuries
(e) Shifts Lost
(f) Severity

for all contractors and employees.

3.0 Injury and Incident Reporting and Recording

3.1 There must be in place a system whereby:

(a) All injuries are reported to the line manager responsible immediately.
(b) The line manager must record all material details of the injury or incident as required by local regulation, in a timely manner, in an appropriate log and ensure that the person responsible for HSE record keeping is informed.
(c) The HSE record-keeper must ensure that all internal and external reporting requirements are satisfied and that the injury or incident is correctly classified for internal and external purposes.
(d) Significant incidents are reported to the senior site manager as soon as possible and certainly within 12 hours of the occurrence.

3.2 There must be a system for ensuring that **Rio Tinto Injury Statistics** are supplied to Rio Tinto on the forms, in the manner and by the deadline prescribed from time to time.

3.3 There must be in place a system for recording and reporting all incidents involving injury, damage to property or damage to the environment or the potential for such injury or damage. This system must satisfy applicable regulatory requirements.

3.4 There must be in place a system for ensuring that a written report of Significant Incidents are submitted to the Chief Executive of Rio Tinto, with a copy to the Product Group Chief Executive, within 24 hours of their occurrence.

3.5 There must be a system for ensuring that safety incidents of relevance to other Group operations are posted on the Rio Tinto safety web site within seven days of their occurrence.

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C: OPERATIONS STANDARDS

C1. ISOLATION

1.0 Scope

1.1 This standard applies to all sources of hazardous energy and hazardous substances.

1.2 **Hazardous energy**: Electrical, Pneumatic, Hydraulic, Stored (springs, batteries), Potential (by virtue of position), Heat (hot water, steam), Radiation.

1.3 **Hazardous substances**: Gases, Vapours, Liquids, Dusts with the potential to cause injury or illness, e.g. toxic, corrosive, flammable.

1.4 **Isolation Officer**: Whenever a piece of plant or equipment is to be isolated, there must be a person designated to carry out the Isolation Procedure. That person is referred to as the Isolation Officer. No person may be designated as the Isolation Officer for a piece of equipment unless s/he has been trained, tested and certified as competent to carry out the Isolation Procedure for that piece of plant or equipment. Tests for voltage, for example, require competency in electrical work as outlined in the electrical standard.

1.5 **Isolation Procedure**: All designated systems, plant and equipment must have written procedures for isolation (see Rio Tinto Standard A1.3.1). This procedure will set out how the system, plant or equipment is to be made safe and kept safe. It will include, for example: decontamination; venting of stored energy; securing of rotors or fan blades; chocking of vehicles; and disconnecting, blocking or bleeding of equipment, cables, pipes and vessels. It will show any connections to Distributed Control Systems. It will also show the isolation points for lockout and test procedures**.**

2.0 Isolation Officer's Responsibility

2.1 Before any work is begun on or in a system, plant or equipment, the Isolation Officer must first ensure that it is made safe in accordance with the **Isolation Procedure**.

2.2 The Isolation Officer's **Lock** and **Identification Tag** must be the first to be applied and the last to be removed.

2.3 (a) The Isolation Officer's lock must be a master series lock since it will remain on the plant or equipment when handing over to subsequent shifts. Keys to the Isolation Officer's lock must only be held by other designated Isolation Officers for that plant or equipment.

(b) Where isolation involves only one person on jobs to be completed within a single shift and where it is not appropriate for a master series lock to be utilised, the person must be an Isolation Officer and s/he must apply his/her personal lock and identification tag.

2.4 After locking and tagging, the Isolation Officer must **Clear** the area of personnel before a **Trial** step to ensure that the plant or equipment has been isolated.

2.5 In the case of electrical isolation, a **Test** for voltage must be carried out, after the switching device, to ensure the absence of voltage.

2.6 Where there is a need for work to extend over multiple shifts or where there are large numbers of people involved in the work (such as large maintenance projects) then a project isolation procedure can be implemented. This procedure must, however, have the requirements that personal locks must be used for each person working on the project, an Isolation Officer's control lock is in place and this control lock cannot be unlocked without all personal locks being removed.

3.0 Everyone's Responsibility

3.1 Everyone, including the Isolation Officer, who has to perform work on the plant, equipment or system, must first apply a personal lock and identification tag in accordance with the Isolation Procedure.

3.2 Personal locks must be such that they can only be unlocked by their owner.

3.3 Personal locks may never be removed other than by the person to whom they belong, other than in the presence of and under the supervision of the Department or Area Manager or his/her appointed nominee, and in accordance with a written procedure.

C2. ELECTRICAL SAFETY

C: OPERATIONS STANDARDS

1.0 Scope

1.1 This standard applies to all electrical work above 110 volts DC or 32 volts AC.

2.0 Competency Standards and Safe Work Procedures

2.1 There shall be electrical competency standards and safe work procedures for all electrical work, i.e. construction, decommissioning and demolition of electrical equipment.

2.2 The competency standards shall specify the frequency for re-certification, which shall be no less than every two years.

2.3 All electrical installation work shall be conducted by competent personnel in accordance with governing regulation, code, design criteria and safe work procedures.

3.0 Electrical Equipment

3.1 Electrical safety devices such as earth leakage and overload protection shall be installed on all final distribution circuits and the settings established by qualified personnel.

3.2 Electrical equipment, grounding continuity and electrical safety devices shall be inspected and/or tested on a suitable schedule and the findings recorded.

3.3 There must be a system for removing electrical equipment unfit or unsafe for purpose.

3.4 There must be a system for maintaining an up-to-date set of single line diagrams. The diagrams will show: system fault calculations; equipment details; electrical protection discrimination curves; and cable ratings.

4.0 Isolation and Access

4.1 Equipment shall be isolated in accordance with the site Isolation Procedure (see Rio Tinto Standard C.1 Isolation). Where it is necessary to work on live equipment for the purposes of troubleshooting or testing, such work must be carried out according to a written safe work procedure.

4.2 Electrical panels, enclosures, control centres, substations and equipment shall be appropriately guarded, labelled, and made inaccessible (except for emergency shut off mechanisms) to unauthorised personnel. Areas containing such equipment are ‘controlled areas’.

4.3 Where it is necessary for untrained personnel (e.g. visitors) to enter controlled areas there shall be a system for communicating the hazards and for escorting them with appropriately trained personnel. Contractors must have a permit to work in controlled areas.

4.4 Employees and contractors exposed to electrical hazards shall receive electrical hazard training at the commencement of their employment and thereafter on an annual basis.

C: OPERATIONS STANDARDS

C3. VEHICLES AND DRIVING

1.0 Scope

1.1 This standard applies to all vehicles, including mobile mining equipment, owned and operated by Rio Tinto or its contractors, which are used on Rio Tinto sites or off-site for Rio Tinto business purposes.

2.0 Risk Analysis

2.1 A comprehensive risk analysis shall be conducted to clearly identify the conditional and behavioural factors that impact vehicles and driving safety. The risk analysis must cover all aspects of vehicles and driving and will have up-to-date action plans in place to manage identified issues.

3.0 Vehicles

3.1 All vehicles used for work purposes must be subject to a risk assessment. The assessment must:

(a) Involve operators and maintainers who will use the equipment; and,
(b) Address all aspects of safe operation including handling, driver vision, brake failure, tyre blow out and access/egress for operators and maintainers.

3.2 All vehicles driven for work purposes must be subject to an appropriate pre-operation safety check based on a risk assessment.

3.3 All vehicles used for work purposes must be fitted with fixed seats and safety belts for driver and all passengers unless the risk assessment specifies otherwise.

3.4 All light vehicles used for work purposes must comply with all aspects of the Rio Tinto Light Vehicle Guidelines unless the risk assessment specifies otherwise.

3.5 All vehicles used for work purposes that are capable of exceeding the lowest applicable speed limit must be fitted with a speedometer.

4.0 Training and Licensing

4.1 No person may drive a vehicle unless they are trained, competent, tested and licensed to operate that vehicle. The training must address hazards assessed for (a) that vehicle and (b) the tasks for which it is to be used.

4.2 All persons required to drive/operate vehicles on site must have a site license to operate those vehicles. A state or civil driving license is an approved alternative except where (a) there is a need for a specific set of Company rules/procedures (for example, in a pit area where a pit license or permit is required) or (b) the state or civil licence does not apply to the class of vehicle being driven.

4.3 The Manager shall have a system in place to ensure that the renewal of licenses will be based on an assessment of competency to drive and or operate the equipment. The frequency of assessment will be either annual, or derived from a risk assessment for each vehicle type.

4.4 A system shall be in place that limits the number of people that drive in an open pit. In addition, because of the constant change in conditions, no person shall be licensed to drive in an open pit unless they are required to do so more than once in a two week period.

5.0 Traffic Rules

5.1 The driver and all passengers must wear their seat belts, where fitted, at all times.

5.2 Speed limits and traffic rules must be reviewed regularly and rigorously enforced.

5.3 There must be rules to ensure that:

(a) No vehicle approaches within 50 metres of a shovel, dozer or drag line without first making positive contact with the operator of that equipment.

(b) The interaction between heavy and light vehicles is controlled.

(c) If site rules permit overtaking in the pit area, then no vehicle will overtake a haul truck or water truck before making positive contact with the driver.

(d) No vehicle tows equipment unless it is engineered to do so.

C: OPERATIONS STANDARDS

C4. WORKING AT HEIGHTS

1.0 Scope

1.1 This standard applies to any task where the risk assessment highlights a danger of falling. In any case, fall prevention or protection shall be used for elevated work above 1.8 meters.

1.2 **Fall prevention.** Wherever practical, a safe working area must be provided by means of work platforms or scaffolds. Fall Prevention standards are set out below.

1.3 **Fall protection.** In all other cases, Fall Protection must be used. This includes situations in which work is being carried out from an elevating work platform or manlift. Fall protection standards are set out below.

1.4 **Ladders.** A person may climb or descend a ladder without Fall Protection provided that they are able to use both hands and legs to do so; face the ladder and use one step at a time. Ladders shall be tied off or supported below.

1.5 **Barricades**. Where overhead work is being conducted, barricades must be erected around the work area to protect others below from falling objects.

2.0 Fall Prevention

2.1 Work platforms and scaffolds must have complete floors, guardrails and toe-boards and safe access and egress must be provided.

2.2 A person must be designated to control the work platform, scissor lift or man-lift ("the basket"), who is trained and competent to do so and qualified as required under local regulations.

2.3 Where practical, the designated person should be in the 'basket'.

2.4 Every person in the 'basket' must be secured at all times with proper Fall Protection equipment and there must be systems in place to prevent tools and equipment from falling.

2.5 There shall be a system for ensuring the design, construction, certification, maintenance and inspection of elevating work platforms and man-lifts.

3.0 Fall Protection

3.1 A person has Fall Protection if s/he is secured with an approved full body harness, shock absorbing lanyard (where the potential to fall is greater than 4 meters) or short restraining lanyards (where the potential to fall is less than 4 meters), self-locking snap hooks (or carrabiner type rings) and secure anchorage points.

3.2 Anchorage points must, where practical, be above the head of the worker, and must ensure that in the event of a fall the worker will neither swing nor touch the ground.

3.3 There must be a system for ensuring that anchorage points are tested and approved by a competent person to ensure that they are secure and can take the required load.

3.4 There must be a system for ensuring that Fall Protection equipment is:

(a) Tested and certified for use;
(b) Inspected by the user before use; and,
(c) Destroyed following a fall or where inspection has shown evidence of excessive wear or mechanical malfunction.

3.5 There must be a system for preparing and testing emergency rescue procedures for fall victims.

C: OPERATIONS STANDARDS

C5. CONFINED SPACES

1.0 Scope

1.1 **Confined space** is an enclosed or partially enclosed space that:

(a) Has been identified as such in a risk assessment;
(b) Is not intended or designed primarily as place of work;
(c) May have restricted entry and exit; and,
(d) May:

(i) Have an atmosphere which contains potentially harmful levels of contaminant;
(ii) Not have a safe level of oxygen e.g. following a nitrogen purge; or
(iii) Cause entrapment or engulfment.

1.2 Confined spaces may include, but are not limited to:

(a) Storage tanks, process vessels, boilers, pressure vessels, tank-like compartments that have only a manhole for entry, ceiling and floor spaces;
(b) Open-topped spaces such as pits, or grease traps, or excavations more than 1.5 metres deep;
(c) Pipes, pumps, sewers, shafts, ducts, drains, tunnels, cellars, basements and similar structures; and,
(d) Abandoned workings and exploration adits.

1.3 **Contaminant** is any dust, fume, mist, vapour, gas, or other substance in liquid or solid form, the presence of which may be harmful to health and safety.

1.4 **Entry to confined space** occurs when a person's whole body, upper body or head is within the confined space. However, this is not intended to prevent a person from inserting their hand or arm while holding a test instrument or probe into a confined space as part of the evaluation procedure provided that this procedure is duly authorised.

2.0 Identification

2.1 Confined spaces must be identified and signs erected at the entry points denoting that a permit is required prior to entry. Where signage is impractical, for example with adits other means of highlighting the dangers need to be used.

3.0 Permit System

3.1 Entry to a confined space must only be allowed after a written approval, in the form of a permit, has been issued by a competent person, whom is authorised to issue such permits.

3.2 The permitting process must include the following elements:

(a) a risk assessment, including the need for a competent person to assess such things as oxygen levels, contaminants, temperature extremes, and concentrations of flammable substances;
(b) isolation procedures for contaminants and other energy sources;
(c) the requirement for breathing apparatus;
(d) the sign-in and sign-out of all persons entering the confined space;
(e) display of the permit;
(f) communication equipment;
(g) safety specification of equipment to be taken into the confined space;
(h) barricading;
(i) rescue plan and equipment;
(j) standby person; and,
(k) a completion procedure.

4.0 Other Requirements

4.1 All persons required to work in a confined space, or to act as a standby person, must be trained, competent and tested.

4.2 Specific safe work procedures must be developed for work activities that are more hazardous when carried out in a confined space than elsewhere. These activities would include hot work (cutting and welding), chemical cleaning, steam cleaning, and abrasive blasting.

4.3 The standby person will have no other duties and is to be positioned outside the confined space entry point at all times while personnel are within the space.

4.4 Where the risk assessment has identified the need for ventilation, then this must be covered by a documented procedure.

C: OPERATIONS STANDARDS

C6. CRANES AND LIFTING EQUIPMENT

1.0 Scope

1.1 This standard applies to all cranes including vehicle-mounted cranes, equipment used as cranes, hoists, lifting and rigging equipment. The standard does not apply to hoisting operations in underground mines.

2.0 Planning

2.1 Each operation must develop a register of critical lifts and a documented plan for each critical lift to address the associated hazards. Critical lifts include all multiple crane lifts; lifts over operating facilities where this may endanger personnel; lifts over power lines; lifts involving personnel cages; and lifts at maximum rated loads. The lift plan must include:

- **Lift data**: equipment weight, rigging weight, total weight, height of lift, radius of lift and equipment surface area, center of gravity.
- **Equipment data**: manufacturer, model, size, boom length, jib length, load block, material size.
- **Rigging data:** sling diameter, length, sling configuration, capacity, hook type, shackle size and capacity.
- **Lift computation:** boom length, radius of lift, equipment capacity, size of outrigger footplates, and wind speed.
- **Proximity to power lines and process areas**: mobile cranes working in proximity to energised power lines must operate under a proximity permit, which must define exclusion zones and spotter duties.
- **Local hazards and their controls**: including the route for the crane, ground stability, proximity of people or equipment and agreed communication method.

2.2 Crane drivers and rigging crews involved in critical lifts must have input into the lifting plan and be consulted prior to finalisation of the plan.

2.3 Lifts not subject to detailed lift plans must be subject to a risk assessment.

2.4 Where practicable or where the weight of a lift is uncertain, cranes should be fitted with a load cell with the weight of the load displayed in the visual range of the operator.

2.5 Where practicable, cranes should be equipped with an anti two-block device or limit switch that includes audible and visual alarms.

3.0 Operation

3.1 There must be a documented process that ensures all critical components are inspected and in place prior to a crane being commissioned and put into service.

3.2 Crane operators must undertake a pre-operational safety check for each shift the crane is used and this should be kept with the crane. The detail required in the pre-operational safety check must be based on a risk assessment for the crane.

3.3 A crane must not be operated with an inoperable or defective safety device.

3.4 There must be documented procedures that require:

- All rigging connections to be checked and correct prior to commencing a lift.
- Checks that the load being lifted is within the rated capacity of the crane and lifting attachments and is also within the limits set out in the lift plan.
- Checks of all safety devices or overload limiters to ensure they are not overridden or cut out.

3.5 All lifting hooks (except for grab and chain shortening hooks) will be fitted with a safety latch to prevent the load from accidentally detaching, unless otherwise specified in a risk assessment.

3.6 Loads must not swing over people or occupied buildings and no person shall be under a suspended load or in a position where they could be struck by a falling load. Where there is a risk of a load falling and striking a person, barricading or similar controls to prevent access must be in place.

3.7 The operator shall not leave the crane controls while a load is suspended.

3.8 Overhead travelling cranes must be fitted with audible travel alarms or an equivalent warning device.

3.9 Tag lines must be attached to loads that require steadying or guidance while suspended. The load must be well secured and properly balanced in the sling or lifting device.

3.10 There must be a documented and approved method for communication between the crane driver and those assisting with the lift.

3.11 A procedure must be in place to prevent the use of lifting or rigging equipment in lifting operations if such equipment has been used for towing.

3.12 Mobile cranes must have a rating capacity chart fixed in a position visible to the crane operator or available in the crane cabin.

3.13 Operator control stations for vehicle-mounted cranes must be located in an area protected from swinging loads and from the crane jib.

3.14 Slew pins must be secured in place in mobile cranes while travelling.

3.15 Slewing to test the integrity of outriggers on mobile cranes must be conducted prior to commencing lifts.

4.0 Maintenance and Inspection

4.1 A register of cranes, hoists, rigging attachments and lifting slings must be established.

4.2 Any crane brought to site must have a current test certificate and a pre-use safety inspection to ensure the crane is fit for purpose. As a minimum, this inspection must satisfy regulatory and manufacturer requirements for frequency of inspection and physical condition of the machine.

4.3 There must be a system for the inspection, maintenance and approval of lifting equipment, including a process that verifies the equipment is able to function to its design specifications and the integrity of:

- Mechanical and electrical components.
- Controls for each piece of lifting or rigging equipment.
- Crane cables and all lifting attachments.
- Structural components of the hoist, brakes, wheels, hooks, hook-blocks and rails.
- Integrity of load limiting devices, safety devices, limit switches and control systems required for individual equipment e.g. independent fail-safe braking systems, a device to stop the crane such as a "dead-persons" switch, and emergency shut-off switch.

4.4 Inspections and repairs to cranes, cables and lifting equipment must comply with the manufacturers specifications and regulatory requirements as a minimum.

4.5 Records of maintenance inspections and cable tests must be kept.

5.0 Training

5.1 Personnel must be trained, competent and authorised if they operate cranes; set-up or rig loads; provide signals for controlling lifts; or inspect, maintain or test cranes, hoists, personnel cages, lifting or rigging equipment.

5.2 There must be a system for establishing minimum operating time, frequency of operation and testing to ensure competency for each class of crane.

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Attachment C

Rio Tinto Health Standards (As Applicable)

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RIO TINTO

OCCUPATIONAL HEALTH STANDARDS

TABLE OF CONTENTS

Definitions

- **Full implementation** of the Rio Tinto Occupational Health Standards (by end 2004) is taken to mean that for operations:

  a) risk assessments have been carried out;

  b) control systems that protect health are in place and being maintained;

  c) health improvement strategies are in place;

  d) human and financial resources are allocated; and

  e) the business is working through the plan to address remaining issues.

- A **safety critical job** is defined as one in which there is a potential for serious injury or death, significant equipment / plant damage, or significant environmental impact, where "significant" encompasses high or critical issues as defined in the Rio Tinto Six-monthly report guideline “Priority and Definition of Incidents and Issues” table. A haul truck driver job would fall into this category.

- A **Category 1 contractor** is defined as per Safety Standard A3: individuals engaged on temporary contracts to work within existing operations (ie, those contractors, such as say a mechanical fitter, you take on to do work alongside your employees for a period of time).

- **Competent person** is defined as a person who has acquired through training, qualification or experience, or a combination of these, the knowledge and skills, including OH&S knowledge and skills, qualifying that person to perform the task required.

- **Biological testing or monitoring** involves the measurement of the concentration of chemicals, a metabolite or a biochemical change in body fluids such as saliva, blood and urine. May also involve measurement of the concentration of a chemical in exhaled breath (eg. CO).

- **High priority hazardous substances** are those that are extremely dangerous by the fact of their: Being capable of causing death on short or continuous exposure; Being capable of causing serious temporary or permanent injury on short exposure; Being likely to rapidly or completely vaporise or ignite under almost all ambient temperatures; Being likely to detonate or decompose explosively; Requiring special handling, storage or fire fighting precautions.

The Standards, Information and Guidance (OHIGs), Best Practices, References and Incidents are available on the Rio Tinto HSE Portal at :

http://portal.riotinto.org

Occupational Health Discussions are available at
http://rtcf.riotinto.org/riotinto/dispatch.cgi/f.occupationa/

Scoring system:

Score	Meaning
NA	Not applicable[1]
0	Element not yet addressed
1	Gap analysis and broad-brush risk assessment completed, and in action plan
2	Documented in site OH&S management system, but not effectively used; or informally implemented without sufficient documentation
3	Risks assessed and protective action plans implemented
4	Fully implemented with engineering controls of risks demonstrably used where practicable, based on good quantitative risk assessment
5	External audit shows fully integrated into work procedures and culture

[1] Usually only applies to the performance standards (ie. 'B' standards), or those standards for which a variance form has been authorised.

Priority and Definition of OH Standard Clauses / Issues

LOW • Low probability of event occurring with a low consequence of harm to. • Improvement required in: existing system; public perception. • Required to position Operation for: anticipatory aspects of policy and regulatory changes; trends in community expectations.	• Incident with potential for first aid treatment e.g. cuts and abrasions, minor irritations of eyes, throat, nose and or skin, or minor unaccustomed muscular discomfort. • Procedural issue e.g. record keeping failure that is not likely to compromise compliance.
MODERATE • Probability of event occurring with a low consequence to people. • Low probability of event occurring with a high consequence of harm to people. • Required to position Operation: for closure; for impending legislation; to meet current HSE management objectives.	• Incident with potential for medical treatment injury e.g. furnace fume leakage resulting in exposures approaching standard. • Reversible health effects of concern e.g. back strain and over-use syndrome. • Reversible injuries of concern e.g. extreme temperature effects and moderate irritation of eyes, throat, nose and/or skin, fractured foot or hand. • Record keeping failure compromising compliance. • Failure to characterise workplace exposures where exposures are not likely to exceed limit.

Priority and Definition of OH Standard Clauses / Issues

HIGH • Probability of event occurring with potential for harm: to people; operational integrity. • Negative public perception. • Non-compliance or compliance being compromised. • Potential to deteriorate to a critical situation. • Issue which could have wider Rio Tinto Group implications. • Required to position Operation for imminent closure.	• **Serious injury or potential for fatality from incident e.g. vehicle collision or fall from height, any fracture or dislocation other than of hand or foot, cuts requiring suturing, loss of consciousness.** • **Persisting exposure over the Rio Tinto or local exposure standard.** • **Potential for long-term chronic health effects for workers or members of the public e.g. noise induced hearing loss, occupational asthma, metals toxicity or post-traumatic stress reactions.** • **Failure to quantify exposures to carcinogens, reproductive toxicants or to substances having chronic health effects (could be critical if exposures considered to have potential to lead to potential long term harm).** • **Permanent change of job as a consequence of occupational disease or injury.** • **Injury or harm to community member, as a result of operations, that requires hospitalisation.**

Priority and Definition of OH Standard Clauses / Issues

CRITICAL • Probability of event occurring with significant harm to people; operational integrity. • Loss of company credibility with key audiences. • Non-compliance with likelihood of prosecution. • Issue which could close operations prematurely.	• **Likely fatality or potential for multiple fatalities e.g. process plant explosion.** • **Potential for significant permanent disability e.g. paraplegia, amputation of limb above toes/fingers, lung disease or blindness.** • **Chronic health effects leading to a reduction in lifespan for workers or members of the public e.g. silicosis.** • **Persisting workplace over-exposure to reproductive toxicants, carcinogens or asbestos.** • **Occupational disease requiring medical retirement.** • **Permanent harm or fatality to community member as a result of operations.**

A1. GENERAL OCCUPATIONAL HEALTH SYSTEMS

1.0 Scope

In order to satisfy this Standard, a system must:

(a) Be documented in a clear and auditable form;

(b) Be practical;

(c) Be working effectively; and

(d) Include procedures for periodic review and revision.

2.0 Legal Requirements

All regulatory requirements must be met.

(a) A list of current occupational health regulatory requirements, including external reporting requirements, must be available.

(b) The list must detail site responsibilities for compliance.

(c) Local regulatory standards and requirements will take precedence over these (Rio Tinto) Standards, except in those cases where the Rio Tinto Standards provide a more strict standard.

Priority = M or H	Score = 0 1 2 3 or 4

3.0 Minimum requirements: health management system

3.1 Every Business and site must have an occupational health policy (either separate or integral with safety and/or environment) and an occupational health strategy, consistent with the Rio Tinto statement of business practice, "The way we work", and the Occupational Health Strategy documents. Both policy and strategy must:

(a) Address key occupational health issues relevant to the facility's products and operations;

(b) Guide the setting of objectives and targets;

(c) Be endorsed by current management;

(d) Be subject to regular review;

(e) Be readily available to employees and contractors;

(f) Establish the priority of occupational health protection in relation to other business goals; and

(g) Ensure that occupational health/hygiene responsibilities and accountabilities are defined, designated, documented and communicated.

Priority = M or H	Score = 0 1 2 3 or 4

3.2 As part of the Annual Management Plan, every Business and site must have in place an <u>occupational health improvement action plan</u> for preventing all new occupational illnesses in its operations. This plan must:

(a) Be integrated into operational planning and procedures, such that adequate resources are allocated and performance is monitored; and

(b) Cover objectives, responsibilities, timing, priorities, deliverables and resources.

Priority = M	Score = 0 1 2 3 or 4

3.3 Every employee must have:

(a) Targets setting out how they are expected to contribute to the <u>occupational health improvement action plan</u>;

(b) A formal meeting at least once a year with their immediate manager in which these targets are agreed and documented; and

(c) A formal meeting at least once a year with their immediate manager in which their performance against targets is reviewed and an appropriate action plan agreed and documented.

Priority = M	Score = 0 1 2 3 or 4

3.4 Priority site occupational health issues must be addressed and documented in site work procedures. These must be available to all employees and contractors, and inform them of their occupational health responsibilities.

Priority = M	Score = 0 1 2 3 or 4

3.5 There must be in place a system for identifying and correcting inadequate occupational health performance. Consistent with local medical confidentiality laws, incidents and health anomalies must be recorded and analysed.

Priority = M	Score = 0 1 2 3 or 4

4.0 Minimum requirements: work systems that do not compromise health

4.1 There must be a system to minimise exposure to hazardous substances, physical agents and activities.♣ The system must be based on risk assessment and ensure that effective controls exist for hazardous activities.

Priority = M H or C	Score = 0 1 2 3 or 4

♣ Note that detailed information is provided in the *Rio Tinto Hazard Management Guidelines* document.

4.2 There must be a system for ensuring that employees are trained and equipped to carry out their work according to applicable work procedures that minimise exposure to hazards, and that their understanding and capability of this has been evaluated. Requirements for avoiding or minimising occupational health risks must be integrated into skills training.

Priority = M	Score = 0 1 2 3 or 4

4.3 All plant and equipment must be designed, operated and maintained throughout life so as to minimise adverse health exposures.

Priority = M or H	Score = 0 1 2 3 or 4

4.4 Each Business and site must have an audit system consistent with the Group HSE Policy and Objectives, and guidelines, to verify conformance with these standards.

Priority = M	Score = 0 1 2 3 or 4

5.0 Minimum requirements: health organisation and communication system

5.1 There must be an occupational health organisation structure with the following elements:

(a) A management coordination role must be designated for occupational health, with clearly defined accountabilities;

(b) A committee that supports line management in developing and overseeing the occupational health and safety (OH&S) improvement action plans;

(c) A structure of divisional and/or departmental committees which ensures occupational health coverage of all areas of the operation; and

(d) A system to promote OH&S awareness.

Priority = M	Score = 0 1 2 3 or 4

5.2 All Businesses must have access to the services of a medical adviser and an occupational (or industrial) hygiene adviser. A system to ensure their knowledge remains current is required.

Priority = M	Score = 0 1 2 3 or 4

5.3 There must be an induction process for new employees and contractors addressing possible occupational health issues. Understanding of their awareness must be evaluated.

Priority = M	Score = 0 1 2 3 or 4

5.4 An annual summary of occupational hygiene and medical monitoring results must be maintained for all areas where a risk assessment has indicated the need for those investigations. As a minimum the occupational hygiene summary must include the mean and 95 percentile results for each exposure group, the appropriate exposure limits against which to judge these results and a summary of the effectiveness of any work during the year to reduce exposures. As a minimum the medical monitoring summary must summarise, without identifying individuals, the monitoring results and draw attention to any new cases of illness or adverse trends.

Priority = M	Score = 0 1 2 3 or 4

5.5 There must be a system for encouraging, collecting, evaluating, documenting, archiving and (as appropriate) implementing suggestions relating to occupational health issues. Occupational health effects and complaints must be analysed to identify causes and any necessary corrective actions.

Priority = M	Score = 0 1 2 3 or 4

5.6 There must be a system for ensuring that relevant incidents or hazardous conditions, which have been reported by other operations on the Rio Tinto Intranet Web Site, are communicated internally.

Priority = M	Score = 0 1 2 3 or 4

6.0 Minimum requirements: change management

Every Business must have in place a system for ensuring that change does not cause injury or illness to people, as per the Rio Tinto Safety Standard for Change Management. There must be established procedures for alerting personnel to changes in processes.

Priority = M H or C	Score = 0 1 2 3 or 4

7.0 Minimum requirements: contractor health management

As per the Rio Tinto Safety Standard for Contractor Management, contractors fall into three categories. Rules that apply to each of these contractor categories are as in the Safety Standard.

7.1 Occupational health performance, where available and where consistent with local medical confidentiality laws, must be taken into account when selecting contractors. Standard occupational health clauses pertinent to site-specific high-risk hazards must be included in consultancy agreements and contracts.

Priority = M or H	Score = 0 1 2 3 or 4

7.2 An assessment must be made of the occupational health risks for each contract. Where the assessment concludes that occupational health risk could occur, arrangements must be agreed with the contractor for their management. The management of occupational health risks must comply with these standards.

Priority = M H or C	Score = 0 1 2 3 or 4

A2. RISK MANAGEMENT

1.0 Scope

To protect all who work on our sites from occupational illness in a cost-effective manner, a control programme based on exposure assessments is required. The basis of the occupational health-risk programme is that the potential risk to a person's health is a function of both the magnitude and frequency of the exposure to the hazard and the inherent capacity of the hazard to cause harm. Businesses must develop control systems designed to eliminate or reduce exposure to hazardous agents / conditions, appropriate for the degree of risk to health. This Standard details the requirements for a suitable programme to manage the risks to health.

2.0 Programme Design

2.1 A risk management programme requires the following elements:

(a) Hazard identification;
(b) Exposure characterisation;
(c) Risk assessment;
(d) Risk control or treatment;
(e) Monitoring and review of controls; and
(f) Documentation.

2.2 People with adequate knowledge and experience in determining risk levels are required for both the initial risk assessment and to address the implications of plant and equipment upgrades and modifications.

Priority = M or H	Score = 0 1 2 3 or 4

3.0 Hazard Identification

3.1 The hazards in each work area must be defined and a hazard inventory that includes all the chemical, physical, biological and ergonomic hazards compiled.

Priority = M or H	Score = 0 1 2 3 or 4

3.2 A health effect rating, the inherent capacity to cause harm, for each hazard must be determined. Special attention must be given to carcinogens and reproductive hazards.

Priority = M	Score = 0 1 2 3 or 4

4.0 Exposure Characterisation

4.1 Exposures must be characterised for worker groups who have similar responsibilities and so would be expected to have similar exposure to the same range of hazards, termed 'Similar Exposure Groups' (SEGs). SEGs must be based on payroll classifications or Personnel employee job (occupation) codes plus job observation / interview.

Priority = M	Score = 0 1 2 3 or 4

4.2 Exposure characterisation must use qualitative or quantitative methods as appropriate. Quantitative assessment must be conducted for SEGs where:

(a) Exposures could exceed, or have exceeded, an occupational exposure limit (OEL);

(b) Exposures have aroused complaints or adverse symptoms directly or indirectly related to chemical or physical agents in the workplace;

(c) Exposures are the result of a change in activities or processes that could potentially increase exposures;

(d) Exposures are to carcinogens, ionising radiation or crystalline silica; or

(e) Required by regulations.

Priority = M	Score = 0 1 2 3 or 4

4.3 Hazards with very low exposure potential must be documented but need not be further assessed. However, this assessment must be reviewed periodically.

Priority = L	Score = 0 1 2 3 or 4

5.0 Risk Assessment

5.1 Risk assessment is the evaluation of the probability of adverse health consequences occurring because of conditions identified on the site. The following steps are required:

(a) All the monitoring data for employee health checks, the general workplace, personal monitoring and specific operations, and their relevance with regard to toxicity (OEL, duration of exposure, individual susceptibility, etc.) must be reviewed;

(b) An exposure rating for each SEG for each relevant hazard must be determined. This rating must record existing control equipment and procedures;

(c) A health risk assessment using a risk matrix to determine relative (not absolute) risk must be performed; and

(d) Action identification and prioritisation must then be determined.

Priority = H or C	Score = 0 1 2 3 or 4

5.2 The assessment must be repeated at appropriate intervals.

Priority = H or C	Score = 0 1 2 3 or 4

6.0 Risk Control or Treatment

6.1 Where risk assessment indicates the need for controls or treatment, these must be assessed as to their efficacy in minimising or eliminating the risk of adverse health effect in a staged manner according to the hierarchy of controls:

(a) Removal or substitution of the hazard - the permanent solution;
(b) Isolation (eg. process automation, enclosure or local exhaust ventilation);
(c) Administrative controls such as rotation of personnel; and then
(d) Personal protective equipment (PPE).

Priority = M	Score = 0 1 2 3 or 4

6.2 PPE must only be used to achieve compliance with OELs in situations where the use of higher level controls is not commensurate with the degree of risk and cost, while higher level control options are being developed and implemented, or for short duration tasks.

Priority = M	Score = 0 1 2 3 or 4

6.3 Control systems must be:

(a) Designed to be compatible with process and maintenance requirements;
(b) Designed according to good occupational hygiene engineering practices;
(c) Cost effective at achieving control of potentially hazardous exposures; and

(d) Regularly maintained and monitored.

Priority = M or H	Score = 0 1 2 3 or 4

6.4 Whenever practicable, purchasing criteria must be developed such that new equipment brought to site will not expose workers to more than the OEL in operating mode.

Priority = M	Score = 0 1 2 3 or 4

6.5 Administrative controls must be appropriate. Where work practices are used for exposure control, they must be understood and followed as a result of training and enforcement. Safe handling procedures and precautions must be included in standard operating procedures (SOPs).

Priority = M	Score = 0 1 2 3 or 4

6.6 Where risk assessment indicates the need to reduce exposures to toxic substances, good personal hygiene must be enforced. The programme must include:

(a) No smoking, eating or drinking in designated hazard areas;

(b) Washing of hands and face prior to eating or smoking;

(c) Showering at work post shift or after exposure to 'dirty' conditions; and

(d) Laundering of contaminated clothing by the Business or site.

Priority = M or H	Score = 0 1 2 3 or 4

6.7 Where PPE is required, it must be provided, be appropriate and be managed effectively, such that:

(a) A single individual / function must be assigned overall responsibility for the PPE programme for the site;

(b) The programme must be adequately documented, to include contractors;

(c) The programme must specify selection, administration, maintenance of PPE, training, and designate responsibilities, and include signposting for PPE use;

(d) The programme must be consistent with local standards or regulations;

(e) PPE of the proper types must be readily available and their use (where required) must be enforced. Defective or damaged PPE must not be used;

(f) Protective equipment requirements must be indicated in operating manuals, and procedures must be posted in hazardous areas and included in employee training;

(g) Employees must be trained in the health effects of exposures to specific hazards, when to use which PPE, how to fit it correctly, what to do if it fails and how to maintain it; and

(h) PPE use must be reviewed regularly for continued relevance.

Priority = M	Score = 0 1 2 3 or 4

7.0 Monitoring and Review of Controls

7.1 The risk assessment must reach one of the following conclusions for each SEG exposure:

(a) The risk is controlled by engineering standards;

(b) The risk is controlled only by the use of personal protective equipment (PPE) or administrative controls. Substitution / engineering controls must be considered and any reasons for their not being adopted documented;

(c) There are insufficient data to make a valid assessment. This must be coupled with a statement on the time scale over which valid data will be acquired; or

(d) There is a health risk at current exposures. This must be coupled with an action plan and time scale to control the identified risks.

Priority = C	Score = 0 1 2 3 or 4

7.2 For carcinogens and reproductive toxicants (known and suspected), meeting an OEL is not adequate; exposures must be "as low as reasonably achievable or practicable". There must be an annual documented review of exposure controls for these substances.

Priority = C	Score = 0 1 2 3 or 4

7.3 Performance standards and indicators for all control programmes must be developed and reviewed regularly.

Priority = M	Score = 0 1 2 3 or 4

8.0 Documentation

8.1 The risk management process must be documented in a comprehensive 'Risk Register' that lists all of the key risks that could impact on worker health, and an occupational health improvement action plan, with clear accountabilities, to deal with these must be derived.

Priority = M	Score = 0 1 2 3 or 4

A3. WORKPLACE MONITORING

1.0 Scope

If a risk assessment indicates the need, a workplace-monitoring programme is used to evaluate potential exposures and to develop controls that will protect the health of all who work on our sites. This Standard applies only to monitoring, sampling and analysis conducted within the workplace. It is not intended to extend to environmental or community monitoring, although some principles will be applicable to all monitoring programmes.

2.0 Programme Design

2.1 The workplace-monitoring programme must be based on risk-based exposure assessments and professional judgement.

Priority = M	Score = 0 1 2 3 or 4

2.2 The programme must be consistent with site health risks, linked to employee health surveillance, and be linked to the facility's objectives and targets.

Priority = M	Score = 0 1 2 3 or 4

2.3 The programme must be designed to provide data to demonstrate compliance with legal standards.

Priority = M	Score = 0 1 2 3 or 4

2.4 The data collected must enable an annual summary of each SEG's exposures to be produced.

Priority = M	Score = 0 1 2 3 or 4

2.5 The programme must be designed to document representative and the range of work exposure conditions.

Priority = M	Score = 0 1 2 3 or 4

2.6 To the extent possible, all monitoring data must be collected such that it is statistically valid.

Priority = M	Score = 0 1 2 3 or 4

3.0 Monitoring

3.1 The workplace monitoring procedures must be adequate with regard to locations or persons monitored, parameters measured, frequency of measurements, sample collection technique used, and analytical method used.

Priority = M or H	Score = 0 1 2 3 or 4

3.2 Personal monitoring rather than 'static', fixed-place or area monitoring must be performed for defining potential employee exposures. Static monitoring can only be used for measuring employee exposures when found to be well correlated with personal monitoring data.

Priority = M	Score = 0 1 2 3 or 4

3.3 Monitoring must be conducted to determine potential for adverse exposure during both routine and non-routine or intermittent exposures (eg. maintenance and campaign shutdowns or turnarounds), and for the purpose of designing controls and for assessing the success of controls.

Priority = M	Score = 0 1 2 3 or 4

3.4 For carcinogens and reproductive toxicants (known and suspected), exposure data must be statistically valid on an annual basis. Time-weighted average (TWA) measurements over several shifts, and consistent with the work-day period, must be used.

Priority = C	Score = 0 1 2 3 or 4

3.5 For progressive chronic conditions with a known cause (requiring long-term exposure for an effect to manifest; excluding noise), exposure data must be statistically valid on an annual basis. TWA measurements over several shifts, and consistent with the work-day period, must be used. If three or more years data are all low (<50% of OEL), then monitoring periodicity can go out to three-yearly, provided the process does not change.

Priority = H	Score = 0 1 2 3 or 4

3.6 For substances that manifest toxic effects after short-term exposures (eg. CO, H_2S and SO_2 gas, and some substances causing occupational asthma), a much shorter monitoring period throughout shifts will be required (in the order of seconds to minutes).

Priority = M H or C	Score = 0 1 2 3 or 4

3.7 Where risk assessment indicates the possible presence of levels of gas or vapour sufficient to cause health effects in less than one shift, continuous monitoring is required as long as the potential for harm exists.

Priority = M H or C	Score = 0 1 2 3 or 4

3.8 Capabilities for conducting any special air samples (eg. tank entry, incident investigations, etc.) must be available.

Priority = M H or C	Score = 0 1 2 3 or 4

4.0 Reporting

4.1 As a minimum, site data must be summarized using descriptive statistics - typically their central tendency (mean, median and geometric mean) and their spread (range, minimum and maximum, standard deviation, and geometric standard deviation).

Priority = M	Score = 0 1 2 3 or 4

4.2 All unexpected non-conformances and OEL exceedences must be reported within 24 hours upon receipt and confirmation of analysis results to the manager of the area or department in which they occurred. All non-conformances and OEL exceedences must be reported in writing within 7 days upon receipt and confirmation of analysis results.

Priority = M	Score = 0 1 2 3 or 4

4.3 Data must be regularly reviewed, interpreted and reported. Management reports for the various hazards assessed and controlled should be regularly prepared and distributed to effected parties, including the medical adviser. Reports must include health hazard control recommendations and actions taken.

Priority = M	Score = 0 1 2 3 or 4

4.4 All personal monitoring results must be reported back to the employees concerned, and their significance explained, within a reasonable time from when results are available.

Priority = M	Score = 0 1 2 3 or 4

5.0 Quality Control

5.1 Written protocols / procedures for sampling and analysis, including quality control requirements, must be available and be regularly reviewed.

Priority = M	Score = 0 1 2 3 or 4

5.2 Measuring equipment must be appropriate with regard to precision, accuracy, reliability, data output, backups, standards and availability of servicing. Equipment must be appropriately calibrated regularly.

Priority = M	Score = 0 1 2 3 or 4

5.3 Staff carrying out workplace monitoring must have adequate training/experience and technical oversight where appropriate.

Priority = M	Score = 0 1 2 3 or 4

5.4 There must be internal procedures for checking on the quality and relevance of monitoring data. SEGs must be periodically reviewed and data should be periodically checked statistically for outlier results.

Priority = M	Score = 0 1 2 3 or 4

5.5 The analytical laboratory services used must have an active quality assurance or quality control programme in place.

Priority = M	Score = 0 1 2 3 or 4

A4. MEDICAL AND FIRST AID TREATMENT

1.0 Scope

This Standard covers the provision of facilities, equipment and services for the prompt and effective treatment of injuries and illnesses, whether to employees, contractors or visitors, occurring on a site, and the transfer to other facilities for ongoing treatment where required.

Many sites have more extensive services, for instance those providing medical treatment for the local communities. The general principles given below must also be applied to these services.

2.0 Organisation

2.1 The arrangements for the provision of appropriate treatment services must be risk based and documented. These can include local off-site provisions, where they are adequate. The risk assessment must consider:

(a) The health and injury risks of the site and numbers and types of treatments experienced;

(b) Special situations such as underground, remote, expatriate and lone workers;

(c) Provisions for treatments throughout a 24-hour day and at weekends;

(d) The location and adequacy of local, non-company treatment facilities; and

(e) Transport arrangements for emergency evacuation when required.

Priority = M	Score = 0 1 2 3 or 4

2.2 Adequate levels of staff, equipment and facilities must be provided. The minimum acceptable standard is:

(a) A person appointed to take charge of first-aid / medical arrangements;

(b) A qualified medical practitioner to act as the medical adviser (can also be the 'appointed' person and may be contracted);

(c) Ready access to a suitably qualified person to provide medical treatment;

(d) One trained and certified first aider per 50 employees on every shift, or the provision of full time emergency services or paramedic support onsite. More first aiders may be required in underground or remote locations;

(e) Suitably stocked first-aid boxes or equivalent provision, located such that they are readily available;

(f) For permanent facilities, a first aid or 'sick' room that provides privacy for injured or sick employees during their wait for medical treatment or recuperation;

(g) An emergency vehicle, suitable for conveying injured or sick persons to a local treatment centre or 'pick-up point', where a local ambulance service is deemed inadequate; and

(h) Basic diagnostic capabilities for local diseases, where the site is 'established' and remote.

Priority = M H or C	Score = 0 1 2 3 or 4

2.3 The site medical and first aid treatment system must be integrated into the site emergency procedures and safety reporting system. There must be an established and documented emergency communication system.

Priority = M H or C	Score = 0 1 2 3 or 4

2.4 The selected 'appointed' person and first aiders must be trained in first aid according to accredited standards.

Priority = M	Score = 0 1 2 3 or 4

2.5 All employees must be informed of the first aid / medical arrangements and the procedure for activating the emergency procedure. Notices indicating contact details for first aiders or appointed persons, the emergency contact number / radio frequency, and where the first-aid box is, must be posted about the site. Special arrangements may be required to give first-aid information to employees with reading or language difficulties.

Priority = M	Score = 0 1 2 3 or 4

3.0 First-aid Boxes

The contents of the first aid box must be determined in consultation with local medical opinion, and must be appropriate to the number of employees and risks associated with the area. Adequate availability of the contents must be assured.

Priority = M	Score = 0 1 2 3 or 4

A5. OCCUPATIONAL MEDICAL SURVEILLANCE

1.0 Scope

Medical surveillance in these Standards is restricted to the detection of conditions caused by workplace conditions, or conditions that might be risk factors for poor adaptation to work conditions, and applies to employees and Category 1 contractors only. The use of medical examinations for improving general health or for healthier lifestyle promotion, although valid reasons for periodic medical examination, is not covered in this Standard.

2.0 Programme Design

2.1 The medical surveillance programme must be consistent with local regulatory requirements, site health risks and be linked to the facility's objectives and targets. It must be based on workplace monitoring and assessment. Where a possible health risk is identified, workers must be encouraged to participate in the medical surveillance programme.

Priority = M	Score = 0 1 2 3 or 4

2.2 The medical surveillance programme must be based on sound ethical and clinical practice, such that:

(a) Worker's privacy and confidentiality of individual health information is maintained;

(b) Test equipment is adequate and appropriate for identified health hazards, and written protocols, including quality control requirements, are available;

(c) Biological monitoring methods are appropriate;

(d) There are documented medical standards for all safety critical jobs;

(e) There are documented methods, standards or guidelines available for determining illness progression resulting from workplace exposures;

(f) There are guidelines available for determining removal and re-entry levels for priority hazardous substances and agents where required; and

(g) Fitness for a particular type of work is determined.

Priority = M or H	Score = 0 1 2 3 or 4

2.3 Workers must be informed of the potential risks from tests and of the monitoring results.

Priority = M	Score = 0 1 2 3 or 4

2.4 A system must be in place to notify appropriate personnel of new employees, those transferring to another job and those leaving the company.

Priority = M	Score = 0 1 2 3 or 4

2.5 Where legally possible, a system must be in place that encourages employees to report health conditions that could affect their ability to do their job safely, or that might be confounded by job exposures (eg. pregnancy and reproductive health risks).

Priority = M	Score = 0 1 2 3 or 4

3.0 Examinations

3.1 Medical examinations must be conducted by a physician, nurse or equivalent, as allowed by local law.

Priority = M	Score = 0 1 2 3 or 4

3.2 A pre-employment or pre-placement examination is required when:

(a) The proposed job has specific health requirements; OR

(b) There is a risk that at current site conditions an adverse health effect could occur; OR

(c) There is a legal requirement.

Priority = M or H	Score = 0 1 2 3 or 4

3.3 Pre-placement standards for medical examination must be appropriate to the actual, or foreseeable future, risks from the employment or the job assignment.

Priority = M	Score = 0 1 2 3 or 4

3.4 Any invasive tests must only be undertaken when indicated by the nature of the future job and with the written permission of the candidate. Failure to provide an appropriate sample can be used to make a decision of suitability.

Priority = M	Score = 0 1 2 3 or 4

3.5 A periodic health surveillance programme is required when either:

(a) There is a probability that a health effect could occur from conditions on site; and
(b) There is a test that can detect that effect reliably; and
(c) Detecting the abnormality brings a health benefit to the worker; and
(d) The health benefits are greater than any harm from the testing; OR
(e) There is a legal requirement for periodic health monitoring.

Priority = M or H	Score = 0 1 2 3 or 4

3.6 Particular attention must be given to appropriate medical monitoring for workers where risk assessment indicates the potential for exposure to high-risk hazardous substances including carcinogens, reproductive toxicants or respirable crystalline silica.

Priority = H or C	Score = 0 1 2 3 or 4

3.7 The frequency of examinations must be documented and be based on an assessment of the level of health risk, the speed of progression of any illness and on legal requirements.

Priority = M	Score = 0 1 2 3 or 4

3.8 In some countries, staff with no recognised health qualifications such as foremen, are used in periodic health surveillance. In these cases, the staff must be appropriately trained, be aware of the need to maintain medical confidentiality, and have professional back up for referral of possible problems.

Priority = M	Score = NA 0 1 2 3 or 4

3.9 Employees must undergo an examination on resumption of work after a prolonged absence for health reasons.

Priority = M or H	Score = 0 1 2 3 or 4

3.10 A medical examination is required on termination of employment, or where this is not legally possible must be offered, when either:

(a) There is a possibility that health changes could have occurred;

(b) There is a need to document the degree of health changes during employment; or

(c) There is a legal requirement.

Priority = M	Score = 0 1 2 3 or 4

4.0 Biological Testing

4.1 Occupational health physicians or medical practitioners must retain overall responsibility for biological tests and other medical investigations.

Priority = M	Score = 0 1 2 3 or 4

4.2 Biological monitoring must not be a substitute for the monitoring of the working environment and the assessment of individual exposures.

Priority = M	Score = 0 1 2 3 or 4

4.3 Where legislation or company policy has both a workplace environment standard (OEL), and a biological standard, compliance with both must be achieved. Compliance with one cannot be used to excuse non-compliance with the other

Priority = M	Score = 0 1 2 3 or 4

5.0 Reporting

5.1 The prime responsibility of a physician or nurse is to the individual patient. However, additional control of workplace conditions required to improve the health of the worker requires management actions. Where adverse health cases are detected, the physician/nurse must seek the worker's written permission to give sufficient information to the appropriate manager to effect change, without breaking confidentiality conventions. The physician must encourage the employee to give this permission. If this permission is refused, the physician must record this in the individual's notes, and consider, after consultation with plant staff on job requirements or the safety of others, if the potential outcome of continuing exposure is sufficient to warrant removal of the worker from further exposure.

Priority = M	Score = 0 1 2 3 or 4

5.2 Medical surveillance information must be provided to the Company management in a form that respects the privacy of the individual, but enables the Company to fulfill their duty of care obligations to employees.

Priority = M	Score = 0 1 2 3 or 4

5.3 Adverse trends in health monitoring results for an area must be reported to the area manager in writing within seven days. The names of individuals may not be disclosed without their written authorisation

Priority = M	Score = 0 1 2 3 or 4

A6. RECORDS

1.0 Scope

This Standard covers creation, use and storage of occupational health and hygiene records. In cases where workers are grouped into similar exposure groups for occupational hygiene measurements, individual deployment or personnel records will be needed to enable each worker's exposures to be re-created.

2.0 Record Types

2.1 The following record types must be maintained:

(a) A register of site regulatory requirements;

(b) A register of injuries/illness and first aid treatments;

(c) Worker's Compensation report forms with medical certificates;

(d) Rio Tinto 'Reporting & Investigation of Fatal & Significant Incidents' forms;

(e) Occupational illness cases reported for the annual Rio Tinto Social and Environment report;

(f) Documentation of site occupational health risk assessments – a risk register;

(g) Documentation of site-derived OELs and SEGs;

(h) A register of site MSDS, and of people/organisations who receive a site product MSDS;

(i) A register of site occupational health audits and reviews;

(j) A register of site occupational hygiene survey and assessment reports, including those by consultants and regulators;

(k) Personal and static monitoring and survey field sheets;

(l) Summary reports of workplace monitoring data and controls performance;

(m) Documented procedures for inspection, assessment and maintenance of exposure controls, both engineering and personal protective equipment, where applicable;

(n) Employee personal occupational medical files;

(o) Employee site job history;

(p) Training records of the site's professional employees responsible for health and occupational hygiene advice; and

(q) Instrument calibration certificates and quality control documentation.

Priority = M	Score = 0 1 2 3 or 4

2.2 All confirmed occupational illness incidents (see Definitions) attributable to site exposures must be reported annually as part of the Social and Environment data collection, and where lessons can be shared, on the Rio Tinto Occupational Health Intranet website. Those occupational illness incidents regarded as being significant* must also be reported according to the Rio Tinto Procedure for the Notification of Fatal or Significant Issues.

Priority = M	Score = 0 1 2 3 or 4

* Significant issues are as per high or critical issues as defined in the Rio Tinto "Priority and Definition of Incidents and Issues" table.

3.0 <u>Records Content</u>

3.1 All health and hygiene risk assessments and surveillance results must be recorded, reported and maintained. These records must be legible, identifiable and traceable to the activity, product or service involved.

Priority = M	Score = 0 1 2 3 or 4

3.2 A structured database of occupational hygiene monitoring data must be maintained and documented. Monitoring records must provide sufficient process and operation detail to allow an assessment of sampling and control effectiveness.

Priority = M	Score = 0 1 2 3 or 4

3.3 A personal occupational medical file must be maintained for all employees and made available to that employee or their personal doctor on request. It is preferable that a copy of each employee's SEG personal monitoring data also be maintained on this file, or can be readily linked to this file.

Priority = M	Score = 0 1 2 3 or 4

3.4 Each medical examination report must be dated and signed by the examining physician, nurse or equivalent, with a printed name to identify (electronic signature is acceptable).

Priority = M	Score = 0 1 2 3 or 4

3.5 Records must contain data that have been reviewed and interpreted to a level of rigour sufficient to defend the Business reputation in the case of community or regulatory challenge, from current or proposed legislation.

Priority = M or H	Score = 0 1 2 3 or 4

3.6 With the employee's consent, any significant finding on medical examination should be reported to their personal physician.

Priority = M	Score = 0 1 2 3 or 4

4.0 <u>Retention Policy</u>

4.1 On closure of permanent sites, the medical records must remain confidential. The physician must discuss with the Rio Tinto occupational physician, or records custodian, appropriate storage arrangements and responsibility for these records.

Priority = M	Score = 0 1 2 3 or 4

4.2 Occupational health and hygiene records must be stored and maintained in such a way that they are readily retrievable and protected against damage, deterioration or loss. Their retention times must be established and recorded. Records must be kept for a period consistent with legal requirements or 30 years after employment ceases, whichever is longer.

Priority = M or H	Score = 0 1 2 3 or 4

5.0 Confidentiality

5.1 All medical results must be treated as confidential personal information and access restricted to physicians, nurses and equivalent, and to individual employees for their own records. Each site must devise a procedure for handling confidential medical records that protects them from access by unauthorised personnel. All individuals working as "medical" personnel at the sites must sign a confidentiality agreement.

Priority = M	Score = 0 1 2 3 or 4

5.2 Medical information may be supplied outside the bounds presented above, where there is explicit consent for the information to be used for a specific purpose (eg. to meet worker's compensation or superannuation requirements). In these cases, the information must only be used for this purpose and the information either destroyed or transferred to the individual's medical records when the investigation is complete.

Priority = M	Score = 0 1 2 3 or 4

B1. PARTICULATE AND GAS/VAPOUR EXPOSURES

1.0 Scope

This Standard applies to dust, fibres, mist and fume (ie. particulates), and gas and vapour exposures in the workplace, with emphasis on inhalation as the prime route of exposure. It covers particulate and gas/vapour hazard evaluation, control programme design and control programme evaluation (medical surveillance), to ensure that employees and contractors will not suffer adverse health effects from particulates or gas/vapours, either used or generated by the Business.

2.0 Programme Design

2.1 Where risk assessment indicates the need, a workplace air monitoring programme must be in place such that:

(a) It complies with all relevant requirements in the A Standards;
(b) The air quality of the workplace with regard to dust, fibre, mist, fume, gas and vapour emissions is adequately described;
(c) Workplace particulate and gas/vapour sources that contribute to the exceedance of OELs are identified and adequately characterised; and
(d) Control measures are periodically checked that they minimise emissions and protect employees and contractors from adverse exposure.

Priority = M	Score = NA 0 1 2 3 or 4

2.2 Where it is likely that the 95 percentile value of a TWA mean concentration for total inhalable dust, respirable dust, respirable crystalline silica, asbestos or non-asbestos fibrous materials exceeds the relevant OEL, the area must be identified and mapped, signposted or otherwise clearly communicated to employees working in the area. Areas where other identifiable particulate hazards (eg. PAH, lead, mercury, etc), or gases (eg. CO, SO_2, NH_3, etc), or vapours exceed the relevant OEL, must also be similarly identified and clearly communicated. Signposting, where necessary, must use appropriate wording or symbols on signs to identify the hazard.

Priority = H	Score = NA 0 1 2 3 or 4

2.3 These designated areas require a documented respiratory protection programme, regular monitoring of SEGs working in the area and a formal review of the practicality of engineering controls.

Priority = H	Score = NA 0 1 2 3 or 4

2.4 Particulate and gas / vapour monitoring must be based on the use of equipment approved by local regulatory authorities, as per documented methods.

Priority = M	Score = NA 0 1 2 3 or 4

2.5 There must be a special consideration given to the sampling of hot/volatile/ pressurised toxic process streams where they occur.

Priority = M H or C	Score = NA 0 1 2 3 or 4

3.0 Medical Surveillance

3.1 Employees and Category 1 contractors must be covered by a medical surveillance programme when:

(a) Their SEG TWA mean exposure to respirable crystalline silica, total inhalable dust, respirable dust, lead or asbestos dust is greater than 50% of the relevant OEL;
(b) The medical adviser considers that it is advisable; or
(c) There is a legal requirement for medical monitoring.

Priority = M or H	Score = NA 0 1 2 3 or 4

3.2 Where risk assessment indicates a risk of a respiratory condition, assessment programmes must include chest x-rays and/or lung function tests. Where indicated, they must meet the following standards:

(a) High quality chest x-rays will be taken every 5 years, unless local legislation requires these to be more frequent;
(b) All chest x-rays will be read to ILO standards by an ILO B reader, wherever possible;
(c) Any progression of more than one step on the ILO extended scheme to a reading above 1/0 will be reviewed by a physician;
(d) Any reading suggesting active lung disease will be reviewed by a physician; and
(e) All spirometry will be by trained staff following the American Thoracic Society guidelines or equivalent.

Priority = M	Score = NA 0 1 2 3 or 4

3.3 All lead monitoring programmes must meet the following standards:

(a) All testing will be of venous blood according to local standards;
(b) Only laboratories using an active quality assurance or quality control scheme will be used for testing;
(c) All male workers with a whole-blood lead above 40µg/dL will be removed from exposure until the level has fallen below 30 µg/dL, and until the physician declares the worker fit for duty; and
(d) Females of reproductive capacity with a whole-blood lead above 20µg/dL will be removed from exposure until the physician declares the worker fit for duty, and exposure to lead should cease when pregnancy is notified to the Company.

Priority = M	Score = NA 0 1 2 3 or 4

3.4 All monitoring programmes for other substances must be documented.

Priority = M	Score = NA 0 1 2 3 or 4

4.0 Exposure Controls

4.1 Elimination or substitution must be considered.

Priority = M	Score = 0 1 2 3 or 4

4.2 Where required or practicable, there must be engineering controls in place**.**

Priority = M or H	Score = 0 1 2 3 or 4

4.3 There must be documented procedures for inspection, assessment and maintenance of the engineering controls to ensure that the equipment continues to operate to design specifications.

Priority = M or H	Score = 0 1 2 3 or 4

4.4 Controls must be of an adequate standard such that surfaces are adequately cleaned to avoid:

(a) dust generation due to material dislodgment (eg. wind blown), where practicable; and
(b) fume generation from accumulated dust during welding/heating or cutting operations.

Priority = M	Score = 0 1 2 3 or 4

4.5 Employees must not eat or smoke in areas or jobs with potentially harmful exposures. Cigarette smoking must also be prohibited wherever people are likely to be exposed to harmful levels of smoke.

Priority = M H or C	Score = 0 1 2 3 or 4

4.6 Abrasive blast cleaning must be conducted so as to protect worker health and minimise dust emissions. Substitutes must be used whenever practicable for abrasives containing crystalline silica. However, if such abrasives are used, workers must be aware of the hazards and exposure monitoring conducted. The hazardous properties of alternative materials must be considered before use.

Priority = C	Score = NA 0 1 2 3 or 4

4.7 Fixed station monitors and alarms must be installed where appropriate to warn against accidental or periodic releases of toxic gases/vapours (eg. HCN, CO, SO_2). Such monitors must only be installed after training all affected personnel on the capabilities and limitations of the monitors.

Priority = H or C	Score = NA 0 1 2 3 or 4

4.8 All fixed station monitors / alarms must be identified, listed and included in a periodic schedule of preventive maintenance and testing, including calibration of detectors. Periodic drills with regard to response to sounding of the alarm must be conducted. Periodicity should be based on level of risk.

Priority = M H or C	Score = NA 0 1 2 3 or 4

4.9 Where required, there must be a documented respiratory protection device (RPD) programme based on suitable standards, that provides training in the recognition of signs and symptoms of hazardous particulate and gas / vapour exposure, emergency procedures and preventative measures.

Priority = M	Score = NA 0 1 2 3 or 4

5.0 Respiratory Protection Devices

5.1 RPDs must be selected with regard to:

(a) The potential particulate particles size, gas / vapour types, substance toxicity and likely concentrations;

(b) Compatibility with the work tasks; and

(c) Comfort (as it affects wear-time) and allowance for adequate communication.

Priority = M or H	Score = NA 0 1 2 3 or 4

5.2 Half-face and full-face air-purifying respirators must not be used where:

(a) The atmosphere is oxygen deficient (< 19.5%);

(b) The atmosphere is immediately dangerous to life or health (eg. in areas where CO concentrations are > 1,500 ppm or NH_4 > 300 ppm);

(c) Gases and vapours are more than 10 times their OEL or greater than 1000 ppm for half-face respirators, or more than 100 times their OEL for full-face respirators; or

(d) Particulates are more than 10 times their OEL for half-face respirators, or more than 100 times their OEL for full-face respirators.

Priority = C	Score = NA 0 1 2 3 or 4

5.3 For atmospheres that are oxygen deficient, or contain unknown hazards, or have concentrations of gases and vapours that are unknown, or could potentially exceed immediately dangerous to life or health (IDLH) values, an air-supplied type respirator must be worn.

Priority = C	Score = NA 0 1 2 3 or 4

5.4 For effective use of air-purifying respirators (other than powered air-purifying respirators), fit testing must be qualitative and documented as a minimum, although quantitative fit testing is preferred. There must be a policy requiring a clean shaven face when using a negative or neutral pressure RPD for routine tasks, or the use of a positive pressure RPD will be required. A pulmonary function test may be required to determine whether or not an individual is medically fit to wear a respirator.

Priority = M or H	Score = NA 0 1 2 3 or 4

5.5 For air-supplied RPDs, breathing air must be effectively filtered and / or isolated from plant and instrument air, and isolated from sources of nitrogen and carbon monoxide potential exposure. The quality of the breathing air must be checked for conformance with national standards.

Priority = C	Score = NA 0 1 2 3 or 4

B2. HEARING CONSERVATION

1.0 Scope

This Standard applies only to noise exposures in the workplace. It covers noise hazard evaluation, control programme design and control programme evaluation (audiometric surveillance), to ensure that employees and contractors will not suffer adverse health effects from noise generated by the Business.

2.0 Programme Design

2.1 Where risk assessment indicates the need, a hearing conservation programme must be in place such that:

(a) It complies with all relevant requirements in the A Standards;
(b) Workplace noise exposures are adequately described;
(c) Noise sources that contribute to the exceedance of OELs are identified and adequately characterised; and
(d) Control measures are in place to minimise noise levels and protect employees and contractors from adverse exposure.

Priority = M	Score = NA 0 1 2 3 or 4

2.2 Where it is likely that the 95 percentile value of an 8-hour Leq mean exceeds 85 dB(A), or impulse noise exceeds 140 dB(C), the area must be identified and mapped, signposted or otherwise clearly communicated to employees working in the area. Signposting, where necessary, must use appropriate wording or symbols on signs to identify the hazard.

Priority = H	Score = NA 0 1 2 3 or 4

2.3 These designated areas require a documented hearing conservation programme, regular monitoring of SEGs working in the area and a formal review of the practicality of engineering controls.

Priority = H	Score = NA 0 1 2 3 or 4

2.4 Monitoring must be based on the use of a sound level meter (SLM) approved by local regulatory authorities, with 3 dB exchange rate, and A-weighting and impulse noise measurement capability, as per documented methods.

Priority = M	Score = 0 1 2 3 or 4

2.5 Employees and Category 1 contractors whose potential Leq exceeds 85 dB(A), or impulse noise exposure exceeds 140 dB(C), must be encouraged to undergo audiometry. The results should be discussed with the worker.

Priority = M	Score = NA 0 1 2 3 or 4

3.0 Audiometry Programme

3.1 Where an audiometry programme is indicated, it must meet the following standards:

(a) All testing must be by pure tone audiometry in an audiometry booth or quiet room, with measured noise levels less than 40 dB(A);

(b) The initial audiogram must be taken prior to exposure to significant workplace noise. Further audiograms must be taken periodically; annually where exposures are over 85 dB(A) Leq or where continued deterioration to hearing is occurring;

(c) Testing must be by trained personnel;

(d) Audiometers must be calibrated according to the manufacturer's guidelines. As a minimum these will be a weekly biological calibration using a member of staff and an annual quantitative check. All results must be documented;

(e) Audiograms must be read by trained persons who will identify any increasing hearing loss and then determine if this is noise induced. Any employee whose hearing deteriorates by 15dB or more from baseline at 3, 4 or 6 KHz must be retested following removal from noise for a minimum of 48 hours, usually after a days-off period. If the downward shift persists the employee must be reviewed by a physician; and

(f) All results must be kept in medical confidence. Efforts should be made to persuade any worker with a progressing loss to allow this fact to be communicated to the relevant manager, such that duty of care obligations are fulfilled.

Priority = M	Score = NA 0 1 2 3 or 4

4.0 Exposure Controls

4.1 Elimination or substitution must be considered.

Priority = M	Score = 0 1 2 3 or 4

4.2 Where required or practicable, there must be engineering controls in place.

Priority = H	Score = 0 1 2 3 or 4

4.3 There must be documented procedures for inspection, assessment and maintenance of the engineering controls and noisy equipment to ensure that the equipment continues to operate to design specifications.

Priority = M	Score = 0 1 2 3 or 4

4.4 Where required, there must be a documented hearing protection device (HPD) programme based on suitable standards, that provides training in the recognition of signs and symptoms of hazardous noise exposure, emergency procedures and preventative measures.

Priority = M	Score = NA 0 1 2 3 or 4

4.5 HPDs must be selected with regard to the potential type and loudness of noise likely, comfort and compatibility with the work tasks.

Priority = M	Score = NA 0 1 2 3 or 4

B3. MANUAL HANDLING AND VIBRATION

1.0 Scope

This Standard focuses on musculo-skeletal damage that can result from manual handling and from vibration. This Standard covers musculo-skeletal hazard evaluation, control programme design and control programme evaluation, to ensure that employees and contractors will not suffer adverse health effects from poor task and equipment design, or from inappropriate behavioural practices

2.0 Programme Design

2.1 Where risk assessment indicates the need, a documented programme must be in place such that:

(a) It complies with all relevant requirements in the A Standards;

(b) Workplace vibration sources that contribute to the exceedance of OELs (hence potential for impact on worker musculo-skeletal fitness) are identified and adequately characterised;

(c) Workplace manual / materials handling tasks are assessed and recorded to include biomechanical factors (eg. posture, bending, twisting, repetitive motions, working overhead, exerting force away from the body);

(d) Manual handling tasks assessed as having potential to cause an LTI (ie. with potential for impact on worker musculo-skeletal fitness) are identified and adequately characterised; and

(e) Control measures are in place to minimise exposures and protect employees and contractors from adverse exposure. Machines, working equipment and tasks should be evaluated for possible modification or replacement where necessary, and education provided to employees to address behavioural issues.

Priority = M	Score = NA 0 1 2 3 or 4

2.2 The workplace must be assessed by an appropriately experienced person for compliance with good design, layout and practice, to minimise adverse health consequences due to manual handling and vibration issues.

Priority = M	Score = 0 1 2 3 or 4

2.3 The quantitative evaluation of vibration produced by specific equipment must include the following measure- ment parameters: direction of movement, frequency, intensity, and variation with time and duration, as per documented methods.

Priority = M	Score = NA 0 1 2 3 or 4

2.4 Operators must be informed of the results of assessments, trained to recognise potentially hazardous manual handling and vibration issues, and instructed in appropriate manual handling techniques, where the risk assessment indicates a need.

Priority = M	Score = 0 1 2 3 or 4

3.0 Exposure Controls

3.1 Design criteria that address ergonomic requirements, and the minimisation of vibration where appropriate, must be available for the purchase or fabrication of all new workplace equipment and furniture.

Priority = M	Score = 0 1 2 3 or 4

3.2 Ergonomic assessment of work processes must be incorporated into planning activities.

Priority = M	Score = 0 1 2 3 or 4

3.3 Where possible, machines or equipment, or alternative systems of work, must be employed to conduct heavy, awkward or repetitive tasks.

Priority = M	Score = 0 1 2 3 or 4

3.4 There must be documented procedures for inspection, assessment and maintenance of the engineering controls.

Priority = M	Score = 0 1 2 3 or 4

3.5 The vibration / manual handling training programme must include elements to encourage operators to keep fit and healthy (keep body weight down), recognise unsafe manual handling and vibration conditions, adopt good posture, lift everything twice (mentally then physically), use correct lifting methods, use a team lift or mechanical lifting aids whenever possible, and employ other preventative measures as appropriate.

Priority = M	Score = 0 1 2 3 or 4

B4. HAZARDOUS SUBSTANCES

1.0 Scope

This Standard applies to both dangerous goods and hazardous substances, be they process or non-process materials. It covers hazard evaluation, control programme design and control programme evaluation, to ensure that employees, contractors and third parties will not suffer adverse health effects from hazardous substances either used or generated by the Business. Local definitions of dangerous goods and hazardous substances in regulations should be adhered to by Businesses.

2.0 Programme Design

2.1 A hazardous materials register or inventory system must be available and be used to control the purchase and introduction of new materials to operations, including those brought in by contractors. The register must be updated regularly.

Priority = H	Score = 0 1 2 3 or 4

2.2 The properties of materials brought to site, site products, intermediates, by-products and wastes must be adequately understood and documented with regard to their ability to impact on health. Material Safety Data Sheets (MSDS) must be obtained where possible and when required by law prior to using hazardous materials at site.

Priority = M H or C	Score = 0 1 2 3 or 4

2.3 MSDS for products and any process or waste materials sent off site must be sent to customers.

Priority = M	Score = NA 0 1 2 3 or 4

2.4 MSDS must be used to:

(a) Provide adequate information regarding health effects, precautions and safe handling practices to end users of all hazardous materials/substances on site;
(b) Conduct a risk assessment to determine the need for workplace monitoring, medical surveillance and controls;
(c) Prepare workplace labels as necessary; and
(d) Provide emergency response information.

Priority = M	Score = 0 1 2 3 or 4

2.5 A coordinator must be assigned the accountability for maintaining the hazardous materials register and MSDS system.

Priority = M	Score = 0 1 2 3 or 4

2.6 Safe working procedures and training in the safe handling, transport and storage of hazardous substances, and also appropriate storage facilities and personal protective equipment, must be provided.

Priority = M	Score = 0 1 2 3 or 4

2.7 The assessment as to potential for adverse exposure during routine and non-routine or intermittent operations or tasks must take into account:

(a) Inhalation as airborne particulate, gases or vapours;
(b) Skin contact with hazardous substances; and
(c) Ingestion of hazardous substances.

Priority = M or H	Score = 0 1 2 3 or 4

3.0 Material Safety Data Sheets

3.1 MSDS must comply with the more comprehensive of the 'Globally Harmonised System' for MSDS or local regulatory requirements. They must be revised, as necessary, every 5 years.

Priority = M	Score = NA 0 1 2 3 or 4

3.2 MSDS, or a computer database containing MSDS, must be readily available to employees, contractors and other affected parties (eg. local community, emergency services), and be in the language(s) commonly used on site.

Priority = M	Score = 0 1 2 3 or 4

4.0 Controls

4.1 Hazardous substances must be prioritised and controlled in a manner consistent with the A2 Standard, to ensure employee exposure to these substances is minimised.

Priority = M	Score = 0 1 2 3 or 4

4.2 There must be written procedures for the use, storage and disposal of identified high priority hazardous substances. These must be audited every 12 months.

Priority = C	Score = NA 0 1 2 3 or 4

4.3 Storage facilities must be secure and protected from damage. They must also be designed for easy access for fire fighting. Where applicable, the storage facility must protect chemical containers from physical damage due to temperature extremes, moisture, corrosive mists or vapours and vehicles.

Priority = M H or C	Score = NA 0 1 2 3 or 4

4.4 Stored hazardous substances must be adequately segregated based on:

(a) Quantity of materials stored;
(b) Physical state of the chemicals (solid, liquid or gas);
(c) Degree of incompatibility; and
(d) Known behaviour of the materials.

Priority = C	Score = NA 0 1 2 3 or 4

4.5 All containers must be adequately and clearly labelled to indicate identity, precautionary requirements and date for expiry, where relevant.

Priority = H	Score = 0 1 2 3 or 4

4.6 Prior to disposal, empty containers / equipment must be properly decontaminated.

Priority = M	Score = NA 0 1 2 3 or 4

4.7 There must be a programme to assess safer alternatives to current hazardous chemicals / substances, and to limit worker access to, and stored quantities of, hazardous substances.

Priority = M	Score = NA 0 1 2 3 or 4

4.8 Appropriate PPE for skin and eye protection must be selected with regard to the potential hazards likely, permeability, penetration, resistance to damage and compatibility with the work tasks.

Priority = M or H	Score = NA 0 1 2 3 or 4

4.9 Emergency showers and eye-wash stations must be available where required by law, or where their need is indicated by risk assessment, and then appropriately located and sign posted. Workers must be trained as to their location and use.

Priority = M H or C	Score = NA 0 1 2 3 or 4

5.0 Asbestos and Non-asbestos Fibrous Silicates

5.1 This section applies to asbestos and bio-persistent non-asbestos fibrous silicates that may display asbestos-like toxicity, related to fibre diameter and length. Where required, local regulations must be followed as a minimum. In any case the following requirements must be met:

- (a) A management programme compliant with all relevant requirements of the A Standards must be in place and actively pursued;
- (b) No new products containing these materials should be purchased unless there is no viable alternative giving acceptable performance. The necessity of using these products must be kept under review;
- (c) Installed materials of this type must be identified and assessed for current safety. Where 'safe in place', it should not be removed;
- (d) Work areas must be separated by ropes or barriers and signposted to restrict entry;
- (e) Contaminated material must be placed in marked plastic disposal bags or covered containers promptly for disposal to an approved landfill; and
- (f) Work areas must be kept clean.

Priority = C	Score = NA 0 1 2 3 or 4

5.2 All workers exposed to these materials must be on a register. "Exposed" means working on or near such material that has been disturbed, abraded or cut. The register must contain details of their annual medical examination and the results of occupational hygiene monitoring.

Priority = H	Score = NA 0 1 2 3 or 4

5.3 Contractor bid specifications must be reviewed and an individual identified who is responsible for overseeing contractor performance. Asbestos contractors must be competent, registered and have adequate equipment, procedures and monitoring.

Priority = C	Score = NA 0 1 2 3 or 4

5.4 Where required, the asbestos / bio-persistent non-asbestos fibrous silicates management programme must cover work practices, training, monitoring, medical surveillance, waste handling and disposal, and the above noted detail.

Priority = H	Score = NA 0 1 2 3 or 4

5.5 Maintenance operations must be made aware of potential cristobalite exposure hazards when disturbing non-asbestos fibrous silicates that have undergone high temperature conditions.

Priority = C	Score = NA 0 1 2 3 or 4

5.6 The potential for occurrence of naturally occurring asbestiform materials in exploration or mining production activities must be assessed, the risk of exposure determined and appropriate control measures implemented where required.

Priority = H	Score = NA 0 1 2 3 or 4

B5. RADIATION

1.0 Scope

This Standard is applicable to workplace radiation issues associated with process monitoring, products or waste streams, and includes both ionising and non-ionising radiation. It covers radiation hazard evaluation, programme design, exposure controls and employee information, to ensure that employees, contractors and third parties will not suffer adverse health effects from radiation sources either used or generated by the Business.

2.0 Programme Design – All Types of Radiation

2.1 The risk associated with ionising (from both naturally occurring radioactive mineral (NORM) and radon, and man-made sources), ultra violet (UV) and electromagnetic field (EMF) radiation exposure must be assessed.

Priority = M	Score = 0 1 2 3 or 4

2.2 There must be an inventory of all types of radiation sources that have a potential for adverse health effect, and should include radiation source type, type of radiation (eg. radioisotope, radon, EMF, laser, etc.), strength and unit/material location.

Priority = M	Score = NA 0 1 2 3 or 4

2.3 Where risk assessment indicates the need, a documented radiation management programme must be developed such that:

(a) All types of radiation sources that could contribute to the exceedance of OELs are adequately characterised and described;

(b) Such exposures can be reduced to as low as reasonably practicable (ALARP);

(c) The relevant requirements of the A Standards are met;

(d) It provides a clearly defined chain of responsibility, with duties and responsibility documented; and

(e) Education is provided for employees and contractors regarding radiation safety, including the radiation management programme elements.

Priority = C	Score = NA 0 1 2 3 or 4

3.0 Programme Design – Ionising Radiation

3.1 The ionising radiation management programme must meet all applicable regulatory requirements, and if applicable, include at least the following elements:

(a) Surveyed radiation areas and quantification of exposure sources/levels;

(b) Exposure and medical monitoring programmes based on established investigation levels;

(c) Transport of radioactive materials in compliance with international radiation transport regulations, when no local regulations are in place;

(d) Waste monitoring and disposal programmes;

(e) Feedstocks and equipment checks for naturally-occurring ionising radiation;

(f) Clearance and control procedures for all materials and equipment leaving site (including scrap);

(g) Leak (wipe) tests on sealed radioactive containing equipment;

(h) Mine ventilation with specific reference to radiation protection (for underground mines);

(i) Water management and air emission control;

(j) Lock-out procedures for vessels and equipment containing radioactive sources and radon decay product measurement prior to entry;

(k) Emergency procedures;

(l) Environmental impact risk assessment (air, water, waste, foods, etc);

(m) Product/waste life cycle control; and

(n) Dose assessment for employees and a critical public group, according to documented methods and by an appropriately qualified person.

Priority = C	Score = NA 0 1 2 3 or 4

3.2 Areas with ionising radiation with annual doses greater than 5 milli Sieverts (mSv) must be designated as restricted access or controlled areas. These areas must be identified and mapped, signposted or otherwise clearly communicated to employees working in the area.

Priority = C	Score = NA 0 1 2 3 or 4

3.3 All underground operations must have conducted a baseline radon survey using passive area monitoring techniques. All underground operations with an identified radon issue must conduct similar surveys once every two years. Areas with levels greater than the International

Commission on Radiological Protection (ICRP) action levels must be designated as restricted access or controlled areas.

Priority = H	Score = NA 0 1 2 3 or 4

3.4 These designated restricted areas will require the development of engineering controls. Signposting, where necessary, must use appropriate wording or symbols on signs to identify the hazard.

Priority = C	Score = NA 0 1 2 3 or 4

3.5 Each person whose potential exposure exceeds 5mSv per annum or who is a designated radiation worker must undergo periodic personal radiation monitoring and medical examination that is reviewed by the medical adviser. The results must be discussed with the worker.

Priority = C	Score = NA 0 1 2 3 or 4

4.0 Exposure Controls

4.1 Exposure control for any type of radiation must include some form of control of the process from which the radiation is emitted (eg. use a lower energy source, shielding or isolation), a limitation on the time spent in close proximity to strong radiation sources, and training as to the location of sources and what to do about them.

Priority = C	Score = NA 0 1 2 3 or 4

4.2 All sources for ionising radiation must be managed in use and disposed of or securely stored in accordance with local regulations. Each site where individual worker's exposures could exceed 5 mSv per annum must have a trained radiation protection adviser in post or ready access to a trained protection consultant.

Priority = C	Score = NA 0 1 2 3 or 4

4.3 There must be documented procedures for inspection, assessment and maintenance of the controls, as well as emergency procedures to deal with incidents involving ionising radiation sources (including fire and explosions). All controls must be reassessed annually to ensure their continued effectiveness and that operating practices are in accordance with written procedures.

Priority = C	Score = NA 0 1 2 3 or 4

B6. THERMAL STRESS

1.0 Scope

This Standard addresses both workplace heat stress and cold stress. It covers high temperature conditions generated by the industrial process or the mining environment, temperatures exacerbated by hot weather, and extreme cold weather conditions, that can pose a risk to health and safety of employees and contractors.

2.0 Programme Design

2.1 Where risk assessment indicates the need, a documented thermal stress management programme must be in place such that:

(a) It complies with all relevant requirements in the A Standards;

(b) Workplace thermal stress levels (temperature, air movement, humidity, etc.) are adequately characterised and described;

(c) Activities (work level, etc.) and conditions (clothing, health, etc.) that have the potential to exacerbate thermal stress effects are identified and adequately characterised and described;

(d) Hot areas or activities where employees have experienced excessive fatigue, muscle cramp, dehydration, dizziness and other symptoms of heat stress are identified and described;

(e) Cold areas or activities where employees have experienced pain or loss of feeling in extremities, frostbite, severe shivering, excessive fatigue and other symptoms of cold stress are identified and described; and

(f) Control measures, including training and clear documented work procedures, are in place to minimise thermal stress levels and protect employees and contractors from adverse exposure.

Priority = M	Score = NA 0 1 2 3 or 4

2.2 Where a risk of thermal stress is determined, an appropriately qualified person, in consultation with employees must conduct monitoring surveys on site.

Priority = M	Score = NA 0 1 2 3 or 4

2.3 Medical examinations, as per Standard A5, must include information about the operator's physiological and biomedical aspects, and an interpretation of job fitness provided for defined extreme thermal conditions and job activities.

Priority = M	Score = NA 0 1 2 3 or 4

3.0 Measurement Techniques

3.1 Detailed heat stress assessment of identified tasks or jobs must be tiered to:

(a) Commence with the use of a simple heat stress index as a screening tool; then, if necessary
(b) Use rational heat stress indices in an iterative manner to determine the ‘best’ control methods for alleviating potential heat stress; then
(c) Undertake physiological monitoring when exposure

times are calculated to be less than 30 minutes, or where high level PPE that limits heat loss must be worn.

Priority = M	Score = NA 0 1 2 3 or 4

3.2 Detailed cold stress assessment of identified tasks or jobs must be conducted according to current appropriate guidelines, incorporating a cold stress index, to determine the 'best' control methods for alleviating potential cold stress.

Priority = M	Score = NA 0 1 2 3 or 4

4. <u>Exposure Controls & Treatment</u>

4.1 Where relevant, elimination or substitution must be considered.

Priority = M	Score = NA 0 1 2 3 or 4

4.2 Exposure controls must include:

(a) An acclimatisation period for new workers and those returning from extended leave or sickness;

(b) Training in the recognition of signs and symptoms of heat or cold stress, emergency procedures and preventative measures;

(c) Protective observation (buddy system or supervision); and

(d) A requirement for self-paced working.

Priority = M or H	Score = NA 0 1 2 3 or 4

4.3 The following exposure controls must be considered:

(a) Work / rest regimes based on the interpretation (by an expert) of measurements conducted, and job rotation;

(b) Suitable rest areas with a provision of cool drinking water and cool conditions for high temperatures, or provision of warm drinks and warm conditions for cold temperatures;

(c) Selection of appropriate clothing or other PPE for extreme temperature conditions; and

(d) The use of engineering controls.

Priority = M	Score = NA 0 1 2 3 or 4

4.4 Where thermal stress is assessed to be a risk, the site must develop a suitable emergency response plan.

Priority = M or H	Score = NA 0 1 2 3 or 4

B7. FITNESS FOR WORK

1.0 Scope

This Standard applies where a risk assessment has identified that fatigue or other causes of impaired fitness for work could produce a potential for serious injury or death, significant* equipment / plant damage, or significant environmental impact. It covers programme design, management of shift systems, and personal fitness. 'Personal fitness' includes the person's physical, mental and emotional state.

2.0 Programme Design

2.1 All roles where fatigue or other causes of reduced fitness for work could lead to serious injury or death to employees, significant equipment / plant damage, or for significant environmental impact, must be identified and an assessment of the risks from these conditions made**.**

Priority = M	Score = NA 0 1 2 3 or 4

2.2 Where identified, a programme to manage these risks is required, and must consider both employees and contractors. The programme, in addition to the requirements in Standard A5, must include:

(a) Mechanisms for managing fatigue, stress and lack of fitness;

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* Significant issues are as per high or critical issues as defined in the Rio Tinto "Priority and Definition of Incidents and Issues" table.

(b) An alcohol and other (including prescription, pharmaceutical or illicit) drugs policy that applies to employees, contractors and visitors;

(c) Employee Assistance Programme providing confidential access to counsellors; and

(d) Training and awareness programmes.

Priority = M	Score = NA 0 1 2 3 or 4

3.0 Management of Shifts and Work Hours

3.1 Sleep deprivation during shift work or from excessive working hours is a known cause of fatigue. Fatigued employees are at increased risk of accidents. Shift system design must consider:

(a) The effect on worker fatigue;

(b) The effects of activities carried out during rostered and over time hours;

(c) The effects of activities carried out during non-rostered hours; and

(d) The monitoring and control of working hours.

Priority = C	Score = NA 0 1 2 3 or 4

4.0 Personal Fitness

4.1 All workers commencing work in safety critical jobs must have a pre-placement medical examination, followed up by routine medical examinations, based on risk assessment and detailed position descriptions.

Priority = C	Score = NA 0 1 2 3 or 4

4.2 The criteria for fitness must be documented, preferably through detailed position descriptions, and quality control aspects of testing implemented. Acceptable limits (for alcohol, drugs, physical fitness, etc.) must be based on risk assessment, local legal requirements and appropriate standards.

Priority = H	Score = NA 0 1 2 3 or 4

4.3 All workers in safety critical jobs must report to their supervisor / manager any condition that might impair their ability to safely perform the functions of their position. A confidential mechanism must be in place for such reports to be referred to the medical adviser for consideration as to the worker's fitness for their type of work.

Priority = C	Score = NA 0 1 2 3 or 4

4.4 A programme must be available for those workers who require assistance to regain fitness for their work.

Priority = C	Score = NA 0 1 2 3 or 4

B8. LEGIONNAIRES DISEASE

1.0 Scope

This Standard applies to Legionnaires disease in the workplace. It covers *Legionella* hazard evaluation, control programme design and control programme evaluation, to ensure that employees, contractors and third parties will not suffer adverse health effects.

2.0 Programme Design

2.1 All equipment with the potential for generating *Legionella* (cooling towers and associated equipment, air-handling systems and hot water services) must be identified and the risks of contamination and aerosol generation assessed.

Priority = H	Score = 0 1 2 3 or 4

2.2 Where there is an assessed risk that *Legionella* could grow in the system and cause harm, a programme must be in place such that:

(a) All such equipment is identified on a register. The register must contain details of the regular maintenance, cleaning and checking programmes;

(b) Control measures are in place to minimise aerosol emissions;

(c) There must be a documented water treatment programme; and

(d) New equipment is designed and constructed to minimise the risk of *Legionella* growth.

Priority = C	Score = NA 0 1 2 3 or 4

3.0 Monitoring

3.1 Where available, the *Legionella* plate count test should be used if more effective methods are not available.

Priority = M	Score = NA 0 1 2 3 or 4

4.0 Controls

4.1 Good maintenance procedures must be followed to minimise the risk of significant contamination of equipment with other bacteria and microbial organisms.

Priority = M	Score = NA 0 1 2 3 or 4

4.2 Adequate procedures must be available for disinfecting systems if significant concentrations of *Legionella* bacteria are present. Once disinfected, systems must be retested to confirm effectiveness of treatment**.**

Priority = M	Score = NA 0 1 2 3 or 4

4.3 There must be documented procedures for inspection, assessment and maintenance of the controls

Priority = M	Score = NA 0 1 2 3 or 4

B9. TRAVEL AND REMOTE SITE HEALTH

1.0 Scope

This Standard covers the general travel health issues associated with temporary site visits, health issues associated with working in remote areas, and altitude sickness. It covers travel health programme design and management, to ensure that employees, contractors and third parties will not suffer adverse health effects.

2.0 Programme Design

2.1 There must be in place a programme to prevent both chronic and acute illnesses through proper sanitation and control of disease vectors at remote sites.

Priority = M H or C	Score = NA 0 1 2 3 or 4

2.2 There must be in place a programme to minimise as far as possible the impact of travel related ill-health and ensure that all international travellers are adequately prepared before travel. The programme must include information on jet lag, deep vein thrombosis (DVT) and infectious diseases.

Priority = M	Score = NA 0 1 2 3 or 4

2.3 The programme must include the possibility of altitude sickness, which may affect any visitor to sites above 3000 metres.

Priority = M	Score = NA 0 1 2 3 or 4

3.0 Management

3.1 Visitors, secondees and contractors who are travelling internationally, must be informed of relevant local community health hazards and precautions before arrival at site.

Priority = M	Score = NA 0 1 2 3 or 4

3.2 The need for immunisations and behavioural precautions (eg. sunscreen, insect repellent, appropriate clothing, food preparation, etc) must be documented and communicated to relevant staff.

Priority = M	Score = NA 0 1 2 3 or 4

3.3 An in-house occupational health service, a service provider or a general practice must provide relevant pre-travel advice and preparation. Professional responsibility for the provision of these pre-travel medical services must be defined. Where a service provider or a general practice is used, standards for the level of service provided must be established.

Priority = M	Score = NA 0 1 2 3 or 4

3.4 Consultants, bulletins and the Rio Tinto Intranet must be used to provide up-to-date warnings on health risks for remote area workers and visitors. A nominated person will post warnings received from the sites to the Intranet.

Priority = M	Score = NA 0 1 2 3 or 4

3.5 A process to allow travellers to be medically reviewed on return to home if there are health concerns must be defined.

Priority = M	Score = NA 0 1 2 3 or 4

3.6 Where food and water is provided by the Business, there must be a system to monitor that:

(a) Food is purchased from reputable sources, stored at appropriate temperatures and prepared in a hygienic manner and location. It must be inspected for temperature and signs of spoilage on receipt;

(b) Potable water sources are located away from potential sources of contamination, are treated to kill disease-producing organisms and are periodically checked for potability;

(c) Waste is treated in a way that will prevent water and air pollution and is not accessible to insects or rodents;

(d) Vector control is conducted in a manner that prevents the transmission of disease and ensures that control measures are applied in a safe and healthy manner; and

(e) Documented procedures are available for the above requirements and relevant employees are trained in these procedures.

Priority = M or H	Score = NA 0 1 2 3 or 4

4.0 Altitude

4.1 Prior to a visit, a physician must have reviewed all travellers to altitudes above 3000m within the previous 12 months, specifically for travel to high altitudes, and the following must be included in the review:

(a) Previous history of travel to similar altitudes;

(b) Lung function to establish the absence of significant restrictions;

(c) Heart function to establish normal exercise tolerance and absence of significant ischaemic or valvular disease. An electrocardiogram (ECG) should be performed;

(d) Blood pressure to ensure the absence of significant uncontrolled hypertension. Particular care is required for those with labile or poorly controlled disease;

(e) Cerebral function to establish the absence of conditions such as epilepsy that may be adversely affected by low oxygen concentrations;

(f) Any other concern of the traveller about the trip; and

(g) The use of medications to reduce the effects of altitude.

Priority = H	Score = NA 0 1 2 3 or 4

4.2 Whenever possible two or three days must be allowed to begin acclimatisation to altitude before work commences.

Priority = M	Score = NA 0 1 2 3 or 4

4.3 Whenever possible, visitors must move to lower levels at night. Practical experience suggests that moving to 3500 or below significantly improves the duration of sleep.

Priority = M	Score = NA 0 1 2 3 or 4

4.4 In the first week of a trip considerable caution must be exercised to avoid excessive physical exercise. Thereafter, exercise can increase very slowly.

Priority = M	Score = NA 0 1 2 3 or 4

4.5 While some discomfort is normal at these altitudes, irritability and severe breathlessness or anxiety may be indicators of maladjustment to altitude, and must be treated by moving the sufferer to lower altitude.

Priority = H	Score = NA 0 1 2 3 or 4

B10. OCCUPATIONAL EXPOSURE LIMITS

1.0 Scope

To protect all who work on our sites from occupational illness, workplace hazardous exposures must be controlled to below occupational exposure limit (OEL) and/or biological test limit values. The lists of substances (or agents) were derived from an assessment of business unit exposures, but do not necessarily include all hazardous exposures found within the Rio Tinto Group.

2.0 Definitions

2.1 Occupational Exposure Limits (OELs) are levels of agents in workplace air, which it is believed are low enough to protect nearly all workers from discomfort and adverse health effects over a series of eight-hour shifts for a working lifetime. Biological test limit values provide a method of determining total exposure to a chemical by measurement of a chemical, a metabolite or a biochemical change in the body. OEL and biological test limit values should be used as guidelines only, rather than *not safe / safe* limits.

2.2 The Rio Tinto OEL and biological test limit values will take precedence in all cases except where a lower legal limit is applicable.

2.3 Skin absorption may be a significant additional source of exposure for some agents. These are indicated in the list with a “sk” notation.

3.0 Programme Design

3.1 Each Business or site must establish or adopt an OEL for each agent for which significant worker exposure is possible. Where, in the absence of a legal or Rio Tinto OEL, a Business / site standard is developed, this OEL must be documented.

Priority = M	Score = NA 0 1 2 3 or 4

3.2 OEL and biological test limit values must be reviewed annually for relevance and efficacy.

Priority = M	Score = NA 0 1 2 3 or 4

3.3 Where workers have a working day longer than eight hours or unusual shift rotations are in effect, the TWA OEL may need to be reduced by a suitable factor to ensure adequate worker protection. Such factors require specialist consideration.

Priority = M	Score = NA 0 1 2 3 or 4

3.4 For some agents, the existence of an adverse carcinogenic health effect is known or suspected, but there is no internationally accepted assessment of the appropriate OEL or no agreed practical method to quantify workplace levels. In these cases, exposures to agents meeting these criteria must be reduced wherever possible.

Priority = M	Score = NA 0 1 2 3 or 4

4.0 Rio Tinto OEL Values

Agents in Air	Rio Tinto OEL
Ammonia	25 ppm (TWA) 35 ppm (STEL)
Arsenic	0.05 mg/m^3
Asbestos	0.5 f/mL (chrysotile) 0.1 f/mL (others)
Beryllium	0.002 mg/m^3
Boron (as B)	1 mg/m^3
Cadmium fume	0.025 mg/m^3
Carbon disulphide	10 ppm sk
Carbon monoxide (CO)	35 ppm
Chromium	0.05 mg/m^3 (Cr VI) 0.5 mg/m^3 (Cr other)
[1]Coal tar pitch (CTP) volatiles	0.2 mg/m^3 (BSM) sk

Agents in Air	Rio Tinto OEL
Copper	1 mg/m^3 (dust/mist) 0.2 mg/m^3 (fume)
Fluorides	2.5 mg/m^3
Hydrogen cyanide (HCN)	5 ppm (TWA) sk 10 ppm (STEL)
Hydrogen fluoride (HF)	2.5 mg/m^3 (ceiling)
Hydrogen sulphide (H_2S)	10 ppm (TWA) 15 ppm (STEL)
Inhalable dust (total)	10 mg/m^3
Ionising radiation (gamma / x-rays) – includes radon contributions	20 mSv/year
Lead	0.1 mg/m^3
Mercury	0.025 mg/m^3 sk
Nickel	0.5 mg/m^3 (metal & insol.) 0.1 mg/m^3 (soluble)
Nitrogen dioxide	3 ppm (TWA) 5 ppm (ceiling)
Non-asbestos fibrous silicates (NAFS) – respirable	1.0 f/mL
NAFS – non-respirable	5 mg/m^3
Noise	85 dB(A) (Leq) 140 dB (C)

Agents (in air)	Rio Tinto OEL
Oil mist	5 mg/m^3 (TWA) 10 mg/m^3 (STEL)
Respirable crystalline silica (quartz)	0.1 mg/m^3
Respirable coal dust	3 mg/m^3
Respirable dust - other	5 mg/m^3
Selenium	0.1 mg/m^3
Silver	0.1 mg/m^3 (insol.) 0.01 mg/m^3 (soluble)
Sodium hydroxide mist (NaOH)	2.0 mg/m^3 (ceiling)
Sulphuric acid mist	1 mg/m^3 (TWA) 3 mg/m^3 (STEL)
Sulphur dioxide (SO_2)	2 ppm (TWA) 5 ppm (STEL)
Wood dust - respirable	1 mg/m^3 (hardwood) 5 mg/m^3 (softwood)
Zinc	5 mg/m^3 (dust/mist) 1 mg/m^3 (fume)

[1]The BSM is accepted as the current OEL, but is recognised to need revision. It is recommended that Businesses / sites work to this and investigate reducing exposures whenever possible until agreement on a modified standard is achieved. Absorption through intact skin can be significant and must be managed actively.

5.0 Rio Tinto Biological Test Limit Values

Agents	Rio Tinto Biological Test Limit
Arsenic in urine (creatinine corrected)	50 µg/g CR (end work week)
Cadmium in blood Cadmium in urine (creatinine corrected)	5 µg/L (any time) 5 µg/g CR (any time)
Carbon monoxide in end-exhaled air	30 ppm (post-shift)
Carboxyhaemoglobin in blood	5% (post-shift)
Chromium (VI) in urine (creatinine corrected)	30 µg/g CR (end work week)
Fluoride in urine (creatinine corrected)	3 mg/g CR (pre-shift) 10 mg/g CR (post-shift)
Lead in blood – male Lead in blood – female of reproductive capacity	40 µg/dL (any time) 20 µg/dL (any time)
Mercury in urine (creatinine corrected)	40 µg/g CR (pre-shift)
Uranium in urine	40 µg/L

10 GOLDEN RULES FOR EMPLOYEES

All employees must:

1. Participate in OH induction and training programmes, and be able to apply what has been learnt.
2. Have knowledge of the site OH policy and strategy, and their role or targets in their site's health improvement action plan.
3. Understand their occupational health/hygiene responsibilities and accountabilities, as documented in site work procedures, and follow all reasonable instructions documented in them.
4. Understand the site first aid / medical arrangements and the procedure for activating the site emergency procedure.
5. Be aware of all occupational hazards in their work areas or applicable to their 'similar exposure group' (SEG), as far as they are informed of them, and participate in risk ranking where required.
6. Participate fully in the workplace monitoring and the medical surveillance programmes when required.
7. Operate and maintain all plant and equipment that they use, as far as its design and their training will allow, so as to minimise adverse health exposures. They must attempt to correct any conditions or faults that could contribute to adverse exposures in the first instance, and when this is not feasible they must report the defect to management.
8. Wear and maintain supplied PPE or warning devices such that they provide the designed degree of protection. PPE must be worn wherever health risks have been mapped, signposted or otherwise communicated.
9. Report all OH incidents, health anomalies and potential adverse exposures to their immediate manager or via the site's reporting system, and participate in any investigation. In

particular, they must report any health condition that could affect their ability to do their job safely, or that might be confounded by work exposures.

10. Maintain a sufficient level of fitness, alertness and health for their particular type of work such that they do not put at risk the health and safety of themselves (particularly with regard to manual handling and high temperature conditions) and their fellow workers (particularly with regard to 'safety critical' jobs, such as operating heavy equipment).

10 GOLDEN RULES FOR EMPLOYERS

1. ***Develop a practical health management system***, consistent with safety and environment management systems, encompassing documentation of OH policy, strategy, annual improvement action plan, organisation structure, responsibilities and accountabilities, procedures and practices, communication and training programmes, recording and reporting systems, performance targets, contractor management, and change management.
2. ***Base the occupational health management system on a documented assessment of the risks to health caused by site operations*.** Specific health risks related to exposure to particulate and gas/vapour, noise, manual handling, vibration, hazardous substances, radiation, thermal stress, Legionnaires disease, travel, remote site living, and fitness (fatigue, stress, alcohol and drugs, etc.) issues, are detailed in performance standards to guide hazard identification and characterisation.
3. Where risk assessment indicates the need, or where the law dictates, ***measure and quantify workers' exposures to hazardous substances or agents*** to a statistically valid degree, comparing similar exposure group (SEG) values to occupational exposure limits (OELs), while adhering to quality

control principles.

4. ***Provide adequate treatment and first aid facilities*** based on an assessment of the site needs and availability of other local facilities, and/or on legal requirements.
5. Where risk assessment or workplace monitoring indicates the need, or where the law dictates, ***develop a health surveillance system that ensures that workers are fit for their work, and recognises any diseases that may develop*** due to workplace exposures, while complying with local laws.
6. ***Develop the health surveillance system based on sound ethical and clinical practice.*** Tests used must be able to detect a health change reliably and be used only where detection of the change is of benefit to the worker. Worker's privacy and confidentiality of individual health information must be maintained.
7. Where risk assessment indicates the need, ***develop a system to minimise, manage or control identified risks***. It must be based on the hierarchy of exposure controls: eliminate the hazard; substitute for something safer; enclose the hazard; dilute it; reduce the time of workers' exposure; and finally, provide personal protective equipment.
8. ***Develop a system to record and report monitored workplace exposures, medical surveillance data and controls,*** to provide a basis from which the site management team can demonstrate that all health risks have been managed appropriately, and to defend the company in any future claims
9. ***Include an annual summary of workplace exposures and health surveillance trends*** in the reporting system, while ensuring individual worker privacy and confidentiality. Relevant information regarding health risks must be disseminated to workers (and third parties where applicable)

in a timely manner.

10. ***Review operations regularly in order to take reasonable and effective actions to reduce exposures as scientific knowledge changes*****,** in advance of legal requirements

Attachment D

Rio Tinto Environmental Standards (As Applicable)

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Annex Proposed Definitions

Acid Rock Drainage (ARD)	ARD is drainage of reduced quality resulting from the chemical and / or biological oxidation of rocks containing metal sulfides. The quality of water draining from mining wastes of this nature depends on a number of factors including weathering conditions, extent of oxidation and the nature of neutralisation reactions that may occur. The drainage may have a pH ranging from highly acidic to slightly alkaline and may contain dissolved metals (metal leaching), sulfates and other salts (solute enrichment) which can contaminate surface and ground waters. The term ARD is used whenever the source of the contamination is the initial oxidation of sulfide sulfur within the rock or waste mass.
Ambient Air	That portion of the atmosphere, external to buildings, to which the general public has access. This term does not apply to areas, within lease or ownership boundaries, which are controlled and to which the public is excluded.
Area Source	Any source of air pollution that is released over a broad area, and is not associated with a stationary location or fixed facility. Examples include dust from mining disturbance areas, emissions from tailpipes, etc.
Audit	An Audit is defined as a systematic, documented, periodic and objective evaluation of a business's systems, practices and performance in relation to pre determined criteria. It is conducted according to a defined schedule ad protocol, and includes inspections, interviews and document review.
Background level	The concentration of a substance in the soil, air or water that occurs naturally or is not a result of human activity.
Background noise	The underlying level of noise present in the environment, excluding the noise source under investigation.
Baseline noise assessment	The assessment of noise associated with a given environment pre - establishment of the operation.
Business	Business is an entity managed by a Rio Tinto product group. It may have other shareholders; it may be a single operation (eg Rössing) or several operations with a common locality and/or product (eg Pacific Coal). Individuals engaged on temporary contracts to work within existing operations.
Category 2 and 3 Contractors	(see Rio Tinto Safety Standard)
Contamination	The presence of any chemical substance in soil, air or water, at a concentration above background levels, that may make the soil, air or water unfit for its current or future use, or adversely affects some environmental value.
Contractors	Includes: Contractors and consultants who were associated with the operation for an extended period of time.
Emission Trading	Emission credits, which give the holder the right to emit a certain quantity of GHG, will, in the future be tradable between countries and other legal entities (Adapted from WBCSD definition).
Emissions	The intentional and unintentional release of GHGs into the atmosphere.

Ephemeral Stream	A stream that, before our discharging into it, flows at the surface only periodically, e.g. streams which flow only seasonally or during and after heavy rain.
External Audit	An Audit carried out by a team external to the Rio Tinto Group. An audit is still external if a Rio Tinto person joined the audit team but the report is prepared by an organisation external to Rio Tinto.
Facility	Facility is a discrete unit within an operation, eg Utah Power Plant is a facility within the Kennecott Utah Copper operation.
Fresh Water	Good quality water with total dissolved solids less than 1,500 mg/L and pH range 5 - 9. Includes potable water and raw water meeting the total dissolved solids criteria.
Fugitive Emissions	A diffuse, uncontrolled emission, eg roof ventilation systems, buildings, etc.
Greenhouse gases (GHG)	For the purposes of Environmental Standard or Guidance Note, GHGs are the six gases (or groups of gases) listed in the Kyoto Protocol: carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydroflurocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF6).
Ground water	Water under the surface of the ground occupying pores, cavities, cracks and other voids. Includes groundwater that has seeped into impoundments.
Hazardous Material	Any substance or article that poses a threat to human health and/or the environment. Typically hazardous materials are toxic, corrosive, inflammable, explosive or radio active.
Hazardous Waste	All waste classified as hazardous by the regulations applying to an operation.
Impounded Water	Surface runoff and rainfall intercepted by on-site impoundments and either used or directly discharged without use, impoundments include mining pits, dams and ponds (including tailings dams).
Internal Audit	Where the audit team is largely or wholly Rio Tinto Group personnel and the report prepared by Rio Tinto Group personnel.
Land-Use Management Plan	Plan based on an interdisciplinary process of evaluating, organising and controlling the present and future development and use of lands and their resources in terms of their sustainability on a sustained yield base. It includes an overall ecological evaluation in terms of specific kinds of uses as well as evaluations of social, economic and physical contexts to the land.
Land-Use Zoning	The methodology (and the final product of the application of the methodology) used to define and characterise land units according to their potential and conditions/restrictions for certain uses.
Major Waste Disposal Facility	For the purposes of Environmental Standard or Guidance Note, a major waste disposal facility is any facility that can potentially produce a high or critical impact to the environment or communities and whose details and issues are required to be included in the Six-Monthly Social and Environmental Report.
Managed operation	Managed operation is an operation or business which Rio Tinto manages. The financial interest in these operations varies from 100 per cent to less than 20 per cent.

Mineral Waste The part of an ore deposit that is too low in grade to be of economic value at the time of mining, but which may be stored separately for possible treatment later; and
Refuse and impurities removed in mining and treating coal.

Monitoring (in preparation)

Non managed operation Non managed operation is an operation in which Rio Tinto has a financial interest but does not manage.

Non-Mineral Waste Materials associated with the process of mining/milling or smelting/refining. This includes, but is not limited to such wastes as:

a. Industrial, building, office and workshop wastes;
b. Spent refractory, including spent cell linings;
c. Putrescible wastes (e.g. canteen wastes);
d. Spent oil and lubricant, antifreeze and Cooling fluids; drilling additives and fluids;
e. Tyres and rubber waste;
f. Scrap steel and construction wastes;
g. Laboratory waste, biomedical and radioactive wastes;
h. Camp wastes;
i. Laundry waste from on-site living accommodations.

Offset A verifiable emissions reduction achieved by undertaking a GHG reduction project.

Operation Operation is a single entity managed by Rio Tinto at a specific location with a principal product. A single operation may be a business, or a subcomponent of a business.

Point Source A stationary location or fixed facility from which pollutants are emitted. Also, any single identifiable source of pollution, e.g., a smoke stack, baghouse vent, etc.

Product group Product group is a managed group of businesses within Rio Tinto, on a product basis, for example Energy.

Reclamation (in preparation)

Rehabilitation (in preparation)

Remediation Work done to remove or contain contamination, to reduce risk to an acceptable level.

Rio Tinto The collective expressions "Rio Tinto", "Rio Tinto Group" and "Group" are used for convenience only. Depending on the context in which they are used, they mean Rio Tinto plc and/or Rio Tinto Limited and/or one or more of the individual companies in which Rio Tinto plc and/or Rio Tinto Limited directly or indirectly own investments, all of which are separate and distinct legal entities.

Risk The probability that an adverse effect on human health, the environment, property and/or the business, will occur as a result of contamination.

RT Land Any discrete parcel of land that is either fully or jointly managed by the Rio Tinto Business or Operation.

Significant water storage facilities	(in preparation)
Surface Water	Water in lakes, rivers, streams and offsite dams. Does not include impounded and marine water.
Waste reduction	Any practice that reduces the quantity and/or toxicity of a waste prior to recycling, treatment, or disposal. Examples include: equipment modifications, material substitution, process improvements, maintenance controls, and inventory controls.

Acid Rock Drainage Prediction and Control

A Intent

The intent of the standard is to ensure that Acid Rock Drainage (ARD) risks for Rio Tinto projects and operations are effectively identified through all phases of a mine and managed to prevent or minimise adverse environmental impacts and to reduce long-term costs and liabilities. The emphasis is on timely and thorough analysis of the risks, early identification and implementation of control (management) strategies and thorough integration of controls with mine planning and operational activities.

B Scope

This standard is applicable to all Rio Tinto Business Units and managed Operations. The requirements of this Standard are to be followed by all Operations that indicate existing or potential ARD conditions. The Standard covers the management of ARD through the complete mineral project development timeline from exploration through project development, approval and mining, changes in the orebody mineralogy and/or process conditions, through to closure and post-closure periods.

Other relevant documents are:

- Environmental Management System Standard
- Land Use Stewardship Standard
- Mineral Waste Management Standard
- Water Use and Quality Control Standard
- Rio Tinto Closure Standard (under preparation)
- Acid Rock Drainage Prediction and Control Guidance Note
- ARD – Early Warning Protocol for Exploration

C Requirements

Rio Tinto Business Units and/or managed Operations are required to:

1.0 *Planning*

1.1 Understand the geological setting and the mineralogy of sulphide containing rocks and adjacent lithology in order to support ARD potential and predictions studies.

1.2 Assess the ARD potential of any new development as part of exploration, order of magnitude, pre-feasibility and feasibility studies, due-diligence reviews for acquisitions, and also for changes in process and/or mineralogy.

1.3 Undertake appropriate environmental baseline studies for ARD before the commencement of a development project or any significant expansions of existing operations.

1.4 Due Diligence studies as part of potential project acquisitions must include assessment of the project current and potential ARD issues.

1.5 Maintain an ARD prediction program for forecasting the short-term and long-term behaviour under local weathering conditions of

a. The mineral bodies exposed to oxidation in open pits and underground mines;
b. Ores and other materials moved; and
c. Tailings and other process wastes stored.

1.6 Ensure the ARD prediction program reduces uncertainty about potential risk and liability to a level which permits a decision to be made to either reject the project or initiative, or to put in place effective mining and waste management strategies.

1.7 Ensure that recognised ARD experts are consulted for the initial assessment to determine whether there is an ARD issue at the site, design of the prediction program, the interpretation of its results, and the development of the management plan.

1.8 Develop an ARD management plan, commensurate with the ARD potential of mineral wastes and products and in line with the ARD prediction program, addressing as a minimum:

a. The prevention or limitation of ARD primary products generation;
b. The limitation of the mobilization and dispersion of ARD primary and secondary products;
c. The Maximisation of neutralisation and buffering reactions;
d. The compliance with regulated discharge limits and achieve receiving environment objectives;
e. The minimisation of reclamation and post closure liability;
f. The risks and impacts of potential modes of failure of the strategy.

2.0 *Implementation and Operation*

2.1 Implement the ARD Management Plan and make sure that it is integrated with mine and processing design, waste scheduling, closure planning, relevant operational procedures, and the business plan.

2.2 Maintain an inventory comprising quantities, location and representative characteristics of all materials extracted from a mine or exposed to oxidation with respect to their abilities to generate or mitigate ARD.

2.3 Assign accountabilities at each affected Operation for undertaking the ARD prediction program and for developing and implementing the ARD Management Plan.

2.4 Ensure that induction, general awareness and job specific training contains additional elements relating to ARD risks and how they are managed, where ARD is a significant issue for the operation. In such operations, the management team must have an appropriate knowledge of ARD prediction and control.

3.0 *Performance Measurement*

3.1 Maintain a monitoring procedure appropriate to the potential ARD impacts, which, as a minimum, allows adequate early warning and management decisions on ARD, facilitates the ongoing prediction program and confirms assumptions used in the management plan.

3.2 Arrange for independent review of the ARD Management Plan at regular intervals (at least every 4 years, or more frequently when operational or environmental conditions so dictate). The review must be carried out by an ARD expert and produce an independent document attesting the status of the prediction program and control strategies in place and indicating any potential threats to the Operation and the Rio Tinto Group.

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Air Quality Control

A Intent

The intent of this standard is to ensure that Rio Tinto Operations have identified and minimised air pollutant emissions and their potential impacts from all activities. This is to be accomplished by evaluating and prioritising them according to the significance of their impact, and taking effective measures to design and implement appropriate controls of emissions to ensure protection of ambient air quality.

B Scope

This standard is applicable to all Rio Tinto Business Units and managed Operations. It covers emissions from all sources, including fugitive emissions, during exploration, mining, mineral processing, materials handling, smelting, refining and on-site transport, and also their incremental impacts on the ambient air quality. Where the Business or Operation is also responsible for ancillary activities (eg power generation) or off-site transport (rail, truck and ship), those activities are also under the scope of this standard.

Other relevant documents are:

- Environmental Management System Standard
- Greenhouse Gas Emissions Standard
- Land Use Stewardship Standard
- Occupational Health Standards (hygiene aspects)
- Cleaner Production Principles
- Air Quality Guidance Note

C Requirements

Rio Tinto Business Units and/or managed Operations are required to:

1.0 *Planning*

1.1 Determine and maintain records of background ambient air quality, meteorological characteristics affecting pollutant dispersion and other sources of emission in the vicinity of the facilities.

1.2 Identify and characterise all significant pollutant emissions, from all sources, including fugitive, emissions and their method of release into the environment.

1.3 Identify and assess all community health and environmental risks associated with the exposure to individual and combined air pollutant emissions from the operation's facilities, and prioritise them on the basis of their predicted impacts.

1.4 Employ environmental aspect identification and change management procedures for new developments or substantive changes to existing facilities to determine and manage potential adverse impacts on ambient air quality.

1.5 Demonstrate that emissions, under normal and worst case conditions, from the operation, current or after a modification, will not cause the ambient air to violate regional or national air quality regulations, criteria and/ or licensed conditions.

1.6 Develop internal criteria on ambient air quality when government regulations are absent or incomplete to ensure protection of local community health and the environment. The criteria must have formal approval from the operations MD and be in line with internationally accepted regulations, guidelines and methodologies.

2.0 *Implementation and Operation*

2.1 Implement appropriate procedures or control technologies to manage those emissions selected in the environmental aspects identification process as having potential or actual significant impacts on ambient air quality.

2.2 Prepare emergency preparedness and response procedures to respond to abnormal emission and dispersion conditions and to cover exceedences of air quality standards, including immediate measures to protect community health.

3.0 *Performance Measurement*

3.1 Implement a monitoring program to measure (or estimate if appropriate) all significant emissions, air quality and ambient air impacts or nuisance air impacts from the operations where indicated by environmental aspects identification or regulatory authority. Where appropriate, impacts can be established by dispersion modelling studies that are validated against ambient air quality measurements.

3.2 In any monitoring program, identify and use the specifications of local regulatory authorities for:

a. Monitoring equipment;
b. Modelling assumptions;
c. Modelling programs;
d. Emission factors.

In the absence of such regulatory requirements, or if incomplete or inadequate adopt recognised international specifications, which must have formal approval from the operations MD.

Air Quality Control

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The intent of this standard is to ensure that Rio Tinto Operations identify and minimise air pollutant emissions and their potential impacts from all activities. This is to be accomplished by evaluating and prioritising them according to the significance of their impact, and taking effective measures to design and implement appropriate controls of emissions to ensure protection of ambient air quality.

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1.0 *Planning*

1.1 Determine and maintain records of background ambient air quality, meteorological characteristics affecting pollutant dispersion and other sources of emission in the vicinity of the facilities.

1.2 Identify and characterise all significant pollutant emissions, from all sources, including fugitive emissions and their method of release into the environment.

1.3 Identify and assess all community health and environmental risks associated with the exposure to individual and combined air pollutant emissions from the operation's facilities, and prioritise them on the basis of their predicted impacts.

1.4 Employ environmental aspect identification and change management procedures for new developments or substantive changes to existing facilities to determine and manage potential adverse impacts on ambient air quality.

1.5 Demonstrate that emissions from the current operation or following a modification, under normal and worst case conditions, will be in compliance with regional or national air quality regulations, criteria and/ or licensed conditions.

1.6 Develop internal criteria on ambient air quality when government regulations are absent or incomplete to ensure protection of local community health and the environment. The criteria must have formal approval from the operations MD and be in line with internationally accepted regulations, guidelines and methodologies.

2.0 *Implementation and Operation*

2.1 Implement appropriate procedures or control technologies to manage those emissions identified/selected in the environmental aspects identification process as having potential or actual significant impacts on ambient air quality.

2.2 Prepare emergency preparedness and response procedures to respond to abnormal emission and dispersion conditions and to cover exceedences of air quality standards, including immediate measures to protect community health.

3.0 *Performance Measurement*

3.1 Implement a monitoring program to measure (or estimate if appropriate) all significant emissions, air quality and ambient air impacts or nuisance air impacts from the operations, where indicated by environmental aspects identification or a regulatory authority. Where appropriate, impacts can be established by dispersion modelling studies that are validated against ambient air quality measurements.

3.2 In any monitoring program, identify and use the specifications of local regulatory authorities for:

a. Monitoring equipment;
b. Modelling assumptions;
c. Modelling programs;
d. Emission factors.

In the absence of such regulatory requirements, or if incomplete or inadequate adopt recognised international specifications, which must have formal approval from the operations MD.

Annex to the Environmental Standards

GLOSSARY OF TERMS

A B C E F G H I L M N O P R S T W

A

	Definition
Acid Rock Drainage (ARD)	ARD is low to neutral pH drainage that is derived from the products of oxidation of sulfide minerals and their reactions with other minerals in the mine rocks. Depending on the nature of the sulfide and other minerals, and other factors such as climate, ARD can contain acidity, sulfate, metals and dissolved salts, and can adversely impact surface and ground waters.
Acid Potential	The maximum potential acid generation from a sample. Knowledge of the sample chemistry, sulphur mineralogy and sulphide mineral chemistry are required for an accurate assessment. The procedures used to derive acid potential should be clearly identified (Adapted from INAP definition).
Ambient Air	That portion of the atmosphere, external to buildings, to which the general public has access. This term does not apply to areas, within lease or ownership boundaries, which are controlled and to which the public is excluded.
Area Source	Any source of air pollution that is released over a broad area, and is not associated with a stationary location or fixed facility. Examples include dust from mining disturbance areas, emissions from vehicles, etc.
Audit	An Audit is defined as a systematic, documented, periodic and objective evaluation of a business's systems, practices and performance in relation to pre determined criteria. It is conducted according to a defined schedule and protocol, and includes inspections, interviews and document review. *Does not include:*

	Definition
	• Inspections by staff, such as weekly or monthly inspection by the manager of general manager such as for housekeeping. These are considered to be routine management activities.

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B

	Definition
Background level	The concentration of a substance in the soil, air or water that occurs naturally or is not a result of human activity.
Background noise	The underlying level of noise present in the environment, excluding the noise source under investigation.
Baseline noise assessment	The assessment of noise associated with a given environment pre establishment of the operation.
Business	Business is an entity managed by a Rio Tinto product group. It may be a single operation (eg Rössing) or several operations with a common locality and/or product (eg Pacific Coal).

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C

	Definition
Cleaner Production	The continuous application of an integrated preventative strategy to processes, products and services to increase the overall efficiency and reduce risks to humans and the environment.
Climate Change	A term used to describe short and long-term effects on the Earth's climate as a result of both naturally caused climate variation and human activities such as fossil fuel combustion and vegetation clearing and burning.
Contamination	The presence of a substance at a concentration above that normally found at that locality that may make water or soil unfit for any current or potential beneficial use or adversely affect some environmental value.

	Definition
	Includes: • Substances not naturally found in the soil or water. • Substances found at a concentration above that which would have naturally occurred. *Does not include:* • Concentration increases in water comparable to that which would have occurred naturally while moving through the mineralised zone.
Contractors	Contractors and consultants who are associated with the operation for a period of time. Contactors as defined in the safety standards • Cat. 1 – Individuals engaged on temporary contracts to work within existing operations. • Cat 2 – Companies or individuals engaged for a discrete project. • Cat 3 – companies or individuals engaged under contract to carry out specific tasks or provide specified services within existing operations areas

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E

	Definition
Eco Efficiency	The delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life cycle to a level at least in line with the earth's estimated carrying capacity.
Emission Trading	Emission credits, which give the holder the right to emit a certain quantity of GHG and will in the future, be tradable between countries and other legal entities (Adapted from WBCSD definition).

	Definition
Environment	Ecosystems and their constituent parts, including people and communities; natural and physical resources; the qualities and characteristics of locations, places and areas; the social, economic and cultural aspects of a thing mentioned in the previous three criteria. (Australia State of the environment report)
Ephemeral Stream	A stream that, before our discharging into it, flows at the surface only periodically, e.g. streams which flow only seasonally or during and after heavy rain.
External Audit	An Audit carried out by a team external to the Rio Tinto Group. An audit is still external if a Rio Tinto person joined the audit team but the report is prepared by an organisation external to Rio Tinto.

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F

	Definition
Facility	Facility is a discrete unit within an operation, eg Utah Power Plant is a facility within the Kennecott Utah Copper operation.
Fresh Water	Potable water is good quality water with total dissolved solids less than 1,500 milligrams per litre, pH 5-9, and individual dissolved constituents (metals, anions etc) at concentrations suitable for agricultural/ livestock or irrigation use (based on local / regional / national guidelines).
Fugitive Emissions	A diffuse, uncontrolled emission, eg roof ventilation systems, buildings, etc.

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G

	Definition
Greenhouse gases (GHG)	GHGs are defined for the purpose of the standard as the six gases (or groups of gases) listed in the Kyoto Protocol: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydroflurocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6)

	Definition
	hexafluoride (SF6).
Greenhouse Gas Emissions	The intentional and unintentional release of those gases that, by affecting the radiation transfer through the atmosphere, contribute to the greenhouse effect.
Groundwater	Water under the surface of the ground occupying pores, cavities, cracks and other voids. *Includes:* • Dewatering and / or depressurisation flows through water withdrawal from bores. *Does not include:* • Groundwater that migrates to the surface.

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H

	Definition
Hazardous Material	Any substance or material that poses a threat to human health and/or the environment. Typically hazardous materials are toxic, corrosive, inflammable, explosive or radioactive.
Hazardous Waste	All waste classified as hazardous by the regulations applying to an operation.

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I

	Definition
Impounded Water	Surface runoff and rainfall intercepted by on-site impoundments.

	Definition
	Includes: • Rainfall and runoff water intercepted in mining pits and withdrawn for process use or directly discharged. • Rainfall and runoff water intercepted in on-site impoundments (eg clean water storage dam or sedimentation pond). • Runoff rainwater that is directed into a tailings impoundment or return water dam for use in the process. • Groundwater that migrates into a pit or impoundment. *Does not include:* • Tailings decant water. • Water from off site dams and lakes (this is classified as "surface water").
Internal Audit	An audit carried out by a team of largely or wholly Rio Tinto Group personnel and where the report is prepared by the Rio Tinto Group personnel.

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L

	Definition
Land-Use Management Plan	.A land-use management plan integrates the key environmental and social issues of biodiversity conservation; environmental offsets; interactions with adjoining lands, including communities; legacy and protection of socio-cultural and natural heritage features.
Land-Use Zoning	The methodology (and the final product of the application of the methodology) used to define and characterise land units according to their potential and conditions/restrictions for certain uses.

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M

	Definition
Major Waste Disposal Facility	A major waste disposal facility is any facility that can potentially produce a high or critical impact to the environment or communities and whose details and issues are required to be included in the Six-Monthly Social and Environmental Report.
Managed operation	Managed operation is an operation or business that Rio Tinto manages. The financial interest in these operations varies from 100 per cent to less than 20 per cent.
Mineral Waste	Refuse and impurities removed in mining and treating of ore. For the purpose of the Standards, it also includes the part of an ore deposit that is too low in grade to be of economic value at the time of mining, but which may be stored separately for possible treatment later, i.e. low grade ore.
Monitoring	Measurement of constituents in air or water is referred to as monitoring. Monitoring provides an accurate picture of the release of constituents as a result of activities at the operations. Enhanced monitoring programs may include keeping records on materials used by the source, periodic inspections, and installation of continuous emission monitoring systems (CEMS). Continuous emission monitoring systems will measure, on a continuous basis, how much of a constituent is being released.

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N

	Definition
Neutralisation Potential (NP)	A sample's or a material's capability to neutralise acidity. The objective of the NP analysis, in conjunction with measurements of AP, is to determine the net ARD potential. An understanding is needed of the mineralogy of the carbonate and other potential neutralising minerals present and of the analytical procedures that should be clearly defined. (Adapted form INAP definition).
Non Rio Tinto managed operation	Operations in which Rio Tinto has a financial interest but does not manage.

	Definition
Non Mineral Waste	Materials associated with the process of mining/milling or smelting/refining. *Includes:* • Industrial, building, office and workshop wastes; • Spent refractory, including spent cell linings; • Putrescible wastes (e.g. canteen wastes); • Spent oil and lubricant, antifreeze and Cooling fluids; drilling additives and fluids; • Tyres and rubber waste; • Scrap steel and construction wastes; • Laboratory waste; • biomedical and radioactive wastes; • Camp wastes; • Laundry waste from on-site living accommodations. *Does not include:* • Discarded portion of the mineral feedstock derived from mining and processing.

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O

	Definition
Offset	A verifiable emissions reduction achieved by undertaking a GHG reduction project.

	Definition
Operation	Operation is a single entity managed by Rio Tinto at a specific location with a principal product. A single operation may be a business, or a subcomponent of a business. For example, Tarong is an operation of Pacific Coa; Jacob's Ranch is an operation of KEC.

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P

	Definition
Point Source	A stationary location or fixed facility from which pollutants are emitted. Also, any single identifiable source of pollution, e.g., a stack, baghouse vent, etc.
Product group	Product group is a managed group of businesses within Rio Tinto, on a product basis, for example Energy.
Pollutant emissions	Release of polluting substances in the air, water and soil from a given source and measured at the emission point.

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R

	Definition
Reclamation	The term "reclamation" is itself used in at least three ways, referring to 1) conversion of mined or other disturbed lands into economically productive properties, such as grazing land or orchards, 2) filling in of wetlands or shallow coastal waters to create land, usually for housing or urban infrastructure, but also for agriculture in some parts of the world, and 3) conversion of disturbed lands to natural or semi-natural habitat (adapted from Ramsar Convention working group glossary).
Rehabilitation	Rehabilitation is the conversion of mined or other disturbed lands into economically productive properties, such as grazing land or orchards
Remediation	Work done to remove or contain contamination, to reduce risk to an acceptable level.

	Definition
Rio Tinto	The collective expressions "Rio Tinto", "Rio Tinto Group" and "Group" are used for convenience only. Depending on the context in which they are used, they mean Rio Tinto plc and/Rio Tinto Limited and/or one or more of the individual companies in which Rio Tinto plc and/or Rio Tinto Limited directly or indirectly own investments, all of which are separate and distinct legal entities.
Risk	The probability that an adverse effect on human health, the environment, property and/or the business that will occur as a result of an activity or situation.
Rio Tinto Land	Any discrete parcel of land that is either fully or jointly managed by the Rio Tinto Business or Operation.

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S

	Definition
Significant water storage facilities	(in preparation)
Surface Water	Water in lakes, rivers, streams and offsite dams. Does not include marine water.
Sustainable Development	Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development Definition).

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T

	Definition
Targets	Targets are specified levels or ranges of measurable parameters that the Group or a business has agreed they will try to achieve. Targets are policy tools, but they may have a scientific base.

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W

	Definition
Waste reduction	Any practice that reduces the quantity of a waste prior to recycling, treatment, or disposal. Examples include: equipment modifications, material substitution, process improvements, maintenance controls, and inventory controls. Includes: • Practices that reduce generation of waste by changes to raw material inputs, technology changes, operating practices and product changes.

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Environmental Management System

A. Intent

The intent of this standard is to ensure that Rio Tinto Businesses manage their environmentally related aspects in a manner that is planned, controlled, monitored, recorded and audited, using an Environmental Management System (EMS) that drives continual performance improvement.

This Standard will provide a comprehensive framework for the implementation of the other Rio Tinto Environmental Standards.

B. Scope

This Standard is applicable to all Rio Tinto Business Units. The Standard covers all exploration, construction, mining, processing, smelting, refining, distribution, transport, closure and corporate activities of the Rio Tinto Group. It also applies to contractors and suppliers with the level of EMS implementation commensurate to the level of hazard associated with the products and services provided by the contractor or supplier.

Other relevant documents are:

- The Way We Work
- ISO 14001:1996 Environmental Management System
- European Eco-Management and Audit Scheme - EMAS
- ARD Prediction and Control Standard
- Air Quality Control Standard
- Greenhouse Gas Emission Control Standard
- Hazardous Materials and Contamination Control Standard
- Land Use Stewardship Standard
- Mineral Waste Management Standard
- Non-Mineral Waste Management Standard
- Noise and Vibration Standard
- Water Use and Quality Control Standard
- Rio Tinto Occupational Health Standards
- Rio Tinto Safety Standards
- Rio Tinto Closure Standard (under preparation)
- Rio Tinto Data Quality Guidance Note
- Rio Tinto Guideline for Six-Monthly Social and Environmental Reporting
- Rio Tinto Procedure For Notification And Investigation Of Fatal And All Other Critical Incidents
- Rio Tinto's Guideline for HSE Auditing Within Group Companies
- Environmental Management System Guidance Notes
- Biodiversity Guidance Note (under preparation)
- Product Stewardship Guidance Note (under preparation)
- Social and Environment Reporting Guideline

C. Requirements

Rio Tinto Business Units and/or managed Operations are required to:

1.0 *General*

1.1 Maintain a certified Environmental Management System (EMS) conforming to the ISO 14001 Standard or EMAS (European Eco-Management and Audit Scheme). An accredited certification body must conduct the certification.

1.2 Ensure that the EMS is compatible with the overall management system of the Operation or Business Unit and in particular with the occupational health and safety management systems.

1.3 Ensure that contractors and suppliers are encouraged to maintain an EMS.

1.4 Ensure that Category 1 contractors are treated as employees for all purposes of the EMS application.

Maintain for Category 2 and 3 contractors a contractor environmental management procedure covering as a minimum:

a. Pre-qualification of Contractor
b. Pre-bid Meeting/Discussions
c. Bid Documents
d. Selection
e. Contract Terms
f. Pre-job Conference
g. Monitoring and Evaluation
h. Feedback

2.0 *Policy*

2.1 Ensure that the environmental policy is aligned and compatible with the Rio Tinto corporate environment policy, as expressed in the "The way we work", and all voluntary environment-related policy principles contained in codes and charters adopted by Rio Tinto.

3.0 *Planning*

3.1 In conformity with the adopted international EMS standard and considering the corresponding Rio Tinto Guidance Notes:

- Identify the environmental aspects and assess the significance of their impacts;
- Identify the applicable legal, Rio Tinto and other requirements;
- Establish environmental objectives and targets;
- Establish environmental management programmes.

3.2 Consider as a minimum, the following in the process of identifying environmental aspects associated with the operation and any ancillary activities:

a. Emissions to air
b. Greenhouse gas emissions
c. Noise and vibration
d. Releases to underground and surface waters including ARD
e. Mineral and non-mineral waste generation and disposal
f. Land use/management
g. Use of hazardous materials
h. Use of natural resources
i. Biodiversity/Changes to ecosystems
j. Product life cycle

3.3 Where any of the environmental aspects in 3.2 above is not applicable to the operation, keep a register with a documented justification of that fact.

3.4 Ensure that new activities, organisational arrangements and management procedures or changes to existing ones are subjected to Identification of their environmental aspects and impact assessment through a change management procedure.

3.5 Translate into the appropriate operational plans, program, projects and procedures the Group, Business Unit and Operation environmental performance indicators, objectives and targets.

3.6 Identify all relevant internal and external business and operational environmental data requirements and establish the data quality provisions necessary to ensure:

a. Completeness
b. Comparability
c. Representativeness
d. Defensible methodologies and
e. Accuracy and precision

4.0 *Implementation and Operation*

4.1 In conformity with the adopted international EMS standard and considering the corresponding Rio Tinto Guidance Notes:

- Define environmental management structure and responsibilities;
- Ensure personnel are trained, aware and competent for managing the environmental aspects and impacts related to their roles;
- Establish internal and external communication procedures;
- Maintain the documented elements of the EMS;
- Establish and maintain document control procedures;
- Implement operational control of environmental aspects;
- Maintain an environmental emergency preparedness and response procedure and capability.

4.2 Designate operational control of the relevant environmental aspects as a clear and accountable responsibility of line management. This must include the authority, resources and competence required for operating to established plans and procedures and for achieving the specified environmental performance outcomes and targets.

4.3 Establish a cross-functional committee, including the line managers, to support the development, implementation and operation of the EMS including the establishment of targets and objectives on environmental matters.

4.4 Ensure that the General Manager (or equivalent) is fully aware of, and adequately resourced to manage the environmental aspects connected with the Operation.

4.5 Establish a communication programme related to environmental aspects including keeping records of:

a. Stakeholder complaints, enquiries and views;
b. Responses and feedback to (a).

4.6 Ensure that no material change in process or management that might involve an environmental aspect is carried out prior to competent process of approval, communication and incorporation into appropriate routines or procedures.

4.7 Establish, document and implement procedures, including quality control elements, for the measurement or estimation of all environmental data requirements.

The procedures must:

a. Encompass all of the principal and ancillary parameters for which environmental data must be measured or estimated;
b. Ensure that the measurement or estimate is consistent with the criteria against which the data are to be evaluated;
c. Detail the method(s) for ensuring that the measurement or estimate takes into account the inherent variability of the operation's activities;
d. Detail the method(s) for measurement/estimations that are consistent with external requirements and recognized good practice; and
e. Include an estimate of uncertainty.

5.0 *Checking and Corrective Action*

5.1 In conformity with the adopted international EMS standard, comply with the following requirements of that standard:

- Maintain procedures to monitor and measure activities that can lead to impact on the environment;
- Maintain procedures for handling non-conformances and for corrective and preventive actions;
- Maintain procedures for environmental record-keeping; and
- Maintain procedures of environmental management system and performance auditing.

5.2 Review environmental data on a regular basis and take corrective actions if quality requirements are not met.

5.3 Establish a process of internal environmental audits covering environmental performance and the environmental management system. The audit requirements and process must be compatible with Rio Tinto's Guideline for HSE Auditing Within Group Companies.

5.4 Ensure the following conditions for the internal environmental auditing are met:

a. The members of an audit team must be sufficiently removed from the activities they audit to ensure independence of the audit process and its findings;
b. Develop and maintain audit protocols that reflect the environmental aspects and significant impacts of each activity/operation/business to be audited;
c. The frequency and coverage of the auditing process must be compatible with the significance of the potential environmental impacts;
d. A documented report must be prepared for each environmental audit, including the significant audit findings to be reported as indicated in the Guideline for Six-Monthly Social and Environmental Reporting.

5.5 Establish a system for recording and reporting all incidents involving injury, damage to property or damage to the environment or the potential for such injury or damage. This system must satisfy applicable regulatory requirements.

5.6 Establish a system for ensuring that written reports of Critical Incidents are submitted to the Chief Executive of Rio Tinto, with a copy to the Product Group Chief Executive and Head of HSE, within 24 hours of their occurrence.

5.7 Establish a system for ensuring that environmental incidents of relevance to other Group operations are posted on the Rio Tinto Portal Intranet Site within seven days of their occurrence.

5.8 Investigate any significant environmental incidents and non-conformances using qualified and trained personnel and transparent procedures. Incident and investigation reports must be communicated in accordance with the Procedure For Notification And Investigation Of Fatal And All Other Critical Incidents.

6.0 *Management Review /Performance Measurement*

6.1 Assess environmental performance regularly and review objectives and targets to maintain continual improvement.

6.2 Conduct a review of the EMS by senior management at least every three years or at lesser intervals if needed The review process and its outcomes must be documented and signed off by management.

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Environmental Management System

A. Intent

The intent of this standard is to ensure that Rio Tinto Businesses manage their environmental related aspects in a manner that is planned, controlled, monitored, recorded and audited, using an Environmental Management System (EMS) that drives continual performance improvement.

This Standard will provide the comprehensive framework for the implementation of the other Rio Tinto Environmental Standards.

B. Scope

This Standard is applicable to all Rio Tinto Business Units. The Standard covers all exploration, construction, mining, processing, smelting, refining, distribution, transport, closure and corporate activities of the Rio Tinto Group. It also applies to contractors and suppliers with the level of EMS implementation commensurate to the level of hazard associated with the products and services provided by the contractor or supplier.

Other relevant documents are:

- The Way We Work
- ISO 14001:1996 Environmental Management System
- European Eco-Management and Audit Scheme - EMAS
- ARD Prediction and Control Standard
- Air Quality Control Standard
- Greenhouse Gas Emission Control Standard
- Hazardous Materials and Contamination Control Standard
- Land Use Stewardship Standard
- Mineral Waste Management Standard
- Non-Mineral Waste Management Standard
- Noise and Vibration Standard
- Water Use and Quality Control Standard
- Rio Tinto Occupational Health Standards
- Rio Tinto Safety Standards
- Rio Tinto Closure Standard (under preparation)
- Rio Tinto Data Quality Guidance Note
- Rio Tinto Guideline for Six-Monthly Social and Environmental Reporting
- Rio Tinto Procedure for Reporting Investigation of Fatal and Critical Incidents
- Rio Tinto's Guideline for HSE Auditing Within Group Companies
- Environmental Management System Guidance Notes
- Biodiversity Guidance Note (under preparation)
- Product Stewardship Guidance Note (under preparation)
- S&E Reporting Guideline

C. Requirements

Rio Tinto managed Operations and/or Business Units are required to:

1.0 *General*

1.1 Maintain a certified Environmental Management System conforming to the ISO 14001 Standard or EMAS (European Eco-Management and Audit Scheme). An accredited certification body must conduct the certification.

1.2 Ensure that the EMS is compatible with the overall management system of the Operation or Business Unit and in particular with the occupational health and safety management systems.

1.3 Ensure that contractors and suppliers are encouraged to maintain an EMS.

1.4 Ensure that category 1 contractors are treated as employees for all purposes of the EMS application.

Maintain for Category 2 and 3 contractors a contractor environmental management procedure covering as a minimum:

a. Pre-qualification of Contractor
b. Pre-bid Meeting/Discussions
c. Bid Documents
d. Selection
e. Contract Terms
f. Pre-job Conference
g. Monitoring and Evaluation
h. Feedback

2.0 *Policy*

2.1 Ensure that the environmental policy is aligned and compatible with the Rio Tinto corporate environment policy, as expressed in the "The way we work", and all voluntary environment-related policy principles contained in codes and charters adopted by Rio Tinto.

3.0 *Planning*

3.1 In conformity with the adopted international EMS standard and considering the corresponding Rio Tinto Guidance Notes:

- Identify the environmental aspects and assess the significance of their impacts;
- Identify the applicable legal, Rio Tinto and other requirements;
- Establish environmental objectives and targets;
- Establish environmental management programmes.

3.2 Consider as a minimum, the following list in the process of identifying environmental aspects associated with the operation:

a. Emissions to air
b. Greenhouse gas emissions
c. Noise and vibration
d. Releases to underground and surface waters
e. Mineral and non-mineral waste generation and disposal
f. Land use
g. Use of hazardous materials
h. Use of natural resources
i. Changes to ecosystems
j. Product life cycle

3.3 Where any of the environmental aspects in the list is not applicable to the operation, keep a register with a documented justification of that.

3.4 Ensure that new activities, organisational arrangements and management procedures or changes to existing ones are subjected to previous identification of their environmental aspects and impact assessment through a change management procedure.

3.5 Translate into the appropriate operational plans, programmes, projects and procedures the Group, Business Unit and operation environmental performance indicators, objectives and targets.

3.6 Identify all relevant internal and external business and operational environmental data requirements and establish the data quality provisions necessary to ensure:

a. Completeness
b. Comparability
c. Representativeness
d. Methods used are defensible and
e. Accuracy and precision

4.0 *Implementation and Operation*

4.1 In conformity with the adopted international EMS standard and considering the corresponding Rio Tinto's Guidance Notes:

- Define environmental management structure and responsibilities;
- Ensure personnel are trained, aware and competent for managing the environmental aspects and impacts related to their roles;
- Establish internal and external communication procedures;
- Maintain the EMS elements documented;
- Establish and maintain document control procedures;
- Implement operational control of environmental aspects;
- Maintain an environmental emergency preparedness and response procedure and capability.

4.2 Designate operational control of the relevant environmental aspects as a clear and accountable responsibility of line management. This must include the authority, resources and competence required for operating to established plans and procedures and for achieving the specified environmental performance outcomes and targets.

4.3 Establish a cross-functional committee, including the line managers, to support the development, implementation and operation of the EMS including the establishment of targets and objectives on environmental matters.

4.4 Ensure that the General Manager (or equivalent) is fully aware of, and adequately resourced to manage the environmental aspects connected with the Operation.

4.5 Establish a communication programme related to environmental aspects including keeping records of:

a. Stakeholder complaints, enquiries and views;
b. Responses and feedback to (a).

4.6 Ensure that no material change in process or management that might involve an environmental aspect is carried out prior to competent process of approval, communication and incorporation into appropriate routines or procedures.

4.7 Establish, document and implement procedures, including quality control elements, for the measurement or estimation of all environmental data requirements.

The procedures must:

a. Encompass all of the principal and ancillary parameters for which environmental data must be measured or estimated;
b. Ensure that the measurement or estimate is consistent with the criteria against which the data are to be evaluated;
c. Detail the method(s) for ensuring that the measurement or estimate takes into account the inherent variability of the operation's activities;
d. Detail the method(s) for measurement/estimations that are consistent with external requirements and recognized good practice; and
e. Include an estimate of uncertainty.

5.0 *Checking and Corrective Action*

5.1 In conformity with the adopted international EMS standard, comply with the following requirements of that standard:

- Maintain procedures to monitor and measure activities that can lead to impact on the environment;
- Maintain procedures for handling non-conformances and for corrective and preventive actions;
- Maintain procedures for environmental record-keeping; and
- Maintain procedures of environmental management system and performance auditing.

5.2 Review environmental data on a regular basis and take corrective actions if quality requirements are not met.

5.3 Establish a process of internal environmental audits covering environmental performance and the environmental management system. The audit requirements and process must be compatible with Rio Tinto's Guideline for HSE Auditing Within Group Companies.

5.4 Ensure the following conditions for the internal environmental auditing are met:

a. The members of an audit team must be sufficiently removed from the activities they audit to ensure independence of the audit process and its findings;
b. Develop and maintain audit protocols that reflect the environmental aspects and significant impacts of each activity/operation/business to be audited;
c. The frequency and coverage of the auditing process must be compatible with the significance of the potential environmental impacts;
d. A documented report must be prepared for each environmental audit, including the significant audit findings to be reported as indicated in the Guideline for Six-Monthly Social and Environmental Reporting.

5.5 Establish a system for recording and reporting all incidents involving injury, damage to property or damage to the environment or the potential for such injury or damage. This system must satisfy applicable regulatory requirements.

5.6 Establish a system for ensuring that a written report of Significant Incidents are submitted to the Chief Executive of Rio Tinto, with a copy to the Product Group Chief Executive and Head of HSE, within 24 hours of their occurrence.

5.7 Establish a system for ensuring that environment incidents of relevance to other Group operations are posted on the Rio Tinto Portal Intranet Site within seven days of their occurrence.

5.8 Investigate any significant environmental incidents and non-conformances using qualified and trained personnel and transparent procedures. Incident and investigation reports must be communicated in accordance with the Procedure for Reporting Investigation of Fatal and Critical Incidents.

6.0 *Management Review*

6.1 Assess environmental performance regularly and review objectives and targets to maintain continual improvement.

6.2 Conduct a review of the EMS by senior management at least every three years or at lesser intervals if needed. The review process and its outcomes must be documented and signed off by management.

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Greenhouse Gas Emissions

A. Intent

The intent of this standard is to ensure that Rio Tinto Operations identify and minimise GHG emissions from all relevant activities. This is to be accomplished by identifying GHG emissions sources, evaluating and prioritising them according to significance, and then designing and implementing appropriate control, reduction and mitigation measures of greenhouse gas emissions to the environment.

B. Scope

This standard is applicable to all Rio Tinto Business Units and those managed operations that significantly contribute to Rio Tinto's total GHG emissions It covers all sources of GHG emissions during exploration, mining, mineral processing, materials handling, smelting, refining and on-site transport. Where the business unit or operation is also responsible for ancillary activities (eg power generation) or off-site transport (rail, truck and ship), those activities are also within the scope of this standard.

GHG issues associated with product life cycles are covered in the Product Stewardship Guidance Note.

Other relevant documents are:

- Rio Tinto Climate Change Policy (under preparation)
- Environmental Management System Standard
- Air Quality Control Standard
- Product Stewardship Guidance Note (under preparation)
- Biodiversity Guidance Note (under preparation)
- Greenhouse Gas Emission Guidance Note

C. Requirements

Rio Tinto Business Units and/or managed Operations are required to:

1.0 *Planning*

1.1 Develop, document and maintain knowledge of GHG emissions. This must include an understanding of current and future GHG sources and the factors that affect emission levels from the sources.

1.2 Identify and assess GHG related risks and opportunities for the business or operation. This is to include where applicable, the use of specific or generic emissions abatement cost curves, assessments of emissions trading, offset opportunities and factor in changes as a result of national or international policies and measures

1.3 Develop and achieve GHG emissions reduction targets to drive improvements in emissions control and reduction. Progress towards the targets must be supported by suitable sets of actions and milestones that are linked to the business planning process.

1.4 Ensure that technical and commercial considerations of GHG emissions issues (including possible costs inferred by government-imposed carbon tax schemes or CO_2 emissions regulations) are included in:

a. Annual business plans and valuations;
b. New project evaluations;
c. Capital expenditure programs;
d. Due diligence reviews for divestments and acquisitions.

2.0 *Implementation and Operation*

2.1 Implement and maintain GHG emission control and reduction programs. Upgrade these as the business needs and external requirements change and as there is progress in the understanding of, and responses to, climate change issues.

2.2 Assign clear responsibilities, resources and accountabilities for GHG management. Responsibilities must include progressing established actions for achieving GHG targets.

3.0 *Performance Measurement*

3.1 Ensure that the appropriate measures are in place for metering, or estimating where appropriate, GHG emissions.

3.2 Conduct periodic reviews to identify potential risks and opportunities associated with GHG issues at the business or operation.

Greenhouse Gas Emissions

A. Intent

The intent of this standard is to ensure greenhouse gas (GHG) emissions minimisation in Rio Tinto. This is to be accomplished by identifying GHG emissions sources, evaluating and prioritising them according to significance, and then designing and implementing appropriate control, reduction and mitigation measures of greenhouse gas emissions to the environment.

B. Scope

This standard is applicable to all Rio Tinto Business Units and those managed operations that significantly contribute to Rio Tinto's total GHG emissions. It covers all sources of GHG emissions during exploration, mining, mineral processing, materials handling, smelting refining and on-site transport. Where the business unit or operation is also responsible for ancillary activities (eg power generation) or off-site transport (rail, truck and ship) those activities will be covered under the scope of this standard.

GHG issues associated with product life cycles are covered in the Product Stewardship Guidance Note.

Other relevant documents are:

- Rio Tinto Climate Change Policy
- Environmental Management System Standard
- Air Quality Control Standard
- Product Stewardship Guidance Note (under preparation)
- Biodiversity Guidance Note
- Greenhouse Gas Emission Guidance Note

C. Requirements

Rio Tinto Business Units and/or managed Operations are required to:

1.0 *Planning*

1.1 Develop, document and maintain knowledge of GHG emissions. This must include an understanding of current and future GHG sources and the factors that affect emission levels from the sources.

1.2 Identify and assess GHG related risks and opportunities for the business or operation. Including, where applicable the use of specific or generic emissions abatement cost curves and assessments of emissions trading and offset opportunities and factor in changes as a result of national or international policies and measures.

1.3 Develop and achieve GHG emissions reduction targets to drive improvements in emissions control and reduction. Progress towards the targets must be supported by suitable sets of actions and milestones that are linked to the business planning process.

1.4 Ensure that technical and commercial considerations of GHG emissions issues (including possible costs inferred by government imposed carbon tax schemes or CO_2 emissions regulations) are included in:

a. Annual business plans and valuations;
b. New project evaluations;
c. Capital expenditure programs;
d. Due diligence reviews for divestments and acquisitions.

2.0 *Implementation and Operation*

2.1 Implement and maintain GHG emission control and reduction programs. Upgrade these as the business needs and external requirements change and as there is progress in the understanding of, and responses to, climate change issues.

2.2 Assign clear responsibilities and accountabilities for GHG management. Responsibilities must include progressing established actions for achieving GHG targets.

3.0 *Performance Measurement*

3.1 Ensure that the appropriate measures are in place for metering, or estimating where appropriate, GHG emissions.

3.2 Conduct periodic reviews to identify potential risks and opportunities associated with GHG issues at the business or where appropriate operation.

Hazardous Materials and Contamination Control

A. Intent

The intent of this standard is to ensure the safe and responsible use and control of all hazardous materials handled by Rio Tinto operations, in ways commensurate with their risks to the environment. The control measures shall also ensure the minimisation of risks and environmental impacts due to spill or other escapes.

For those cases where site contamination has occurred, the intent of the standard is to ensure that contamination is properly characterised and managed.

B. Scope

This standard is applicable to all Rio Tinto Business Units and managed Operations from exploration/development and acquisition through to closure and post closure. It covers the management of hazardous materials, including hazard identification and evaluation, cleaner production, reduction of use, re-use and recycling, inventory reduction, secure storage and transport, contamination investigations, site remediation and emergency response. Where the Business or Operation is also responsible for ancillary activities (e.g. power generation) or off-site transport (rail, truck and ship), those activities are also within the scope of this standard.

Other relevant documents are:

- Environmental Management System Standard
- Non-Mineral Waste Management Standard
- Water Use and Quality Control Standard
- Land-Use Stewardship Standard
- Mineral Waste Management Standard
- B4 (Hazardous Substances) Occupational Health Standard
- Product Stewardship Guidance Note (under preparation)
- Hazardous Materials and Contamination Control Guidance Note

C. Requirements

Rio Tinto Business Units and/or managed Operations are required to:

1.0 *Planning*

1.1 Understand and document the environmental hazards of materials brought to site, site products, intermediate products and by-products.

1.2 Identify and assess the environmental aspects and potential impacts associated with the transport, storage, use and transfer of hazardous materials, including failures of secondary containment structures.

1.3 Develop internal criteria for hazardous materials and site contamination when government regulations are absent or incomplete to ensure the correct classification of such materials. The criteria must have formal approval from the operations MD and be in line with internationally accepted regulations, guidelines, definitions and methodologies.

1.4 Maintain a documented inventory of hazardous materials brought to site or produced onsite and document their storage, usage and final destination.

1.5 Develop and maintain a contaminated sites register, with geographical references, for land currently or previously owned, leased and/or managed (RT land). Existing contamination must be identified and its environmental impact assessed. The register must include known contamination for sites previously owned or leased regardless of whether remediation liabilities are retained. Ensure that registers are developed as part of the due diligence process for acquisitions.

1.6 Develop and implement a Hazardous Material and Contamination Management Plan that consolidates:

a. Controlling the use and inventory of hazardous materials to minimum necessary quantities;
b. Assessing and promoting the use of environmentally safer alternatives to hazardous materials currently in use;
c. Ensuring the safe use, storage and transport of hazardous materials.

2.0 *Implementation and Operation*

2.1 Ensure that all employees and contractors involved with hazardous materials handling or remediation of contamination are fully aware of the associated environmental hazards and risks and are appropriately trained in routine activities and emergency actions.

2.2 Ensure that new hazardous materials including those brought to site by contractors do not adversely impact the environment.

2.3 Ensure that all hazardous materials are kept in adequate conditions and containment, within controlled areas and securely protected from contact of non-authorised personnel and, where necessary, from birds and other animals.

2.4 Operate effective containment barriers for preventing spills of hazardous material from reaching the environment. Above ground tanks, drum storages and pipelines that contain hazardous material must have properly designed secondary containments.

2.5 Ensure that storage tanks and pipelines containing or transporting hazardous materials are above ground. Any exception must be justified and authorised by the General Manager (or equivalent).

2.6 Ensure that storage tanks and pipelines containing or transporting hazardous materials have leakage / spill identification and response controls in place.

2.7 Implement selection criteria and control procedures for third party transporters, purchasers and other recipients of hazardous materials and implement follow-up procedures for any hazardous material sent off the premises.

2.8 Maintain and test emergency response procedures, associated equipment and personnel for responding to potential, on-site and off-site hazardous material releases.

2.9 Develop and implement a remediation strategy for those existing contaminated sites where site investigation has shown there is an unacceptable environmental impact to current land uses, ecological function, surface and ground water resources, or where off-site impacts are occurring or are likely to occur.

3.0 *Performance Measurement*

3.1 Implement routine inspections, testing and monitoring procedures for leaks from, or deterioration of storage tanks and pipelines with a frequency and methodology commensurate with the associated environmental hazards.

3.2 Maintain spill and leakage detection equipment that is adequate for the risk posed by the hazardous material to the environment and linked to the appropriate operational control and emergency response unit.

3.3 Implement a systematic auditing procedure for significant aspects of hazardous materials management at site in order to verify its adequacy and performance.

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Hazardous Materials and Contamination Control

A. Intent

The intent of this standard is to ensure the safe and responsible use and control of all hazardous materials handled by Rio Tinto operations in ways commensurate with their risks to the environment. The control measures shall also ensure the minimisation of risks and environmental impacts due to spill or other escapes.

For those cases where site contamination has occurred, the intent of the standard is to ensure that contamination is properly characterised and managed.

B. Scope

This standard is applicable to all Rio Tinto Business Units and managed operations from exploration/development and acquisition through to closure and post closure. It covers the management of hazardous materials, including hazard identification and evaluation, cleaner production, reduction of use, re-use and recycling, inventory reduction, secure storage and transport, contamination investigations, site remediation and emergency response. Where the Business or Operation is also responsible for ancillary activities (e.g. power generation) or off-site transport (rail, truck and ship), those activities are also under the scope of this standard.

Other relevant documents are:

- Environmental Management System Standard
- B4 (Hazardous Substances) Occupational Health Standard
- Non-Mineral Waste Management Standard
- Water Use and Quality Control Standard
- Land Use Stewardship Standard
- Mineral Waste Management Standard
- Product Stewardship Guidance Note (under preparation)
- Hazardous Materials and Contamination Control Guidance Note

C. Requirements

Rio Tinto Business Units and/or managed Operations are required to:

1.0 *Planning*

1.1 Understand and document the environmental hazards of materials brought to site, site products, intermediates and by-products.

1.2 Identify and assess the environmental aspects and potential impacts associated with the transport, storage, use and transfer of hazardous materials, including failures of secondary containment structures.

1.3 Develop internal criteria for hazardous materials and site contamination when government regulations are absent or incomplete to ensure the correct classification of such. The criteria must be in line with internationally accepted regulations, guidelines, definitions and methodologies.

1.4 Maintain a documented inventory of hazardous materials brought to site or produced onsite and document their storage, usage and final destination.

1.5 Develop and maintain a contaminated sites register, with geographical references, for land currently or previously owned, leased and/or managed (RT land). Identify existing contamination and assess its environmental impact. The register must include known contamination for sites previously owned or leased regardless of whether remediation liabilities are retained. Ensure that registers are developed as part of the due diligence process for acquisitions.

1.6 Develop and implement a Hazardous Material and Contamination Management Plan that consolidates:

a. Controlling the use and inventory of hazardous materials to minimum necessary quantities;
b. Assessing and promoting the use of environmentally safer alternatives to currently used hazardous materials;
c. Ensuring the safe use, storage and transport of hazardous materials.

2.0 *Implementation and Operation*

2.1 Ensure that all employees and contractors involved with hazardous materials handling or remediation of contamination are fully aware of the associated environmental hazards and risks and are appropriately trained in routine activities and emergency actions.

2.2 Ensure that new hazardous materials including those brought by contractors do not adversely impact the environment.

2.3 Ensure that all hazardous materials are kept in adequate conditions and containment, within controlled areas and securely protected from contact of non-authorised personnel and, where necessary, from birds and other animals.

2.4 Operate effective containment barriers for preventing spills of hazardous material from reaching the environment. Above ground tanks, drum storages and pipelines that contain hazardous material must have properly designed secondary containments.

2.5 Storage tanks and pipelines containing or transporting hazardous materials must be above ground. Any exception must be justified and authorised by the Managing Director.

2.6 Storage tanks and pipelines containing or transporting hazardous materials must have leakage / spill identification and response controls in place.

2.7 Implement selection criteria and control procedures for third party transporters, purchasers and other recipients of hazardous materials and implement follow-up procedures for any hazardous material sent off the premises.

2.8 Maintain and test emergency response procedures, associated equipment and personnel for responding to potential, on-site and off-site hazardous material releases.

2.9 Develop and implement a remediation strategy for those existing contaminated sites where site investigation has shown there are an unacceptable environmental impact to current land uses, ecological function, surface and ground water resources, or where off-site impacts are occurring or are likely to occur.

3.0 *Performance Measurement*

3.1 Implement routine inspections, testing and monitoring procedures for leaks from, or deterioration of storage tanks and pipelines with a frequency and methodology commensurate with the associated environmental hazards.

3.2 Maintain spill and leakage detection equipment that is adequate for the risk posed by the hazardous material to the environment and linked to the appropriate operational control and emergency response unit.

3.3 Implement a systematic auditing procedure for significant aspects of hazardous materials management at site in order to verify its adequacy and performance.

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Land-Use Stewardship

A. Intent

The intent of this standard is to ensure sustainable stewardship of the land, which Rio Tinto owns, leases and / or manages. This requires an understanding of the current and potential use of the land, its value and community expectations followed by development of an integrated and strategic approach to land management that identifies and mitigates the impacts of our operations and ownership on that land and progresses biodiversity and generates beneficial business opportunities that flow from effective management.

B. Scope

This standard is applicable to all Rio Tinto Business Units and managed operations and applies to all lands owned, leased and/or managed (RT land) by the group. It covers all activities of the group from exploration through mining and mineral processing to closure and includes the substantial component of the land that is not used directly for mining, processing or ancillary activities.

Other relevant documents are:

- Environmental Management System Standard
- Water Use and Quality Control Standard
- Greenhouse Gas Emission Standard
- Rio Tinto Closure Standard (under preparation)
- Biodiversity Guidance Note
- Progressive Rehabilitation Guidance Note
- Land Use Stewardship Guidance Note
- Community Relations Standard (under preparation)
- Cultural Heritage Management System Guidance Note (under preparation

C. Requirements

Rio Tinto Business Units and/or managed Operations are required to:

1.0 *Planning*

1.1 Develop and maintain a documented description of all the aspects and implications of the land owned, leased and/or managed (RT land) by the operation. This information base must include:

a. The tenure, customary ownership, community expectations, former and current use of RT land and its immediate surroundings;
b. The environmental, social and physical characteristics and capabilities of RT land and its immediate surroundings;
c. The location of significant natural features;
d. The location of cultural heritage features, in consultation with those for whom the features have meaning/significance;
e. The location of potential legacy issue sites.

1.2 Develop in consultation with key stakeholders a Land Use Zoning. The zoning must be compatible with local and regional regulatory land use management plans and shall:

a. Identify and map all land units on RT Land;
b. Register acceptable uses and any restrictions pertaining to the land units.

1.3 Develop targets to drive improvements in land management. Progress towards the targets must by supported by a suitable set of actions.

1.4 Develop and implement a Land-Use Management Plan based on the Land-Use Zoning that promotes an integrated and sustainable approach to land management. The plan shall address:

a. Issues of biodiversity conservation;
b. Environmental offsets;
c. Interactions with adjoining lands, including communities;
d. Legacy and protection of socio-cultural and natural heritage features.

2.0 *Implementation and Operation*

2.1 Integrate Land-Use Management Plans into Business Unit and/or Operations planning, closure planning, progressive rehabilitation programs, project evaluations and capital expenditure reviews.

2.2 Assign clear responsibilities and accountabilities for land-use management. Responsibilities must include progressing the Land-Use Management Plan and its associated targets.

2.3 Implement an authorization procedure to ensure that all development on RT land is compatible with the Land-Use Zoning and the Land-Use Management Plan.

2.4 Ensure that any alterations to the Land-Use Zoning and or Land-Use Management Plan are adequately researched, justified and documented. Management authorisation must be obtained before any alteration to the Land-Use Zoning or the Land-Use Management Plan can be made.

3.0 *Performance Measurement*

3.1 Conduct a systematic auditing procedure of all aspects of land-use management procedures in order to verify their adequacy, performance and areas of risk or opportunity.

Mineral Waste Management

A Intent

The intent of this standard is to ensure environmentally safe and effective management of mining and process wastes generated or handled by Rio Tinto operations. Waste disposal facilities and sites shall be physically, biologically and chemically safe. Waste production shall be minimised and waste re-use, backfill and recycling maximised.

B Scope

This standard is applicable to all Rio Tinto Business Units and managed Operations and covers the management of mining and process waste generated by their activities, or which are taken by the operations to dispose of or manage on behalf of others.

Mineral waste includes: waste rock, tailings from mineral processing, rejects from beneficiation or concentration of coal and other minerals, red mud from alumina production, refinery discards and sludges, smelter and other furnace slags, ashes, and mine-dredging materials.

Other relevant documents are:

- Environmental Management System Standard
- Air Quality Control Standard
- Non-Mineral Waste Management Standard
- Hazardous Materials and Contamination Control Standard
- Rio Tinto Closure Standard (under preparation)
- Acid Rock Drainage Prediction and Control Standard
- Land-Use Stewardship Standard
- Water Use and Quality Control Standard
- Mineral Waste Management Guidance Note
- Rio Tinto Guideline for Six-Monthly Social and Environmental Reporting

C Requirements

Rio Tinto Business Units and/or managed Operations are required to:

1.0 *Planning*

1.1 Identify, assess and document the quantities, characteristics and hazards of the wastes that will be generated by mining and processing of each distinct section of the mineral deposit.

1.2 Develop and maintain an inventory of mineral wastes generated, handled and disposed of, whether on or offsite, including descriptions of hazard and other characteristics, volumes and details of location and techniques used for handling and disposal.

1.3 Maintain a procedure for identification of hazards, potential modes of failure and assessment of risks posed by tailings dams and other large waste disposal facilities.

1.4 Maintain, for each waste disposal facility or site, an up to date model of the long-term physical and chemical waste behaviour and impacts on the environment. The model must be validated using data from prediction tests and monitoring.

1.5 Ensure that design and construction of all waste disposal facilities or sites are:

a. Compatible with the waste behaviour, addressing any threats to the environment, particularly those posed by contaminated run-off, seepage, liquefaction and leachate;
b. Engineered to best available technology for stability and safety.

1.6 Ensure that new developments do not use tailings disposal facilities for water storage functions. Any existing dual storage of wastes and water must undergo a risk assessment and a study of potential alternatives.

1.7 Apply a change management procedure for the approval of any significant modification in waste generation, handling and disposal.

1.8 Avoid any uncontrolled riverine disposal of mineral wastes.

1.9 Develop targets to drive improvements in mineral waste management. Progress towards the targets must be supported by a suitable set of actions.

1.10 Establish and maintain a documented Mineral Waste Management Plan that covers all stages of waste management from generation to final use and/or disposal.

2.0 *Implementation and Operation*

2.1 Maintain operational procedures commensurate with the identified hazards of each waste disposal facility for managing:

a. The waste mass and its physical and chemical reactions;
b. The containment structure and its stability issues;
c. Spills, unplanned mixture or segregation of wastes;
d. Waste placement.

2.2 Ensure that the supervision and operation of dams and dumps is commensurate with the environmental and safety hazards posed by the structures.

2.3 Undertake assessments of contractors and facilities used for wastes sent off-site for disposal or treatment, to verify that the wastes have been dealt with appropriately.

3.0 *Performance Measurement*

3.1 Monitor physical stability parameters of waste disposal structures as an early detection and warning mechanism for potential failure.

3.2 Conduct regular monitoring of the geochemical reactions occurring through the profile of the waste, for validation or review of the waste behaviour model and early warning of potential pollution problems.

3.3 Conduct independent and external review by qualified engineering specialist(s) of all major waste storage facilities according to protocols and frequencies adequate to their physical and chemical hazards and level of risks. Frequency of external reviews must not be less than once every 2 years. The review must receive signoff from the General Manager (or equivalent). Any significant findings must be reported according to Rio Tinto requirements.

3.4 Maintain an emergency system, including communication with stakeholders, for responding to potential incidents involving waste storage facilities and or transport to disposal facilities.

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Mineral Waste Management

A Intent

The intent of this standard is to ensure environmentally safe and effective management of mining and process wastes generated or handled by Rio Tinto operations. Waste disposal facilities and sites shall be physically, biologically and chemically safe. Waste production shall be minimised and waste re-use, backfill and recycling maximised.

B Scope

This standard is applicable to all Rio Tinto Business Units and managed Operations and covers the management of mining and process waste generated by their activities, or which are taken by the operations to dispose or manage on behalf of others.

Mineral waste includes: waste rock, tailings from mineral processing, rejects from beneficiation or concentration of coal and other minerals, red mud from alumina production, refinery discards and sludges, smelter and other furnace slags, ashes, and mine-dredging materials.

Other relevant environmental documents are:

- Environmental Management System Standard
- Air Quality Control Standard
- Non-Mineral Waste Management Standard
- Hazardous Materials and Contamination Control Standard
- Rio Tinto Closure Standard (under preparation)
- Acid Rock Drainage Prediction and Control Standard
- Land Use Management Standard
- Water Use and Quality Control Standard
- Mineral Waste Management Guidance Note
- Rio Tinto Guideline for Six-Monthly Social and Environmental Reporting

C Requirements

Rio Tinto Business Units and/or managed Operations are required to:

1.0 *Planning*

1.1 Identify, assess and document the quantities, characteristics and hazards of the wastes that will be generated by mining and processing of each distinct section of the mineral deposit.

1.2 Develop and maintain an inventory of mineral wastes generated, handled and disposed of, whether on or offsite, including descriptions of hazard and other characteristics, volumes and details of location and techniques used for handling and disposal.

1.3 Maintain a procedure for identification of hazards, potential modes of failure and assessment of risks posed by tailings dams and other large waste disposal facilities.

1.4 Maintain, for each waste disposal facility or site, an up to date model of the long-term physical and chemical waste behaviour and impacts on the environment. The model must be validated using data from prediction tests and monitoring.

1.5 Ensure that design and construction of all waste disposal facilities or sites are:

a. Compatible with the waste behaviour, addressing any threats to the environment, particularly those posed by contaminated run-off, seepage, liquefaction and leachate;
b. Engineered to best available technology for stability and safety.

1.6 New developments will not use tailings disposal facilities for water storage functions. Any existing dual storage of wastes and water must undergo a risk assessment and a study of potential alternatives.

1.7 Apply a change management procedure for the approval of any significant modification in waste generation, handling and disposal.

1.8 Avoid any uncontrolled riverine disposal of mineral wastes.

1.9 Develop targets to drive improvements in the aspects of mineral waste management. Progress towards the targets must be supported by a suitable set of actions.

1.10 Establish and maintain a documented Mineral Waste Management Plan that covers all stages of waste management from generation to final use and/or disposal.

2.0 *Implementation and Operation*

2.1 Maintain operational procedures commensurate with the identified hazards of each waste disposal facility for managing:

a. The waste mass and its physical and chemical reactions;
b. The containment structure and its stability issues;
c. Spills, unplanned mixture or segregation of wastes;
d. Waste placement.

2.2 Ensure that the supervision and operation of dams and dumps is commensurate with the environmental and safety hazards posed by the structures.

2.3 Undertake assessments of contractors and facilities used for wastes sent off-site for disposal or treatment, to verify that the wastes have been dealt with appropriately.

3.0 *Performance Measurement*

3.1 Monitor physical stability parameters of waste disposal structures as an early detection and warning mechanism for potential failure.

3.2 Conduct regular monitoring of the geochemical reactions occurring through the profile of the waste, for validation or review of the waste behaviour model and early warning of potential pollution problems.

3.3 Conduct independent and external review by qualified engineering specialist(s) of all major waste storage facilities according to protocols and frequencies adequate to their physical and chemical hazards and level of risks. Frequency of external reviews must not be less than once every 2 years and any significant findings must be reported according to Rio Tinto requirements.

3.4 Maintain an emergency system, including communication with stakeholders, for responding to potential incidents involving waste storage facilities and or transport to disposal facilities.

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Noise and Vibration Control

A Intent

The intent of this standard is to ensure that Rio Tinto Operations minimise the impact of noise and vibration on the surrounding environment and communities. This is to be accomplished by identifying noise and vibration sources, evaluating and prioritising the sources according to significance of potential impacts then taking effective measures to design and implement appropriate controls.

B Scope

This standard is applicable to all Rio Tinto Business Units and managed Operations. It covers all components of noise and vibration arising from exploration and operations, including mining, mineral processing, materials handling infrastructure and on-site transport, which may significantly impact on people, communities and the surrounding environment. Where the business or operation is also responsible for ancillary activities (eg power generation) or off-site transport (rail, truck and ship), those activities are also within the scope of this standard.

Occupational noise and vibration exposure is not covered by this standard but rather by the Occupational Health Standards B2 and B3.

Other relevant documents are:

- Environmental Management System Standard
- Land-Use Stewardship Standard
- Occupational Health Standards
- Biodiversity Guidance Note
- Noise and Vibration Control Guidance Note

C Requirements

Rio Tinto Business Units and/or managed Operations are required to:

1.0 *Planning*

1.1 Develop, document and maintain knowledge of the baseline, and for existing operations, background noise and vibration levels.

1.2 Employ change management procedures and predictive modelling of near and far field noise and vibration levels as part of the pre-feasibility and feasibility study for:

a. New developments;
b. Significant expansions;
c. Changes to existing activities and facilities.

The model will, where applicable, incorporate baseline/background data, community expectations and regulatory requirements, and identify significant exposures to sensitive receptors.

1.3 Identify which components of the facility and which activities are the key contributors to external noise and vibration levels and understand their generation, propagation and potential environmental impact under a range of meteorological and operating conditions. Establish the likely effectiveness of noise and vibration control mechanisms in achieving regulatory or license requirements and accommodating community expectations.

1.4 Develop internal criteria on noise and vibration performance when government regulations are absent or incomplete, to ensure protection of local community health and the environment. The criteria must have formal approval from the operations MD and be in line with internationally accepted regulations, guidelines and methodologies.

2.0 *Implementation and Operation*

2.1 Have a procedure in place to manage noise and vibration where an assessment based on predictive modelling or monitoring results indicates the need, in order to meet regulatory requirements and accommodate community expectations.

2.2 Establish a model or real time assessment of near and far field noise and vibration levels throughout the life of the operation.

2.3 Adopt a hierarchy of noise and vibration controls, with engineering or design controls for noise sources being the first option implemented. If due to safety reasons this is not permissible consider other control methods/processes.

2.4 Incorporate and maintain noise and vibration control requirements into design and operational criteria for relevant exploration and mining activities, including drilling and blasting, processing activities and new facilities.

2.5 Incorporate noise and vibration performance criteria into purchasing requirements for relevant equipment and machinery.

3.0 *Performance Measurement*

3.1 Have a procedure in place for monitoring noise and vibration levels outside current operations that adequately samples potentially affected neighbouring areas, and covers/ a broad range of operating and meteorological conditions.

3.2 Implement a monitoring program to:

a. Support operational control;
b. Verify compliance with targets and legal requirements;
c. Update and maintain the relevance of near and far-field noise and vibration models;
d. Assess noise and vibration impact on the environment and communities under a broad range of operating and meteorological conditions.

Noise and Vibration Control

A Intent

The intent of this standard is to ensure that Rio Tinto Operations minimise their noise and vibrations impacts on the surrounding environment and communities. This is to be accomplished by identifying noise and vibration sources, evaluating and prioritising the sources according to significance of potential impacts then taking effective measures to design and implement appropriate controls.

B Scope

This standard is applicable to all Rio Tinto Business Units and managed Operations. It covers all components of noise and vibration arising from exploration and operations, including mining, mineral processing, materials handling infrastructure and on-site transport, which may significantly impact on people, communities and the surrounding environment. Where the business or operation is also responsible for ancillary activities (eg power generation) or off-site transport (rail, truck and ship), those activities are also under the scope of this standard.

Occupational noise and vibration exposure is not covered by this standard but rather by the Occupational Health Standards B2 and B3.

Other relevant documents are:

- Environmental Management System Standard
- Land Use Stewardship Standard
- Occupational Health Standards
- Biodiversity Guidance Note
- Noise and Vibration Control Guidance Note

C Requirements

Rio Tinto Business Units and/or managed Operations are required to:

1.0 *Planning*

1.1 Develop, document and maintain knowledge of the baseline, and for existing operations, background noise and vibration levels.

1.2 Employ change management procedures and predictive modelling of near and far field noise and vibration levels as part of the pre-feasibility and feasibility study for:

a. New developments;
b. Significant expansions;
c. Changes to existing activities and facilities.

The model will, where applicable, incorporate baseline/background data, community expectations, and regulatory requirements and identify significant exposures to sensitive receptors.

1.3 Identify which components of the facility and which activities are the key contributors to external noise and vibration levels and understand the generation, propagation and potential environmental impact under a range of meteorological and operating conditions. Establish the likely effectiveness of noise and vibration control mechanisms in achieving regulatory or license requirements and accommodating community expectations.

1.4 Develop internal criteria on noise and vibration performance when government regulations are absent or incomplete to ensure protection of local community health and the environment. The criteria must be in line with internationally accepted regulations, guidelines and methodologies

2.0 *Implementation and Operation*

2.1 Have a procedure in place to manage noise and vibration where an assessment based on prediction modelling or monitoring results indicates the need, in order to meet regulatory requirements and accommodate community expectations.

2.2 Establish a model or real time assessment of near and far field noise and vibration levels throughout the life of the operation.

2.3 Adopt a hierarchy of noise and vibration controls, with engineering or design controls for noise sources being the first option implemented. If due to safety reasons this is not permissible consider other control processes.

2.4 Incorporate and maintain noise and vibration control requirements into design and operational criteria for relevant exploration and mining activities, including drilling and blasting, processing activities and new facilities.

2.5 Incorporate noise and vibration performance criteria into purchasing requirements for relevant, equipment and machinery.

3.0 *Performance Measurement*

3.1 Have a procedure in place for monitoring noise and vibration levels outside current operations, that adequately samples potentially affected neighbouring areas, and covering a broad range of operating and meteorological conditions.

3.2 Implement a monitoring program to:

a. Support operational control;
b. Verify compliance with targets and legal requirements;
c. Update and maintain the relevance of near and far-field noise and vibration models;
d. Assess noise and vibration impact on the environment and communities under a broad range of operating and meteorological conditions.

Non- Mineral Waste Management

A Intent

The intent of this standard is to ensure sound non-mineral waste management in Rio Tinto Operations by the minimization of waste generation and ensuring the safe handling, treatment and disposal of all wastes generated.

B Scope

This standard is applicable to all Rio Tinto Business Units and managed Operations from exploration/development and acquisition through to closure and post closure. It covers non-mineral wastes generated by the activities of the operation, or non-mineral wastes received by the operation to dispose of or manage on behalf of others.

Mineral wastes generated as a direct product of mining or processing, are addressed in the Mineral Waste Management Standard.

Other relevant documents are:

- Environmental Management System Standard
- Hazardous Materials and Contamination Control Standard
- Mineral Waste Management Standard
- Water Use and Quality Control Standard
- Land-Use Stewardship Standard
- Air Quality Control Standard
- Non-Mineral Waste Management Guidance Note

C Requirements

Rio Tinto Business Units and/or managed Operations are required to:

1.0 *Planning*

1.1 Develop, document and maintain a characterisation of the environmental hazards and risks associated with non-mineral wastes generated, disposed on-site and, transported and disposed off-site or managed on behalf of others.

1.2 Develop and maintain a documented inventory of non-mineral wastes generated or received and disposed on or off-site.

1.3 Maintain measurable indicators and targets for hazard and quantity reduction of significant non-mineral wastes destined for disposal.

1.4 Develop internal criteria on waste classification and management when government regulations are absent or incomplete. The criteria must have formal approval from the operations MD and be in line with internationally accepted regulations, guidelines, definitions and methodologies.

1.5 Develop and implement a Non-mineral Waste Management Plan. The plan shall give priority to those wastes identified as having significant hazard and the actions must demonstrate that the waste management hierarchy has been considered, as follows in order of preference:

a. Waste avoidance and reduction at source;
b. Reuse and recycling and;
c. Waste treatment and/or disposal.

2.0 *Implementation and Operation*

2.1 Ensure that non-mineral wastes are segregated at generation and that wastes awaiting further treatment, transport or disposal are securely contained and monitored.

2.2 Maintain operational procedures and effective controls for the safe handling, on-site and off-site transportation, storage and disposal of non-mineral wastes commensurate with their degree of hazard and compatibility.

2.3 Maintain records of all wastes sent off-site, and a documented inventory and location of on-site waste landfills and storage areas. Historical and abandoned landfills shall be included in this inventory and their geographical location and extent documented.

2.4 Ensure that disposal of waste is only carried out in engineered and approved facilities and in accordance with established operational procedures.

2.5 Undertake verification assessments of contractors and facilities used for wastes sent off-site for disposal or treatment, to verify that the wastes have been dealt with appropriately.

3.0 *Performance Measurement*

3.1 Establish a procedure to inspect and monitor waste handling and storage facilities commensurate with the degree of hazard of the waste. Corrective action must be taken where unacceptable conditions are identified.

3.2 The Non-mineral Waste Management Plan must be reviewed at least every four years or more frequently when operational or environmental conditions so dictate.

Non- Mineral Waste Management

A Intent

The intent of this standard is to ensure sound non-mineral waste management in Rio Tinto Operations by the minimization of waste generation and ensuring the safe handling, treatment and disposal of all generated wastes.

B Scope

This standard is applicable to all Rio Tinto Business Units and managed operations from exploration/development and acquisition through to closure and post closure. It covers non-mineral wastes generated by the activities of the operation, or non-mineral wastes received by the operation to dispose or manage on behalf of others.

Mineral wastes generated as a direct product of mining or processing, are addressed in the Mineral Waste Management Standard.

Other relevant documents are:

- Environmental Management System Standard
- Hazardous Materials and Contamination Control Standard
- Mineral Waste Management Standard
- Water Use and Quality Control Standard
- Land Use Stewardship Standard
- Air Quality Control Standard
- Non-Mineral Waste Management Guidance Note

C Requirements

Rio Tinto Business Units and/or managed Operations are required to:

1.0 *Planning*

1.1 Develop, document and maintain a characterisation of the environmental hazards and risks associated with non-mineral wastes generated, disposed on-site and, transported and disposed off-site or managed on behalf of others.

1.2 Develop and maintain a documented inventory of non-mineral wastes generated or received and disposed on or off-site.

1.3 Maintain measurable indicators and targets for hazard and quantity reduction of significant non-mineral wastes destined for disposal.

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a. Waste avoidance and reduction at source;
b. Reuse and recycling and;
c. Waste treatment and/or disposal.

2.0 *Implementation and Operation*

2.1 Ensure that non-mineral wastes are segregated at generation and that wastes awaiting further treatment transport or disposal are securely contained and monitored.

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3.0 *Performance Measurement*

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3.2 The Non-mineral Waste Management Plan must be reviewed at least every four years or more frequently when operational or environmental conditions so dictate.

Water Use and Quality Control

A. Intent

The intent of this standard is to ensure efficient, safe and sustainable use and protection of water resources and ecosystems in and around Rio Tinto Operations. This requires an understanding of the water resources, their spatial and temporal interrelationships, their ownership in the region and the needs of key catchment stakeholders. This provides the basis for the development of an integrated and strategic approach to water management that promotes the maintenance or improvement of water quality, upstream and downstream, minimisation of fresh water use and the maximisation of reuse and recycling.

B. Scope

This standard is applicable to all Rio Tinto Business Units and managed operations from exploration/development through to closure. It covers all activities connected to water abstraction, dewatering, transport, storage, usage (potable and process), and direct/indirect discharge, involving surface water (including runoff), impounded water and ground water.

Other relevant documents are:

- Environmental Management System Standard
- Acid Rock Drainage Prediction and Control Standard
- Hazardous Materials and Contamination Control Standard
- Mineral Waste Management Standard
- Non-Mineral Waste Management Standard
- Land-Use Stewardship Standard
- Rio Tinto Closure Standard (under preparation)
- Annual Social and Environment Survey Guidelines
- Water Use and Quality Control Guidance Note

C. Requirements

Rio Tinto Business Units and/or managed Operations are required to:

1.0 *Planning*

1.1 Develop, document and maintain an appropriate knowledge of the biotic and abiotic characteristics of surface and groundwater resources in which the operation works. This includes characterisation of climatic, limnological, hydrological, hydro-chemical and hydro-geological systems.

1.2 Develop and maintain an appropriate understanding of the cumulative demands and impacts being placed on water resources and ecosystems in the catchments in which the operations work. This must include understanding the current and future water requirements of key upstream and downstream users and stakeholders, and the regime and quality required to maintain ecosystem integrity.

1.3 Develop and maintain an appropriate 'site water balance', including solute balances, detailing all water inputs, uses, outputs and losses.

1.4 Employ environmental aspects identification and change management procedures to ensure that new developments, existing activities and facilities and substantive changes to existing facilities do not degrade the upstream and downstream quality, function, use and integrity of 'natural' water ecosystems (including ephemeral streams).

1.5 Develop internal criteria on water abstraction, dewatering, effluent discharge or water quality when government regulations are incomplete or inadequate to ensure protection of water resources. The criteria must have formal approval from the operations General Manager (or equivalent) and be in line with internationally accepted criteria, guidelines and methodologies.

1.6 Develop targets to drive improvements in on-site and off-site water management. Progress towards the targets must be supported by suitable sets of actions.

1.7 Develop and implement a Water Management Plan that consolidates the acquired knowledge about the water resources and ecosystems and the actions required to comply with the intent of this Standard and with all regulations and requirements of the pertinent authorities. The Plan must be reviewed at least every four years or more frequently when operational or environmental conditions so dictate.

2.0 *Implementation and Operation*

2.1 Assign clear responsibilities and accountabilities for on-site and off-site water management. Responsibilities must include progressing the Water Management Plan and its associated targets.

2.2 Design, construct and manage water withdrawal, storage, treatment and discharge facilities using current best practice. In the design phase conduct a risk assessment to identify and correct any potential failure scenarios. Ensure that construction meets regulatory requirements and addresses all the identified hazards/risks. Ensure that operation of the facility conforms to approved design criteria and operational procedures and that precautionary measures are put in place to protect freshwater ecosystems.

2.3 Prepare emergency preparedness and response procedures for the following:

a. Drought;
b. Flood;
c. Failures of large water retention structures;
d. Unplanned effluent discharges.

This should be coordinated and compatible with the similar requirements for large waste storage facilities as contained in the Mineral Waste Management Standard.

3.0 *Performance Measurement*

3.1 Maintain safety inspection procedures, including the detailed verification of all identified hazards, for all major water storage facilities. These requirements should be compatible with the major waste storage facilities inspection and signoff requirements detailed in the Mineral Waste Management Standard.

3.2 Implement a monitoring program to:

a. Support operational control;
b. Verify compliance with targets and legal requirements;
c. Update on-site water balances and off-site catchment models;
d. Assess impact on the environment;
e. Assess, where appropriate, cumulative impacts of the operation on the catchment and other users;
f. Meet reporting requirements.

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Water Use and Quality Control

A. Intent

The intent of this standard is to ensure efficient, safe and sustainable use and protection of water resources and ecosystems in and around Rio Tinto Operations. This requires an understanding of the water resources, their spatial and temporal interrelationships, their ownership in the region and the needs of key catchment stakeholders. This provides the basis for the development of an integrated and strategic approach to water management that promotes the maintenance or improvement of water quality, upstream and downstream, minimisation of fresh water use and the maximisation of reuse and recycling.

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Other relevant documents are:

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- Rio Tinto Closure Standard (under preparation)
- Hazardous Materials and Contamination Control Standard
- Mineral Waste Management Standard
- Annual S & E Survey Guidelines
- Water Use and Quality Control Guidance Note

C. Requirements

Rio Tinto Business Units and/or managed Operations are required to:

1.0 *Planning*

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1.2 Develop and maintain an appropriate understanding of the cumulative demands and impacts being placed on water resources and ecosystems in the catchments in which the operations work. This must include understanding the current and future water requirements of key upstream and downstream users and stakeholders, and the regime and quality required to maintain ecosystem integrity.

1.3 Develop and maintain an appropriate 'site water balance', including solute balances, detailing all water inputs, uses, outputs and losses.

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3.2 Implement a monitoring program to:

a. Support operational control;
b. Verify compliance with targets and legal requirements;
c. Update on-site water balances and off-site catchment models;
d. Assess impact on the environment;
e. Assess, where appropriate, cumulative impacts of the operation on the catchment and other users;

f. Meet reporting requirements.

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Attachment E

Pre Task Hazard Assessment

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Pre Task Hazard Assessment Task Group

Ed Bolton(KEC), Joe Carrabba (DDMI-Project Leader),
Rob Hammond (RTP), Tim Kassulke (CALBRIS),
Claudio Lazzari (HSE), Erik Madsen (DDMI), Tony Martyr (RTCA)
Wheldon Nicholson (Hamersley), Tom Palmer/Tony Hughes
(Palabora), John Pettit (Luzenac), Joe Riordan (RTCA)

The Mandate

- To collate pre task hazard assessment tools in use within the group
- To review design and implementation issues of conducting a pre task hazard assessment
- To determine the best practice amongst the group and thus provide a uniform way of conducting these assessments

Objective

- Many businesses have adopted PTHA to get their work force to think through the job prior to initiating the work
- PTHA is used to identify the hazard and mitigate the risk

Risk Assessment Tools

Typical Risk Assessment Tools						
	Behavioural Observation	Take 5	Job Hazard Analysis	Team Based Risk Assessment	What If…/Checklist	HAZOP
Development and Review of Business/Divisional/MRU/Output Team Hazard Registers						
Processing Design Reviews						
Implementing and/or Reviewing Major Change						
Implementing and/or Reviewing Minor Change						
Major Project Engineering Projects						
Job Pre-Planning						
Development of CBP's or SWP's						
Informal Assessment on Day to Day Tasks						

Why the name change to Pre Task Hazard Assessment?

- Pre Task Hazard Assessment is associated with the Probability-Consequence Matrix used by many system around the group
- PTHA have evolved to focus more on the consequence versus the probability of that consequence occurring
- The name is in keeping with the safety interaction effort
- The task force on Safety Interactions and PTHA are looking to leverage from one another

Probability

Consequences	A. Common	B. Likely	C. Possible	D. Unlikely	E. Rare
1. Catastrophic	1	2	4	7	11
2. Major	3	5	8	12	16
3. Significant	6	9	13	17	20
4. Moderate	10	14	18	21	23
5. Minor	15	19	22	24	25

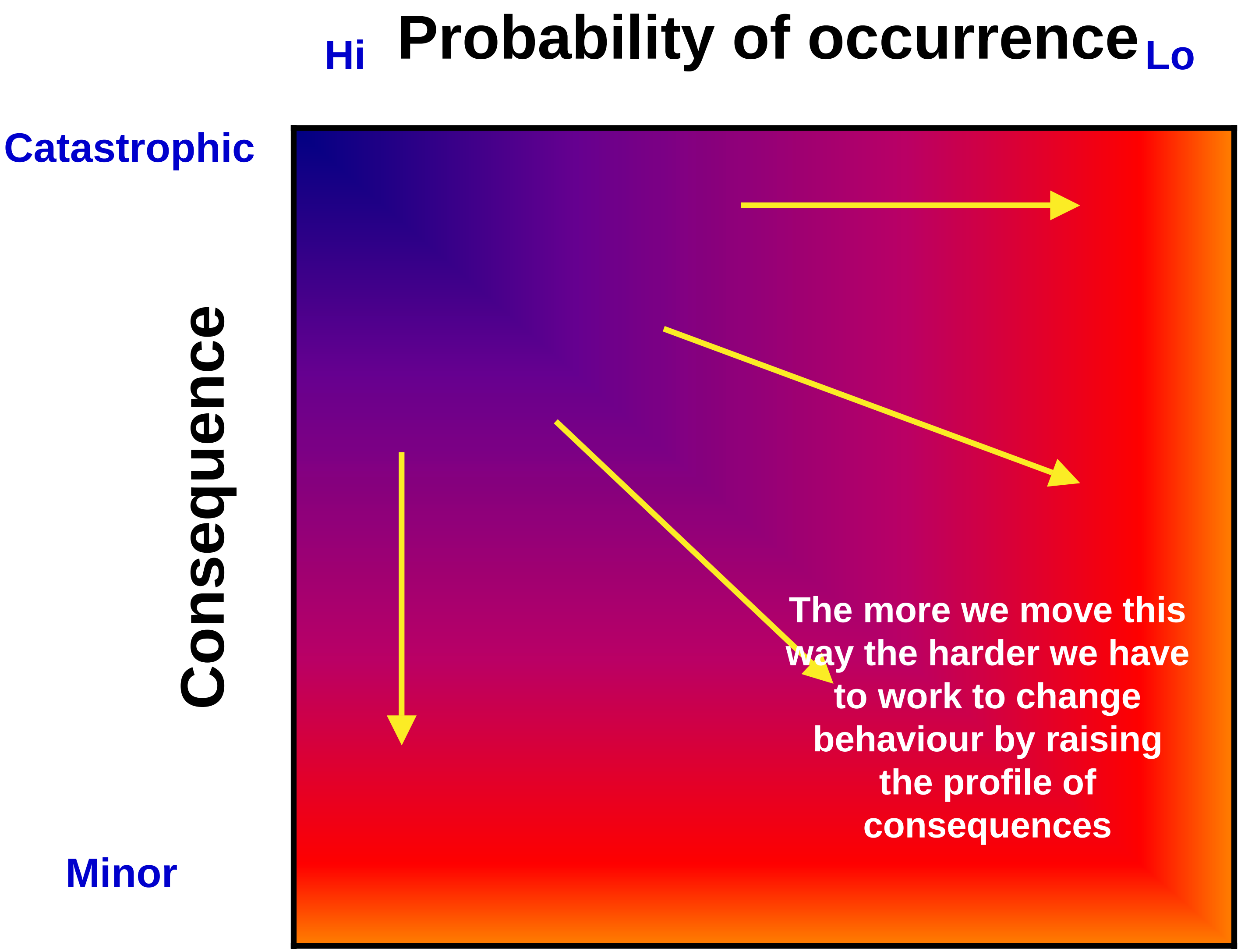
Critical risk 1 – 3

High risk 4 – 10

Medium risk 4 – 10

Low risk 16 – 25

Probability – Consequence



How do you carry out a Pre Task Hazard Assessment?

The FIVE steps of a Take5

Step 1 **Think through the task!**

Step 2 **Look The Hazards!**

Step 3 **Assess the Consequence!**

Step 4 **Take the precautions!**

Step 5 **Do the Job Safely!**

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Think

- ☐ Right tools and equipment
- ☐ Nearby equipment and other operations
- ☐ Procedure to follow
- ☐ Understand the job
- ☐ Right information and permits
- ☐ People or systems affected
- ☐ Safe access
- ☐ What could go wrong?

↓

Look

- ☐ Manual handling, splashes, sprays, moving parts, pinch points
- ☐ Slips, trips and falls
- ☐ Working above ground level
- ☐ Lockout, electrical hazards, vehicle traffic
- ☐ Waste materials, dust and fumes
- ☐ Weather, environmental conditions

↓

Assess the consequence

- ☐ Consequences – the outcome of an event of situation
- ☐ Can the hazards hurt me?

↓

Take precautions

- ☐ Remove the hazard, substitute with less hazardous, isolate the hazard
- ☐ Use safe work procedure, or permits and PPE
- ☐ Communicate hazard controls and learning to team members (update)

↓

Do the job safely

- ☐ Continue thinking about the task, ask yourself “What can go wrong?”
- ☐ Stay tuned for changes is task or surroundings

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Assess the Consequence

Focus on the Consequence

How can I get hurt?

How is it going to affect me and my crew?

Essential Elements of a PTHA

- Plan
- Quality
- Training
- Safety Issues & Opportunity
- Audit

Plan

- PTHA are integrated into an overall Risk Management Framework
- All employees and contractors are aware of the sites requirements and understand when a PTHA is required to be completed

Quality

- PTHA is an opportunity for team members or individuals, to identify hazards before commencing an activity and ensure appropriate controls are in place to manage them
- PTHA also allow individuals to recognise change
- They also link with Safety Interactions because they provide a documented account of the hazards

Training

- Basic training and testing for competency should be a prerequisite for all roles
- Leaders should demonstrate the process skill for effective completion of a PTHA to team members
- Coaching is seen as an excellent way of leaders increasing competency amongst their team
- Coaching and mentoring should be an ongoing process and is also an effective way to build teamwork and a collaborative culture

Safety Issues & Opportunities

- If these hazards are outside of the immediate control of the team, they should trigger a more formal risk management response from team leaders
- PTHA should not be used to attempt to manage all of the major hazards associated with the task, but should be use to ensure that the work environment and procedural controls are in place at the time of undertaking the task

Audit and Safety Interaction

- Systems that are audited are more likely to be consistently implemented and applied
- Auditing of the PTHA should be part of the Safety Interaction process as well as an element of the normal interaction with work teams by leaders

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Safety Interactions Task Group

John O’Reilly (RTTS), Ed Bolton (KEC), Scott Bruce (KUCC), Cort Dial/Bryan Hoggan (Borax), Allan Jackson (RTIO), Erik Madsen (Diavik), Reiner Przyblski (Rossing), Murray Swyripa (Comalco), Eric Turner (Luzenac), Phil Turner (HSE), David Sadler (TS)

Presentation overview

- The systems in use and the name
- Principles and definitions
- Rationale for focussing on consequences
- Using the data
- The overall process and key elements
- Workshop task

Safety Interactions

The name and the systems around the Group

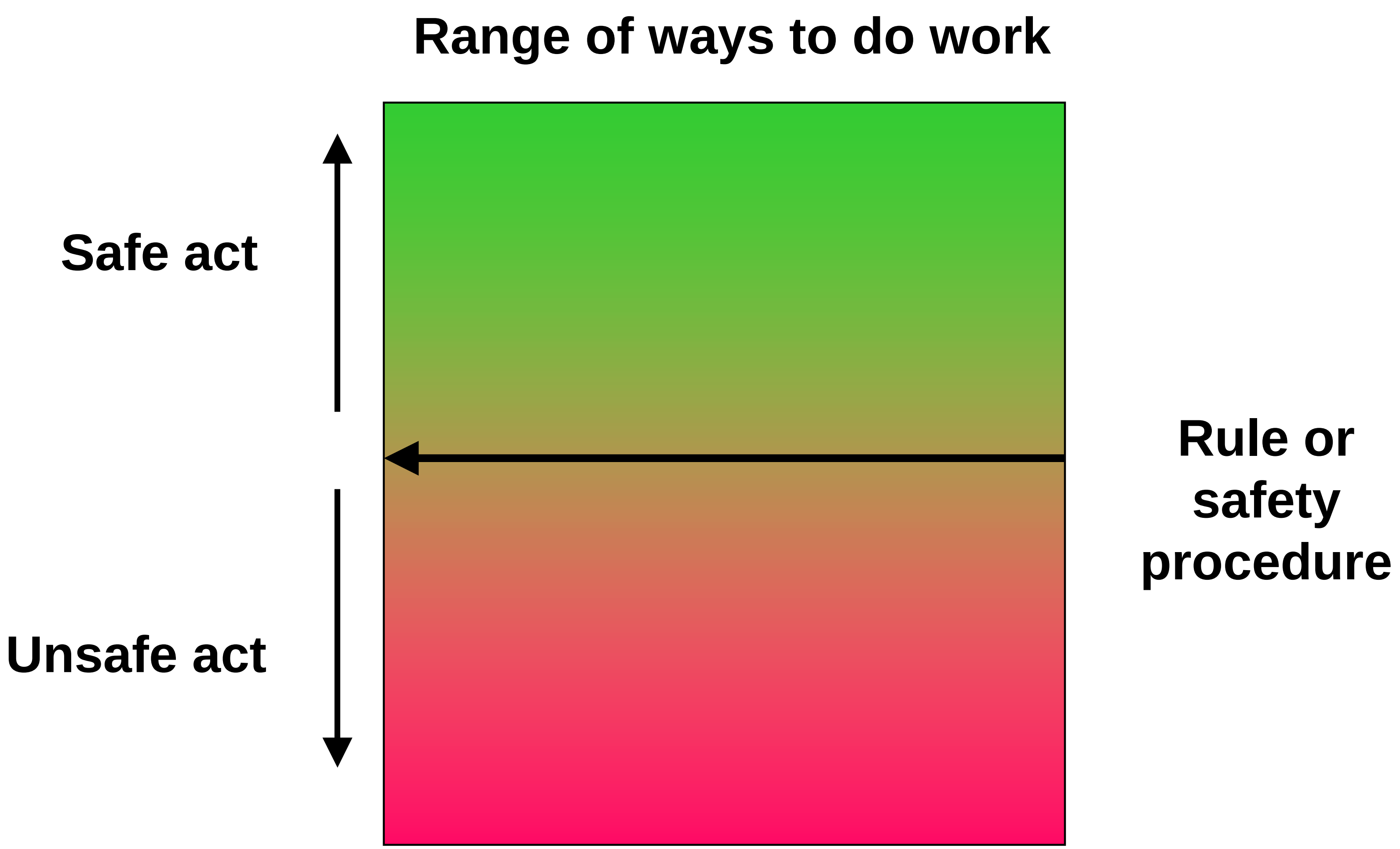
The name and the systems

- Generically referred to as Safety Interactions
  - Businesses can call them what they like, but the system needs to conform to the one recommended by the SLP
- The word SMAT evokes negative feelings
  - “I’ve been SMATed”
- Similar/same systems known by a variety of other names and acronyms
- Major differences/issues around the Group in
  - Planning (always going to the same places, no key messages)
  - Social process (policing, ability to gain commitments, straying off the subject of safety, ability to check on quality)
  - Use of data (especially involving work teams in improvements)
  - System audit (only a few done in the Group)

Principles and definitions

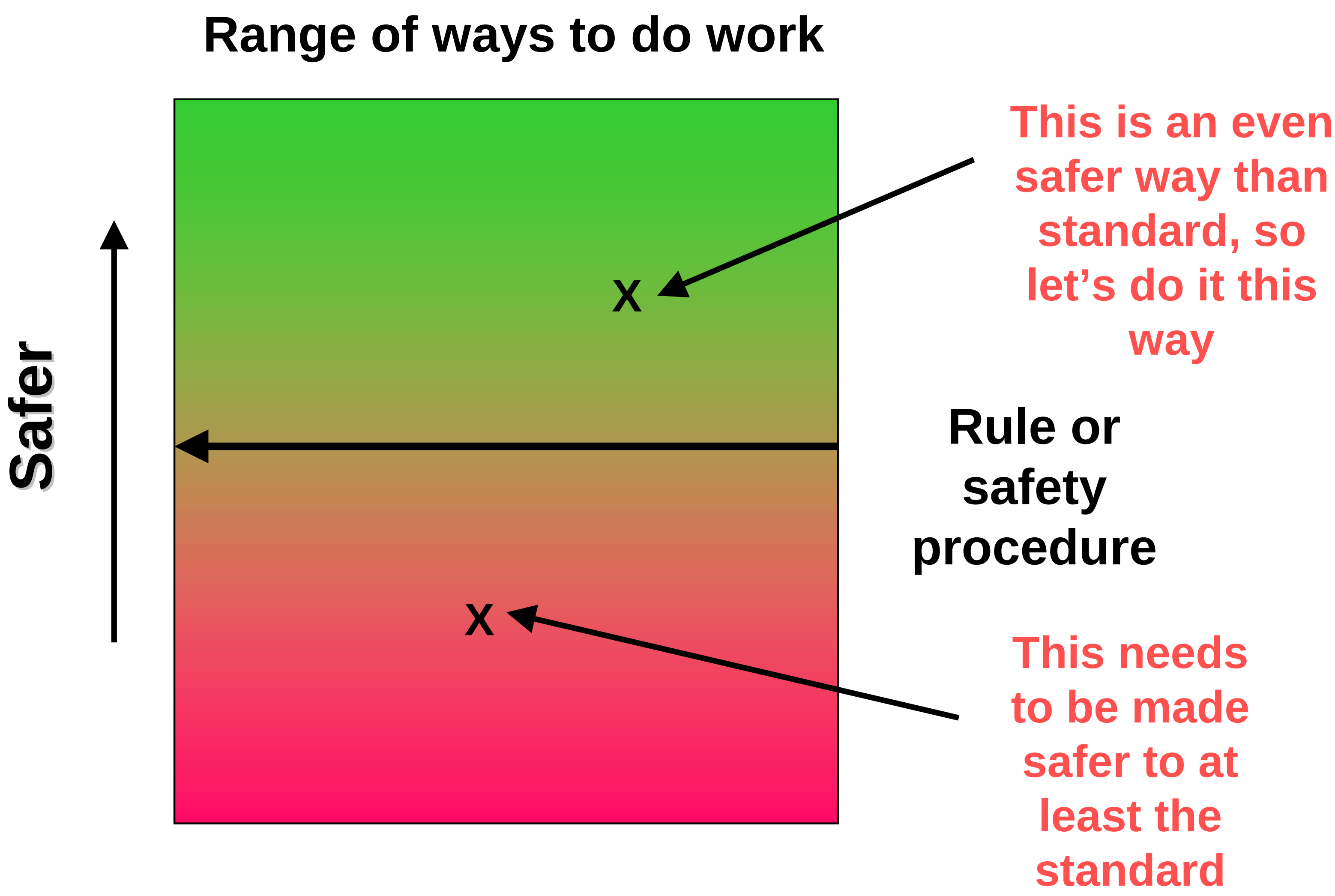
Less safe and at risk behaviour versus unsafe acts

Safe or unsafe?



Inference of definition of unsafe acts- rule violation.
Adhere to the rules and you'll be safe!

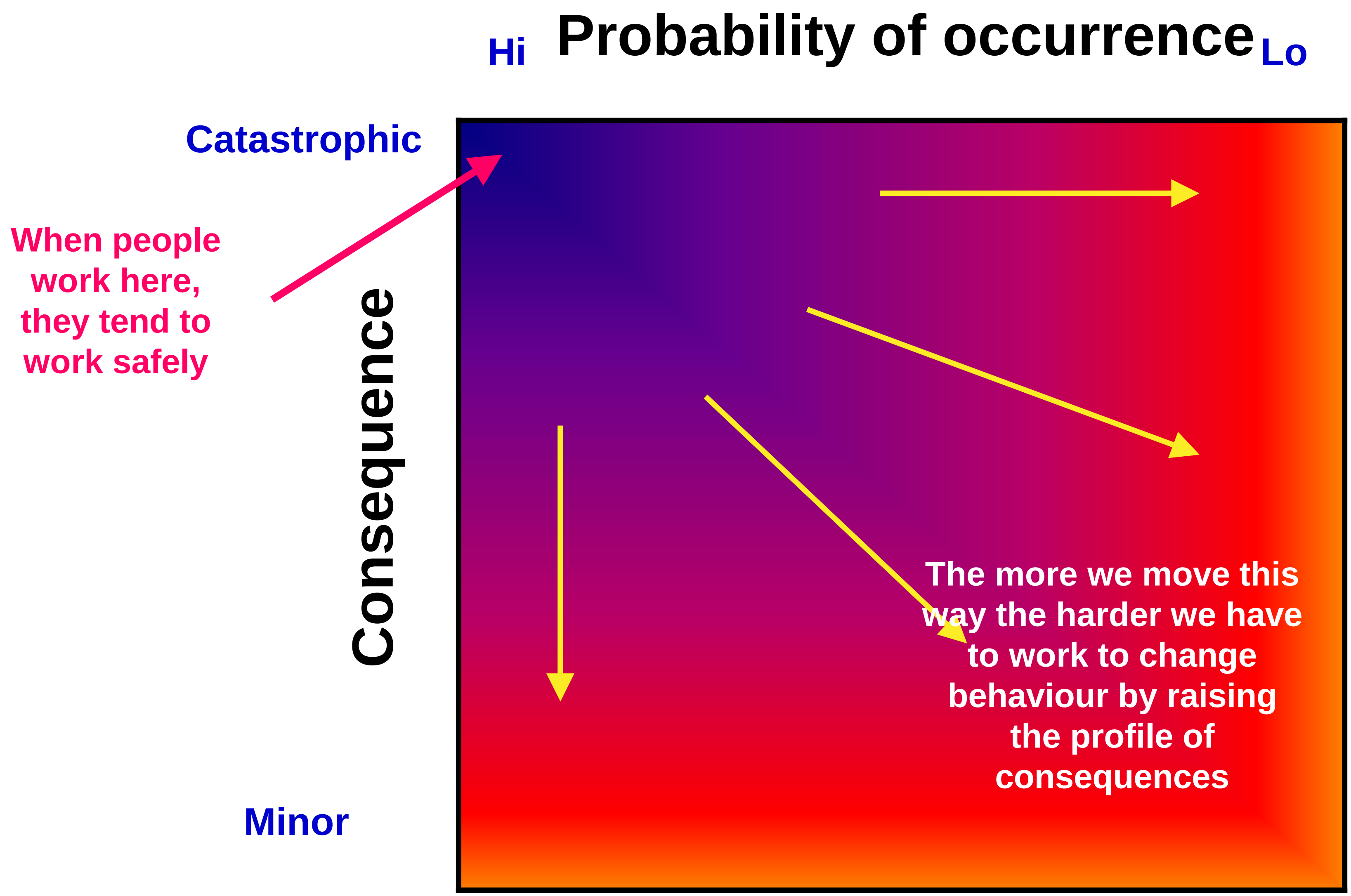
Definition used in safety interactions



Principles and definitions

Why the focus on hazards and consequences?

Probability – Consequence

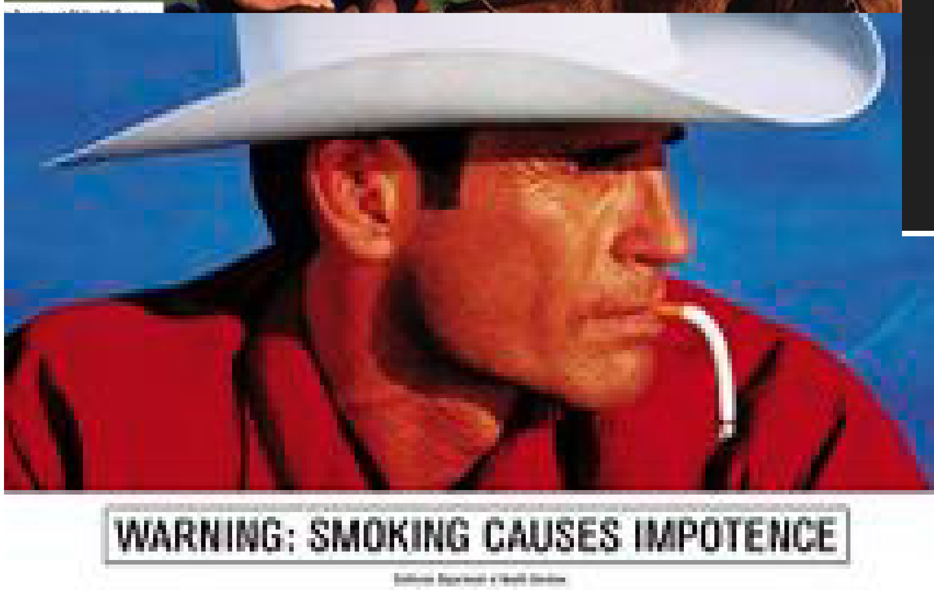


Smoking – an example

- Perceived positive consequences
  - CERTAIN (looks cool, part of the group, addictive)
  - SOON (right now)
  - SIGNIFICANT (depends on peer pressure and addiction)
- Powerful drivers to smoke
- Old myth, “Fred lived until he was 96 and smoked a pack-a-day; smoking never did him any harm.”


I miss my lung, Bob.


Bob, I've got emphysema.


WARNING: SMOKING CAUSES IMPOTENCE


IT DOES
EXACTLY
WHAT IT
SAYS ON
THE PACK

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Research study to identify the most effective anti-smoking ads- top four:

Shows a man who has had a laryngectomy cleaning his stoma. Text introduces man as a cancer patient who has lost his lung and vocal chord from smoking; advert closes over sound of man rasping

Man lights cigarette on stove; surgeon squeezes fatty deposits from a young smoker’s aorta; tag line: "Every cigarette is doing you damage"

Older man talks about his wife who always used to tell him not to smoke. Man relates how he didn’t die from his smoking, but his wife did. Text appears: "Second hand smoke kills more than 53 000 people every year"

Ex-model – Janet Sackman – who has lost her vocal chords from smoking, talks in a croaky voice about tobacco advertising and the health effects of smoking

Anti-smoking campaigns (and others eg drink/driving, speeding)

- Do not discuss probabilities of getting hurt (they do highlight sometimes the certainty of getting caught)

- Do not often highlight how soon the consequences will occur

- Focus heavily on the negative consequences in a realistic and personal way

Safety Interactions work by

- Changing people's perception of consequences for safe and less safe behaviours
  - Positive reinforcement and recognition of safe work
  - Raising awareness of consequences, especially those that are perceived low probability/consequence activities (therefore reinforce Take 5)
- Discussing the consequences of less safe behaviour eg
  - "How can you (or your work mates) get hurt?"
  - "What hazards did your Take 5 identify?"
  - "How bad can it be?"
- Identifying safer ways to do the work eg
  - "What will you do to stop that (consequence) from happening?"
  - "How did you plan to control the risk?"
- Gaining commitments to change less safe behaviour eg
  - "Can I rely on you to do that every time?"

Therefore the process is designed to

- Recognise and reinforce safer behaviours
- Raise awareness of thinking through the task so that appropriate safety behaviours are identified
  - Link this discussion with any pre-task risk assessment
    - This will reinforce and support this
- Gain commitments to change less safe behaviours by:
  - Focussing on consequences
  - Making these personal
  - Identifying changes
  - Making agreements
  - Following up
- Identify and address systems issues and other impediments
- Demonstrate leadership behaviour

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Safety Interactions

Using the data

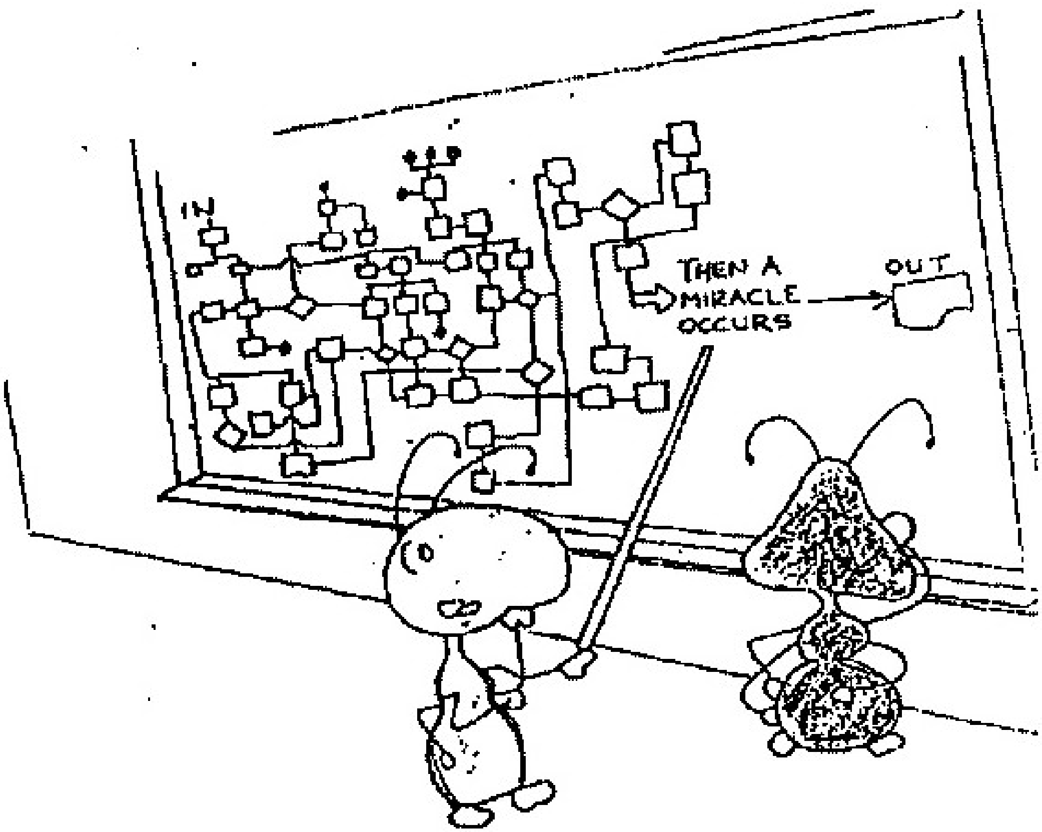
Using the data

- There are many data base systems
- They all do much the same
- They are mainly focussed on management reporting
  - How many are done by whom
  - The less safe acts/hour
- There is limited use of data feeding back to work teams for improvement
  - This is one of the biggest challenges

Using the data (continued)

- Data base systems
  - Recommend that we standardise over time
  - BSG looking at MySAP with Comalco, RTCA and RTIO.
  - Remote data entry thought to be a “nice-to-have”
  - Other good systems are Borax’s, Diavik’s and RBM’s (there are probably others around too)

A Safety Interaction is a process

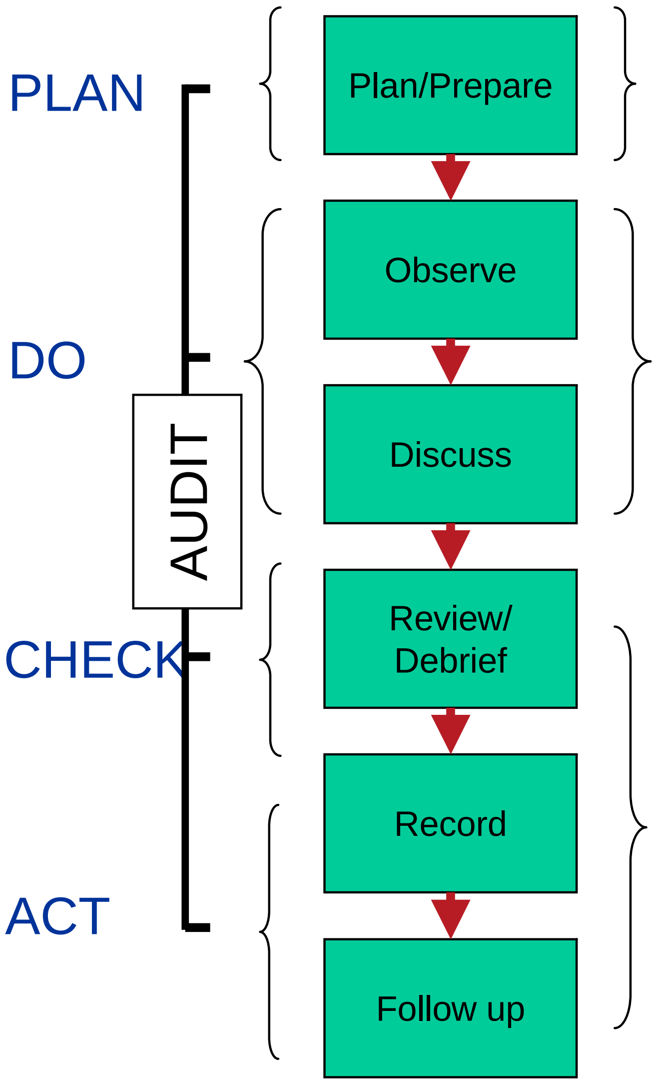


"Good work .... but I think we need just a little more detail right here."

Processes need to be followed to give the desired outcome

A Safety Interaction is a process (continued)

Process flow



Items to consider

- When (back shift)?
- Where (out of the way place)?
- Who (comes with me)?
- What (info do I need)?
- Why (new piece of equip)

- Use all senses
- Good social process
- Open ended questions eg. How can you get hurt? What could go wrong?
- Discover impediments to safe work eg. What prevents you from (safe act)?
- Recognise safe behaviour
- Gain commitment to change less safe behaviour

- Self check or co-auditor feedback

- Systems for capturing displaying information and assigning tasks to improve

Essential elements

A way of planning and checking conformance to plan

Also need a way of auditing to make sure that the system does not decay

AND

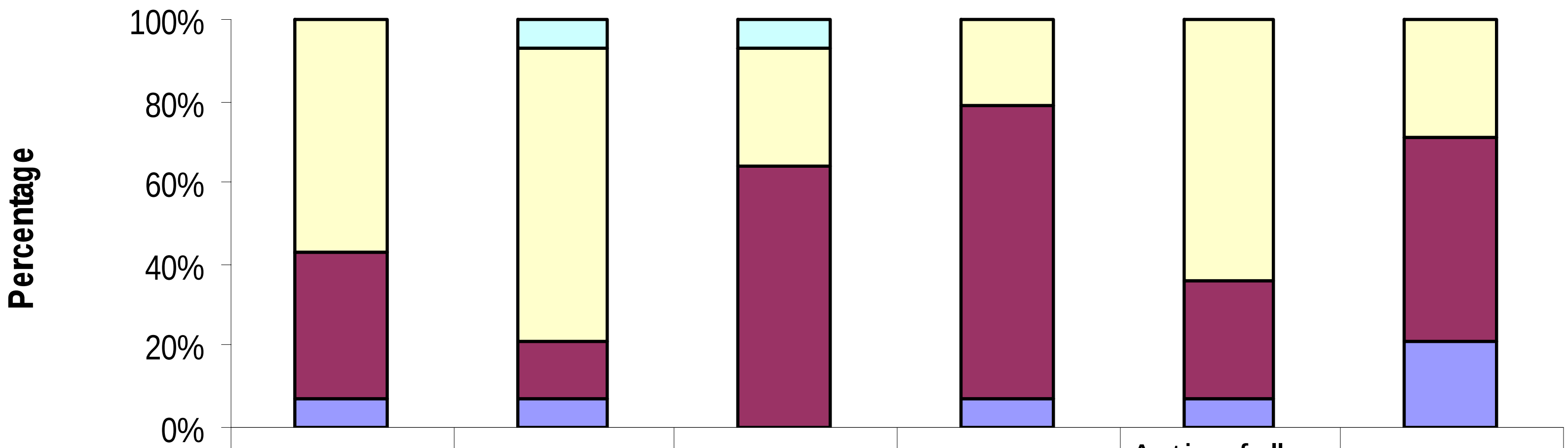
A way of ensuring leaders are competent to carry out the Interaction work

A way of ensuring a good quality interaction process

A way of using the data for improvement

A way of ensuring action items are captured and completed

Self Assessment Summary



	Planning	Quality	Training	Using data	Action follow up	Auditing
Level 4	0	7	7	0	0	0
Level 3	57	71	29	21	64	29
Level 2	36	14	64	71	29	50
Level 1	7	7	0	7	7	21

Workshop task

Context

- Safety Interactions are an essential part of Rio Tinto's safety strategy
- We haven't got the best out of them
- There are several key elements in making up a good Safety Interaction system namely
  - Good planning and preparation
  - Excellent observations and discussions to get to the level of detail required for a step change in safety behaviour and therefore, performance
  - Effective use of data to drive safety improvement
  - Identifying and resolving safety issues and impediments to safe work such as system deficiencies
  - Adequate training and coaching of leaders
  - A regular audit to prevent system decay

Workshop task (continued)

Purpose

- Develop ideas for a draft action plan for your site/Business that will enable you to close any systems gaps

Quality

- Initial draft identifying key gaps and ideas or contacts to be able to bridge the gaps
- Remember that there will be existing mythologies (both positive and negative) about your current system that will flavour any changes you may wish to make in your system

Quantity

- One plan per site or Business

Resources

- The guidance notes and the self assessment sheet for a gap analysis
- The other workshop participants to identify good practice ideas that will enable you to close any gaps

Time

- One hour

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Attachment F
Engineering Manual 385

Safety and Health Requirements
US Army Corps of Engineers
November 3, 2003

Available on the Website below:
http://www.usace.army.mil

Click on Publications.

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ANNEXE 3

DREDGING, DIVISION 01 – SECTION 02325, INTEGRATED GROWTH POLES PROJETS H320555-C003A-E, PORT OF EHOALA PROJECT, MARCH 20, 2006

SECTION TABLE OF CONTENTS

DIVISION 02 - SITE WORK

SECTION 02325

DREDGING

-- End of Section Table of Contents --

SECTION 02325

DREDGING

PART 1 GENERAL

1.1 SCOPE

The Work covered by this section consists of furnishing all labor, materials, and equipment, and performing all excavation and disposal of all material as specified herein or indicated on the drawings. Environmental protection requirements under this Contract are as important to overall completion of the work as other technical aspects. Failure to meet the requirements of these specifications for environmental protection may result in work stoppages or termination for default. No part of the time lost due to any such work stoppages shall be made the subject of claims for extensions of time or for excess costs or damages by the Contractor. If the Contractor fails or refuses to promptly repair any damage caused by violation of the provisions of these specifications, the Employer may have the necessary work performed and charge the cost thereof to the Contractor.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE EM 385-1-1	(2003) Safety – Safety and Health Requirements
COE EM 1110-1—1002	(1990) Survey Markers and Monumentation
COE EM 1110—1—1003	(2003) NAVSTAR Global Positioning System Surveying
COE EM 1110—1-1004	(2002) Geodetic and Control Surveying
COE EM 1110-1-1005	(1994) Topographic Surveying
COE EM 1110—1—2909	(1998; Chag 2) Geospatial Data and Systems
COE EM 1110-2—1003	(2002; Chag 2004) Hydrographic Surveying
COE EM 1110-2-5025	(1983) Dredging and Dredge Material Disposal
COE EM 1110-2-5026	(1987) Beneficial Uses of Dredged Material
COE EM 1110-2-5027	(1987) Confined Disposal of Dredged Material

Copies of the above referenced material may be found on the U.S. Army Corps of Engineers website http://www.usace.army.mil/inet/usace-docs/eng-manuals/em.htm

1.3 RELATED WORK SPECIFIED ELSEWHERE

Section 01200	Price and Payment Procedures
Section 01270	Measurement and Payment
Section 01315	Hydrographic Surveys
Section 01320	Project Schedule
Section 01330	Submittal Procedures
Section 01500	Temporary Construction Facilities
Section 01525	Safety, Health and Environmental Management
Section 02300	Earthwork
Section 02370	Soil Surface Erosion Control
Section 02233	Clearing for Civil Works
Section 02930	Seeding

1.3.1 Blasting

The Employer has not obtained a Blasting Permit for this work. Studies reveal the presence of a marine mammal species classified as vulnerable, Megaptera Novaengliae (Humpback Whale) and five species of long-distance migratory fish, along the coast near Fort Dauphin. The whales migrate past the Fort Dauphin area from the beginning of June to the end of November. It is the Contractor’s responsibility to obtain all required permits if blasting is contemplated by the Contractor. Except as specifically noted below, blasting shall conform to the requirements of the Contractor’s Safety, Health and Environmental Management Plan, as approved by the Employer. It is the Contractor’s responsibility to develop a Protected Species Watch Plan and a Test Blast Program that are acceptable to the Employer.

The Protected Species Watch Plan serves to address potential impacts to marine mammals. No less than 30 days from the first detonation, the Contractor shall supply a list of names and qualifications of all observers to be utilized in the Watch Plan. A formal Plan Coordination Meeting shall be held no later than 14 days before the first detonation event. All participants will be informed about the possible presence of marine mammals in the area. The logistics of the detonation schedule will be discussed. Responsibilities for delaying or calling off the detonations will be assigned so that a clear path of communication is established. The Plan shall establish the Monitoring Zone. The Plan shall state the specifics of the Watch including the number of observers, the use and timing of boats and/or aircraft, type and timing of “fish scares” and the Reporting Requirements.

As a minimum, the Test Blast Program shall contain the following information: designation of an explosive that is specifically designed for underwater use in Environmentally Sensitive Areas. The Test Blast Program shall demonstrate and/or confirm: Drillboat capabilities and production rates, Ideal drill patterns for typical drill patterns, acceptable rock breakage for excavation, tolerable vibration level emitted, directional vibration, and calibration of the environment.

1.4 SUBMITTALS

The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

1.4.1 Preconstruction Submittals

1.4.1.1 Notice of Intent to Dredge FIO

Prior to commencement of work on this Contract, the Contractor shall notify the Malagasy Port, Maritime, and Fluvial Agency of his intended operations to dredge and request that it be published in the Local Notice to Mariners. This notification must be given in sufficient time so that it appears in the Notice to Mariners at least two weeks prior to the commencement of this dredging operation. A copy of the notification shall be provided to the Employer.

1.4.1.2 Relocation of Navigation Aids FIO

The Contractor shall not remove, change the location of, obstruct, willfully damage, make fast to, or interfere with any aid to navigation. Within 60 calendar days following receipt of Commencement Date, the Contractor shall notify the Malagasy Port, Maritime, and Fluvial Agency, of his plan to dredge adjacent to any aids, which require relocation to facilitate dredging. This notification shall be immediately followed by a formal written request with a copy to the Employer. The Contractor shall also contact the Malagasy Port, Maritime, and Fluvial Agency for information concerning the position to which the aids will be relocated.

1.4.1.3 Priority Section Plan; EM/EE

The Contractor shall develop and submit his Dredging Plan in accordance with the Priority Schedule in this Section.

1.4.2 Certificates

1.4.2.1 Electronic Tracking System Data EM/EE

The Contractor shall furnish required discs, CD-ROM, and charts to the Employer for approval and prior to offshore dredge disposal if it is permitted.

1.4.2.2 Equipment and Performance Data EM/EE

The Contractor shall furnish proof of electronic positioning equipment calibration to the Employer.

1.4.2.3 Need for Pre-Dredging and After-Dredging Surveys EM/EE

The Contractor shall give 15 days advance notice, in writing, to the Employer of the need for a pre-dredging survey or after-dredging sweep for final acceptance.

1.4.2.4 Daily/Monthly Report of Operations FIO

The Contractor shall prepare and submit two (2) copies of the Daily Report of Operations, for each dredge and/or unloader working. This report shall be submitted on a daily basis and not in groups. In addition to the daily report, the Contractor shall prepare a Monthly Report of Operations for each month or partial month’s work. The monthly report shall be submitted on or before the 7th of each month, consolidating the previous month’s work. Upon completion of the job, the Contractor shall submit a consolidated job report, combining the monthly reports. The Contractor shall distribute one copy of each report to the Engineer.

Additionally, one copy of the form(s) shall be maintained by the Contractor on the dredge(s) for the Employer's inspection purpose. Further instructions on the preparation of the reports will be furnished at the Preconstruction Conference.

1.4.2.5 Misplaced Material EM/EE

The Contractor shall notify the Malagasy Port, Maritime, and Fluvial Agency and the Employer of any misplaced material.

1.4.2.6 Dredging Operation Plans EM/EE

The Contractor shall submit a Priority Area Plan, Dredging and Reclamation Operations Plan, a Protected Species Watch Plan and a Test Blast Program.

1.5 DREDGING RESTRICTIONS

1.5.1 Order of Work

Dredging shall commence at the outer section, Sta 611+00 of the project and proceed inward toward Sta 602+50 unless otherwise approved by the Engineer, in the following priority areas order:

1) Areas A & B
2) Area C
3) Area D
4) Area E
5) Area F
6) Area G

These are Priority Areas but not acceptance areas. The dredging will be accepted, as a whole, when dredging is completed.

The dredging performed by all dredges shall be continuous within areas approved by the Employer. See Section 02325 pp 3.15 CONTINUITY OF WORK-DREDGING OF ROCK

a. No dredging shall be permitted unless the Contractor appointed quality control person is present at the reclamation area while pumping operations are in progress.

b. The dredged material shall be deposited in the reclamation areas designated on the Contract drawings.

1.6 DREDGING DEBRIS

Debris may be encountered in the channel and turning basins. All such materials shall be brought to the surface and be disposed of in a manner approved by the Engineer in a disposal area obtained by the Contractor.

1.7 PUMPING OF BILGES

Contractors are warned that pumping oil or bilge water containing oil into navigable waters, or receiving waters in wetland, freshwater, esturine or marine environment or into areas which would permit the oil to flow into such waters or environments including upland areas is not permitted.

1.8 UTILITY CROSSINGS

1.8.1 General

It is the Contractor’s responsibility to investigate the location of all utility crossings. The Contractor shall physically locate all utilities, mark the locations with floating devices designed for such use, prior to dredging. The Contractor shall take precautions against damages, which might result from his operations in the vicinity of the utility crossings. If any damage occurs as a result of his operations, the Contractor will be required to suspend dredging until the damage is repaired and approved by the Employer. Costs of such repairs and downtime of the dredge and attendant plant shall be at the Contractor’s expense.

1.9 PERMITS

Dredging Permits, if applicable, will be obtained by the Employer.

1.10 FUEL OIL TRANSFER OPERATIONS

In accordance with Malagasy Port, Maritime, and Fluvial Agency regulations, couplings used in fuel oil transfer operations on any vessel with a capacity of 250 or more barrels of oil shall be either a bolted or full-threaded connection; or a quick-connect coupling approved by the Agency; or an automatic back—pressure shutoff nozzle used to fuel the vessel. An executed fuel oil transfer (Declaration) form signed by the tanker operator shall be submitted to the Employer for each refueling operation. The Malagasy Port, Maritime, and Fluvial Agency shall also be notified prior to any refueling. Emergency response and containment measures for accidental spills of oil, fuel, hydraulic fluids and potential accidents, including vessel traffic accidents shall be submitted to the Employer for approval.

1.11 SIGNAL LIGHTS

The Contractor shall display signal lights and conduct operations in accordance with the International Regulations and the Malagasy Port, Maritime, and Fluvial Agency governing lights and day signals to be displayed by towing vessels with tows on which no signals can be displayed, vessels working on wrecks, dredges, and vessels engaged in laying cables or pipe or in submarine or bank protection operations, lights to be displayed on dredge pipe lines, and day signals to be displayed by vessels of more than 20 metres in length moored or anchored in a fairway or channel, and the passing by other vessels of floating plant working in navigable channels, as applicable.

1.12 NOTICE TO MARINERS – HAZARDS TO NAVIGATION

Should the Contractor, during operations, encounter any objects on the channel bottom, which could be a hazard to navigation, the Contractor shall immediately notify the Employer as to the location of said object and shall provide any other pertinent information necessary for the Employer to prepare and issue a Notice to Mariners.

1.13 FINAL CLEANUP

Final cleanup shall include the removal of all the Contractor’s plant and equipment either for disposal or reuse. Plant and/or equipment and/or materials to be disposed of shall ONLY be disposed in a manner and at locations approved by the Employer. Unless otherwise approved by the Employer, the Contractor will not be permitted to abandon any equipment in the reclamation area or other areas adjacent to the worksite.

a. Failure to promptly remove all plant, pipeline, equipment, and materials upon completion of the dredging will be considered a delay in the completion of the final cleanup and demobilization work. In such case, the Employer will exercise its right to remove any plant and/or equipment and/or materials at the Contractor’s expense.

1.14 WORK VIOLATIONS

Work done in violation of these specifications or a verbal or written stop order of the Employer will be considered as unsatisfactory progress for purposes of progress payments.

1.15 MEASUREMENT AND PAYMENT

Measurement and Payment for Work of this Section shall be based on volume. Payment shall be made on a unit price basis, as indicated in the Bill of Quantities and as specified in Section 01270.

PART 2 PRODUCTS

(NOT APPLICABLE)

PART 3 EXECUTION

3.1 NOTIFICATION OF MALAGASY PORT, MARITIME, AND FLUVIAL AGENCY

3.1.1 Relocation of Navigation Aids

Navigation aids located within or near the areas required to be dredged will be removed, if necessary, by the Malagasy Port, Maritime, and Fluvial Agency in advance of dredging operations. The Contractor shall not remove, change the location of, obstruct, willfully damage, make fast to, or interfere with any aid of navigation.

3.1.2 Dredging Aids

The Contractor shall obtain approval from the Malagasy Port, Maritime, and Fluvial Agency for all buoys, dredging aid markers to be placed in the water, and dredging aid markers affixed with a light prior to the installation. Dredging aid markers and lights shall not be coloured or placed in a manner that they will obstruct or be confused with navigation aids.

3.2 WORK AREA

The Contractor will be permitted to exclude the public from the work areas in the immediate vicinity of the dredging, transporting, and disposal operations. The Contractor shall prevent public access to the discharge end of the pipeline. The Contractor shall post signs in English, Malagasy and French in conspicuous locations with the wording “DANGER - HIGH PRESSURE DISCHARGE FROM DREDGE”. Enforcement shall be the Contractor’s responsibility at no additional cost to the Employer. The enforcement shall be coordinated with local enforcement agencies and will be subject to approval of the Employer. Additionally, the Contractor shall place a safety person at the discharge end of the disposal pipeline. The safety person shall be present at all times during discharge operations and will maintain radio communication between the dredge and the disposal operation. The Contractor will not be permitted to have construction equipment or personnel outside the dredging limits, construction limits or work area limits, except in transit to and from these locations, public roads and right-of-way may be utilized to the extent permitted by local laws and regulations.

3.2.1 Access

The Contractor shall be responsible for providing and maintaining access necessary for his equipment and plant to and from the work site, mooring area, and all disposal areas. The Contractor shall ascertain the environmental conditions, which can affect the access such as climate, winds, currents, waves, depths, shoaling, and scouring tendencies.

3.2.2 Protection of Existing Waterways

The Contractor shall conduct his operations in such a manner that material or other debris are not pushed outside of dredging limits or otherwise deposited in existing side channels, basins, docking areas, or other areas being utilized by vessels. The Contractor will be required to change his method of operations as may be required to comply with the above requirements. Should any bottom material or other debris be pushed into areas described above, as a result of the Contractor’s operations, the same must be promptly removed by and at the expense of the Contractor to the satisfaction of the Employer.

3.2.3 Adjacent Property and Structures

Dredging adjacent to any structure will not be permitted any closer than that shown on the Contract drawings. Any damage to private or public property or structures resulting from the disposal or dredging operations shall be repaired promptly by the Contractor at his expense. Any damage to structures as a result of Contractor’s negligence will result in suspension of dredging and require prompt repair at the Contractor’s expense as a prerequisite to the resumption of dredging.

3.3 PLANT

3.3.1 General

Plant and equipment employed on the work shall be in satisfactory operating condition and capable of safely and efficiently performing the work under exposed environmental conditions and as set forth in the specification and shall be subject to inspection by the Employer at all times. The dredge shall have a minimum of 2000 cutter horsepower. Pipeline for hydraulic machines shall be kept in good condition at all times, any leaks or breaks along their length shall be promptly and properly repaired. No reduction in the capacity of the plant employed on the work shall be made except by written permission of the Employer. The measure of the "Capacity of Plant" shall be its actual performance on the work to which these specifications apply. All floating pipelines used as access ways shall be equipped with walkways and guardrail conforming to the Approved Safety Manual. All operating personnel of the Contractor will be qualified to operate plant machinery and equipment.

3.3.2 Pipeline Right of Ways

The pipeline right of ways, within the Construction Limits, are Employer furnished. However, the Contractor is not restricted to the right-of-ways within the Construction Limits. In those cases where the Contractor routes a pipeline outside of the Construction Limits, he shall obtain all easements, permits, and right-of-ways at his own expense.

3.3.3 Floating Pipeline

Should the Contractor's pipeline not rest on the bottom, it will be considered a floating pipeline and shall be visible on the surface and clearly marked. In no case will the Contractor's pipeline be permitted to fluctuate between the surface and the bottom, or lie partly submerged. Lights shall be installed on the floating pipeline. The lights shall be supported either by buoys or by temporary piling, provided by the Contractor and approved by the Employer. Where the pipeline does not cross a navigable channel, the flashing yellow all-around lights shall be spaced not over 60 metres apart, unless closer spacing is required by Malagasy Port, Maritime, and Fluvial Agency personnel, in which case the requirements of the Malagasy Port, Maritime, and Fluvial Agency shall govern, at no additional cost to the Employer.

3.3.4 Prevention of Landscape Defacement within Pipeline Right-of-Ways.

Unless otherwise noted on the Contract drawing(s), the Contractor shall not deface, injure, or destroy trees or shrubs, nor remove or cut them without the authority of the Engineer. Survey Monuments and markers shall be protected before construction operations commence and until Contract completion.

3.3.5 Restoration of Landscape Damage.

Any tree, grassed area or other landscape scarred or damaged by the Contractor's equipment or operation shall be restored to its original condition at the Contractor's expense.

3.4 CHARACTER OF MATERIALS

The material to be dredged under this Contract is UNCLASSIFIED. It is believed that the material to be removed will consist principally of beachrock, lag deposits and marine sand. The beachrock occurs as a series of ledges that are typically harder than the aeolianite lithologies. The lag deposits represent ancient boulder deposits that consist of layers of cobbles and boulders of reworked aeolianite and beachrock set in a matrix of gravel and coarse sand. The marine unconsolidated sands are poorly sorted and are fairly coarse grained and have a high carbonate content. Occasional “out of context” cobbles and boulders of beachrock and aeolianite can also be expected. Minor variations in the subsurface materials are to be expected and, if encountered, shall not be considered as being materially different within the purview of the Contract. Bidders are expected to examine the site of the work, and decide for themselves the character of the materials. A copy of the Data Report on the Marine Geophysical Survey & Geotechnical Sampling, Fort Dauphin, Madagascar, prepared by MGS, is located in Section VI, Supplementary Information. If the Contractor encounters a significant quantity of material to be dredged that has an Unconfined Compression Strength in excess of 40 MPa, as measured in accordance with the International Society of Rock Mechanics Commission on Standardization of Laboratory and Field Tests (ISRM,1981), the Employer will consider negotiating a new price for that material.

3.5. PLACEMENT OF EXCAVATED MATERIAL

3.5.l Reclamation Area Plan

The Contractor shall use the designated reclamation areas. Within 60 days after receipt of the Commencement Date, the Contractor shall furnish his plan for the dredging and reclamation operations to the Employer for review and approval. This plan shall include a description of all proposed dredging, transporting, and rehandling equipment to be utilized in performance of the Contract work, and shall also include reclamation area layout plans indicating the locations of the dredged material discharge pipeline and the type and locations of the lights to be utilized for night operations. Without compromising safety, night lights should be down-shielded to only illuminate work area and to prevent public nuisance associated with night glow or attraction of nocturnal reptiles, mammals, birds and fish. Dredging will not be permitted to commence until this plan is approved by the Engineer.

3.5.2 Use of the Reclamation Area

The Contractor must confine the retention dikes and dredged material within the designated Contract reclamation site areas. All dikes needed for confining the dredged material, with necessary weir boxes, shall be provided and maintained by the Contractor, and the cost thereof included in the Contract price. The Contractor shall be responsible for any damage arising from the fact that the material or the carrier water (effluent) has been permitted to run off the dredged material reclamation area or for work stoppage as a result of damage and intervention from regulatory agencies or local authorities. The flow of effluent into the channel shall be regulated to such extent as to prevent erosion or the return of dredged material to the channel. The Contractor shall provide adequate drainage for all back areas by keeping drains and water courses open for this purpose. The Contractor shall also be responsible for providing and maintaining adequate ramps over the dredge pipeline where it is necessary to cross roads and streets, and to provide adequate down-shielded lighting and safeguards for such ramps. When necessary to cross private property to get to the reclamation area with roads or pipelines, the Contractor shall obtain permission from the owners of the property before proceeding to cross. The reclamation areas shall be left in a draining condition without significant ponding of water. The reclamation areas shall be graded to a tolerance of plus or minus 15 centimetres from the grades shown on the plans.

3.5.3 Effluent

3.5.3.1 Control of Reclamation Area Effluent

The Contractor shall employ the full length of weir crest at all times. The Contractor shall furnish and install sufficient weir boards to control the elevation of the dredged material under the Contract, and the weir boards so installed shall be left in place upon completion of all work under the Contract.

3.5.3.2 Discharge of Reclamation Area Effluent

Diked reclamation site effluent shall be discharged as near to the area being dredged as is practical. The Contractor shall make a determined effort to minimize the Total Suspended Solids in the effluent at the discharge weir. Effluent from the diked reclamation site shall be discharged directly to open water. The effluent shall not be discharged to any wetland areas. The effluent is to be carried by pipeline over such wetland areas as marshes or wooded swamps in order to prevent sediment accumulation in these environmentally sensitive areas. Any accumulation of sediment on wetlands shall be considered as misplaced excavated material.

3.5.4 Reclamation Area Weir Box

It shall be the responsibility of the Contractor to design, construct, and maintain a weir box or boxes of sufficient size and capacity to take care of the effluent from the reclamation areas, and to prevent any material from escaping through the weir box or boxes. It is the intent of these specifications that the escape of material from the reclamation area be held to an absolute practicable minimum, pipes from the weir box or boxes through the dike shall be of adequate size and number to carry the effluent water. Pipe weirs shall not be permitted. Minimum weir box requirements are as follows:

a. An effluent level board shall be installed on the side of the weir box. It shall be graduated in three centimetre intervals beginning with a datum level of zero at the elevation of the bottom of the weir box discharge pipe. The graduations shall continue to 30 centimetres above the highest point on the dike. Each 30 centimetre interval shall be clearly marked and visible from the dike.

b. A walkway and safety railing shall be installed to the weir box.

c. Weir box(es) shall be constructed and installed outside the limits of the dike toe and effluent pipes shall extend beyond the dike toe to open water.

d. Suitable screen shall be installed around the weir box(es) in order to stop debris entering into the weir box(es).

3.5.5 Misplaced Excavated Material

Any material that is deposited elsewhere than in places designated or approved by the Engineer will not be paid for and the Contractor may be required to remove such misplaced material and deposit it where directed at his expense. Misplaced excavated material may constitute a violation of applicable Local statutes and the Contractor shall be liable for any civil and/or criminal penalties imposed by these statutes.

3.6 RECLAMATION AREA

3.6.1 Retention of Material

The material excavated shall be transported, deposited, and retained in the dredged material reclamation areas designated on the Contract drawings.

3.6.2 Pipeline Leaks

In the event any leaks occur in the dredge pipeline, the Contractor shall immediately discontinue dredging operations until such leaks in the line, or breaks are remedied at the Contractor’s expense. The Contractor shall also, at his expense, recover and remove any material misplaced by such leaks, or breaks.

3.6.3 Restoration of Landscape Damage

Any tree, grassed area or other landscape scarred or damaged by the Contractor’s equipment shall be restored to its original condition at the Contractor’s expense.

3.7 RECLAMATION AREA DIKE CONSTRUCTION

3.7.1 General

The Contractor will be responsible for the construction and integrity of the diked reclamation area and confining dikes, which must confine the dredged material throughout the life of the Contract. The dike shall be constructed at the location shown on the drawings or as otherwise directed or approved by the Engineer. At no time will dredge pipes be permitted to enter a reclamation area through the dike. Under no circumstances shall the operating freeboard be less than 60 centimetres at any time. Freeboard shall be defined as the measurement between the elevation of the retained dredged slurry and the crest elevation of the confining dike.

3.7.2 Stripping and Excavation

The dike foundation and borrow area shall be cleared of all trees and vegetation in accordance with Section 02233 – Clearing for Civil Works. No material shall be excavated within 10 metres of the inside or outside toe of the dike, except for required removal of stripped vegetation or other organic material. The excavated slopes in the interior of the borrow area shall be no steeper than 1.5 horizontal on 1 vertical.

3.7.3 Embankment Material

The dike shall be constructed of material excavated from within the interior of the dike confining area as directed or approved by the Engineer. Dissimilar excavated materials shall be blended so that the materials used to construct the dike are relatively consistent. The dike shall be constructed from suitable materials free of organic material. The moisture content of the dike embankment material shall be controlled as required to allow for proper compaction such that the fill will not be excessively displaced by the normal operating procedure of the hauling and spreading equipment. If, in the opinion of the Engineer, the material is too wet to facilitate the proper compaction, it shall be removed from the fill and replaced or dried out by any method approved by the Engineer.

3.7.4 Dike Construction

Dike widths, slopes and maximum raising heights shall be as specified herein and as shown on the drawings. All dikes shall have a minimum crest width of 2.5 metres. All dikes shall be raised no higher than the maximum elevations specified for each area herein. Exterior side slopes of the new embankment shall be no steeper than 2.5 horizontal on 1 vertical and interior slopes shall be no steeper than 2 horizontal on 1 vertical. The requirements for constructing spur dikes shall be the same as for the confining dikes.

Reclamation of material in the dike shall be made in horizontal lifts not to exceed 30 centimetres in uncompacted thickness. Each lift shall be compacted by the controlled use of the hauling and spreading equipment. Movement of equipment shall be distributed as much as practicable over the surface of each lift to provide uniform compaction and complete coverage of fill. The Contractor shall maintain slopes that are equal to or less steep than those specified at all times during the construction of the confining dikes.

Stabilization of the completed dike slopes shall be accomplished in accordance with the applicable requirements of Section 02370 Soil Surface Erosion Control.

3.7.5 Weir Box Installation and Dike Construction

The Contractor will be responsible for the design and construction of the weir box and the excavation and construction of the dike embankment. The weir box shall be located outside of the limits of the proposed dike toe in the vicinity of the weir box. The ends of the effluent discharge pipes shall also extend beyond the dike toe. Embankment material excavated for the weir box installation shall be stockpiled and used for reconstruction of the dike. Temporary excavation slopes through the existing embankments shall be no steeper than 1H on lV to facilitate compaction. Placement of material in the dikes shall be made in lifts not to exceed 30 centimetres in uncompacted thickness. Each lift shall be compacted by the controlled use of the hauling and spreading equipment, or with approved power tampers. Compaction in areas within 1 metre of the discharge pipe shall be accomplished utilizing power tampers, approved by the Engineer, to a density equivalent to that obtained by use of the hauling and spreading equipment in the adjacent fill. In areas where power tampers are utilized for compaction, the lift thickness shall not exceed 3 centimetres. The moisture content of the dike embankment material shall be controlled as required to allow for proper compaction.

3.8 NONCOMPLIANCE

The Employer will notify the Contractor in writing of any noncompliance with the foregoing provisions. Such notice, when delivered to the Contractor or his authorized representative at the site of the work, shall be deemed sufficient for the purpose. Within 24 hours after the receipt of such notice, the Contractor shall deliver to the Employer or his authorized representative, a complete proposal of the prompt correction of the noncompliance. The Employer will review the proposal and return it to the Contractor approved, subject to such changes or conditions as he finds necessary to assure correction of noncompliance. Immediately upon receipt of such approval, the Contractor shall begin the corrective work and shall carry it to completion. If the Contractor fails or refuses to submit his proposal or to proceed with the corrective work, the Employer may suspend all or any part of the work until satisfactory corrective action has been taken. No part of the time lost due to any such suspension shall be made the subject of a claim for extension of time nor for excess costs or damages by the Contractor. If he so elects, the Employer or his authorized representative may cause the corrective work to be accomplished by others, in which event the cost thereof shall be chargeable against any monies otherwise due the Contractor from the Employer.

3.9 INSPECTION AND TESTING

3.9.1 Inspection

The work will be conducted under the direction of the Contractor and will be subject to review by the Employer and Engineer to insure strict compliance with the specifications.

3.9.1.1 Suspension of Operation

The Contractor shall suspend operations at any unit where the Contractor fails to:

a. (1) to have a full-time Quality Control person present and fully alert and awake on the reclamation areas at all times while pumping operations are in progress or
(2) provide and maintain the required marine band radio for use by Engineer at all times while pumping operations are in progress and to provide and maintain the approved lighting on the reclamation area for safe night operations.

b. An encroachment upon the maintenance of 0.6 metres of operating freeboard on the reclamation area retention dikes.

c. Noticeable dike seepage and/or loss of required dike crest width.

3.10 REQUIRED DEPTH, ALLOWABLE OVERDEPTH AND SIDE SLOPES

3.10.1 Required Depth

The material actually removed from the designated areas to be dredged, to a depth of not more than the required bottom and side slope depth, as shown on the drawings, will be calculated and paid for in accordance with the provisions contained in the subparagraphs Measurement and Payment of Section 01270 MEASUREMENT AND PAYMENT. Confirmation of the removal of all the required material shall be by sweeping.

3.10.2 Side slopes

Material actually removed, within limits approved by the Engineer, to provide for final side slopes, as shown on the drawings, but not in excess of the amount originally lying above this limiting side slope will be calculated and paid for, whether dredged in original position or by dredging space below the pay slope plane at the bottom of the slope for upslope material capable of falling into the cut.

3.10.3 Non-Pay Overdepth

Material taken from beyond the limits in the provisions of paragraphs 3.10.1 and 3.10.2 above will not be measured or paid for. The cost of removing any material below the Required Depth (Section 02325 pp 3.10.1) shall be included in the Unit Price for Dredging Unclassified in the appropriate Area. Nothing herein shall be construed to prevent payment for the removal of shoals performed in accordance with the applicable provisions of the FINAL EXAMINATION AND ACCEPTANCE or SHOALING.

3.10.4 Areas to be Dredged

Based on information currently available to the Employer, areas known to require dredging are depicted on the drawings as crosshatched areas. The actual areas to be dredged may vary from the crosshatched areas shown on the drawings. In order to provide the required project dimensions within and throughout the survey/sweep limits shown on the drawings, the Contractor shall remove material located within the survey/sweep limits as directed by the Engineer, regardless of whether the material is located in a crosshatched area or not. It is anticipated there may be strikes in the non-crosshatched area above the project dimensions that will require removal. Payment for all dredged material, regardless of whether it is dredged from a crosshatched area or areas contiguous to crosshatched areas or a non—crosshatched area, will be made at the Contract unit price for dredging.

3.11 SURVEYS

3.11.1 General

The Contractor shall employ an Independent Surveyor, in accordance with Section 01315, and approved by the Engineer to perform Pre-Dredging and After-Dredging surveys and sweepings.

The Employer shall be notified, in writing, 15 days in advance of the need for pre-dredging surveys and after-dredging sweeping. In addition to the Predredge Survey taken prior to start of dredging, the Contractor’s Independent Surveyor shall also sweep the entire width of the area (200% coverage)from the 17 metre contour in and adjacent to the Departure Channel and the 8 metre contour in the Secondary Berth Harbor to the Survey/Sweep Limits as shown on Drawing 9690-270. Survey/Sweepings will be performed in accordance with Section 01315. A copy of the EM’s can be downloaded from the following web site:
http://www.usace.army.mil/inet/usace-docs/eng-manuals/em.htm.

3.11.2 Contractor Representative

All in—place measurement surveys and final acceptance sweep surveys will be performed by an Independent Surveyor paid for by the Contractor and approved by the Engineer, with a representative of the Engineer and the Contractor on board the platform during the full execution of the survey. No in-place measurement or final acceptance sweep survey will be performed without a representative of the Contractor on board the survey vessel. The

Contractor’s representative shall be fully knowledgeable in offshore construction subsurface surveying procedures, techniques, equipment, and horizontal and vertical calibration methods, and state—of—the—art horizontal and vertical accuracy limitations. The Contractor’s representative shall observe and review, in progress, the adequacy and accuracy of the survey for in-place payment purposes and confirmation of attainment of Required Depth, and for the potential existence of collusion, fraud, or obvious error in the data.

3.11.3 Survey Certification

a. Immediately upon completion of any survey, the Contractor’s representative shall, based on his on-site review of the survey execution, determine that the survey contains no evidence of collusion, fraud, obvious error, and that subsequent horizontal and vertical corrections are accurately annotated on the subsurface record.

b. The Contractor’s authorized representative shall bring aboard the survey vessel a blank copy of the Certification Statement and shall attest to an acceptable survey by signing the Certification Statement before leaving the vessel.

c. In the event the Contractor’s authorized representative observes (and quantifies) specific documentary evidence of either fraud, collusion, or obvious error, the survey will be immediately rerun. Resurveys will totally supersede any previously run survey and will be run over the full reach of any particular Section.

d. If acceptability is not acquired after performing one resurvey of a section, a meeting shall be held between the Contractor and the Employer to expeditiously resolve the issue causing rejection of the survey. Contractor equipment and personnel and Engineer equipment and personnel standby time to resolve acceptability of the survey shall be at the Contractor’s expense.

e. In no case shall a previously unacceptable survey be later judged acceptable by the Contractor; unless such a reassessment/reevaluation is performed within 24 hours after the original survey, and prior to initiating any resurvey action based upon identifiable collusion, fraud, or obvious error.

f. Should the Contractor or his authorized representative refuse to certify to the acceptability of a survey for Contract payment and acceptance without identifiable collusion, fraud, or obvious error, then the following actions will follow:

   1. Preconstruction (pre-dredging) Survey: Excavation shall not commence until representatives of the Contractor and Engineer have met and resolved the basis for refusal of certification. Should the Contractor commence excavation prior to obtaining an acceptable survey, he shall be liable for any excavation performed. If a resurvey is performed, and accepted, prior excavation will not be measured, estimated, or paid for.

   2. Post-Construction (after—dredging) Sweep: The 3-week survey window allowed under subparagraph “Measurement” of Section

01270 MEASUREMENT AND PAYMENT will be indefinitely extended until a final survey is accepted. Any material accretion, which might occur due to such a time extension shall be removed but will not be measured, estimated, or paid for.

3. Refusal to Certify: Contractor equipment and personnel and Engineer equipment and personnel standby time to resolve his refusal to certify to the acceptability of a survey when there is no identifiable collusion, fraud, or obvious error shall be at the Contractor’s expense and resultant delays shall not be the basis for time extensions of the Contract.

g. Intermediate surveys taken between the pre-dredging survey and post–dredging sweeping will not be considered for the purposes of determining quantities for final payment and acceptance of the area dredged.

3.12 INSPECTION

3.12.1 Quality Assurance

The Engineer shall be notified prior to the establishment of horizontal control work (baseline layout, ranges, station flags, shore–based control for EPS/RPS, etc.) and vertical control work (tide staff(s), upland cross sections, construction elevations top/invert, maximum/minimum elevations of dredged materials within disposal area(s), etc.), but the presence or absence of the Engineer shall not relieve the Contractor of his responsibility for proper execution of the work in accordance with the specifications.

The Contractor will be required:

a. To furnish, on the request of the Employer or the Engineer, the use of such boats, boatmen, laborers, and material forming a part of the ordinary and usual equipment and crew of the dredging plant as may be reasonably necessary in inspecting and supervising the work.

b. To furnish, on the request of the Employer or the Engineer, suitable transportation from all points on shore designated by the Employer to and from the various pieces of plant, and to and from the disposal areas.

3.12.2 Failure to Comply

Should the Contractor refuse, neglect, or delay compliance with these requirements, the specific services or facilities may be furnished and maintained by the Employer and the cost thereof will be deducted from any amounts due or to become due the Contractor.

3.13 FINAL EXAMINATION AND ACCEPTANCE

3.13.1 Final Examination of Work by Contractor Employed Independent Surveyor

As soon as practical and no later, than three(3)weeks after the completion of the entire work, and in the opinion of the Employer will not be subject to damage by further operations under the Contract such work will be thoroughly examined at the cost and expense of the Contractor by sweeping or sounding, or both, as determined by the Employer. Should any shoals, lumps, or other lack of Contract depth be disclosed by this examination, the Contractor will be required to remove same by dragging the bottom or by dredging at the Contract rate for dredging. The Contractor or his authorized representative will be notified when soundings and/or sweepings are to be made and will be required to accompany the survey party. When the area is found to be in a satisfactory condition, it will be accepted finally. Should more than one sounding or sweeping operation by the Independent Surveyor’s Survey Crew and/or Engineer over an area be necessary by reason of work for the removal of shoals disclosed at a prior sounding or sweeping, the cost of any subsequent soundings or sweeping operations will be charged against the Contractor at the Employer’s cost for each day in which the Independent Survey Crew and the Engineer are engaged in sounding or sweeping and/or are enroute to or from the site or held at or near the said site for such operation, including expenses and remobilization of equipment, if required.

3.13.2 Final Acceptance

Final acceptance of the whole of the Work and the deductions or corrections of deductions made thereon will not be reopened after having once been made, except on evidence of collusion, fraud or obvious error, and the acceptance of a completed section shall not change the time of payment of the retained percentages of the whole or any part of the Work.

3.14 SHOALING

If, before the Contract is completed, shoaling occurs in any section previously accepted, including shoaling in the finished channel because of the natural lowering of the side slopes, redredging at Contract price, within the limits of available funds may be done if agreeable to both the Contractor and the Employer.

3.15 CONTINUITY OF WORK -- DREDGING OF ROCK

No payment will be made for work done in any Priority Area designated by the Engineer until the full depth required under the Contract is secured in the whole of such area, nor will payment be made for excavation in any area not adjacent to and in prolongation of areas where full depth has been secured, except by decision of the Engineer. Should any such nonadjacent area be excavated to full depth during the operations carried on under the Contract, payment for all work therein may be deferred until the required depth has been made in the area intervening. The Contractor may be required to suspend dredging at any time when, for any reason, the gauges or ranges cannot be seen or properly followed.

3.16 PRIORITY AREA PLAN

The Contractor shall provide a Priority Area Plan, in accordance with the areas shown on the Plans and Paragraph 1.5.1 Order of Work of this Section 02325 including expected weekly production rates in each area and exact x-y coordinates to delineate the entire boundary of each area. The Priority areas are not acceptance areas. The Dredging will be accepted, as a whole, at completion.

3.17 DREDGE SAFETY

All dredge and auxiliary and attendant plant, including the use of divers that may be required for any underwater work or inspection, shall conform to the Approved Safety Plan.

PART 4 QUALITY CONTROL

The Contractor shall establish a Quality Control system to assure compliance with Contract requirements and shall maintain records of his quality control for all construction and dredging operations as required in the QUALITY CONTROL Section.

4.1 QUALITY CONTROL INSPECTIONS AND RESULTS

Includes a description of preparatory, initial, and/or follow-up inspections or meeting; check of subcontractors work and materials delivered to site compared to submittals and/or specifications; comments on proper storage of materials; included comments on corrective actions to be taken.

4.1.1 Quality Control Testing and Results

Comment on tests and attach test reports

4.1.2 Daily Safety Inspections

Include comments on new hazards, copy to be added to Hazard Analysis and corrective action of any safety issues.

4.1.3 Remarks

Include conversations with or instructions from the Employer representatives; delays of any kind that are impacting the job; conflicts in the Contract documents; comments on change orders; environmental considerations; etc.

4.1.4 Contractor’s Verification

I certify that to the best of my knowledge the above report is complete and correct. All material, equipment used, and work performed during the reporting period is in compliance with the Contract plans and specifications except as noted above.

-- End of Section --

ANNEXE 4

DÉVERSEMENTS D’HYDROCARBURES, PROCÉDURE DE QMM (P-SPE-5001)

1. OBJECTIFS

Rassembler dans une même procédure les règles à suivre sur le site et à l'extérieur du site de QMM S.A. pour prévenir et intervenir en cas de déversements d'hydrocarbures.

2. CHAMP D'APPLICATION

Cette procédure s'applique à tous les secteurs ainsi qu'à tout le personnel oeuvrant sur le site de QMM S.A.

L'application de cette procédure s'effectue dans le cadre du domaine d'application du système SPE, tel que défini dans le « manuel du système SPE ».

3. GÉNÉRALITÉ

N/A

4. EPI ET OUTILS DE TRAVAIL

N/A

5. PROCÉDURES

5.1 Prévention

5.1.1 Installation d'**estacades** flottantes de 24 pouces qui empêchent tout déversement éventuel à l'eau de s'éloigner du lieu de déchargement.

5.1.2 **Blocage** de toute ouverture qui permettrait à un éventuel déversement sur le quai (ou la barge) de se rendre à l'eau.

5.1.3 Construction de **digues de sable** tout le long du parcours des canalisations hors terre pour empêcher une fuite sur canalisation de se rendre à l'eau.

5.1.4 Une **embarcation** (petit remorqueur ou bateau de pêche) prête, avec à son bord un pilote et une aide, pour la durée du déchargement d'hydrocarbures.

5.1.5 Quatre cents (400) pieds d'estacades flottantes de 24 pouces prêtes à être déployées par l'embarcation si un déversement survient.

5.1.6 Trente (30) poches de mousse de tourbe, deux puises à grillage fin et trente (30) sacs « hazmat » sur place.

5.1.7 Une personne responsable sur le quai (ou la barge) en communication radio (talkie-walkie) avec l'opérateur de la pompe de transfert sur le bateau d'hydrocarbures.

5.1.8 Autres mesures de prévention :

5.1.8.1 Interdiction de fumer;

5.1.8.2 Extincteurs sur place;

5.1.8.3 Boyaux et lances prêtes;

5.1.8.4 Port de la veste de flottaison par tous;

5.1.8.5 Sacs à lancer ou corde avec bouée de sauvetage;

5.1.8.6 Pelles en aluminium (anti-étincelles).

5.2 <u>Intervention en cas de déversement</u>

5.2.1 Déversement au sol

5.2.1.1 **Arrêter la pompe** du bateau.

5.2.1.2 **Fermer les vannes** les plus proches avant et après le point de fuite.

5.2.1.3 **Endiguer** le déversement avec du sable ou de la mousse de tourbe pour restreindre l'étendue du déversement, et surtout, empêcher qu'il ne se rende à l'eau.

5.2.1.4 **Recouvrir le déversement** de mousse de tourbe.

5.2.1.5 **Ramasser** le déversement et le sol contaminé avec les pelles en aluminium et mettre dans des sacs « hazmat ».

5.2.1.6 **Bien identifier** « hydrocarbures déversés » sur les sacs et **disposer** des sacs en respectant les normes environnementales.

5.2.2 Déversement à la mer

5.2.2.1 Si le déversement <u>est contenu</u> par les estacades déjà en place :

- **Recouvrir le déversement** de mousse de tourbe;
- **Ramasser** la mousse de tourbe imbibée d'hydrocarbures avec les puises et mettre dans des sacs « hazmat »;
- **Bien identifier** « hydrocarbures déversés » sur les sacs et **disposer** des sacs en respectant les normes environnementales.

5.2.2.2 Si le déversement n'est pas contenu par les estacades déjà en place :

- Utiliser l'embarcation pour **déployer les estacades flottantes** supplémentaires;
- **Entourer** le déversement d'hydrocarbures (note : si possible, épandre de la mousse de tourbe le long de l'estacade);
- **Ramener lentement le déversement** vers la barge, le quai ou la barge;
- Pendant ce temps; d'autres intervenants **étendent de la mousse de tourbe le long de la berge**, du quai ou de la barge;
- **Recouvrir le déversement** avec de la mousse de tourbe;
- **Ramasser** la mousse de tourbe imbibée d'hydrocarbures avec les puises et mettre dans des sacs « hazmat »;
- **Bien identifier** « hydrocarbures déversés » sur les sacs « hazmat » et **disposer** des sacs en respectant les normes environnementales.

6. ENREGISTREMENTS

N/A

7. LEXIQUE

N/A

8. RÉFÉRENCES

N/A

Numéro de révision	Sujet de révision	Auteur	Date
1	Nouvelle procédure	R. Perasony	28/02/2006

APPROUVÉE PAR :

Fonction :	Directeur exécutif	Fonction :	Directeur régional FTD
Fonction :	Responsable SPE (auteur)	Fonction :	
Fonction :		Fonction :	

ANNEXE 5

PORT OF EHOALA, FORT DAUPHIN, MADAGASCAR GEOMORPHOLOGY AND SEDIMENT TRANSPORT IN FAUSSE BAIE DES GALIONS , W.F. BAIRD & ASSOCIATES. 2006

PORT OF EHOALA, FORT DAUPHIN, MADAGASCAR

GEOMORPHOLOGY AND SEDIMENT TRANSPORT IN FAUSSE BAIE DES GALIONS

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MARCH 2006

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PORT OF EHOALA
GEOMORPHOLOGY AND SEDIMENT TRANSPORT IN FAUSSE BAIE DES GALIONS

ABSTRACT

This report describes historical changes to the shoreline of Fausse Baie des Galions and provides estimates of the rates of transport of sand by the action of waves and wind.

The issues of the potential for changes to the shoreline and for transport of sediment into the port area are discussed, as well as the groyne intended to prevent the transport of sediment into the port area.

A shoreline monitoring program to be undertaken prior to, during and following construction of the port is also described in this report.

SUMMARY

A comparison between the 2004 shoreline position and an estimate of the shoreline position defined on a 1951 navigation chart of Fausse Baie des Galions indicates that, historically, the bay appears to be relatively stable, with the exception of erosion occurring close to the town of Fort Dauphin. However, analysis of the shoreline location for a more recent and shorter time period (1989 to 2004) suggests that there is some ongoing erosion towards the north end of the bay and some ongoing accretion at the south end of the bay close to the port location. This may be the result of a long-term fluctuation in the shape of the bay, as a result of a long-term fluctuation in the balance between trade winds and southerly swells, or a permanent shift in the balance between southerly swells and easterly sea waves. Recent research on climate change in the Southern Hemisphere concluded that there may have been a reduction in the number of storms that generate the southerly swell waves that reach the site for the period from about 1980 onwards. This could explain the pattern of erosion at the north end of the bay and accretion at the south end. It is not yet possible to say whether the observed climate shift is part of a natural cycle (i.e., reversible) or due to global warming (i.e., potentially irreversible).

Calculations of sand transport within this bay are problematic, principally because of the bi-directional characteristics of the wave climate. It is estimated that there is a net transport of sand from the center of the bay towards the south, and that this transport may be in the order of 50,000 m^3 per year.

However, there is also a significant wind-blown transport of sand from the shoreline to the dunes behind the shoreline in the southern part of the bay. This may be in the order of 30,000 m^3 per year.

Both the wind and wave transport estimates are very approximate due to the complexities of the phenomena as explained in this report. The accumulation of sand at the south end of the bay suggests that the difference between inshore wind losses and net transport of sand to the south by waves is approximately 15,000 m^3 per year (i.e., this has been the annual rate of shoreline accretion between 1989 and 2004). This compares to the difference between the estimated net southerly transport by waves and the estimated inshore wind losses that may be in the order of 20,000 m^3 per year. The extent to which this net accumulation continues, increases or decreases in the future, whether or not the harbor is constructed, is difficult to predict due to the uncertainties of future climate change.

The shape of the bay is defined by the characteristics of the incoming waves and the influence of the headlands on these incoming waves. The south headland creates an area sheltered from both trade wind waves and swell waves (with greater sheltering from the southerly swell waves). Within this zone of headland influence the waves undergo refraction and diffraction, changing their direction. In theory, the shape of the bay shoreline should be approximately parallel to the wave crest at breaking that represents an average of the different wave directions. Construction of the breakwater effectively extends the southern headland and increases the extent of the shelter zone. This extension could result in the bay adjusting its shape with accretion in the lee of the south headland and erosion at the center of the bay. This adjustment to the shape of the bay would be achieved by increased transport of sand towards the port. It has been estimated that the net southerly transport rate could increase by about 15,000 m^3 per year to 65,000 m^3 per year.

In summary, there are two possible influences that may lead to sedimentation in the port area in the absence of a groyne to intercept this sediment. These consist of possible climate change in the Southern Hemisphere (and the decreasing influence of the swell waves) and the influence of an increased shelter zone at the south end of the bay due to the extension of the natural headland by the breakwater. If the apparent climate change influence continues as it has in the past (resulting in 15,000 m^3 per year of accretion) and this is augmented by the impact of the new breakwater on southerly transport into the project area (resulting in an additional 15,000 m^3 per year), the expected rate of accumulation could be in the order of 30,000 m^3 per year. However, there is a possible offsetting influence associated with the fact that if a beach were to accumulate updrift of the groyne increased wind-driven transport may move some of the sand inshore. There are many uncertainties associated with attempting to predict these processes and quantify accretion rates and shoreline change.

In consideration of the complexity and uncertainty associated with these processes, it is recommended that a groyne be considered as part of the design of the port. The groyne could extend to the –5 m contour, the depth to which significant transport of sand could occur. Initially, it would prevent the alongshore transport of sand towards the port and it would direct the alongshore current offshore and away from the port. Deposition of sand adjacent to the groyne, should it occur, will be relatively slow. The form of the fillet beach adjacent to the groyne, predicted by the equilibrium bay analysis, has a capacity of approximately 1,200,000 m^3, not including the possibility of greater inshore wind losses. Development of such an accretion fillet at the groyne would take many years (more than approximately 30 years based on the rough estimate of southerly transport with the breakwater in place). This timing assumes the southerly swell climate remains unchanged from the last 20 years. There is some indication that the climate shift may continue to reduce southerly swell in which case the fillet beach next to the groyne could fill in less than 30 years. The exact rate at which the groyne is filled depends on the future of climate shift in the Southern Hemisphere (if any), the response to the increased shelter provided by the breakwater extending the headland and the possible increased influence of inshore wind transport. As the fillet beach approaches maturity in size there may be some bypassing of the groyne towards the port at a significantly lower rate than the net southerly transport rate.

Given the uncertainty associated with predicting the sand transport within the bay, a small, temporary groyne will be built at the beginning of the port construction phase to provide information on the transport of sand and the rate of accretion against the groyne. Further, a shoreline-monitoring program has been initiated by QMM prior to construction, and will continue during construction, with assistance from the Contractor. Current/wave recorders will be installed and maintained by the Contractor during construction to provide data to assist with this assessment.

The shoreline monitoring program is described in Section 6.0 and will include regular beach profile and shoreline surveys in addition to monitoring wind transport updrift of the groyne. The issue of wind-blown sand interfering with infrastructure development will be considered in the development of the port.

If the monitoring reveals deposition of sand adjacent to the groyne, there may be a corresponding loss of sand at the center of the bay. It will be very difficult to determine the relative contribution to this erosion to climate change or to the breakwater.

If a small, temporary groyne demonstrates that no accretion occurs over one full year with at least a partial breakwater in place, it may be argued, depending on the deepwater wave conditions during that period, that a groyne, or at least a groyne extending to the –5 m contour, may not be required. At the same time as observations of the small groyne are made, the field measurement and monitoring program will be completed to provide data to support ongoing analysis and review of this issue. As part of the Early Works contract, the temporary groyne will initially consist of a small rubblemound structure extending approximately 60m to the –0.5m contour. Based on the results of the monitoring surveys, the temporary groyne may be extended by approximately 140m to the –2m contour during port construction. The final groyne, if required, would be built over this structure.

TABLE OF CONTENTS

1.0 INTRODUCTION

This report discusses the geomorphology of Fausse Baie des Galions and the transport of sediments within the bay before and after the proposed port is built.

The report is divided into seven sections. Section 2.0 describes general observations that can be made from historical charts, air photographs and satellite imagery, as well as during site visits, and provides a general discussion of the geomorphology of the bay.

Section 3.0 describes the wave climate of the region and the bay, and the results of surveys of beach profiles and sand gradations.

In Section 4.0 the results of numerical modeling of sand transport and the analysis of the bay geomorphology are presented and discussed.

Section 5.0 discusses the potential designs of a groyne. The beach monitoring surveys are presented in Section 6.0, and conclusions of this study are presented in Section 7.0.

2.0 GENERAL OBSERVATIONS OF FAUSSE BAIE DES GALIONS

Three sources of information are available that describe the general layout of the bay as follows:

1. A 1951 navigation chart entitled Cote Sud-Est de Madagascar, DU CAP ANDAVAKA A STE. LUCE, Service Hydrographique de la Marine, Paris, 1951, at 1:100,000-scale. The chart provides only limited value for shoreline work due to the small scale of the chart (i.e., at this scale, the thickness of the shoreline line is over 50m).

2. A 1989 aerial photograph mosaic, assembled from 26 individual aerial survey colour frames, with an original photo scale of 1:20,000. Most of the photos were captured on 06 February 1989, but some were captured on 10 February, although once the images were in the mosaic it was not possible for Baird to determine the dates of the individual frames. The aerial survey was conducted by McElhanney Geosurveys Ltd., of Vancouver, British Columbia, Canada.

3. A 2004 high-resolution QuickBird satellite image, captured at approximately 10:00am local time, on 28 March 2004, with an off-nadir angle of 3 degrees. The QuickBird satellite orbits Earth at an altitude of 700km and captures images at a ground resolution of 2.4m colour, and 0.6m black & white. The QuickBird satellite is owned/operated by DigitalGlobe of Longmont, Colorado, U.S.A.

A high-resolution IKONOS satellite image captured on 27 December 2003 is also available. This provides similar information as contained in the 2004 QuickBird image.

All three data sets were georegistered to a common spatial orientation in GIS to provide for a comparison of features. The 2004 QuickBird satellite image was spatially adjusted using Differential GPS ground control points collected by Baird in November 2004. Originally the 1989 airphoto mosaic was presented in the Laborde projection, but was adjusted to match the 2004 QuickBird using 3 visible control points and a 1st order polynomial (affine) transformation method. Similarly, the 1951 navigation chart was rectified using 3 control points along the road network and a 1st order polynomial transformation method.

The 2004 QuickBird image of Fausse Baie des Galions is presented in Figure 2.1.

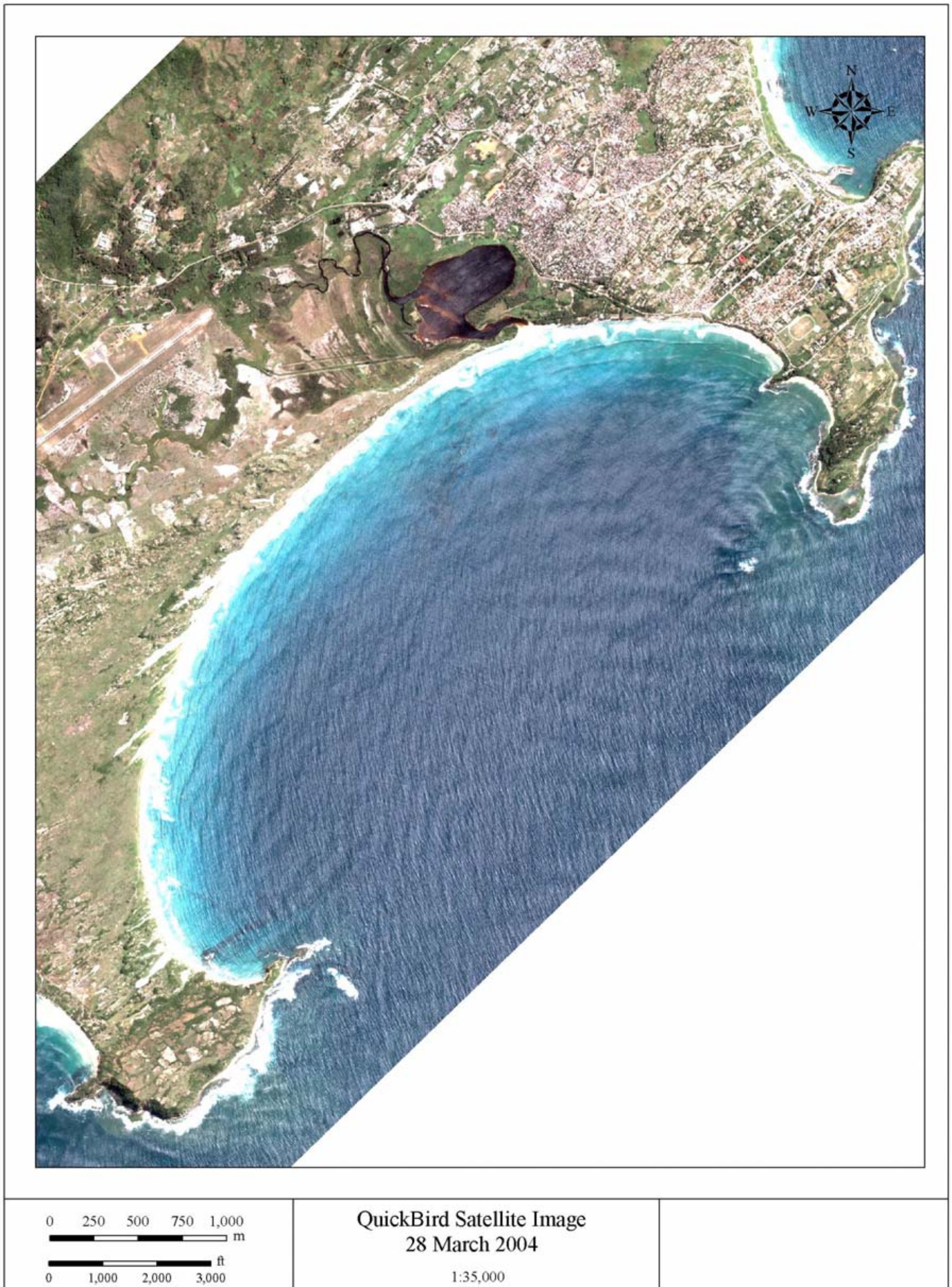


Figure 2.1 2004 QuickBird Image of Fausse Baie des Galions

The 1951 georegistered chart is compared to the 28 March 2004 shoreline in Figure 2.2. This figure shows that, within the scale accuracy (50 metres) of the location of the shoreline as depicted on the chart, the general shape of the bay has not changed significantly from 1951 to 2004. The exception to this is in the north section of the bay, close to the town of Fort Dauphin, where the shoreline appears to have retreated landwards since 1951.

A comparison of the 1989 shoreline with the 2004 shoreline is only possible at large scale mapping that provides a detailed view. Comparisons of sections of the shoreline showing the limits of vegetation are presented in Appendix A. The comparisons were made at transects at 50 m intervals. Review of these comparisons leads to the following conclusions:

1. South - The limit of vegetation moved seaward, indicating accretion of the shoreline, by an amount of 5 to 10 m in the southern part of the bay in the vicinity of the new port facilities. (Figures A01 and A02)

2. Central - The limit of vegetation moved landward, indicating erosion of the shoreline, by an amount of 0 to 50 m in the central part of the bay to the west of the mouth of the small creek. It should be noted that the limit of long-term-permanent vegetation appears relatively stable, but in the 1989 airphoto there are perhaps some sparse dune grasses that are pioneering the beach. (Figures A04 to A06)

3. Creek - The limit of vegetation around the mouth of the small creek in the center of the bay (entrance to Lac Ambinanikely) changed moderately between 1989 and 2004, with accretion values in the range of 5 to 10m. (Figure A08)

4. Town - In the northern part of the bay, east of the creek and close to the town, the shoreline has eroded and in 2004 there is an actively eroding bluff adjacent to the coastal road, as shown in Figures 2.3 and 2.4. (Figures A09 and A10)

This comparison further supports the conclusion that erosion of the shoreline has been occurring in the central and north part of the bay, and these data suggest that the shoreline or bluff may have been eroding at a rate of less than 1 metre per year.

Photographs taken along the shoreline provide further documentation of the shoreline. Representative photographs, with a map showing the approximate location from where the photographs were taken, are contained in Appendix B. These photos also suggest the central part of the shore is in an erosional state, compared to accretion at the south end.

Photographs of the area close to the town of Fort Dauphin (Figures 2.3, 2.4 and 2.5) show the active erosion taking place in 2004.

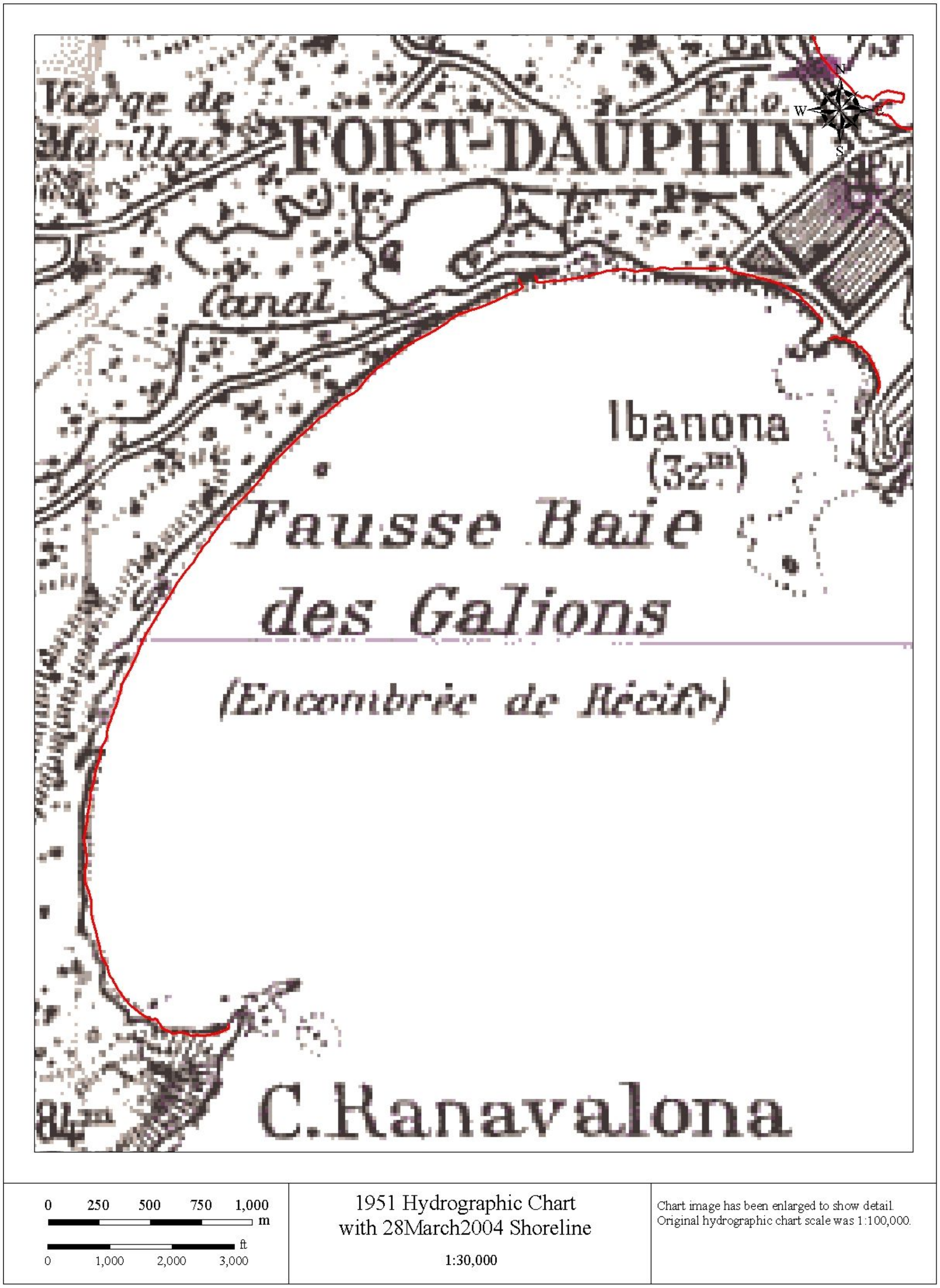


Figure 2.2 Comparison of 28Mar04 Shoreline to 1951 Georegistered Chart

Figure 2.3 Shoreline Erosion at the North End of Fausse Baie des Galions

Figure 2.4 Coastal Road on Actively Eroding Bluff Near Fort Dauphin

Figure 2.5 Shoreline Erosion at the North End of Fausse Baie des Galions

An important feature that is evident in all three data sets, and is very clearly shown in the 2004 image, is the large number of sand dunes that are aligned to the prevailing wind direction. Figure 2.6 presents an example of dunes aligned to the predominant wind direction.

It is interesting to also note that the "old dunes" are now covered with vegetation. Clearly there is a significant quantity of sand blown towards the southwest along the central beach (as shown in Figure 4.5), creating younger dunes that are also gradually covered by new vegetation, as seen in Figure 2.6 and Photos 34 to 56 in Appendix B. Further to the south, and close to the proposed port location, the dunes are old and fully covered by vegetation. Lack of vegetation will destabilize these dunes by exposing them to the prevailing strong winds. Figure 2.7 shows a large sand dune actively eroding at the south end of Fausse Baie des Galions. A new sand dune is forming behind the old dune. Additional photographs of large sand dunes that are forming are contained in Appendix C.

Based on the comparison of the 1989 to 2004 shorelines, and assuming the accretion is taking place over a prism of 12 m (i.e. from the top of low dunes to the nearshore depth of closure), it is estimated that the annualized accretion rate for the south end of the bay through this period is about 15,000 m^3 per year. Whether or not this accretion is simply a cyclic phenomenon or a long-term trend is discussed further in Section 4.0.

Figure 2.6 Sand Dunes Aligned to Predominant Wind Direction

Figure 2.7 Large Sand Dune at South End of Fausse Baie des Galions

3.0 SUMMARY OF WAVE CLIMATE, BEACH PROFILES AND SEDIMENT SURVEYS

3.1 Bathymetry, Geology and Surficial Sediments

The bathymetry of the bay was surveyed by Marine GeoSolutions Ltd (MGS) in 2003 (MGS 2003), with sections resurveyed in 2004 (MGS 2004). The 2003 survey is presented in Figure 3.1. Surficial sediments were also identified by MGS and results are presented in Figure 3.2.

3.2 Grain Size

A series of grab samples were taken from the beaches around the bay. The median grain sizes are shown in Figure 3.3. The grain size generally becomes finer moving north along the bay. The median grain size ranges between 0.2 and 0.7 mm at the southern end of the bay, 0.13 and 0.7 mm in the center of the bay and 0.18 and 0.5 mm in the northern part of the bay.

According to the MGS report (Figure 3.2), the bay is covered with unconsolidated Holocene coarse-grained sand at 15 to 30 m depths, Holocene fine to medium grained sand and Pleistocene reef outcrop at 5 to 15 m depths. At the location of the proposed port, the grain size ranges from 0.6 to 1.5 mm, with an average of 0.95 mm. The Holocene coarse-grained sediment at this location contains high bioclastic content and is not likely to have any interaction and exchange with beach sediment because it is in deeper water and unlikely to be transported onshore by wave motion. The Holocene fine-to-medium grained sediment in 5 to 15 m depths has low bioclastic content and could be made up partially from sediments eroded from the beach and moved offshore as a result of underwater sediment sorting.

Underwater samples at –1 and –3 m contours around the area of the proposed harbor were collected in November 2004. Most of the samples had a median grain size between 0.2 and 0.4 mm, i.e., finer than what was found on the beach at this location (0.3 to 0.7 mm) but close to the sand sizes in the 5 to 15 m depth reported by MGS (fine to medium).

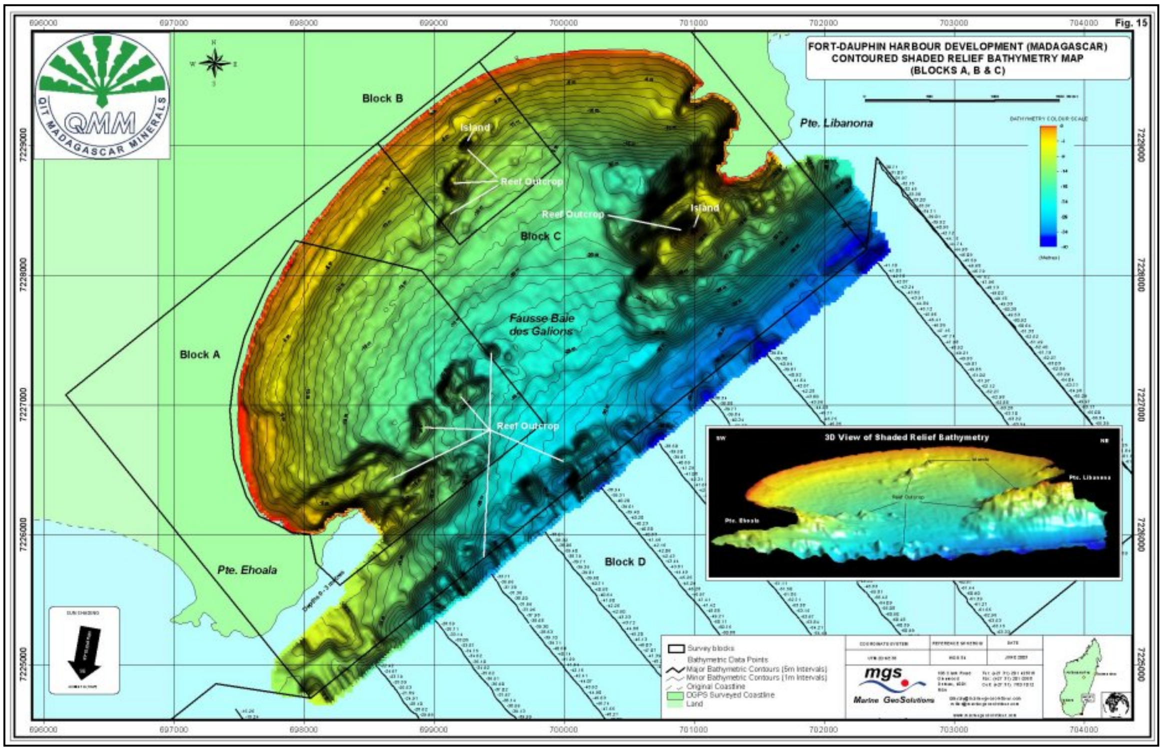


Figure 3.1 MGS 2003 Survey Bathymetry

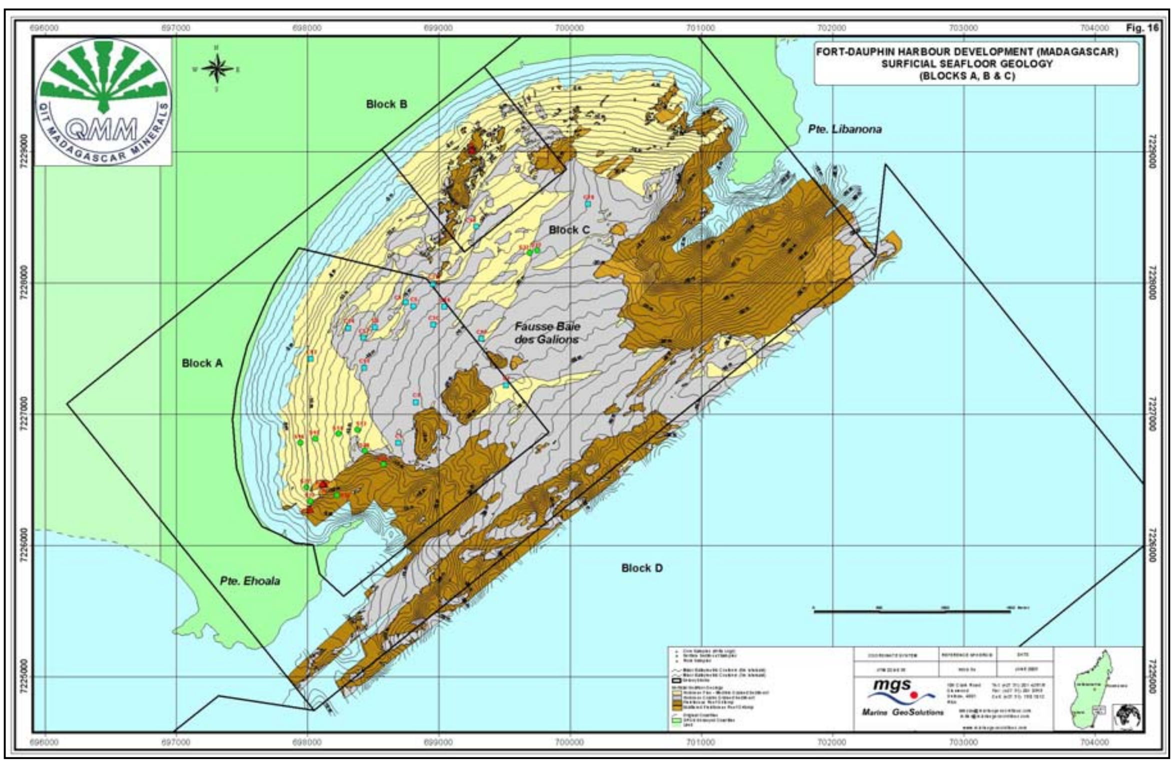


Figure 3.2 Surficial Sediments

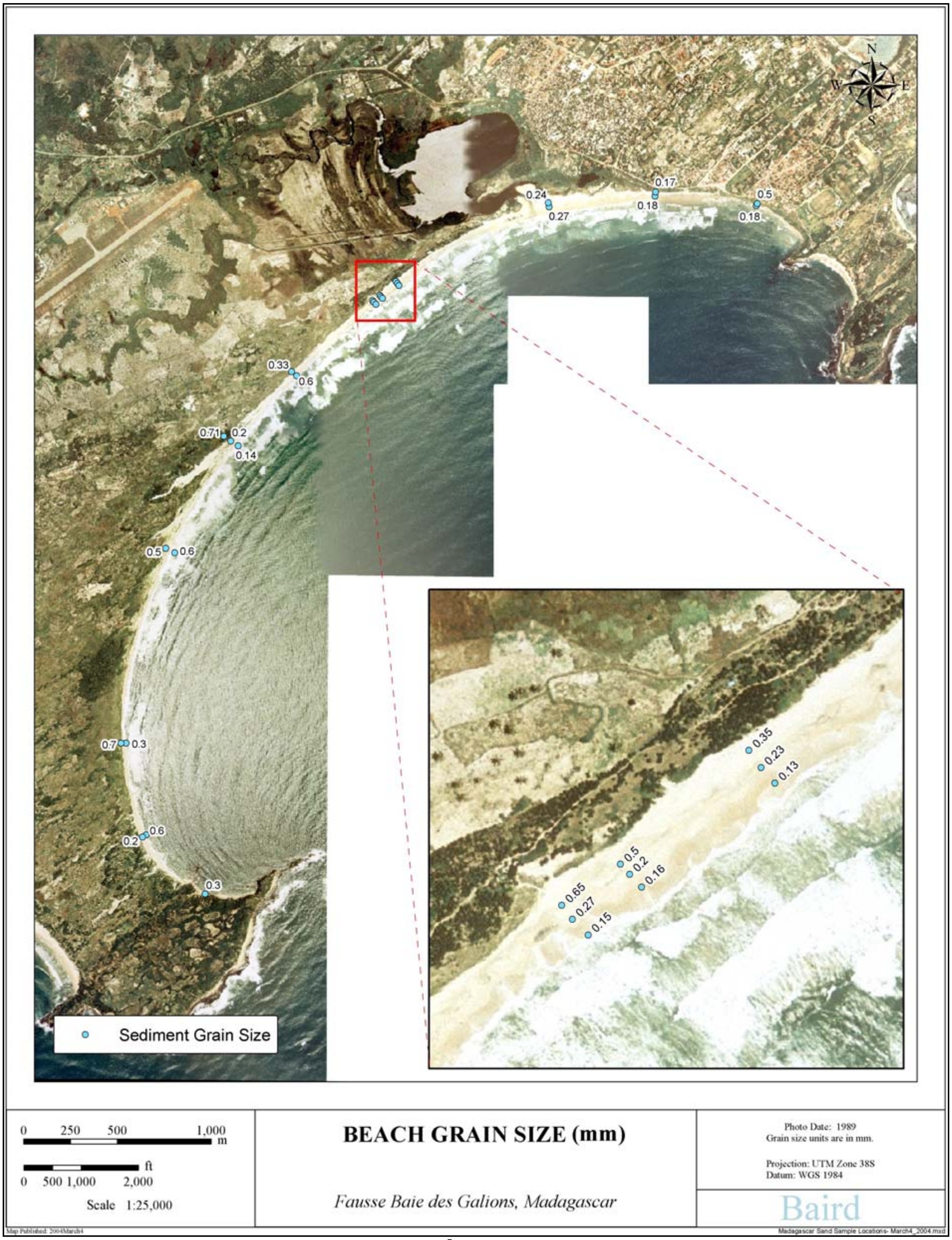


Figure 3.3 Median Grain Sizes

3.3 Wave Climate

The wave climate at Fort Dauphin is dominated by two sources of waves: the locally generated waves produced by the trade winds blowing from the east-northeast, and swell waves resulting from extra-tropical storms in lower latitudes. The swell waves generally arrive from the south-southwest direction. The locally generated waves have significantly shorter wave period than the longer period swell waves. The two systems frequently occur at the same time, producing coupled wave patterns (refer to Figures 2.1 and 3.3 showing the wave patterns in 2004 and 1989, respectively) and nearshore currents that add considerable complexity to the processes of sand transport at the shoreline.

The wave climate of the area has been defined by a hindcast covering the period 1985 to 2004, and has been verified by satellite observations and wave recording. Figures 3.4 and 3.5 present wave roses covering the hindcast period for a location offshore of Fort Dauphin (50 m deep) for both the sea and swell wave conditions, respectively. These figures show that, in this depth of water, most of the waves occur from either the south-southwest or east directions, with minor contributions from the south and east-southeast directions. Approximately 85% of the locally generated waves and 50% of swell waves at this location are 1 m to 3 m in height. During the hindcast period, extreme waves of 5 to 6 m occurred from both the east and south-southwest directions. Most frequent wave periods ranged from 8 to 16 s for swell waves and from 6 to 10 s for locally generated waves. Larger swell waves occurred during April to September with peaks in May and June. Events with swell heights larger than 3 m (lasting for at least 6 hours) occurred 4 times per year, and greater than 4 m every 2 to 3 years over the hindcast period on average. Locally generated waves could occur anytime, but were normally smaller from November to January. Locally generated waves larger than 3 m occurred 7 times per year on average, and storms with peak wave height larger than 4 m happened once every year.

Recent investigations have explored the long-term variability of extra-tropical storms in the mid- and high-latitudes of the Southern Hemisphere. Simmonds and Keay (2000) assessed extra-tropical storms over a 40 year period (1958-97), and noted a significant reduction in the numbers of storms south of 40°S latitude as well as a decrease in storm intensity since the late 1970’s. In the region between 30°S and 70°S, it was found that the maximum number of cyclones occurred in 1970, but that there has been a 10% drop since that time. A similar study by Fyfe (2003) also showed significant decreases in the numbers of extra-tropical storms in the Southern Hemisphere.

Both technical papers attribute the differences in storm numbers to global climatic change, including global warming trends. Fyfe (2003) does, however, note the potential for fictitious trends due to changes in the meteorological observation network in the Southern Hemisphere (there has been a large increase in the network in recent years). Another possible source of variation not identified in the papers is long-term climatic oscillation.

These potential changes in storm frequency and intensity have important implications with respect to wave climate, particularly the swell wave climate occurring in Southern Madagascar. If these trends are real, they would suggest that the swell wave attack at the study site has been diminished since the 1970's. It is yet unclear whether this trend in reduction of swell wave attack at the study site will continue (may be the case if this is indeed a global warming influence) or whether it will be reversed (may be the case if this is simply a natural cycle or oscillation in extra-tropical storm intensity and frequency in the Southern Hemisphere).

Tropical cyclones occur in the general area of Madagascar and associated wave conditions define the design wave conditions for the port. Statistical evaluation of historical cyclone data, in conjunction with the measured cyclone wave heights, suggests that a tropical cyclone may produce significant wave heights at the project site in excess of 4 metres once every three years on average. The most severe cyclone known to impact Fort Dauphin was Tropical Cyclone Deborah, which passed from east to west a few kilometers south of the site in 1975. Hurricane waves will produce significant onshore-to-offshore sand transport, resulting in erosion of beaches. Beaches tend to be rebuilt by longer period sea and swell waves in the years following a cyclone. There are reports that there was significant erosion of the beach adjacent to the existing port of Fort Dauphin during Tropical Cyclone Deborah in 1975.

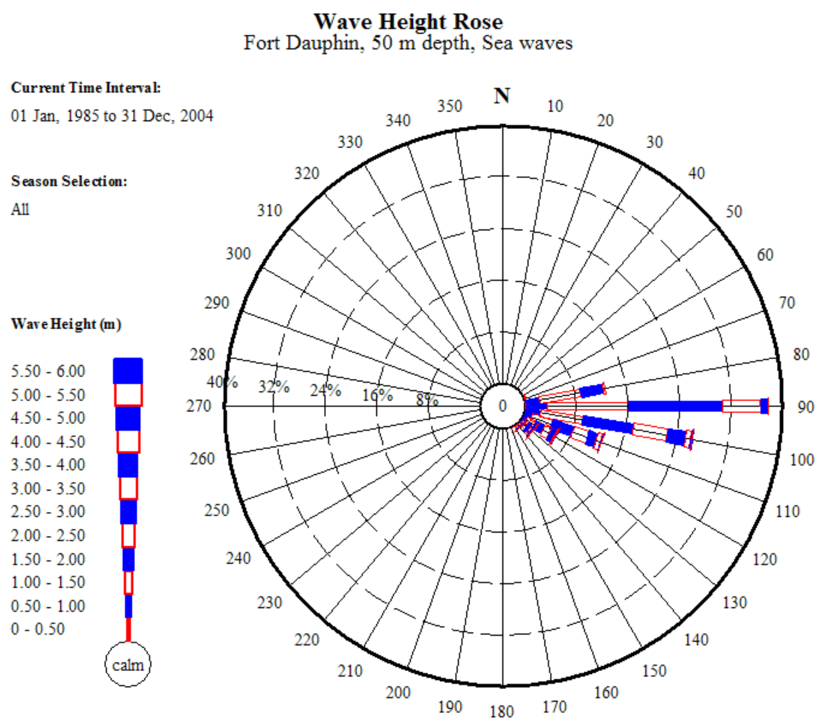


Figure 3.4 Offshore (50 m depth) Wave Height Rose for Sea Waves

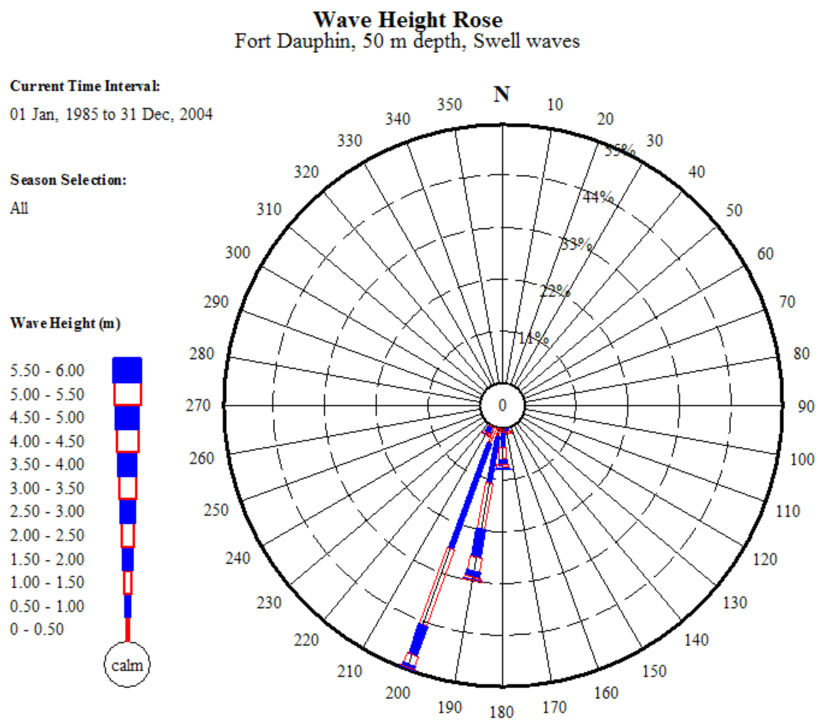


Figure 3.5 Offshore (50 m depth) Wave Height Rose for Swell Waves

4.0 RESULTS OF NUMERICAL MODELLING OF SEDIMENT TRANSPORT

In this section, wave and wind-blown sand transport potentials are examined together with the bay morphology (primarily represented by shoreline change). As was noted in the previous section, the wave climate is bi-modal in direction, height, period and steepness. The hydrodynamics generated by these wave conditions occurring at the same time are extremely complex. Numerical models cannot reliably predict the sediment transport produced by these combined conditions. Consequently, the roles of locally generated waves and swell in the transport of sand have been evaluated separately and the results combined to predict historical transport rates. The results can only provide an indication of the sand transport processes that are occurring. It is quite possible that gross transport rates are overpredicted, as the interaction of two waves systems may reduce the alongshore currents and the transport of sand.

4.1 Nearshore Wave and Circulation Currents

Wave transformation from relatively deep water to the shoreline of the study area and the corresponding nearshore currents were calculated using the *HYDROSED* model. *HYDROSED* is a 2D hydrodynamic and sediment transport model for coastal areas. It consists of a spectral wave transformation model (where the wave field is calculated by the spectral energy conservation equation of Karlsson 1969, with the breaking dissipation term of Isobe, 1987), a hydrodynamic model (Nishimura, 1988) to describe wave generated nearshore currents and circulations (driven by radiation stresses predicted with the spectral wave transformation model), and a sediment transport model presented by Dibajnia et al (2001). The sediment transport model considers the influence of non-linear orbital velocities and undertow and is based on the sheet flow transport formula of Dibajnia and Watanabe (1992), which was extended by Dibajnia (1995) to consider suspended transport over ripples as well as the bedload transport. Dibajnia et al (2001) also conducted a sensitivity test of their model and showed that the model response under various actual nearshore wave environments is satisfactory. For a given wave condition, *HYDROSED* can provide a spatial description of nearshore currents and sand transport around the harbour. The model has been verified through laboratory experiments as well as field measurements and has been extensively applied to several projects by Baird in the past few years. Nevertheless, the model has not been tested for conditions of bi-modal wave conditions. In fact, the condition of two simultaneous wave trains from different directions, and the resulting current and sediment transport patterns, is a phenomenon that is not well understood. Bi-modal wave conditions are not represented in any currently available coupled wave and hydrodynamic models. In addition, the influence of wind-driven currents on the hydrodynamic processes has not been considered. The contribution of wind-driven currents on total longshore current was found through field measurements to be significant for an equilibrium bay beach investigated by Sherman and Greenwood (1984). It is proposed to measure the currents at the site during the construction phase to assess the importance of wind-driven currents at this site.

A calculation domain covering the entire bay with a 445×540 mesh (cross-shore × alongshore) with grid size of 10 m was used to model the existing conditions and the recommended design option. The bathymetry was created from the MGS 2003 and 2004 hydrographic surveys, 1989 topographic data and recent (November 2004) limited profile survey data in the proposed port area. The profiles extended only to the –1 to –2 m contours and, therefore, interpolation was required in the nearshore zone between the –5 and –2 to –1 or 0 m depth contours over the entire bay. The depth at the offshore boundary of the calculation domain was approximately 50 m. Detailed results and calculations are included in Appendix D.

4.2 Summary of Results

The results of the model, while limited in the ability to represent the simultaneous bimodal (directional) wave attack, assist in understanding the dominant sand transport processes and assist with the development of a working hypothesis of sediment transport processes that are of concern with respect to the design of the port. These results are summarized below. The breaker line and wave directions determined from the combination of our wave hindcast and the nearshore transformation with the *HYDROSED* model were verified against the observed wave conditions present at the time of the 1989 aerial photograph and the 2003 satellite image. The results for the swell generated waves corresponded well in the north part of the bay and the locally generated easterly waves fit the observed waves well in the south part of the bay.

Locally Generated Easterly Waves. Figure 4.1 shows the distribution of wave heights and directions within the bay for waves with Hs of 2 m and period of 8 seconds. Figure 4.2 shows the currents generated by these waves. The currents, and the associated sand transport, are towards the southern part of the bay.

Swell Generated Southerly Waves. Figure 4.3 shows the distribution of wave heights and directions for waves with Hs of 1m and period of 12 seconds. Figure 4.4 shows the currents generated by these waves. The currents and the associated sand transport are significantly lower and vary in direction within the bay.

Net Southerly Transport. The conclusion that can be drawn from these analyses is that there is a net transport of sand from the center of the bay towards the southerly part of the bay. Using the approaches described above, it is estimated that there is a net transport of sand from the center of the bay towards the south, and that this transport may be in the order of 50,000 m^3 per year. The possible range is in the order of 33,000 to 65,000 m^3 of sand per year. More detail on the approximated contributions of the sea and swell components are presented in Appendix D.

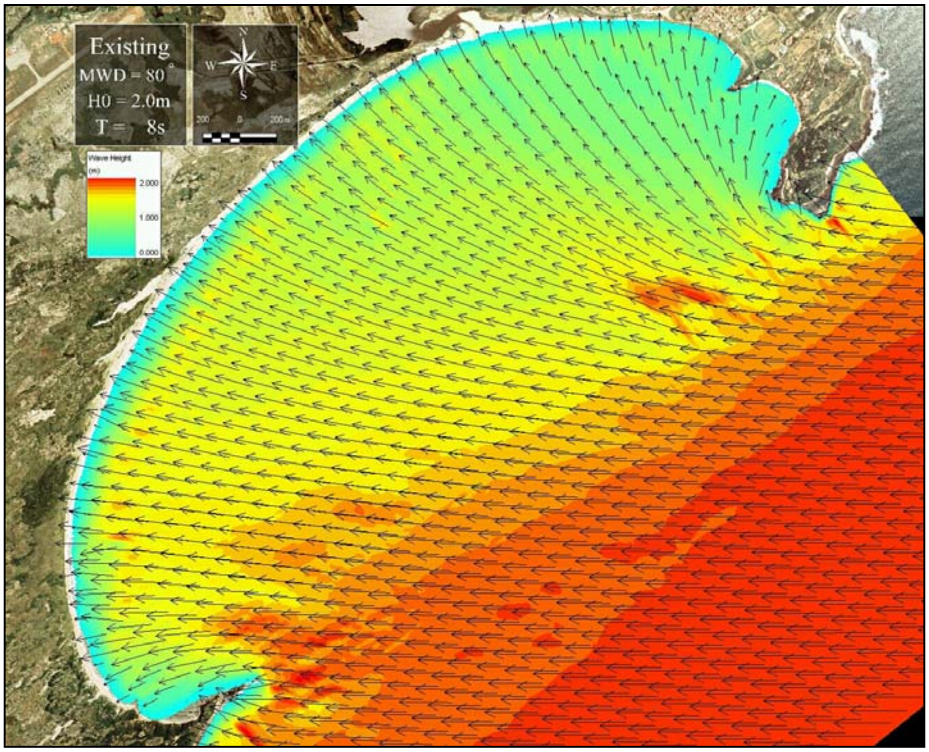


Figure 4.1 Wave Height and Direction for Typical Sea Waves (existing conditions)

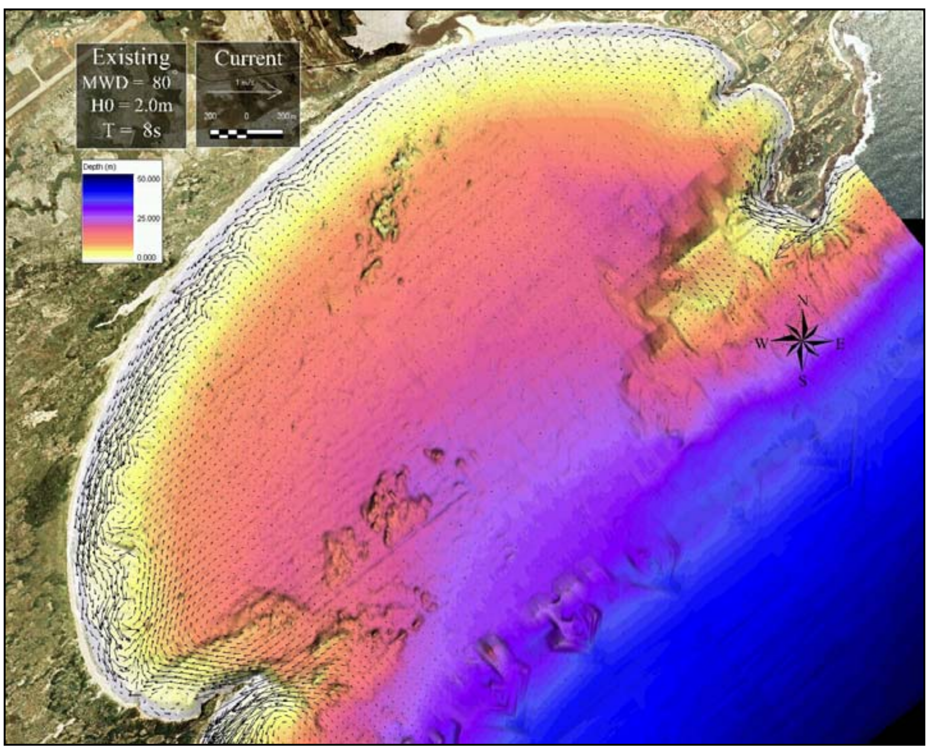


Figure 4.2 Nearshore Currents Due to Predominant East Waves

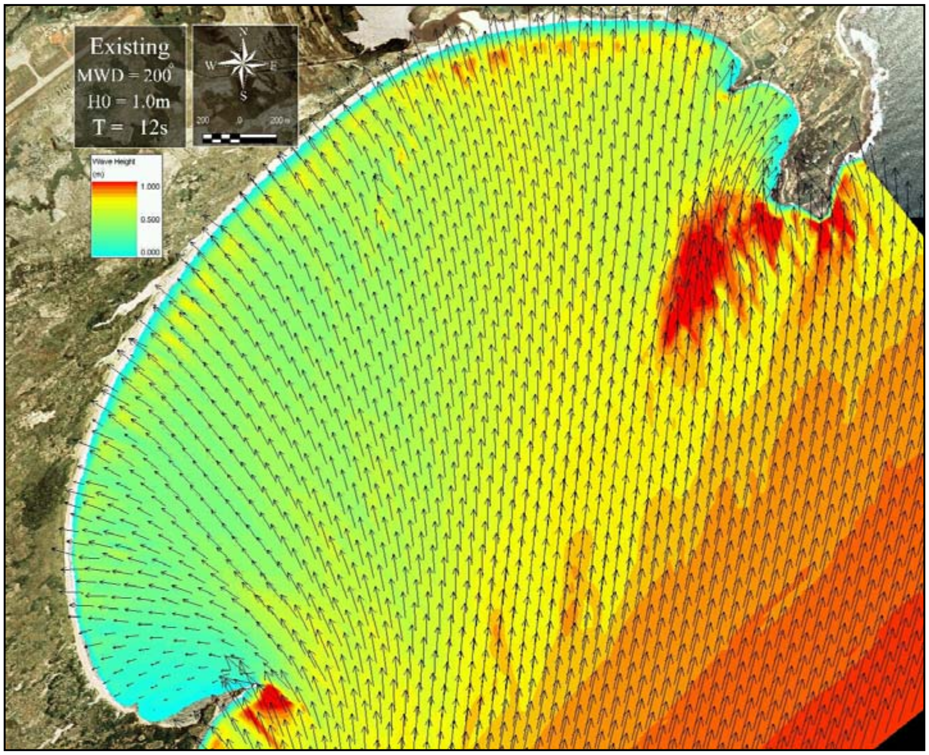


Figure 4.3 Wave Height and Direction for Typical Swell Waves (existing conditions)

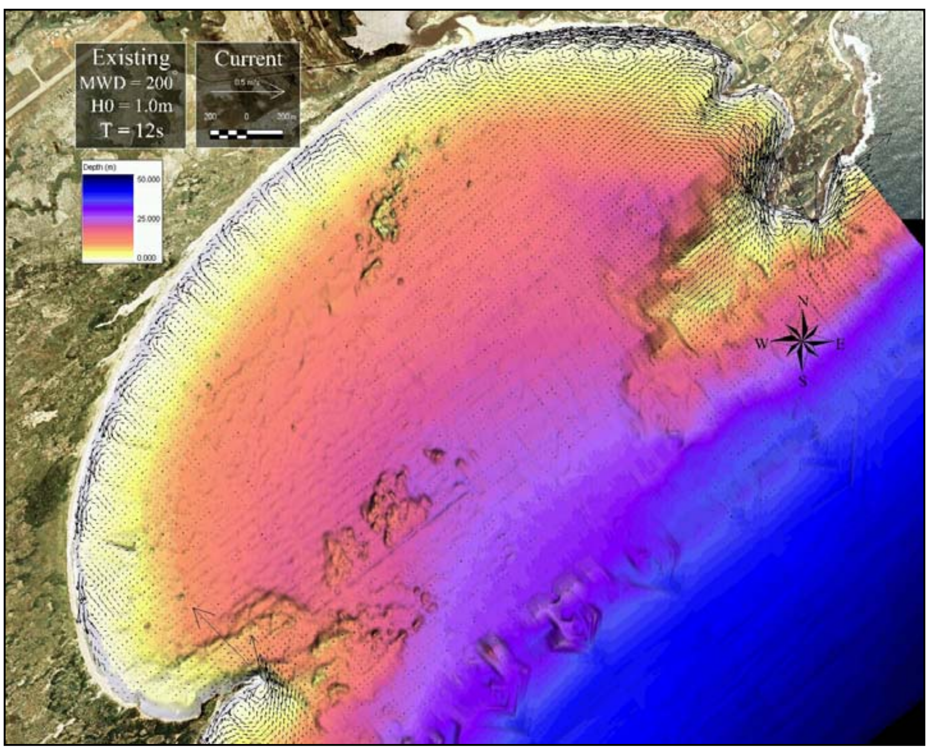


Figure 4.4 Nearshore Currents Due to Predominant Swell Waves

It is to be noted that the calculations, ignoring potential interaction of the two wave directions and associated limitations, indicate a possible upper limit in the order of 65,000 m^3 per year. In addition, the results suggest an increasing gradient in longshore transport directed away from the center of the bay. This pattern of longshore sand transport is compatible with the observation of erosion at the center of the bay. However, the uncertainty associated with the numbers and patterns is to be noted, due to the fact that the influence of simultaneous bi-modal wave attack and wind-driven currents have not been considered.

4.3 Wind-Blown Transport of Sand

Sand transport by wind blowing across the above water beach is likely to be an important component of transport in the bay and in estimating a sediment budget. As noted in Section 2.0, there is evidence of wind transport of sand, and the sand being blown into the vegetation behind the beach can be observed. Therefore, the potential for wind-blown sand transport from the beach onto the land behind the beach has been evaluated. Details of the approaches used to make these estimates are presented in Appendix E. Figure 4.5 shows wind-blown sand along the beach at Fausse Baie des Galions.

Figure 4.5 Wind-Blown Sand Towards the South End of Fausse Baie des Galions

Two different approaches were used to estimate wind-blown sand transport rates: 1) the procedure from the US Army Corps of Engineers Coastal Engineering Manual using the wind-blown sand transport equation of Hsu (1973), and 2) the procedures described by

Horikawa (1988) using the wind-blown sand transport equations by Kawamura (1951) and Bagnold (1954). The total amount of sediment transported by wind was calculated for all winds above the critical threshold (i.e., the wind speed that initiates sand transport). A flat beach with sufficient width to reach potential transport was assumed for the calculations.

The conclusion of this analysis was that the potential average transport of sand from the beach to the land behind the beach is in the order of 20 m^3 per m length of beach (projected in the direction of wind attack) per year. This could amount to a net loss in the order of 30,000 m^3 per year. It is to be noted that calculations show a range in value from 10,000 to 45,000 m^3 per year.

4.4 Summary of Tentative Conclusions With Respect to Existing Conditions

The shoreline change assessment reported in Section 2 found that between 1989 and 2004 the south end of the bay in the vicinity of the proposed port had accreted at a rate of 15,000 m^3 per year. However, comparisons of the 1951 chart to the 2004 satellite image suggest this recent accretion may be unusual and this is also compatible with the general understanding that shoreline of these types of bays are in equilibrium. The accumulation of sand at the south end of the bay occurs through a combination of the following conditions: 1) the southerly transport of sand driven by sea waves generated locally by trade winds is greater than the northerly sand transport driven by swell waves that are generated by extra-tropical storms in the lower latitudes of the Southern Hemisphere; and 2) that the rate of accumulation exceeds the ability of onshore wind transport to move the accreted sand further inshore into the existing land mass. In Section 3 it was noted that there is evidence of a possible climate shift in the Southern Hemisphere consisting of a decrease in the intensity and frequency of extra-tropical storms that generate the waves that eventually reach the site as southerly swell. This reduction in southerly swell would result in the net southerly transport described under condition (1) above. The sediment transport estimates have shown that for the period from 1985 to 2004 the net wave-driven transport was in the order of 50,000 m^3 per year towards the south. The wave climate used to derive these estimates was based on the same meteorological data that different researchers have used to reach the conclusion of possible climate shift in the Southern Hemisphere. The onshore wind losses of sand have been estimated to be in the order of 30,000 m^3 per year giving a net rate of accumulation at the south end of the bay in the order of 20,000 m^3 per year, which is similar to the estimate derived from recent shoreline change.

It is unknown whether the shoreline change between 1989 and 2004 (erosion to the north and accretion in the south) is an irreversible trend related to ongoing climate shift in the Southern Hemisphere or simply the result of some long-term climatic cycle influencing the balance between the easterly and southerly wave components. Due to the uncertainty in understanding and predicting climate change, it is unknown whether the recent accretion pattern at the south end of the bay will be reversed; continue at the current rate or even increase. Finally, it is noted that specific rates and gradients of transport cannot be accurately estimated because of the bi-modal wave characteristic, and, possibly, because wind-driven currents were not included.

The question is then does the construction of the port change this conclusion? This is discussed in the following section.

4.5 Construction of the Port

The port facility to be constructed is shown in Figure 4.6 and will consist of;

- a quarry, located approximately 6km northwest of the site, to provide all stone material required for road construction and coastal structures,
- a rock breakwater approximately 565m long off Ehoala Point at the south end of Fausse Baie des Galions,
- 855,000 m^3 of dredging of an approach channel, a vessel turning basin, and berth pocket at the primary berth,
- construction of a multi-purpose quay with two berths; a 275 m long quay wall primary berth for bulk carriers (up to 230m in length), and a 190 m long quay wall secondary berth located in a small craft harbour in lee of the breakwater for coastal traders/ service tugs,
- a rock fill groyne to restrict longshore sand movement along the beach north of the port into the area of the port,
- 11.5 hectares of land reclamation behind the quay using dredge spoil. The reclaimed land will provide additional land that may, in the future, be used for port bulk materials, storage and out-loading, as well as providing port general cargo handling facilities and port administration and servicing facilities, should there be a demand for these facilities.
- 1500 m of revetments/dikes for coastal roadway, access road, and reclamation containment,
- onshore graded area of approximately 9 hectares for future development.

It is anticipated that the port will be built between September 2006 and September 2008.

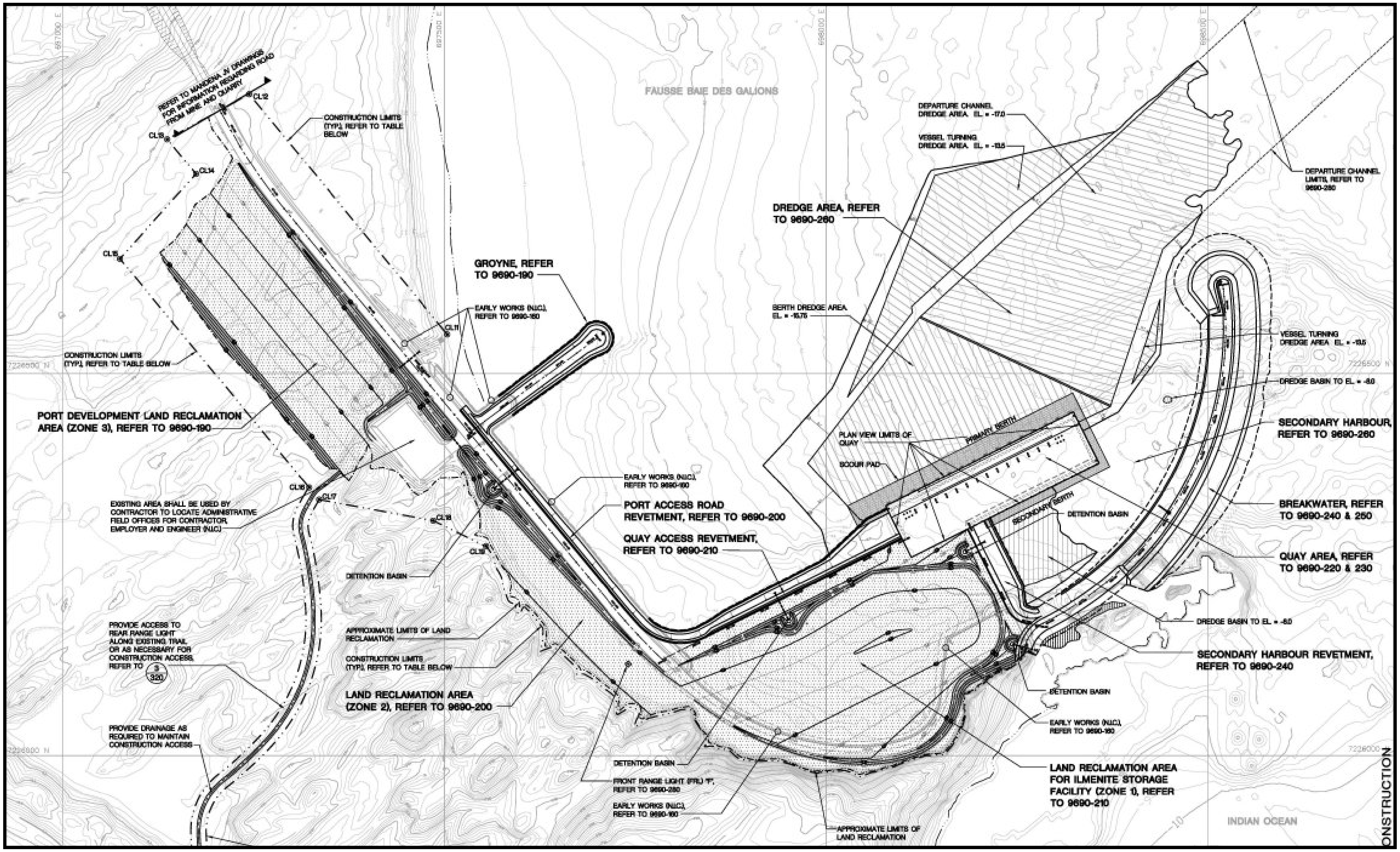


Figure 4.6 Proposed Port Layout

4.5.1 Numerical Modeling Predictions

The analyses of waves and currents described above were repeated with the proposed port included in the model. The currents predicted by the model for east and south waves are presented in Figures 4.7 and 4.8, respectively. It was determined from these results that with the proposed breakwater in place, the net southerly transport rate at the south end of the bay increased from approximately 50,000 to 65,000 m^3 per year. This increase in net southerly transport is caused by the expansion of the shelter zone in the lee of the extended south headland, which reduces the ability of the southerly swell to transport sand back towards the north. This increased southerly transport would continue and slowly diminish until such time that a new equilibrium beach form was achieved in response to the extension of the natural headland by the proposed breakwater.

It is to be noted that, for the existing conditions, the balance between the net southerly transport by waves and the offshore sand losses by wind is estimated to be in the order of 15,000 to 20,000 m^3 per year, which compares to the accretion rate at the south end of the bay between 1989 and 2004. With the extension of the south headland by the proposed breakwater, the numerical model predicts a possible increase in net southerly transport in the order of 15,000 m^3 per year, which in turn would increase the accretion rate at the south end of the bay to a value in the order of 30,000 to 35,000 m^3 per year. Once again it should be noted that the accretion rate caused by the headland extension and expansion of the shelter zone is temporary and would diminish until a new equilibrium beach form is achieved. An approach to determining this new equilibrium form is presented in the next section. Also, it is re-iterated the transport rate estimates are approximate and not definitive owing to the limited capability of the numerical models to accurately simulate the waves, currents and sand transport generated during simultaneous wave attack from two different directions.

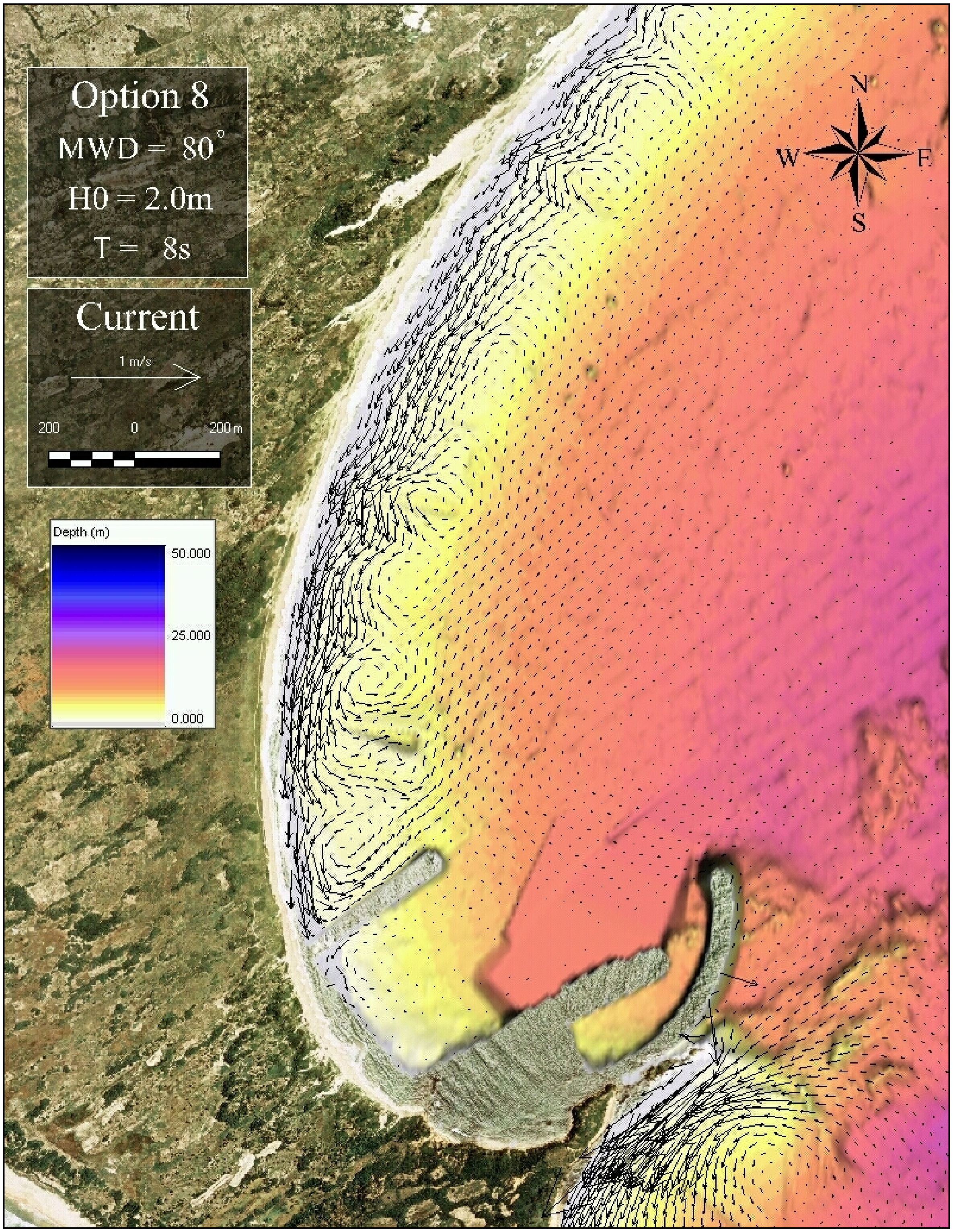


Figure 4.7 Nearshore Currents Under Predominant East Waves for Recommended Design Option

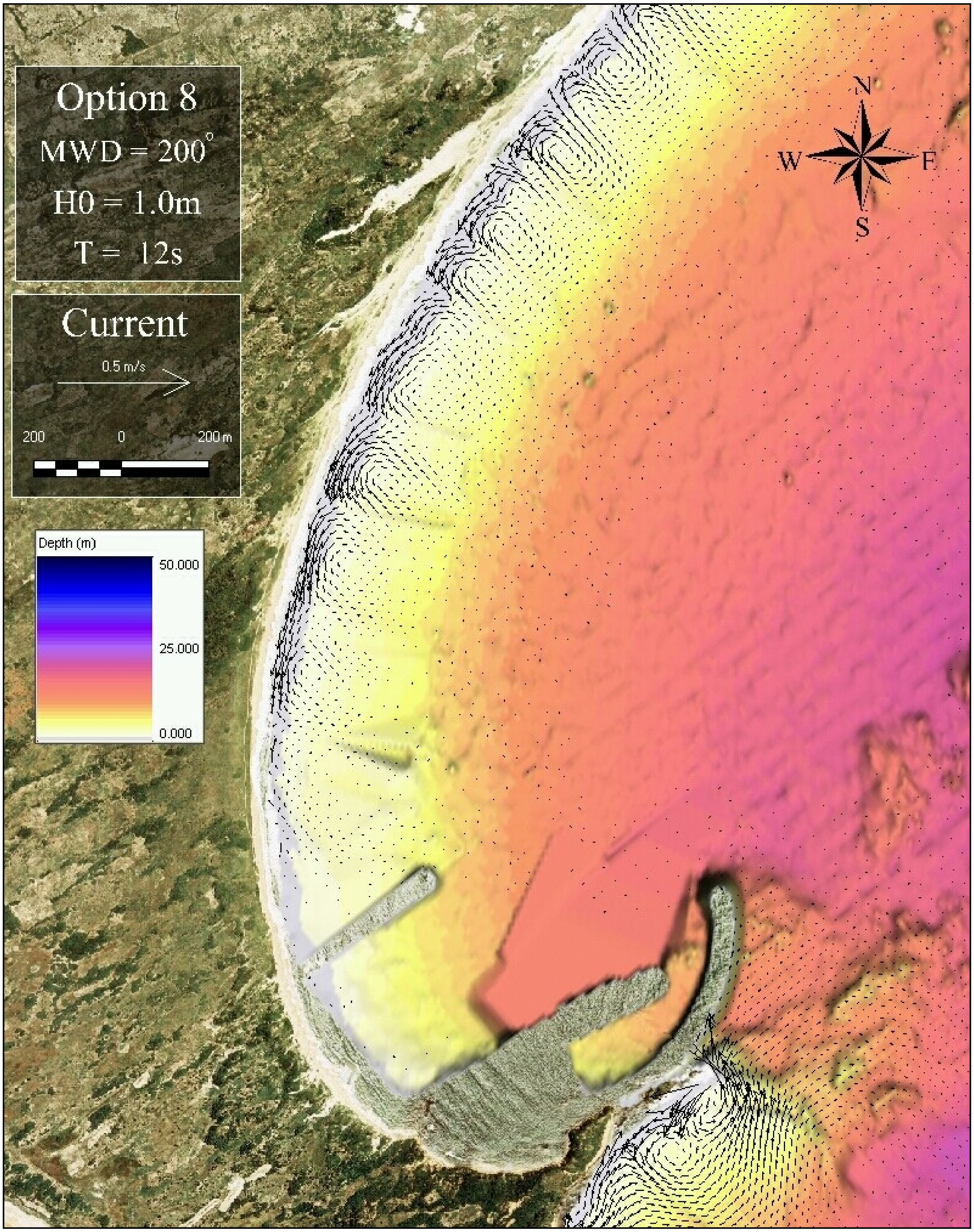


Figure 4.8 Nearshore Currents Under Predominant Southerly Waves for Recommended Design Option

4.5.2 Hsu and Evans Predictions

Both the north and south ends of the Fausse Baie des Galions shoreline exhibit characteristics of what is known as an equilibrium or crenulate bay shape. These curved bay shorelines have been studied at many locations around the world and have been found to exhibit similarities that can be related to the nature of the local physiographic features (headland shape, etc) and the prevailing wave conditions.

Hsu and Evans (1989) equations give a reasonable approximation of the equilibrium beach planform for a certain, known set of conditions. Essentially, the equations developed by Hsu and Evans (1989) predict a parabolic shape between a selected control point and the headland, and a straight line that is parallel to the wave crests beyond the selected control point. This approach assumes that the shoreline orientation will everywhere be parallel to the nearshore wave crest line for a dominant wave direction after the influence of refraction/diffraction processes associated with the presence of the headland.

The three main variables of the Hsu and Evans (1989) approach are: 1) the dominant direction of wave approach; 2) the location of a diffraction point (defining the extent of the shelter zone); and 3) the location of a control point beyond which there is no influence of the headland. At this site in particular, there is uncertainty in specifying these three variables, respectively, owing to: 1) the fact there are two dominant directions of wave attack, requiring some single representative direction to be selected and that the direction of dominant wave attack may be changing due to climate shift in the Southern Hemisphere; 2) the complexity of the bathymetry in the vicinity of the south headland and its influence on diffraction; and 3) the presence of a headland to the north that also effects the shape of the bay. The various reasonable combinations of these three variables that fit the existing bay shape are shown in Figure 4.9. The solid shorelines represent the predicted fit, and the three variables for each estimate are colour coded accordingly. The combination of the three variables was also tested against shape of Fort Dauphin Bay to the north. It was determined that the red and green variable sets (associated with 109° the 129°approach wave directions, respectively) are likely the best descriptors of the existing conditions. Appendix F provides more details of this investigation.

The dashed shorelines shown in Figure 4.9 show the new equilibrium shoreline forms expected with the extension of the south headland with proposed breakwater, as predicted with the Hsu and Evans approach and the assumed variable sets. The red and green variable sets show accretion of a fillet beach updrift to the proposed groyne.

However, it must be noted the equilibrium bay approach has not been verified for bi-modal wave environments and, hence, it may be considered as an imprecise tool that simply provides an indication of a possible range of responses to the breakwater extension. In other words, there is sufficient uncertainty to state that these results are neither definitive nor conclusive, when considered on their own.

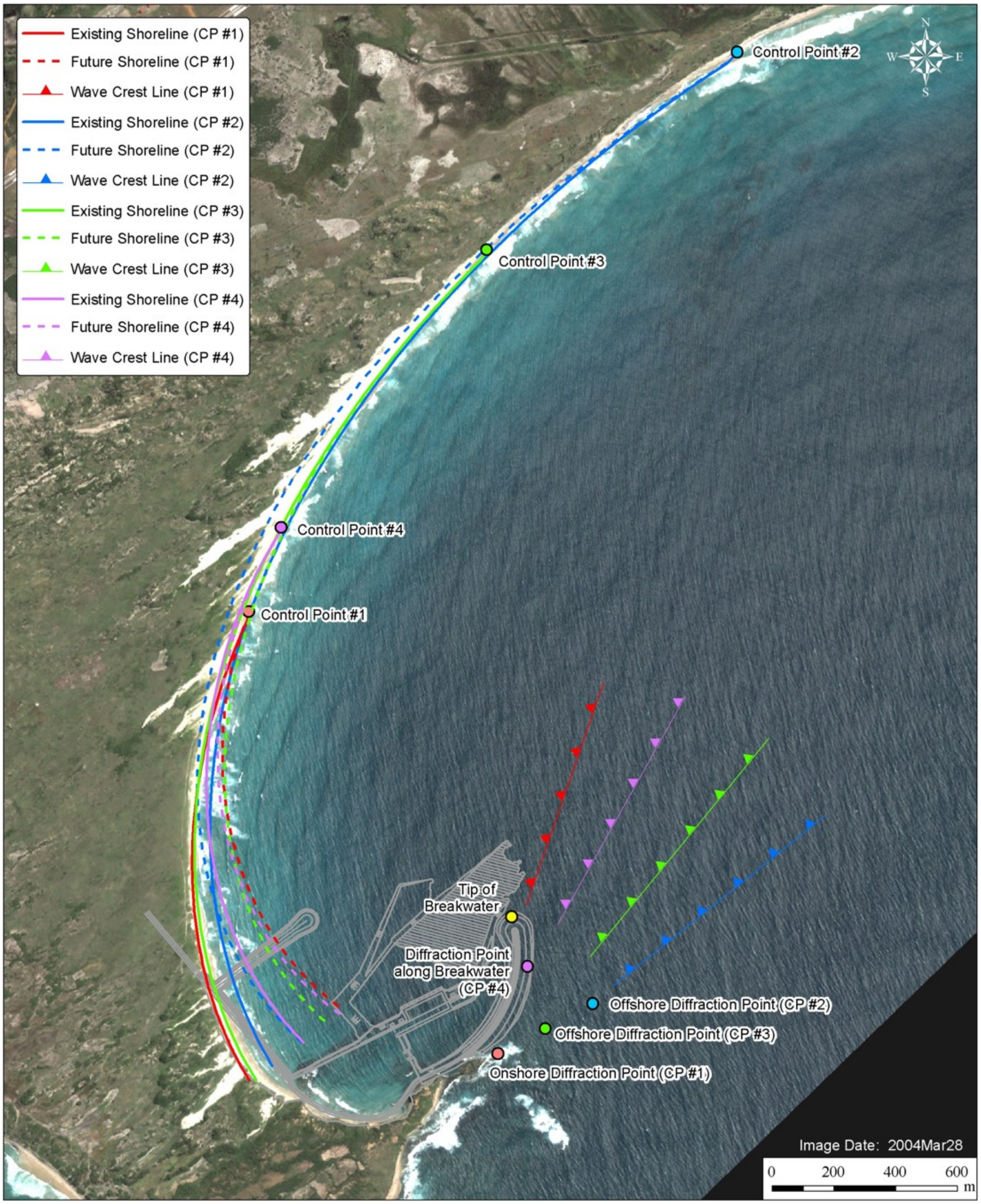


Figure 4.9 Effect of Breakwater on Planform Beach predicted by Hsu and Evans' (1989) equations for varying wave direction

4.5.3 Summary of Impact of the Port on the Shoreline and Requirement for a Groyne

It is possible that the existing bay shape is shifting towards a new equilibrium owing to the diminishing influence of swell compared to the locally generated sea waves. Recent accretion at a rate of 15,000 m^3 per year at the south end of the bay may be the result of this phenomenon. Due to the uncertainty of predicting global climate change it is impossible to predict whether the trend of diminishing southerly swell (related to a reduction in intensity and frequency of extra-tropical storms in the southern latitudes of the Southern Hemisphere) will reverse, continue or accelerate.

Both the numerical modeling and the equilibrium bay approach (using the equations of Hsu and Evans, 1989) show that the extension of the south headland with the proposed breakwater may create a change in the equilibrium bay form, also resulting in accretion at the south end of the bay. The numerical modeling suggests the net accretion rate (balance between wind and wave transport) may increase from 15,000 to 20,000 m^3 per year up to 30,000 to 35,000 m^3 per year, in approximate terms. The equilibrium bay shape predicted by the Hsu and Evans (1989) approach corresponds to accretion in the fillet beach adjacent to the groyne of approximately 1,200,000 m^3, once equilibrium is achieved (this assumes no augmented inshore losses by wind). With the proposed groyne length of 300 m (see Section 5.0) there would be some degree of bypassing of sand into the port area when this new equilibrium shape (related to the headland extension) is achieved. Assuming these rates and quantities are approximately correct, it would take between approximately 30 years for the fillet beach next to the groyne to accrete to its equilibrium form. It may take less time for the fillet beach to reach maturity or equilibrium if the southerly swell continues to diminish due to climate shift, as some researchers suggest may be the case.

There are many uncertainties associated with these predictions as noted throughout the previous sections and any quoted values must be considered to be approximate only. In addition to those noted, it is possible that the expansion of the beach updrift of a groyne could increase the wind-blown transport and thus reduce the rate of growth of the fillet beach.

In summary, in consideration of the "natural" shift of the equilibrium bay owing to the possible climate shift in the Southern Hemisphere, and due to the change to the equilibrium bay shape caused by the increased sheltering of the breakwater extension to the southern headland (as predicted by both the numerical modeling and the equilibrium bay equations), it is appropriate to plan for the construction of a groyne to prevent sedimentation in the port area. The design of a groyne is discussed in the next section.

The complexity of the sediment transport processes under directionally bimodal wave attack, the possible influence of climate change, and the related uncertainty in predicting possible accretion and harbor sedimentation effects, justify monitoring of the wave and current conditions (in addition to shoreline response) to support future decision-making on this issue. The monitoring program is described in Section 6.0.

5.0 DESIGN OF THE GROYNE

This section presents the design considerations for the groyne with respect to sediment transport and sedimentation control.

From the numerical modeling of waves, currents and sand transport it was determined that the majority of sediment transport occurs inshore of the 5 m depth contour. Therefore, this depth was selected as the outer limit of the proposed groyne.

As explained in Section 4.5.3, it is possible that a fillet beach will build next to the groyne in the future. The rate at which this fillet beach builds towards its ultimate or mature equilibrium form depends on the interaction of many complex factors including the rate of onshore wind loss, the future of climate shift in the Southern Hemisphere and the influence of the breakwater extension on sheltering. Assuming the wind loss does not increase with growth in beach width next to the groyne (which is a conservative assumption as increased wind loss it likely), and that climate change does not result in greater southerly transport in the future (which some researchers have suggested might be the case) it will take approximately 30 years for the fillet beach to reach maturity. These are very uncertain assumptions that are impossible to predict reliably.

When and if the fillet beach grows towards maturity, there will be some bypassing around the groyne into the port area. The rate of bypassing, if the fillet beach does grow to maturity will be significantly less than the net southerly transport rate for the period of time under consideration.

In order to help reduce some of the uncertainties regarding the design of the groyne and its future performance in preventing sediment from entering the port area, a test groyne will be built during the construction phase. Since the groyne will be one of the last structures built, a small, rubblemound temporary groyne structure in the Early Works Contract in July / August 2006 will be built, extending approximately 60m to the –0.5m contour, and observations will be made of the shoreline adjacent to this structure. At the same time, the field measurement and monitoring program will be undertaken to provide data to support ongoing analysis and review of this issue (see Section 6.0). Based on the results of this analysis, the temporary structure could be extended approximately 140m to the –2m contour during the construction of the port. The final structure would be built over the temporary structure. It is possible the overall design may be modified following the findings of the monitoring program.

The issue of wind-blown sand interfering with infrastructure development must be considered in the design and development of the port. This is particularly important adjacent to a beach that could form the north side of the groyne.

6.0 DETAILS OF THE MONITORING PROGRAM

The main purpose of the monitoring program is to develop a better understanding of the complex sediment transport processes and to evaluate the groyne design requirements. The monitoring program will be accompanied by the construction of a test groyne, as described in Section 5.0. There will be three primary components of the monitoring program: 1) surveys of shoreline and profile change; 2) measurement of waves and currents; and 3) measurements of wind-blown sediment transport. The approach and justification for each of these components is briefly described below.

6.1 Beach Profiles

It has been assumed that changes to the shoreline of Fausse Baie des Galions between the 1989 snapshot (air photo) and the 2004 snapshot (satellite image) is representative of a long-term average change. It is possible that part or all of this change could be the result of reversible fluctuations in shoreline position.

To obtain an understanding of the variability in shoreline position, the shoreline response monitoring will consist of surveyed beach profiles and shoreline position performed on at least a monthly basis.

A series of beach profiles will be undertaken at various intervals along the shoreline of the bay, northward from the Port to the mouth of Lac Ambinanikely. Wherever possible, the locations of the profiles were selected to match the locations of earlier profiles undertaken by Baird and QMM in 2004 and 2005 in order to provide an historical baseline. Additional profile locations were chosen to ensure that the appropriate information was gathered to assess changes to the shoreline of Fausse Baie des Galions.

The shoreline monitoring program will consist of both land-based and hydrographic surveys, as described below. It will be necessary to carefully coordinate the surveys in order to ensure that both types of surveys are performed within an acceptable timeframe (i.e., no lag between the surveys). The results of the surveys will be provided to Baird for analysis and archiving on a monthly basis.

6.1.1 Land-Based Surveys

The land-based surveys will be undertaken by QMM using both a Total Station and RTK GPS. The Total Station will be used to collect profile information, while the RTK GPS will be used to trace the waterline and the highwater mark along the beach.

The profiles will be measured from the top of the dune (at the back of the beach) to a wading depth. It is desirable to carefully choose the time and date of the survey in order that the wading survey is performed at low tide and on a calm day to obtain information as far offshore as possible.

The profiles will be performed perpendicular to the shoreline, with the exception of a series of closely spaced profiles near the proposed groyne. These profiles will be performed along an alignment parallel to the centerline of the groyne, and will provide information on the formation of a beach fillet and sand bypassing of the groyne, if any. Figure 6.1 shows the locations and alignments of the beach profiles.

The land-based surveys will start in May of 2006 and will proceed on a monthly basis throughout construction of the Port. Based on the results of the information gathered, the shoreline monitoring may continue for a period of time following construction of the Port.

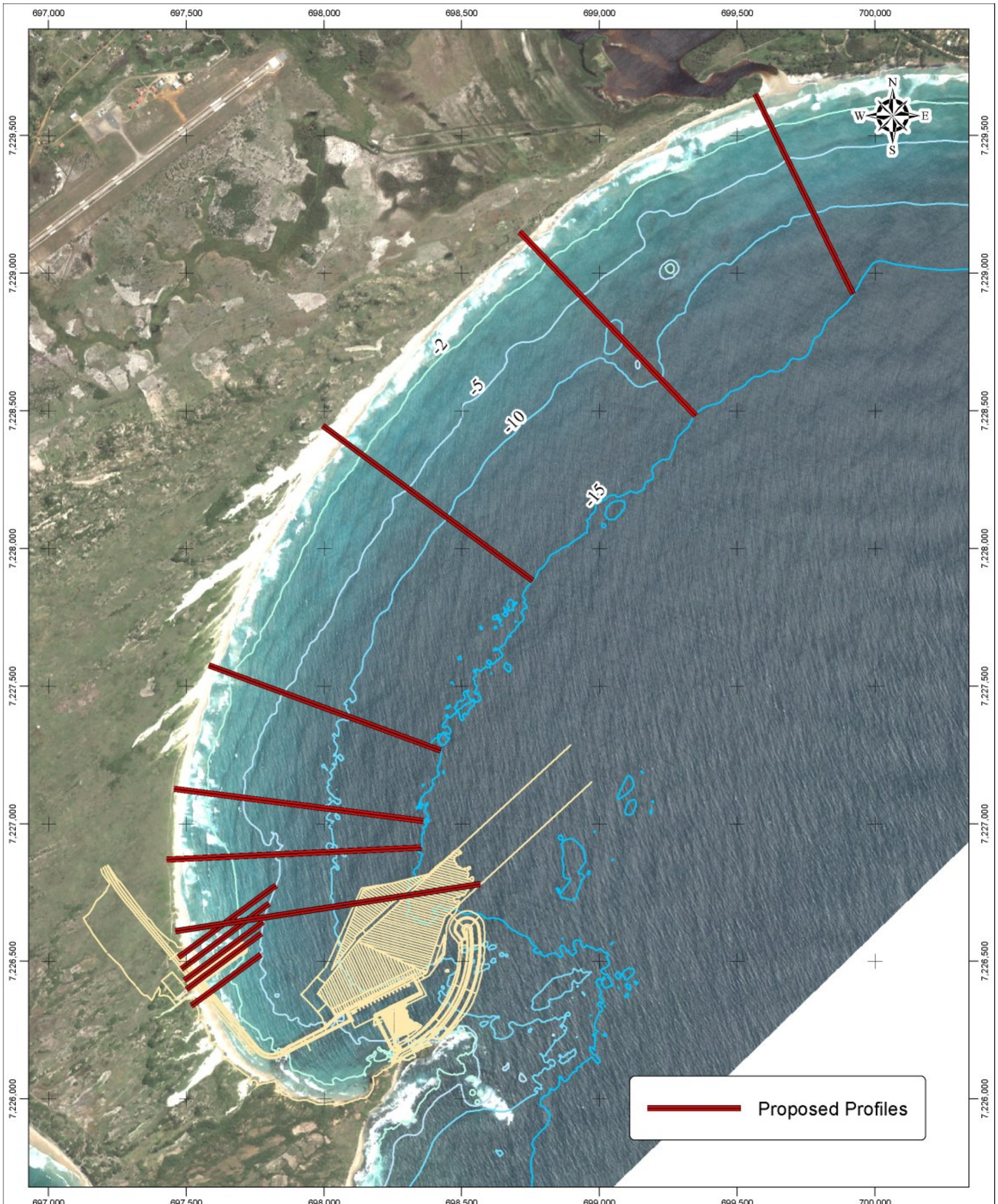
6.1.2 Hydrographic Surveys

The Contractor will be required to extend selected beach profiles from the wading depth to the –15m contour, as shown in Figure 6.1. The surveys will be carefully scheduled to ensure overlap with the land-based surveys. It will be desirable to perform the hydrographic surveys on a calm day and at high tide to obtain information as close to shore as is safely possible.

The hydrographic surveys will commence at the start of construction of the Port and continue on a monthly basis to completion of construction.

6.2 Wave and Current Measurements

It is essential to understand the waves and currents that give rise to the measured shoreline response during the monitoring period in order to determine how the waves during this period compare to the representative conditions expected in the future (i.e., is observed accretion due to an unusually severe storm event or normal conditions).



0 220 440 660 m

0 490 980 1,470 ft

Figure 6.1 - Monitoring Program Proposed Profile Locations

Fausse Baie Des Galions, Madagascar

Photo Date: 2004-Mar-28

Spatial Reference: WGS 1984 UTM Zone 38S

Baird

The wave and current monitoring will be achieved through the deployment of four, bottom-mounted, upward-looking Acoustic Doppler Current Profilers (ADCPs) to measure both directional waves and currents. The ADCPs will also be used to develop an improved understanding of currents and sediment transport under simultaneous bimodal wave attack and due to the influence of wind-generated currents. Figure 6.2 shows the location of the ADCP deployment.

The ADCPs will be deployed and monitored by the Contractor throughout the construction of the Port. The information obtained from the ADCPs will be supplied to Baird for analysis and archiving on a six to eight week basis.

6.3 Rate of Wind-Blown Sand

It will be important to monitor the rate of onshore wind-blown sand and the influence of beach width on this process. As explained in Section 4.0, it is possible that the development of a fillet beach updrift of the proposed groyne may increase the rate of wind-blown sand losses to inshore, thus reducing the rate of accretion next to the groyne.

Appendix E provides a discussion on wind-blown sediment transport. In order to estimate the wind-blown sand transport rate, the following steps are required;

1) Obtain wind speed and direction data,

2) Obtain precipitation and evaporation data,

3) Obtain median grain size of the beach,

4) Compute the critical shear velocity,

5) Compute the potential sand transport if the wind exceeds the critical threshold and the precipitation does not exceed evaporation.

A program is currently being developed whereby the rate of wind-blown sand will be determined during port construction. The program will rely on a sand “trap” and anemometer near the middle of the bay, with precipitation and evaporation data provided by the airport and the weather station that will be implemented by the Contractor (see Figure 6.2). .

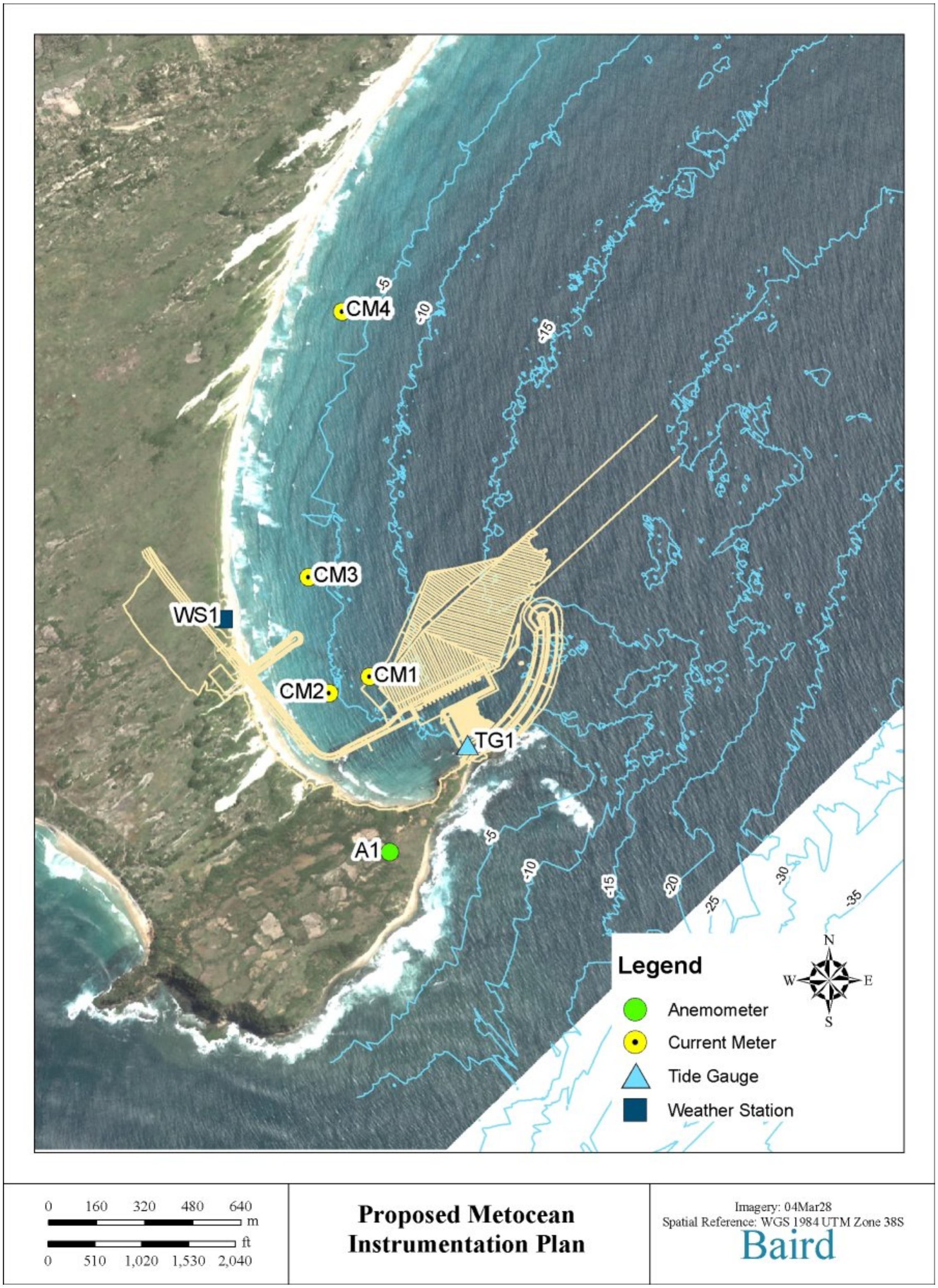


Figure 6.2 Proposed ADCP (Current Meter) and Weather Station Locations

7.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the investigations completed in support of this report, the following list of conclusions and recommendations are provided.

- A comparison between the 2004 shoreline position and an estimate of the shoreline position defined on a 1951 navigation chart of the bay provides an indication that, in the long-term, and at least historically, the bay appears to be relatively stable, with the exception of erosion occurring close to the town of Fort Dauphin.

- However, analysis of the shoreline position for a more recent and shorter time period (1989 to 2004) suggests that there is some ongoing erosion at the center of the bay and some ongoing accretion at the south end of the bay close to the port location. The annualized rate of accretion was estimated to be in the order of 15,000 m^3 per year.

- This accretion may be the result of a climate change in the southern latitudes of the Southern Hemisphere. Researchers have observed that the frequency and intensity of the events that generate southerly swell at the site have diminished since the 1980's. Due to the uncertainty of understanding and predicting climate change, it is impossible to predict whether this shift, and the resulting accretion at the south end of the bay, will reverse, continue or increase in the future.

- For the period of the wave hindcast data from 1985 to 2004, corresponding to the period of reduced southerly swell due to the climate change, it has been estimated that there is a net transport of sand from the center of the bay towards the south. This transport rate may be in the order of 50,000 m^3 per year.

- Because of the bi-modal characteristics of the wave climate in the bay, sediment transport rates and gradients cannot be predicted with accuracy or certainty.

- The prevailing northeasterly winds result in significant wind-blown transport of sand from the shoreline to the dunes along the shoreline in the southwestern part of the bay. This may be in the order of 30,000 m^3 per year.

- The difference between the net southerly wave-generated transport rate and the onshore wind losses (i.e. in the order of 20,000 m^3 per year) compares well to the observed rate of accretion at the south end of the bay of 15,000 m^3 per year. If the bay were in equilibrium, as the available evidence suggests it was historically, it would be expected that there should be no ongoing accretion. Therefore, it would appear that the recent climate change is causing a shift in the equilibrium form of the bay (with erosion in the north and accretion in the south).

- The equilibrium shape of the south end of the bay is defined by the direction of wave attack and the form of the south headland. The south headland creates a shelter zone from both trade wind waves and swell waves (with greater sheltering from the southerly swell waves). Within this zone of headland influence the waves undergo refraction and diffraction, changing their direction. In theory, the shape of the bay shoreline should be approximately parallel to the wave crest at breaking that represents an average of the different wave directions. Construction of the breakwater effectively extends the southern headland and increases the extent of the shelter zone. This extension could result in the bay adjusting its shape with accretion in the lee of the south headland and erosion at the center of the bay. This adjustment to the shape of the bay would be achieved by increased transport of sand towards the port. The new equilibrium form responding to the breakwater extension of the south headland has been approximated using the Hsu and Evans (1989) approach. In maturity, and in the absence of increased onshore wind loss of sand, the capacity of the fillet beach predicted by the Hsu and Evans approach is approximately 1,200,000 m^3.

- The numerical modeling suggests that the net balance between southerly transport (with the breakwater in place) and onshore wind losses (assuming the latter does not change) would increase from 15,000 to 20,000 m^3 per year up to 30,000 to 35,000 m^3 per year, in approximate terms. This rate would diminish if and when the shoreline location changed.

- To minimize any possible transport of sand towards the port, a groyne is proposed that extends to the –5 m contour.

- Based on the estimated net southerly transport rate (due to climate shift and the influence of the breakwater extension to the headland), it would take approximately 30 years for the fillet beach next to the groyne to fill to its final equilibrium form. There is significant uncertainty associated with this time to fill due to: the possible influence of increased inshore wind losses (increasing time to fill); uncertainty on climate shift influence (may increase or decrease time to fill); uncertainty on the influence of simultaneous bimodal wave attack and estimates of transport rates (may increase or decrease time to fill);

- When and if the fillet beach approaches its mature and final equilibrium form, it is possible that there will be some bypassing of sand into the port area at a rate significantly less than the net southerly transport rate corresponding to the wave climate at that time.

- A small temporary groyne will be built in the Early Works Contract prior to construction of the Port to provide information on the transport of sand and the rate of accretion against the groyne.

- It is further recommended that a shoreline-monitoring program be initiated at the start of construction and that four current/wave recorders be installed. This information will help reduce some of the noted uncertainty associated with the predictions.

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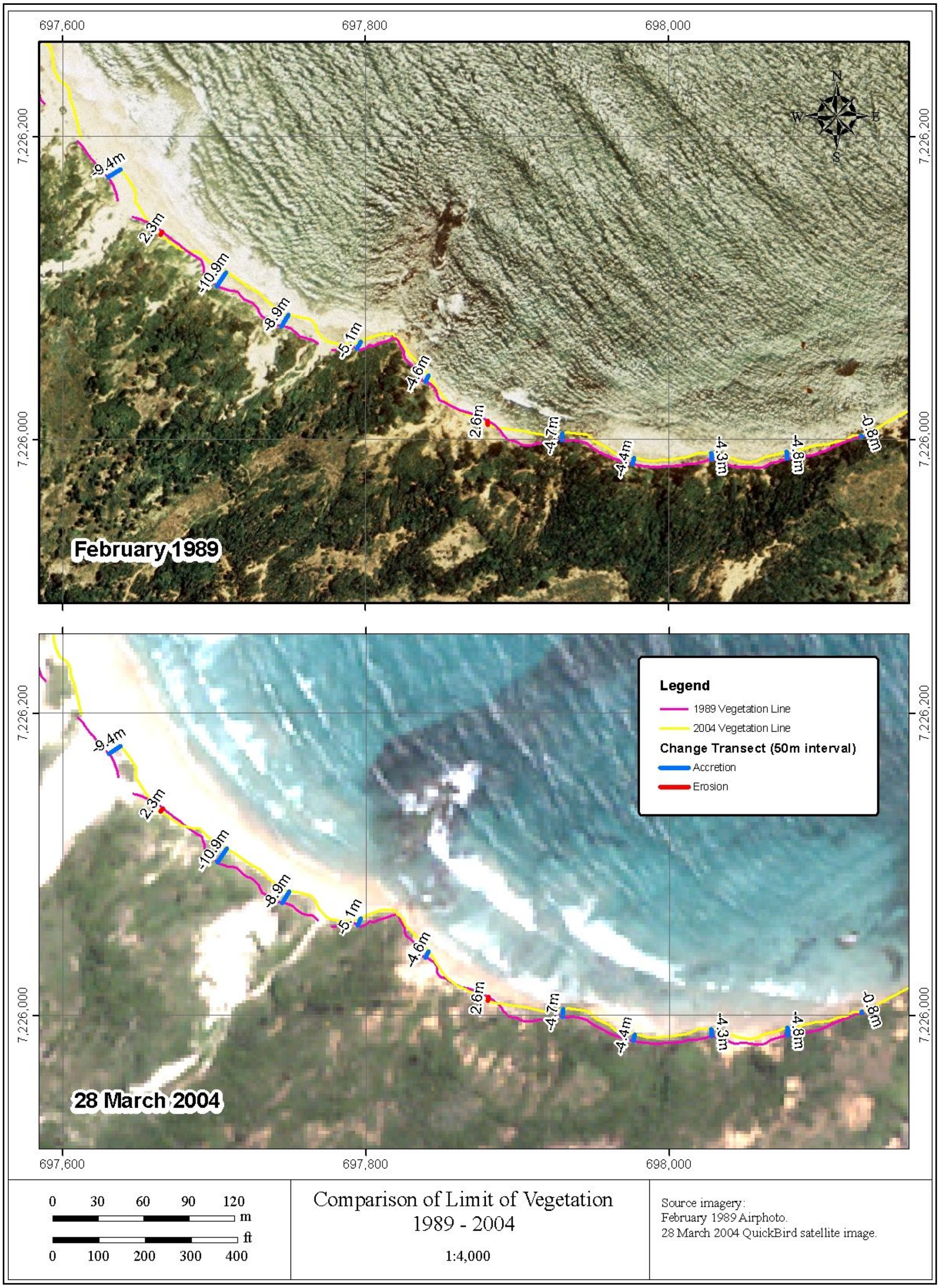
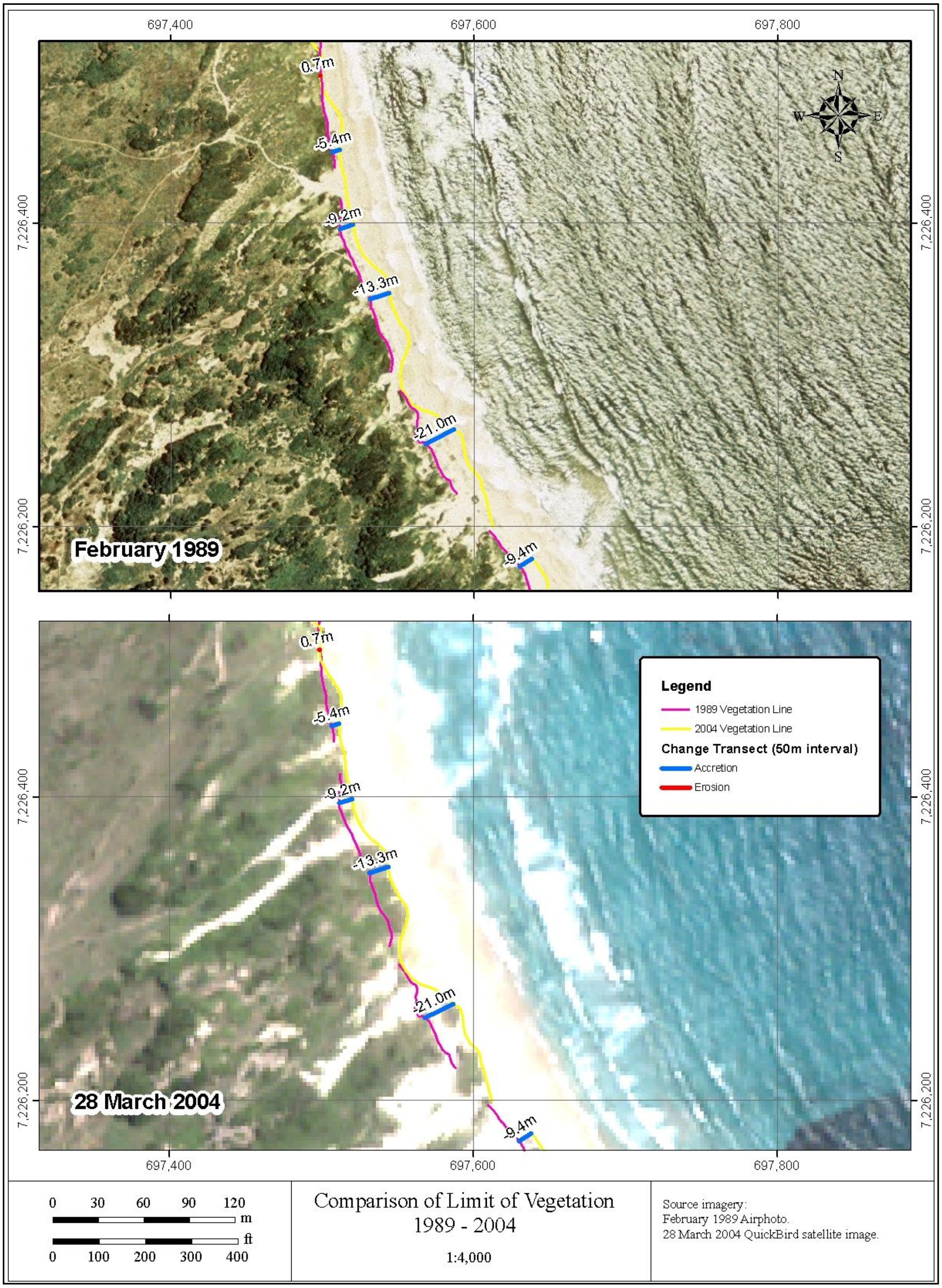
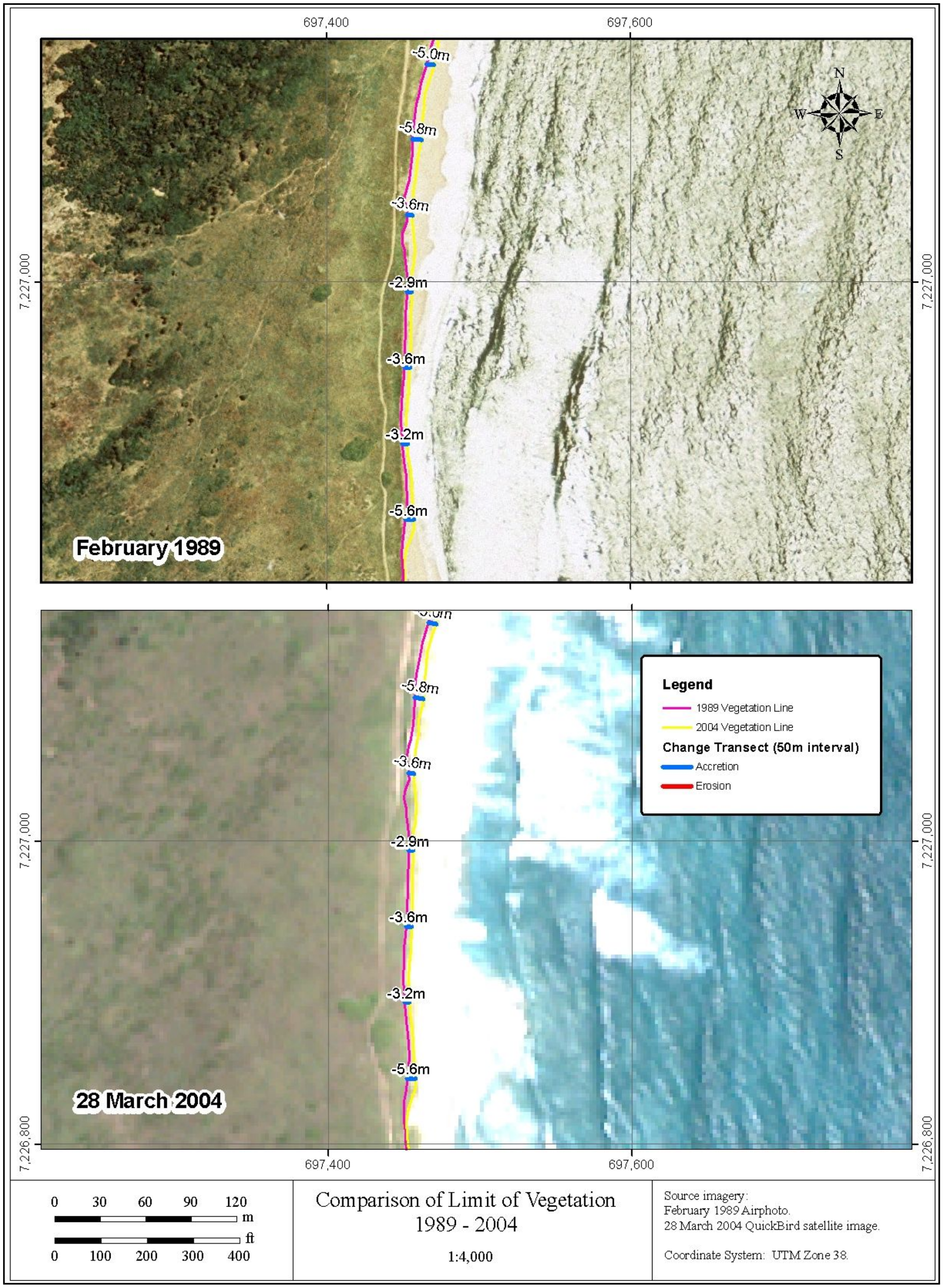
APPENDIX A
SHORELINE COMPARISON



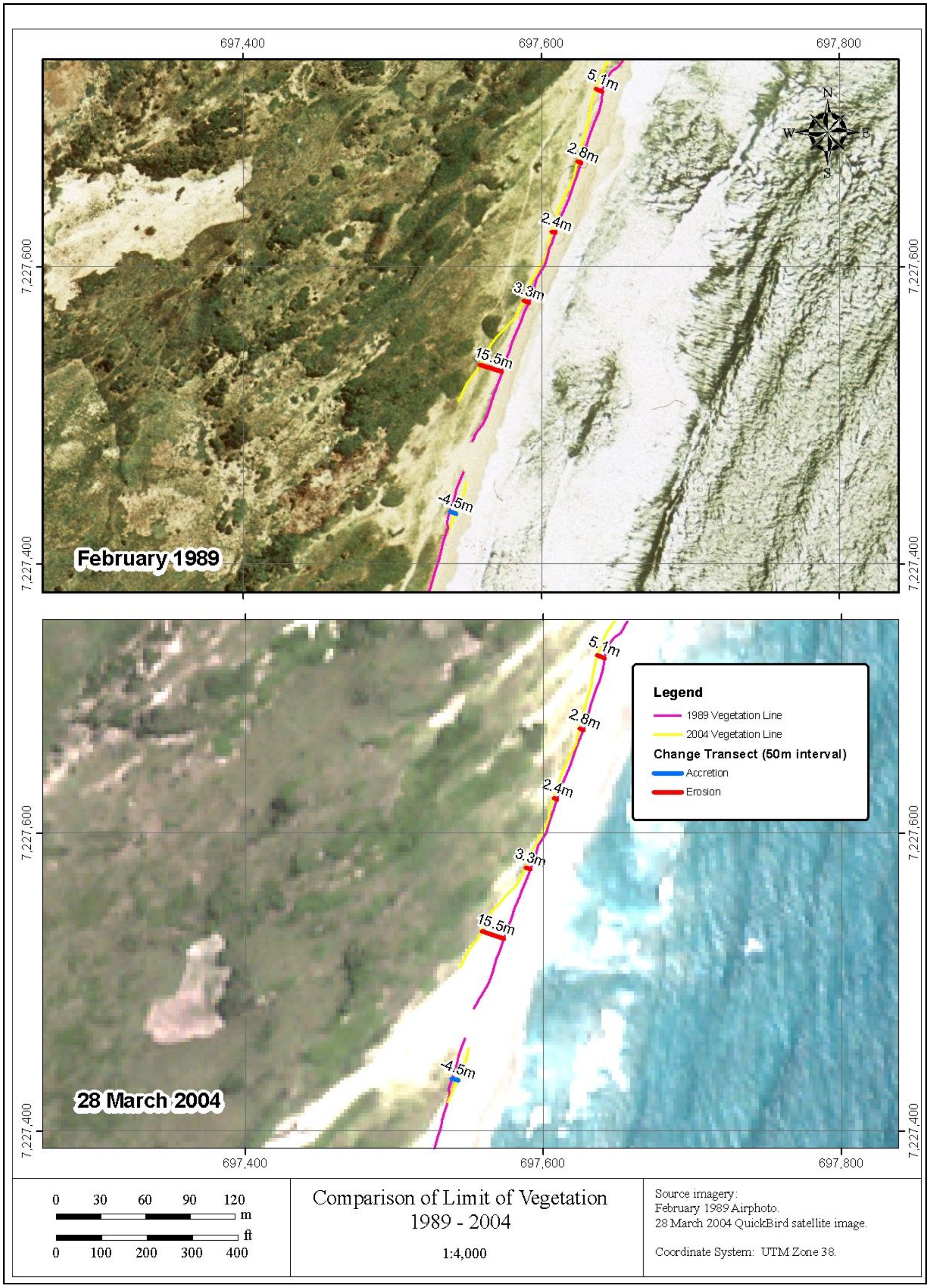
Appendix A - Figure A01



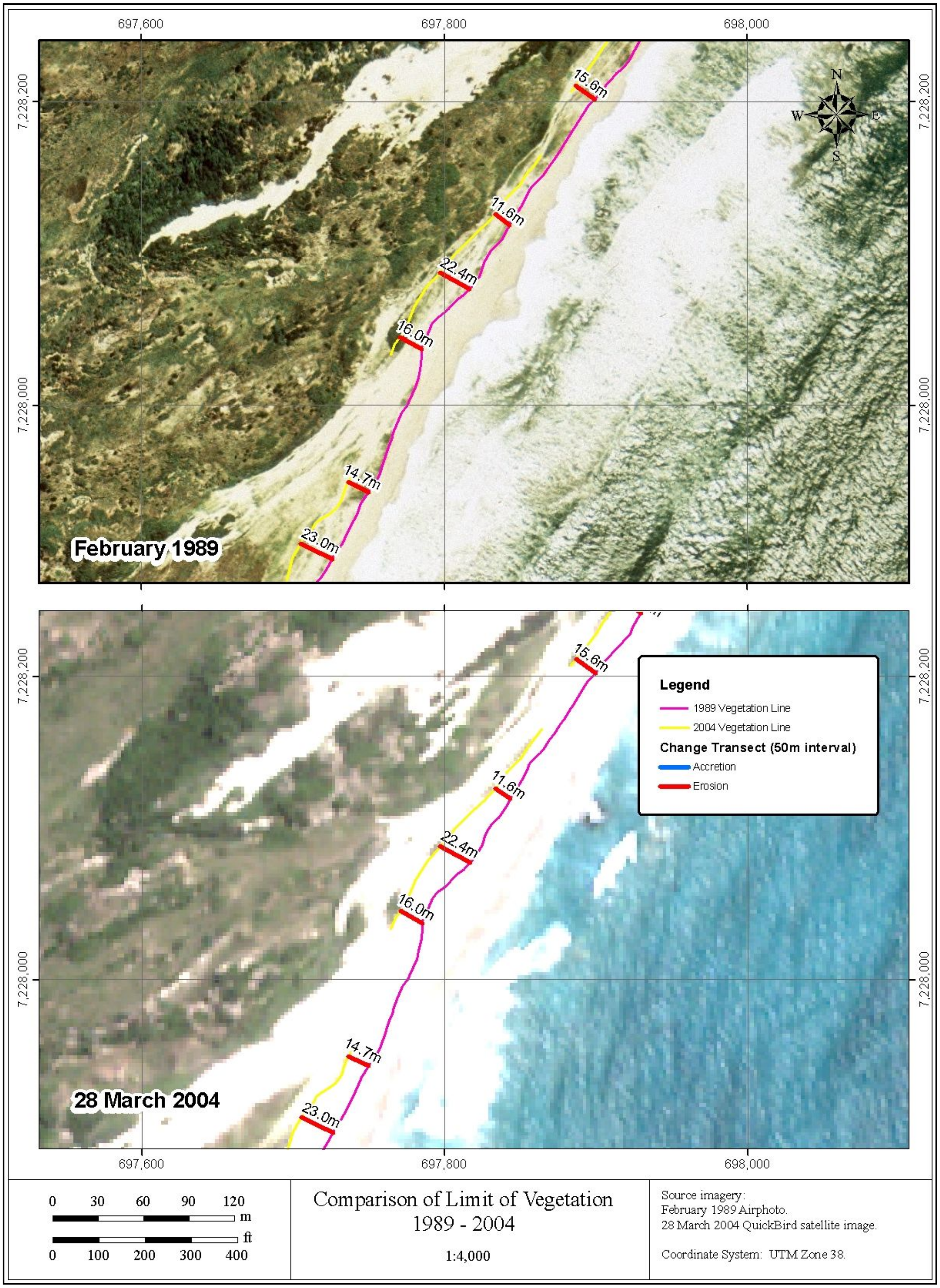
Appendix A - Figure A02



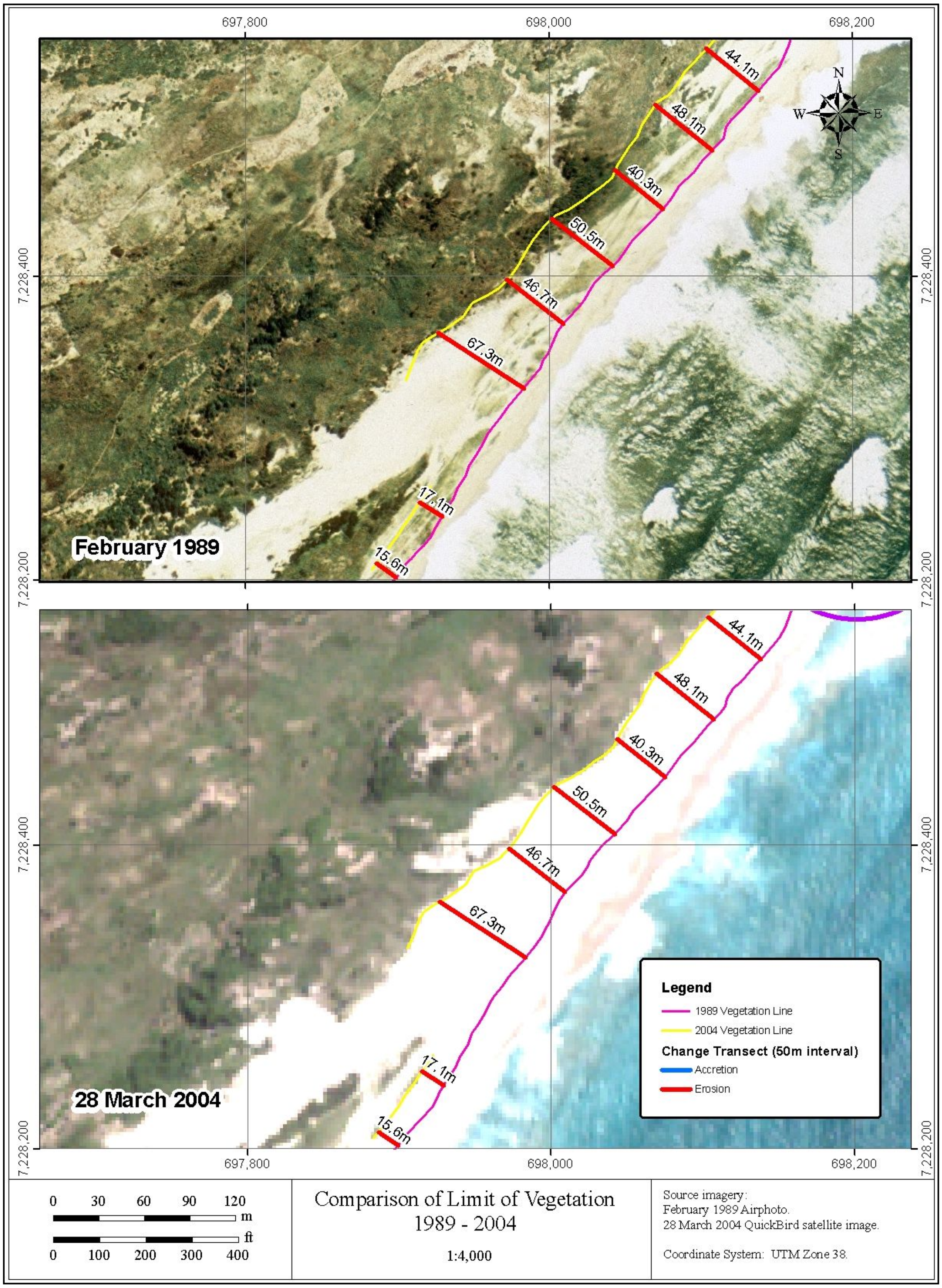
Appendix A - Figure A03



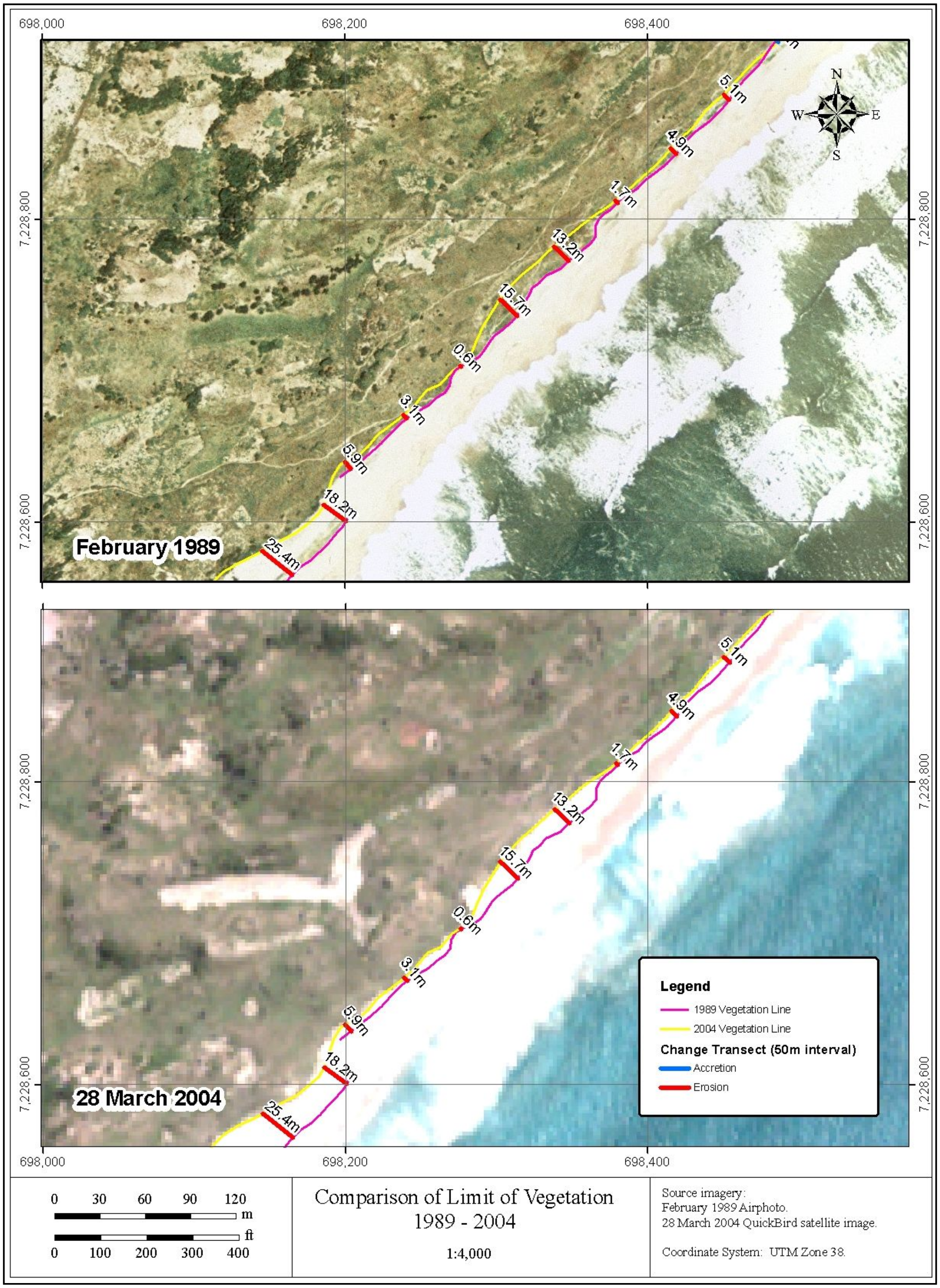
Appendix A - Figure A04



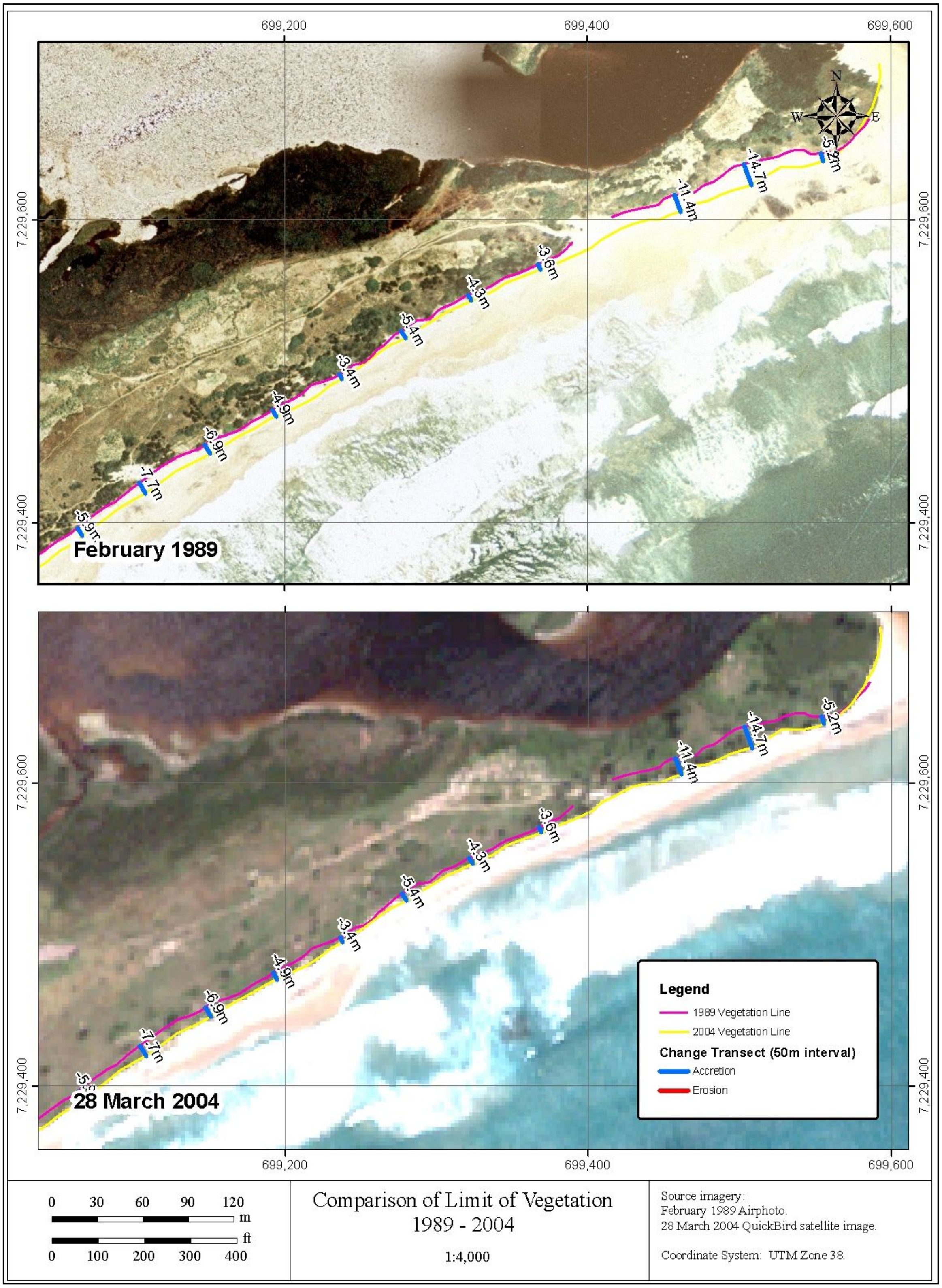
Appendix A - Figure A05



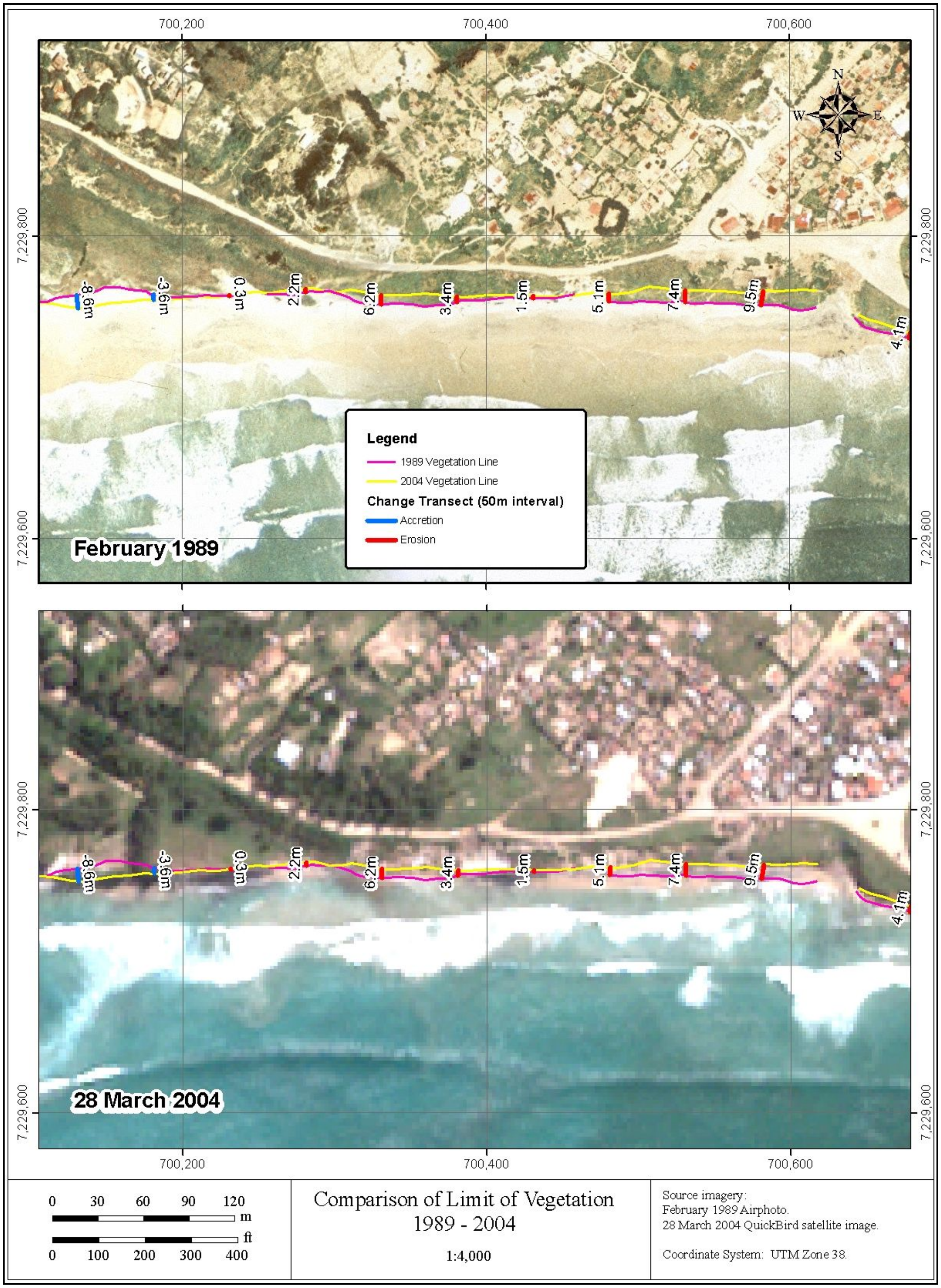
Appendix A - Figure A06



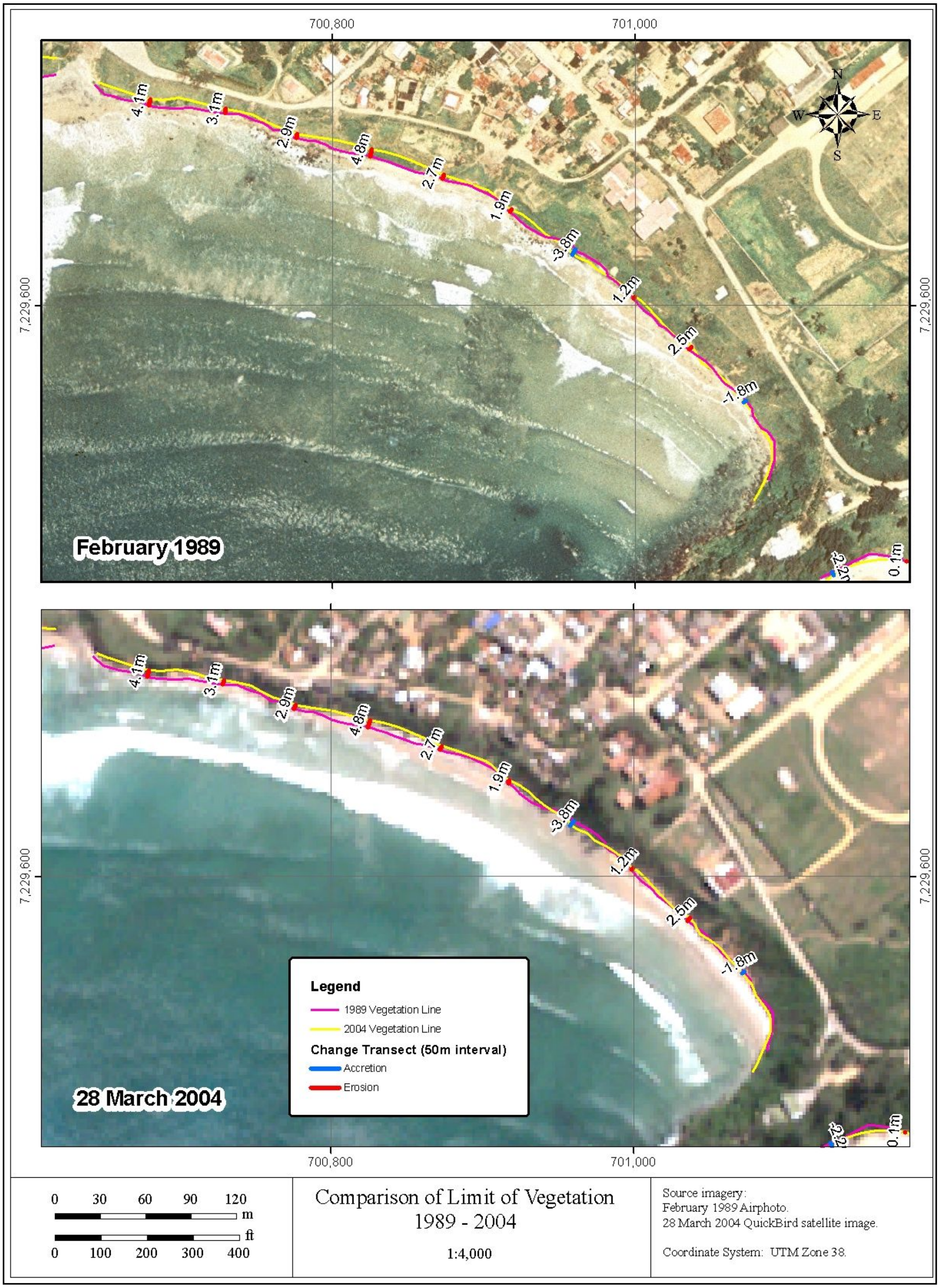
Appendix A - Figure A07



Appendix A - Figure A08

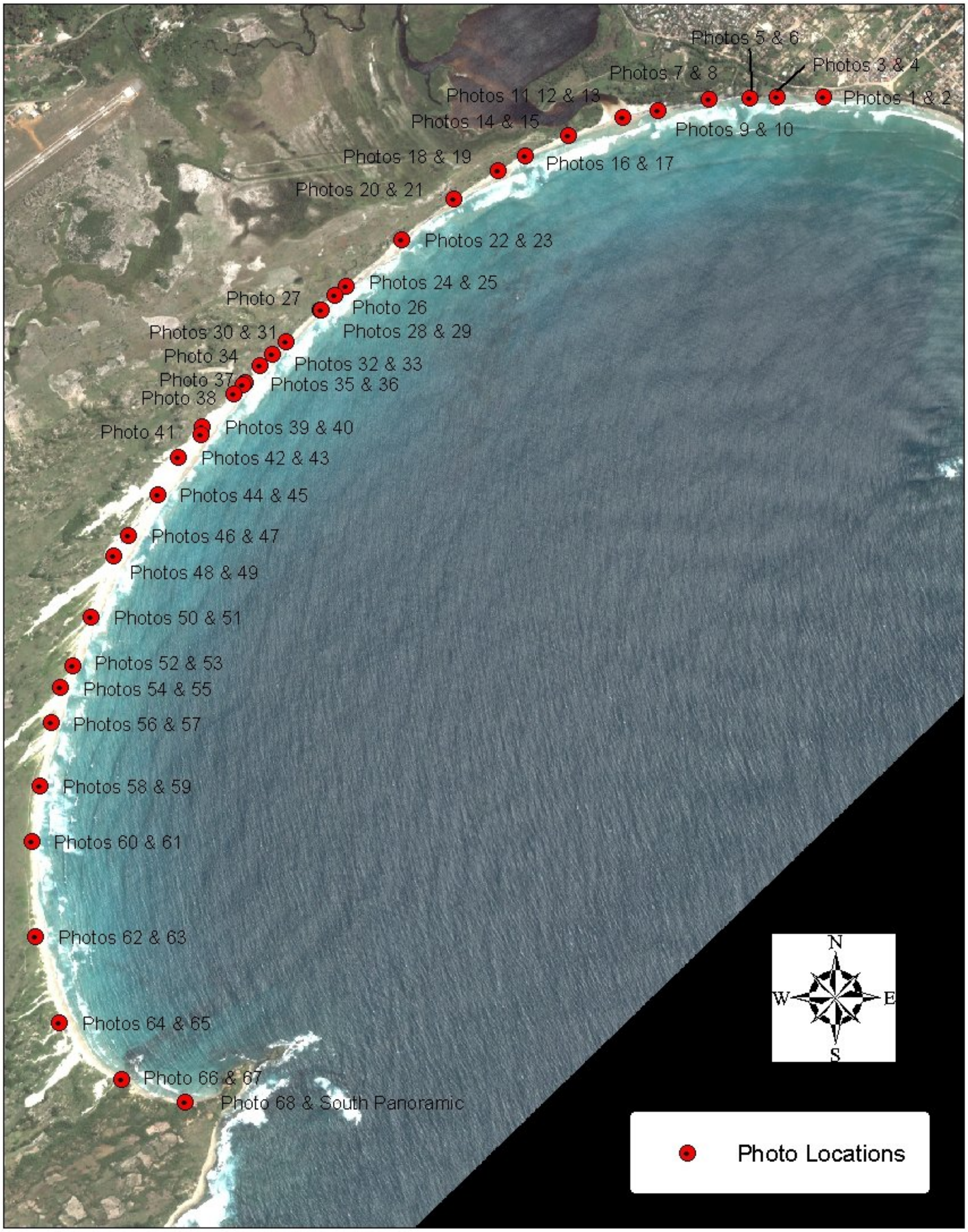


Appendix A - Figure A09



Appendix A - Figure A10

APPENDIX B
FAUSSE BAIE DES GALIONS
BEACH PHOTOS



0 190 380 570 760 m Meters 0 160 320 480 640	Fausse Baie Des Galions, Madagascar Beach Profiles - Photos 1:25,000	Date of Photos: November 25, 2004 Date of Satellite Image: March 2004

Fausse Baie des Galions Beach – Photo 1

Fausse Baie des Galions Beach – Photo 2

Fausse Baie des Galions Beach – Photo 3

Fausse Baie des Galions Beach – Photo 4

Fausse Baie des Galions Beach – Photo 5

Fausse Baie des Galions Beach – Photo 6

Fausse Baie des Galions Beach – Photo 7

Fausse Baie des Galions Beach – Photo 8

Fausse Baie des Galions Beach – Photo 9

Fausse Baie des Galions Beach – Photo 10

Fausse Baie des Galions Beach – Photo 11

Fausse Baie des Galions Beach – Photo 12

Fausse Baie des Galions Beach – Photo 13

Fausse Baie des Galions Beach – Photo 14

Fausse Baie des Galions Beach – Photo 15

Fausse Baie des Galions Beach – Photo 16

Fausse Baie des Galions Beach – Photo 17

Fausse Baie des Galions Beach – Photo 18

Fausse Baie des Galions Beach – Photo 19

Fausse Baie des Galions Beach – Photo 20

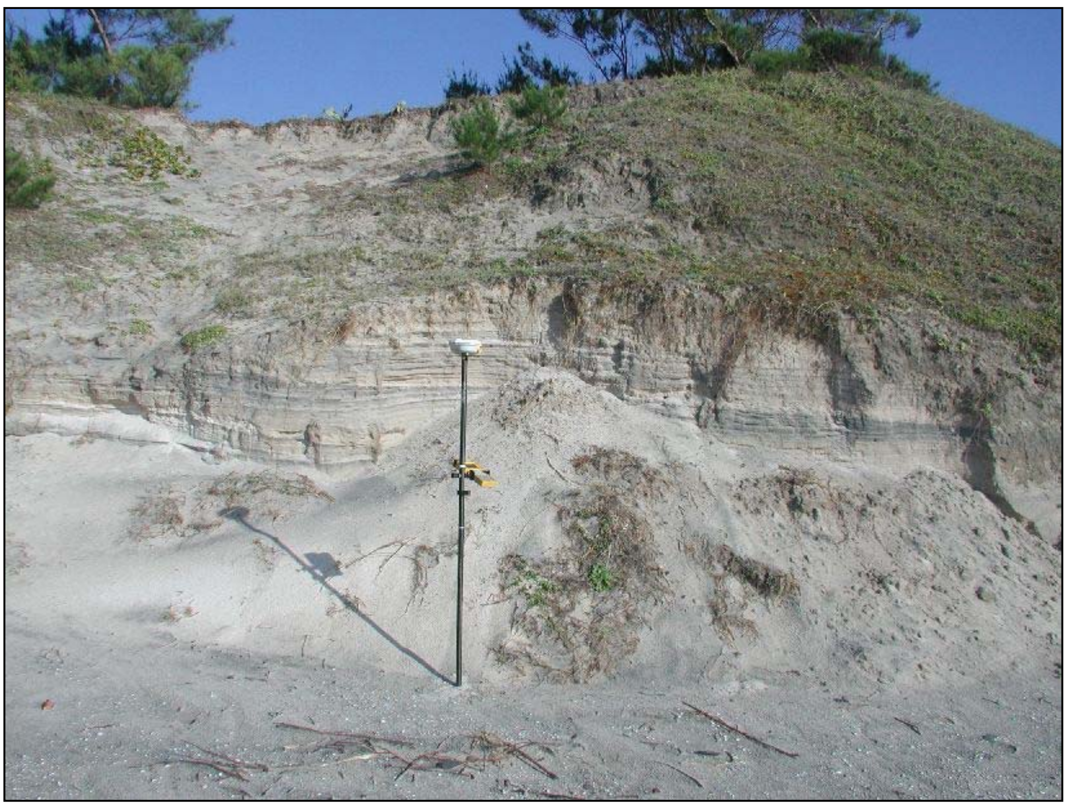
Fausse Baie des Galions Beach – Photo 21

Fausse Baie des Galions Beach – Photo 22

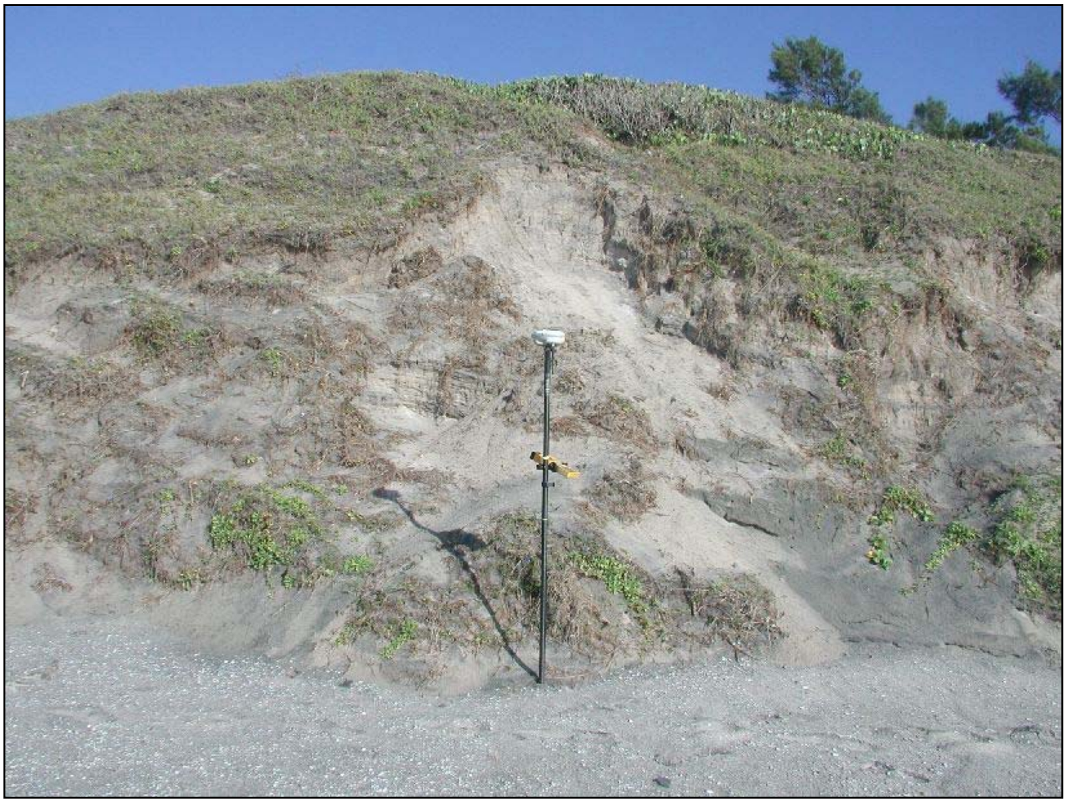
Fausse Baie des Galions Beach – Photo 23

Fausse Baie des Galions Beach – Photo 24

Fausse Baie des Galions Beach – Photo 25



Fausse Baie des Galions Beach – Photo 26



Fausse Baie des Galions Beach – Photo 27

Fausse Baie des Galions Beach – Photo 28

Fausse Baie des Galions Beach – Photo 29

Fausse Baie des Galions Beach – Photo 30

Fausse Baie des Galions Beach – Photo 31

Fausse Baie des Galions Beach – Photo 32

Fausse Baie des Galions Beach – Photo 33

Fausse Baie des Galions Beach – Photo 34

Fausse Baie des Galions Beach – Photo 35

Fausse Baie des Galions Beach – Photo 36

Fausse Baie des Galions Beach – Photo 37

Fausse Baie des Galions Beach – Photo 38

Fausse Baie des Galions Beach – Photo 39

Fausse Baie des Galions Beach – Photo 40

Fausse Baie des Galions Beach – Photo 41

Fausse Baie des Galions Beach – Photo 42

Fausse Baie des Galions Beach – Photo 43

Fausse Baie des Galions Beach – Photo 44

Fausse Baie des Galions Beach – Photo 45

Fausse Baie des Galions Beach – Photo 46

Fausse Baie des Galions Beach – Photo 47

Fausse Baie des Galions Beach – Photo 48

Fausse Baie des Galions Beach – Photo 49

Fausse Baie des Galions Beach – Photo 50

Fausse Baie des Galions Beach – Photo 51

Fausse Baie des Galions Beach – Photo 52

Fausse Baie des Galions Beach – Photo 53

Fausse Baie des Galions Beach – Photo 54

Fausse Baie des Galions Beach – Photo 55

Fausse Baie des Galions Beach – Photo 56

Fausse Baie des Galions Beach – Photo 57

Fausse Baie des Galions Beach – Photo 58

Fausse Baie des Galions Beach – Photo 59

Fausse Baie des Galions Beach – Photo 60

Fausse Baie des Galions Beach – Photo 61

Fausse Baie des Galions Beach – Photo 62

Fausse Baie des Galions Beach – Photo 63

Fausse Baie des Galions Beach – Photo 64

Fausse Baie des Galions Beach – Photo 65

Fausse Baie des Galions Beach – Photo 66

Fausse Baie des Galions Beach – Photo 67

Fausse Baie des Galions Beach – Photo 68

APPENDIX C
FAUSSE BAIE DES GALIONS PHOTOS OF LARGE DUNE FORMATIONS

Large Dune Formation – South End of Fausse Baie des Galions

Large Dune Formation – South End of Fausse Baie des Galions

From Top of Large Dune – Facing South

Southern Tail of Large Dune – Facing North

Typical Dune Blowout at Shoreline - Leading to Large South Dune

Start of Large Dune System at Southwestern Edge of Fausse Baie des Galions

Southwestern Dune Formation – Facing South

Windblown Sand Dune Formation at Southwestern Dune

Large Dune Formation – Southwestern Dune

Windblown Sand Dune Formation at Southwestern Dune

Large Dune Formation – Southwestern Dune

Large Dune Formation – From top of Southwestern Dune

APPENDIX D
HYDROSED MODELING

1.0 INTRODUCTION

The nearshore coastal processes were evaluated using a 2D model of waves currents and sediment transport. Once the existing conditions were described the model was applied to evaluate the conditions with the proposed breakwater and sediment control groyne in place.

Wave transformation from relatively deep water to the shoreline of the study area and the corresponding nearshore currents were calculated using the *HYDROSED* model. *HYDROSED* is a 2D hydrodynamic and sediment transport model for coastal areas. It consists of a spectral wave transformation model (where the wave field is calculated by the spectral energy conservation equation of Karlsson 1969, with the breaking dissipation term of Isobe, 1987), a hydrodynamic model (Nishimura, 1988) to describe wave generated nearshore currents and circulations (driven by radiation stresses predicted with the spectral wave transformation model), and a sediment transport model presented by Dibajnia et al (2001). The sediment transport model considers the influence of non-linear orbital velocities and undertow and is based on the sheet flow transport formula of Dibajnia and Watanabe (1992), which was extended by Dibajnia (1995) to consider suspended transport over ripples as well as the bedload transport. Dibajnia et al (2001) also conducted a sensitivity test of their model and showed that the model response under various actual nearshore wave environments is satisfactory. For a given wave condition, *HYDROSED* can provide a spatial description of nearshore currents and sand transport around the harbour. The model has been verified through laboratory experiments as well as field measurements and has been extensively applied to several projects by Baird in the past few years. Nevertheless, the model has not been tested for conditions of bi-modal wave conditions. In fact, the condition of two simultaneous wave trains from different directions, and the resulting current and sediment transport patterns, is a phenomenon that is not well understood. Bi-modal wave conditions are not represented in any currently available coupled wave and hydrodynamic models. In addition, the influence of wind-driven on the hydrodynamic processes has not been considered. The contribution of wind-driven currents on total longshore current was found through field measurements to be significant for an equilibrium bay beach investigated by Sherman and Greenwood (1984). It is proposed to measure the currents at the site during the construction phase to assess the importance of wind-driven currents at this site.

2.0 2D MODELING APPROACH, TESTING AND RESULTS

2.1 Approach

The waves at this site are bimodal in direction. Baird hindcast results also indicate that seas and swells do occur simultaneously in many instances. Numerical simulations of combined sea and swell environment are not presently practical. Furthermore, the hydrodynamics generated by waves arriving from opposing directions at the same time are extremely complex and are not fully understood. Consequently, the roles of seas and swells in transport of sediment are evaluated separately and their combined effect is predicted by analysis and/or superposition of the results.

2.2 Model Setup

2D wave transformation from relatively deep water to the shoreline of the study area and their corresponding nearshore currents were calculated using the *HYDROSED* model. A calculation domain covering the entire bay with a 445×540 mesh (cross-shore × alongshore) with a grid size of 10 m was used to model the existing conditions and the recommended design option (see Figure D1). The bathymetry was created from MGS 2004 survey, 1989 topographic data and recent (November 2004) limited profile survey data in the proposed port area. The profile survey data only extended to the –1 to –2 m depth contours and, therefore, interpolation in the nearshore zone between the –5 and –1 to –2 or 0 m depth contours was required over the entire bay. The depth at the offshore boundary of the calculation domain was approximately 50 m.

2.3 Model Runs

The *HYDROSED* model was run for 42 different wave conditions. These conditions were selected from the Baird hindcast for swell and locally generated (sea) waves. A summary of the modeled wave conditions is provided in Table D1 below. Swell waves in Fausse Baie des Galions typically come from the south and south-southwest directions, have a period of 12 s and a maximum wave height of 5.5m. Locally generated (sea) waves range in direction from 80-140°, have a period of 8 s and a maximum wave height of 6m. The selected wave conditions were run for two different cases: the existing conditions of the bay and then with the design of the port in place in the southern end of the bay. The results from these two runs will be discussed further below.

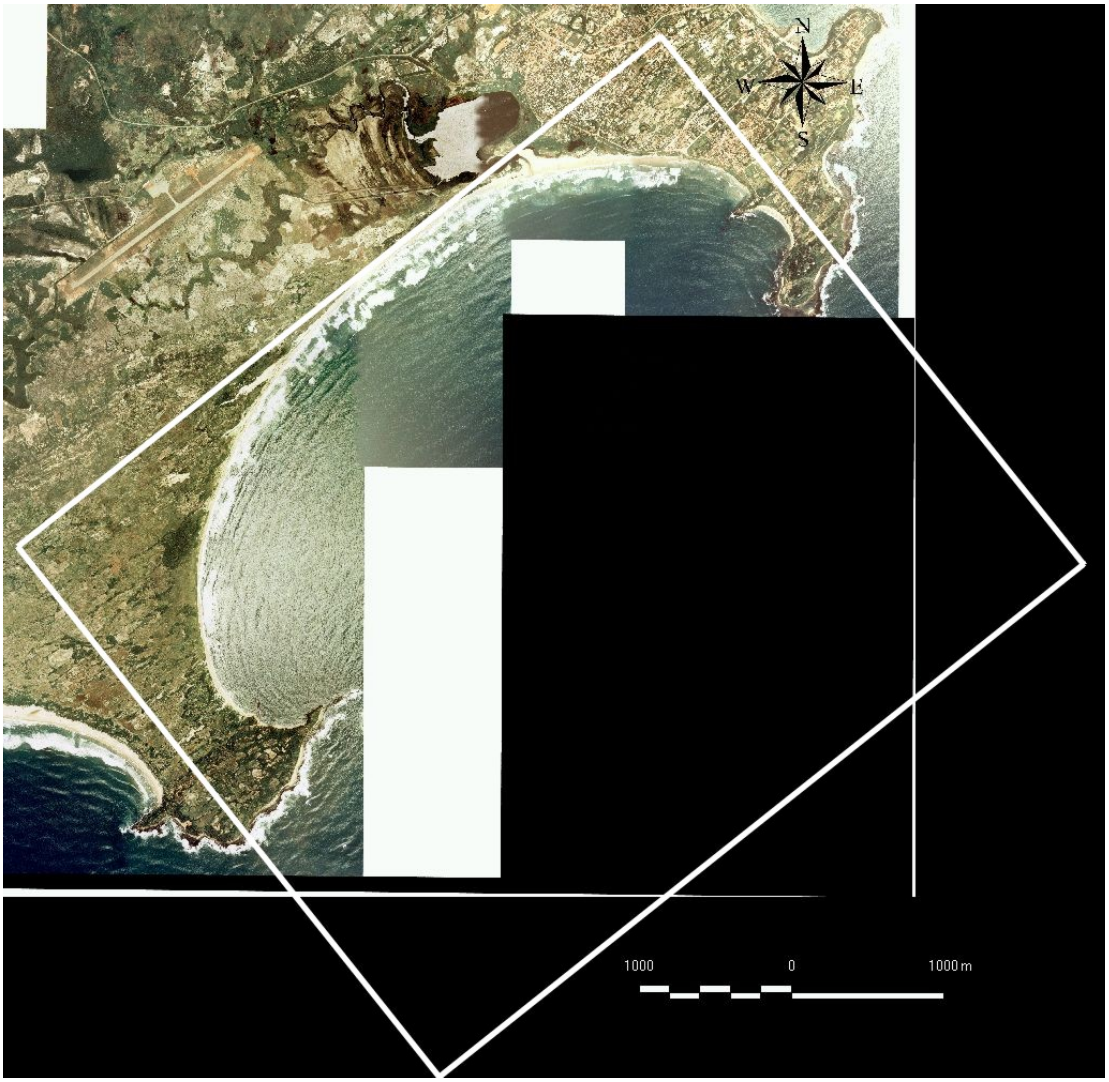


Figure D1 HydroSed Calculation Domain

Table D1. Modeled Wave Conditions

Wave Direction					
Swell (T=12.0s)		Sea (T=8.0s)			
200°	180°	140°	120°	100°	80°
0.5m	0.5m	0.5m	0.5m	0.5m	0.5m
1.0m	1.0m	1.0m	1.0m	1.0m	1.0m
1.5m	1.5m	1.5m	1.5m	1.5m	1.5m
2.0m	2.0m	2.0m	2.0m	2.0m	2.0m
3.0m	3.0m	3.0m	3.0m	3.0m	3.0m
4.0m	4.0m	4.0m	4.0m	4.0m	4.0m
5.5m	5.5m	6.0m	6.0m	6.0m	6.0m

2.4 Model Verification

The breaker line and wave directions determined from the nearshore wave transformation with the *HYDROSED* model were verified against the observed wave conditions present at the time of the 1989 aerial photograph and the 2003 IKONOS satellite image. The QuickBird image was not used because the wave details visible in this image are not sufficient for this comparison. Input wave conditions were obtained from the Baird hindcast at the time of the aerial images.

The Baird hindcast for swell waves for Feb. 6th, 1989 (the date of the aerial photograph) indicates waves in the range of 1.0 to 1.2 m with a period ranging from 12 to 13 s from directions ranging from 182 to 194° from North. The locally generated wave hindcast estimates waves in the range of 1.5 to 1.9 m, with a period ranging from 8.0 to 8.5 s and directions from 122 to 125° from North for the same date.

Modeled waves with a wave height of 1.0 m, a period of 12.0 s, and a direction of 180° and a wave height of 1.0 m, a period of 8.0 s and a direction of 120° were selected to represent the swell and sea waves respectively. The simulated wave directions and representative breaker line are shown on the 1989 airphoto in Figure D2. The results for the swell generated waves corresponded well in the north part of the bay and the locally generated easterly waves fit the observed waves well in the south part of the bay. The predicted wave directions are generally perpendicular to the wave crests and the breaker line is reasonably in line with the observed breaking waves in the airphoto. The locally generated waves fit the conditions in the airphoto for a wave height of 1.0 m, 0.5 m less than that recorded in the hindcast. This may be due a difference between the hindcast and the observed conditions at the time of the airphoto or a difference in the actual bathymetry in the bay and that of our model since the bathymetry was interpolated between –5 and –1 to –2 or 0 m depth contours over the entire bay.

The Baird hindcast for swell waves for Dec 27th, 2003 (the date of the IKONOS satellite image) indicates waves in the range of 0.6 to 0.7 m with a period ranging from 12.5 to 12.9 s from directions ranging from 178 to 197° from North. The locally generated wave hindcast estimates waves in the range of 1.65 to 1.8 m, with a period ranging from 8.8 to 9.0 s period and directions from 100 to 112° from North for the same date.

Modeled waves with a wave height of 1.0 m, period of 12.0 s, and a direction of 180° and a wave height of 1.0 m, a period of 8.0 s and a direction of 100° were selected to represent the swell and sea waves respectively. The simulated wave directions and representative breaker line are superimposed on the 2003 satellite image in Figure D3. Again, the swell and sea waves correspond to the north and south parts of the bay respectively, and the modeled results that fit the satellite image in the south end of the bay (the locally generated waves) are about 0.5 m below that calculated in the hindcast which may be due to errors in the hindcast or bathymetry in the model.

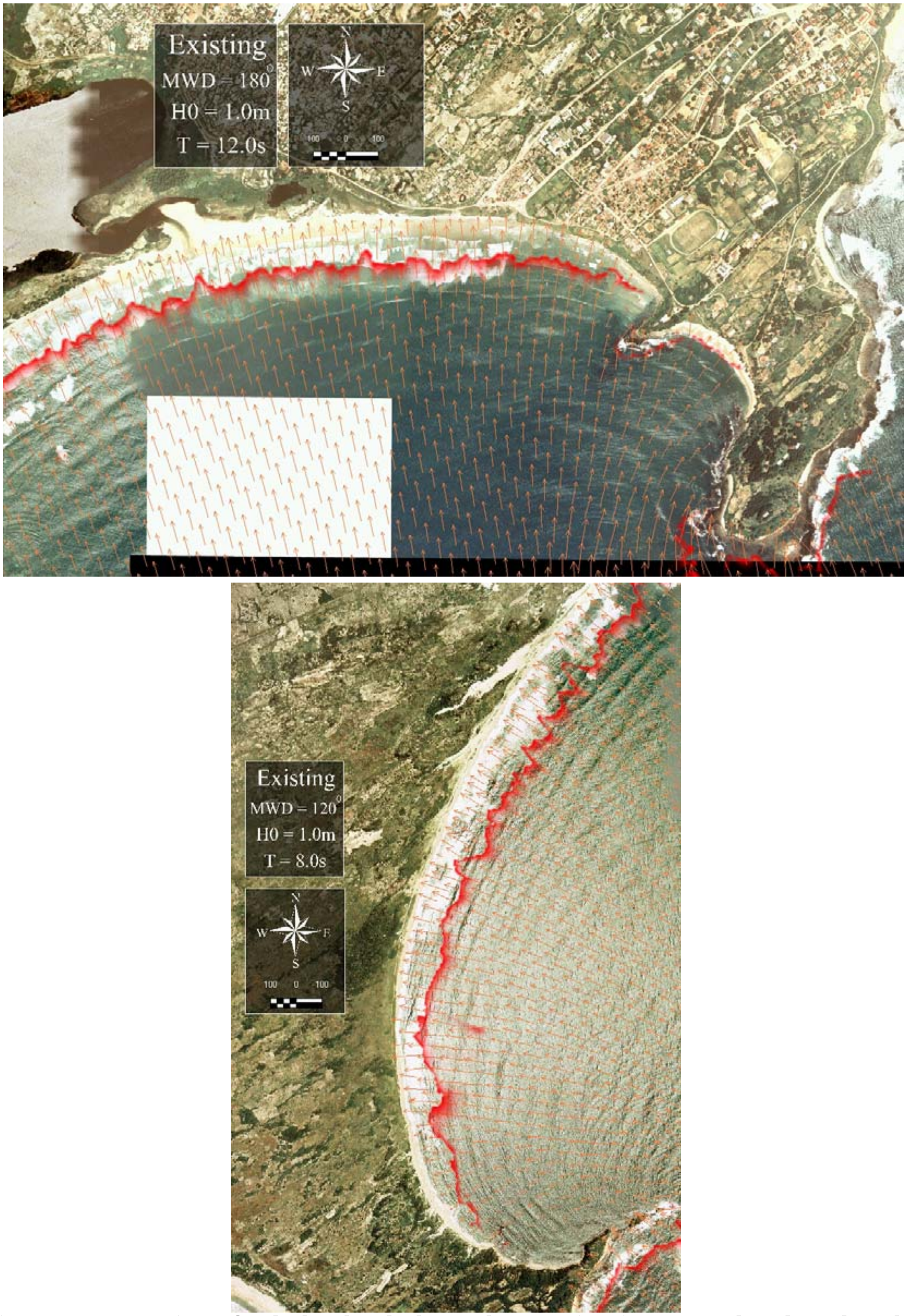
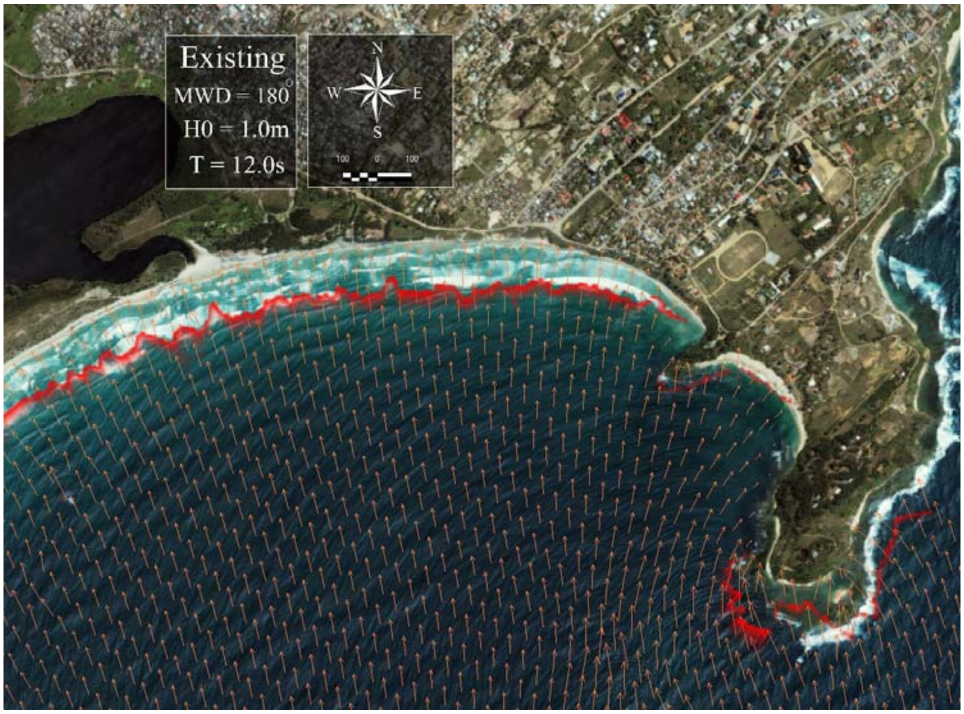


Figure D2 Comparison of Calculated and Observed Wave Directions at North and South Ends of the Bay with 1989 Airphoto



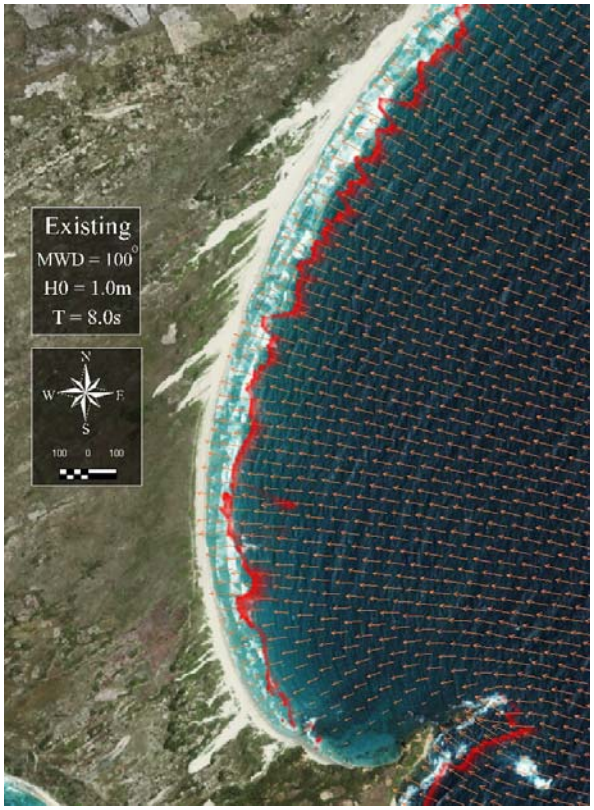


Figure D3 Comparison of Calculated and Observed Wave Directions at North and South Ends of the Bay with 2003 Satellite Image

2.5 Model Results – Existing Conditions

Figure 4.1 in the main body of the report shows the distribution of wave height and direction for a predominant sea wave condition with 8 s wave period and height of 2 m from 80° direction (conditions at 50 m depth). The model results show that sea waves directly attack the central to south shores of the bay, but are refracted with a reduction in wave height before arriving at the north shores. Figure 4.3 in the main body of the report shows the same results for a typical swell wave from the south-southwest direction with 12s wave period and height of 1m. The swell waves directly attack the north shores, but go through considerable refraction and diffraction before arriving at the shorelines in the southern half of the bay.

Figure 4.2 in the main body of the report shows the nearshore currents that result from the sea waves of Figure 4.1. The results from *HYDROSED* indicate that for this condition there is a well-established longshore current from the central shores of Fausse Baie des Galions to the south. This pattern of longshore sand transport is compatible with the observation of erosion at the center of the bay. Minor circulation currents are also observed towards the north. Figure D4 presents a detailed view of nearshore currents in the south half of the bay for the same waves. The model indicates that the southward longshore current does not continue to the south end of the bay and is counteracted by a local westward current and diverted offshore. The local westward current is created in the lee of the south headland because the headland blocks the waves, creating an energy gradient. There is a natural ridge located about 300 m west of the south headland. A circulation current in the little embayment between the south headland and the natural ridge is also seen under east waves.

Figure 4.4 in the main body of the report shows the nearshore currents generated by the swell waves shown in Figure 4.3. The results indicate that there is a well-established longshore current from the creek inlet to the north and that circulation cells exist along the central shores towards the south. The currents at the south end of the bay are shown in Figure D5 for the same waves. As seen in this figure, further to the south, there seems to be intermittent local southward longshore current systems, but with much smaller velocities as compared to those in the north half of the bay. The southward longshore current does not continue to the south end of the bay and almost diminishes towards the existing natural ridge. Figure D6 shows a plot of sediment transport vectors and indicates that sediment moves onshore under predominant swell waves.

For predominant east waves (seas), the southward longshore current is stronger and more pronounced than that due to southerly swells. However, the results indicate that a local current at the natural ridge counteracts the southward longshore current. Therefore, under east wave attack, the existing nearshore current system might not result in sediment accumulation at the proposed harbor area (i.e. the little embayment between south headland and the natural groyne). However, the uncertainty associated with these patterns is to be noted, due to the fact that the influence of simultaneous bi-modal wave attack and wind-driven currents have not been considered

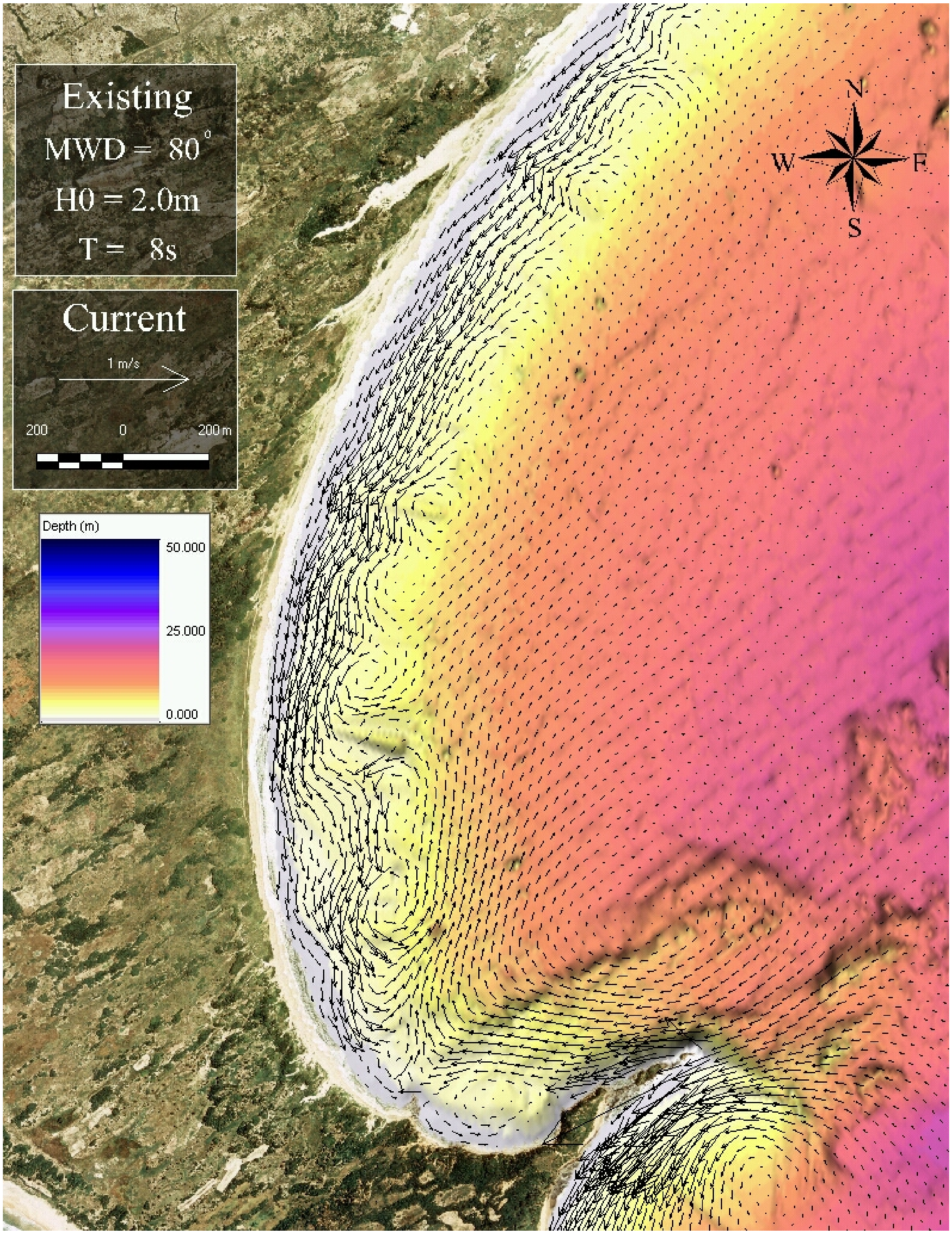


Figure D4. Nearshore Currents Under Predominant East Waves at South End of the Bay.

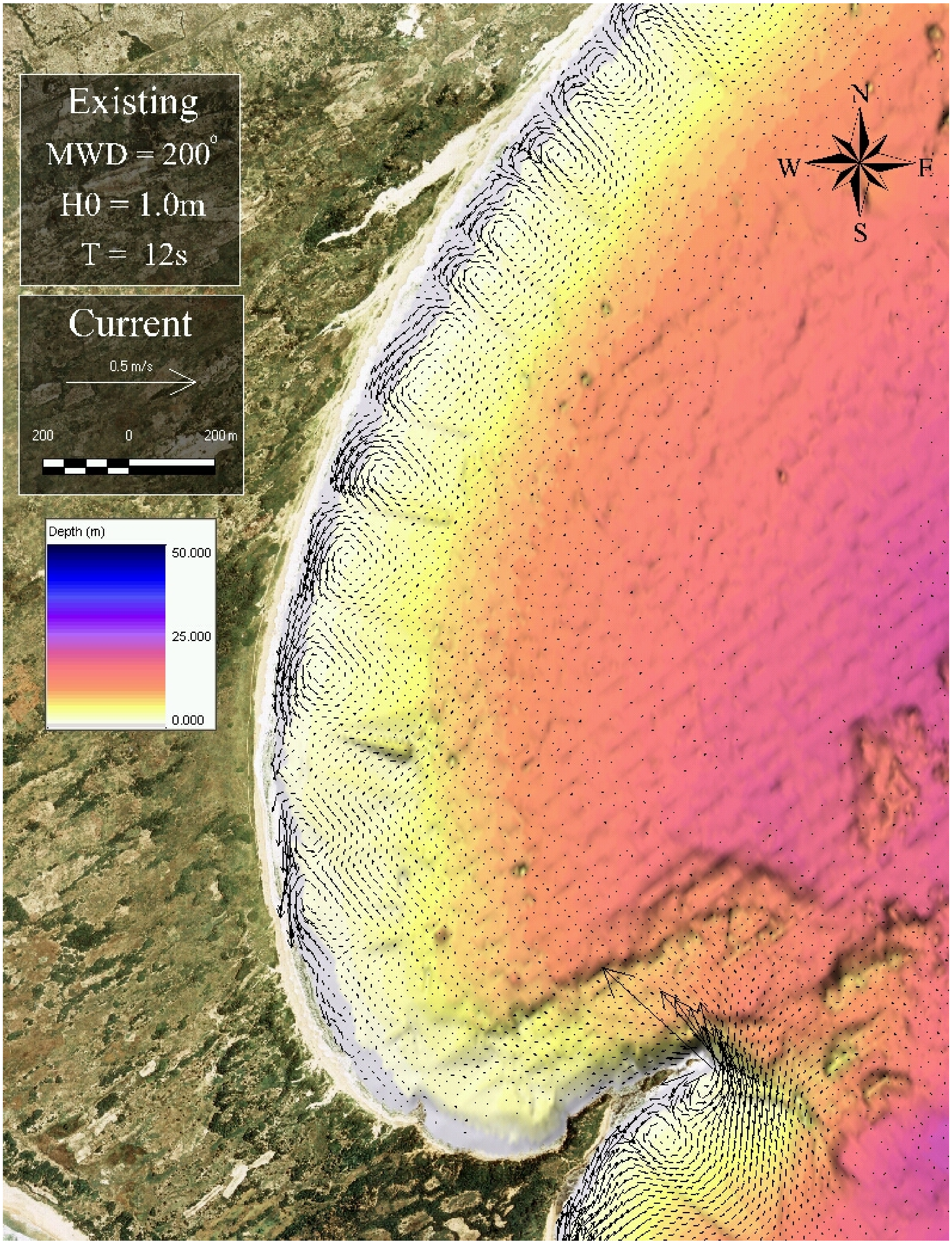


Figure D5 Nearshore currents under predominant swell waves at south end of the Bay

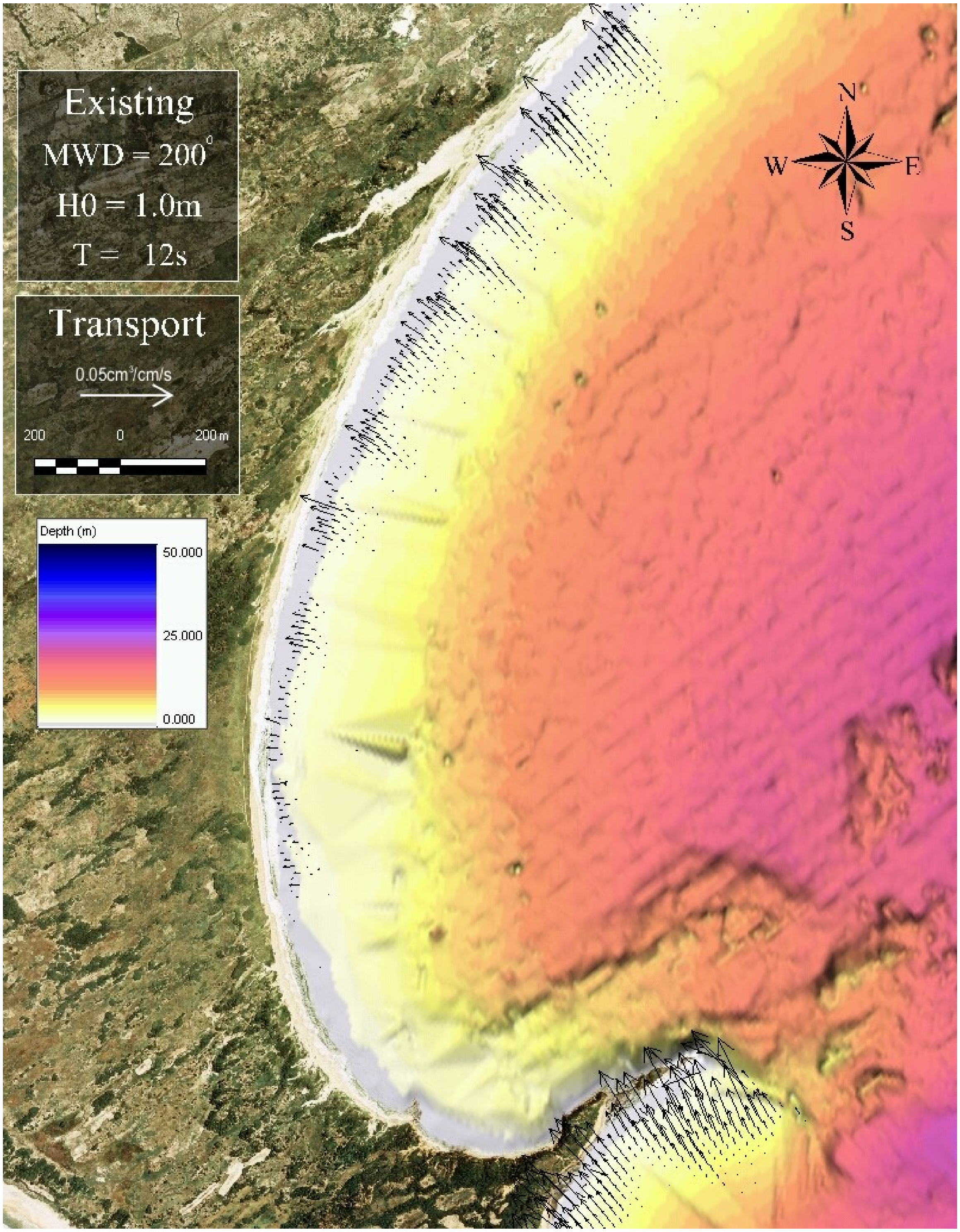


Figure D6 Sediment Transport Rate Vectors Under Predominant Swell Waves

Figures D7 and D8 show the wave height distribution and the nearshore currents under an extreme east storm event (6 m wave height, 8 s period at 50 m depth), respectively. In this case, the southward longshore current flows partly into the little embayment next to the south headland. The surf zone is wider under extreme storms and the maximum longshore current and the resultant alongshore sediment transport occur far from the shoreline in about 5 m of water. The outer (deeper) part of the southward longshore current joins the westward current from the south headland and forms a large-scale circulation or outgoing flow to the north. Figure D9 shows a plot of sediment transport vectors for this wave condition.

The Longshore Sand Transport (LST) rates at a cross-section about 1 km northwest of the south headland calculated by *HYDROSED* are plotted against the incident wave height for a grain size of 0.3 mm and shown in Figure D10. The location of the cross-section is shown in Figure D9 and LST rates are calculated by integrating shore parallel transport rates from the shoreline out to 10 m depth. It may be seen that southward longshore transport occurs for sea waves from 80 to 100° when the wave height is larger than 1 m, and for wave heights greater than 3 m and 4 m for waves from 120° and 140°, respectively. Swell waves larger than 2 m generate a northward transport but the magnitude is small compared to the transport by sea waves. The curves approximate formulations for calculating LST rates parameterized by wave height.

A simple numerical model was then developed that stepped through a time series of the 20-year (1985 to 2004) hourly hindcast wave data to calculate the long-term LST rate using the above formulations or interpolations between. The average annual longshore transport rate was then calculated from the 20-year total. At the transect 1 km northwest of the south headland the easterly sea waves were found to be capable of moving 34,000 to 67,000 m^3 per year towards the south (this range and the ones presented below are based on estimates with a representative grain size of 0.4 and 0.2 mm, respectively). The southerly swell waves transported only 1,000 to 2,000 m^3 per year. This results in a net southerly transport rate of 33,000 to 65,000 m^3 per year. Also, the extent of the predominant alongshore sediment transport was found to extend to a depth of 5 m.

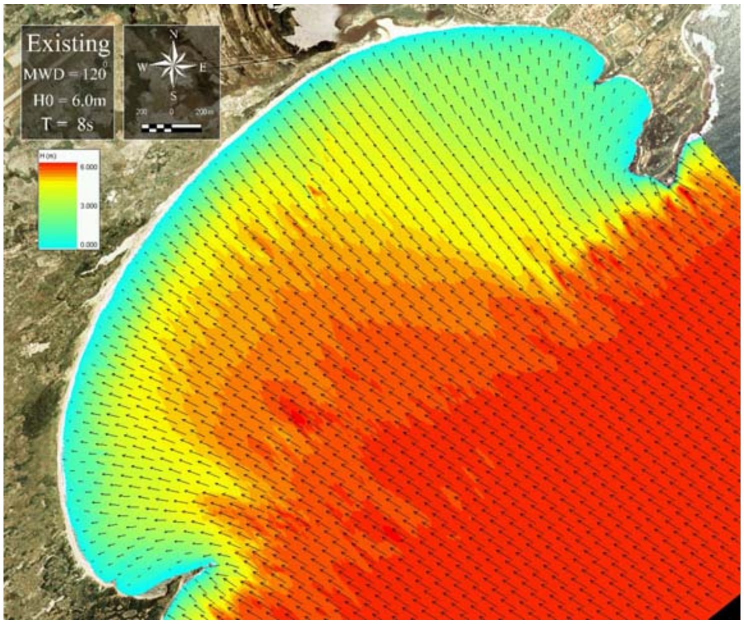


Figure D7. Wave Height and Directions Under Extreme East Storm (Existing Conditions)

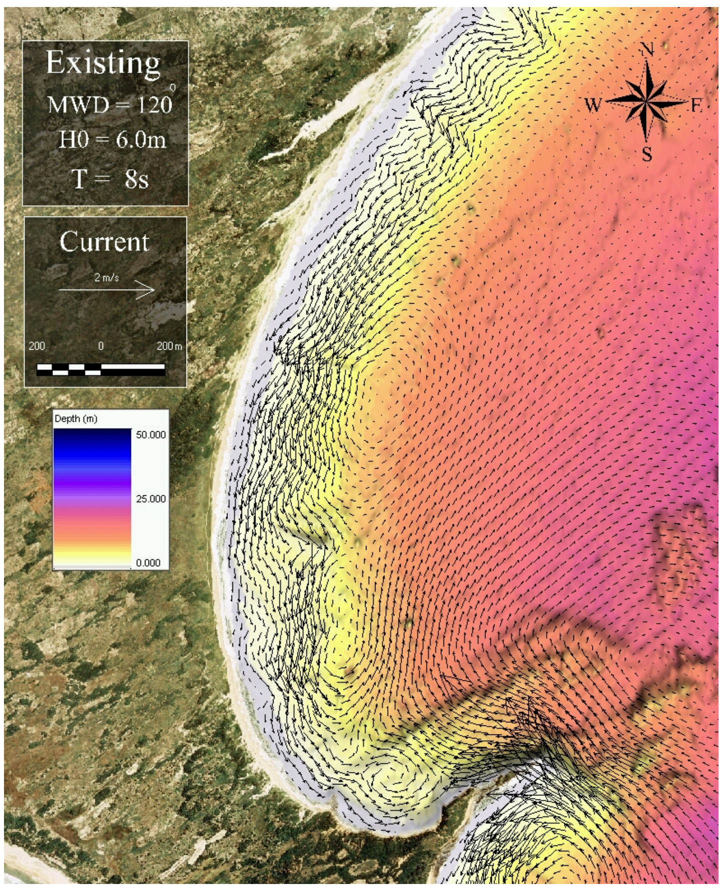


Figure D8 Nearshore Currents Under Extreme East Storm (Existing Condition)

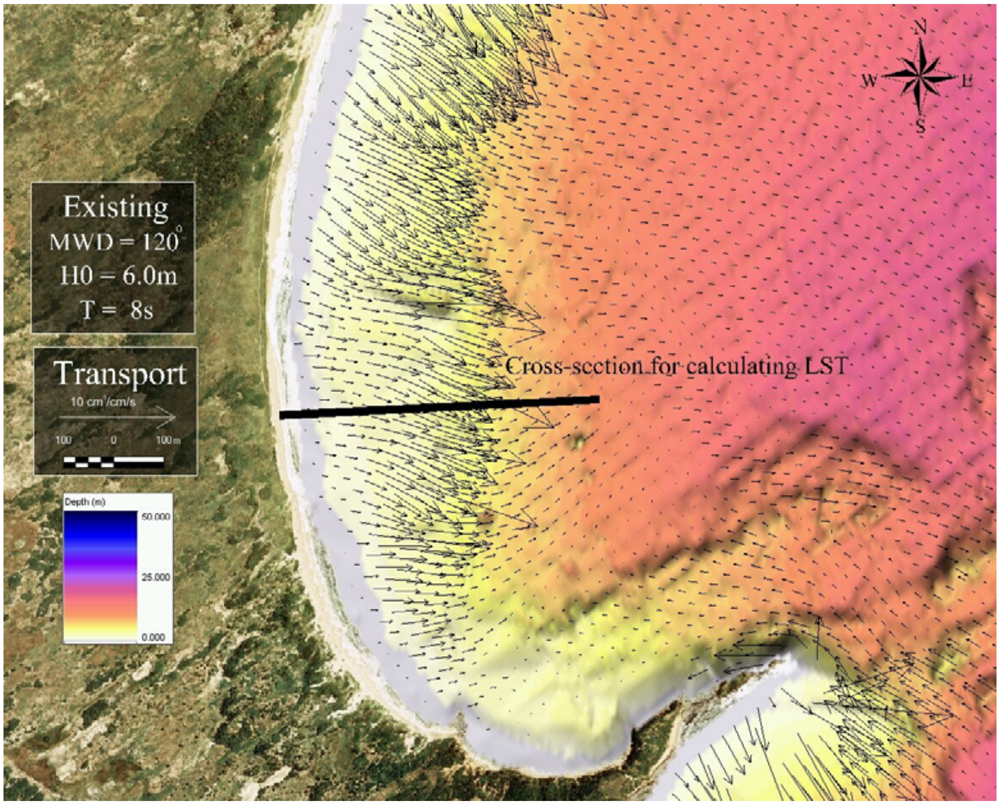


Figure D9 Sediment Transport Rate Vectors Under Extreme East Waves

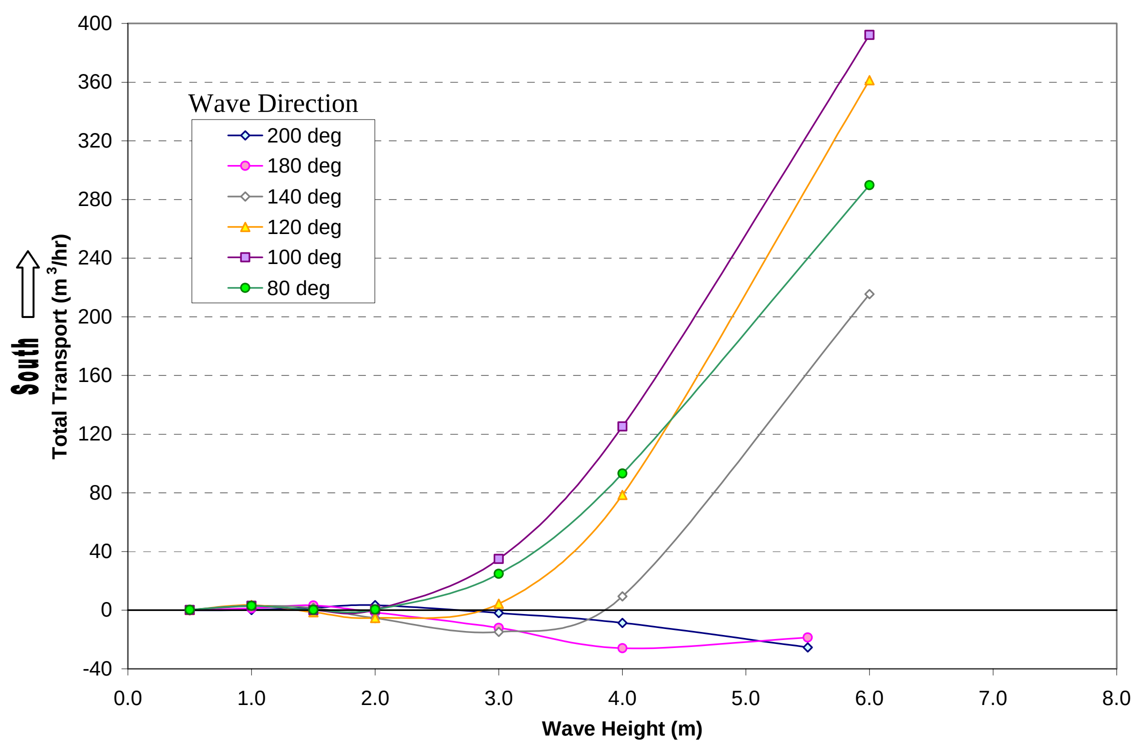


Figure D10 Longshore Sand Transport Rate Vs Wave Height (Existing Conditions)

2.6 Model Results – Recommended Design

The recommended design alternative consists of a 580 m long breakwater, a 350 m long groyne located approximately 250 m west of the existing natural ridge and a dredged basin. The groyne extends to a depth of -5 m to prevent sediment from entering the harbor area. The structures and the dredged basin were included in the *HYDROSED* calculation domain and corresponding waves, nearshore currents and sediment transport distributions were calculated.

Figure 4.6 in the main body of the report shows the nearshore currents calculated for predominant east waves of 2 m height and 8 s wave period. It may be seen that the proposed breakwater blocks the current that presently flows around the south headland into the bay and there is no current to counteract with the southward longshore current next to the natural ridge. However, the proposed groyne blocks the sediment that would have been carried alongshore and deposited in the area sheltered by the breakwater.

Figure 4.7 in the main report shows the nearshore currents calculated for waves from the south-southwest direction. Because of the sheltering provided by the breakwater, swell waves and their corresponding southward longshore current are very small. Examination of calculated sediment transport rates indicated that with the harbor in place, swell waves do not contribute to longshore sediment transport but still move sand onshore. Figure D11 shows nearshore currents calculated for an east extreme storm event (6 m wave height, 8 s period) for the recommended design option. The groyne prevents most of the sediment being carried by the southward current, but there is some bypassing sediment entering the harbor area. This is however, a rare storm event with return period of more than 20 years.

The southward longshore sediment transport rates calculated by *HYDROSED* at about 1 km north of the south headland are plotted against the incident wave height for a grain size of 0.3mm and are shown in Figure D12. With the breakwater in place, swell waves and sea waves with wave heights above 0.5 m always have a longshore transport rate to the south.

The average annual longshore transport rates calculated from the 20-year total are found to be 44,000 to 87,000 m^3/year for grain sizes of 0.4 and 0.2 mm, respectively. The results show that with the recommended design in place, the pattern of sediment transport between the groyne and the central bay remains the same. However, the southerly net transport rate is approximately 30% higher than the net southerly transport rate for the existing conditions at the transect 1 km northwest of the south headland. The breakwater provides a larger sheltered area than by effectively extending the south headland and therefore prevents a reversal in transport direction in the vicinity of the harbour.

Some other transects were taken around the harbour area to determine sedimentation rates in the harbour (see Figure D13). The *HYDROSED* model indicates that sand would be bypassing the groyne at a rate of 350 m^3/year. However, all of this bypassing material is transported behind the groyne and not into the basin area. *HYDROSED* also predicts that sediment could potentially enter the basin area from offshore of the breakwater at a rate of 650 m^3/year. This rate will likely not be achieved since sand is not known to bypass around the south headland into the bay (i.e. there is no sand supply).

Again, it should be noted that these numbers are potential and not actual rates and depend upon the sediment supply available at the site. The numbers are also calculated without considering the influence of the simultaneous bi-modal wave attack and wind-driven currents.

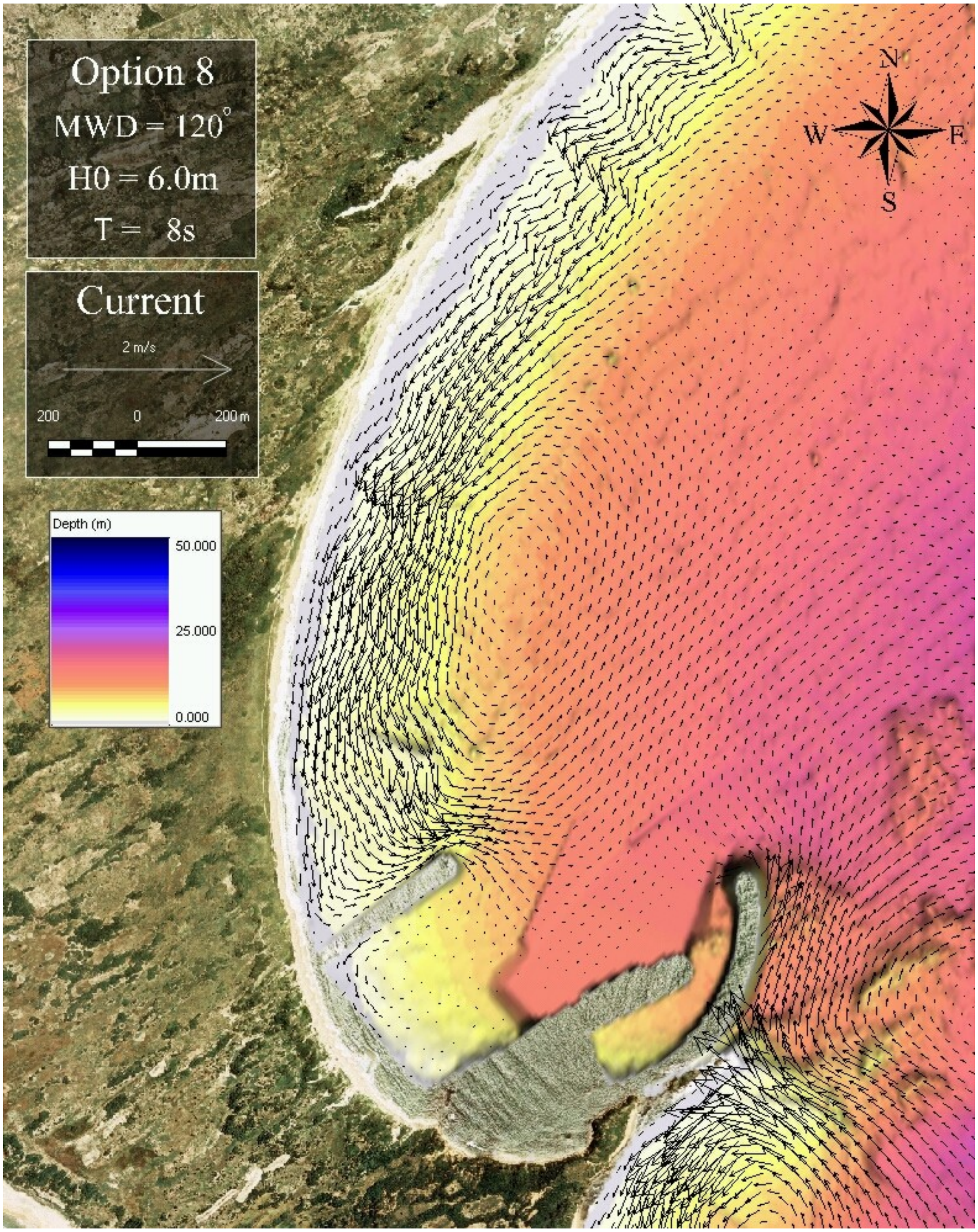


Figure D11 Nearshore Currents Under Extreme East Storm for Recommended Design Option

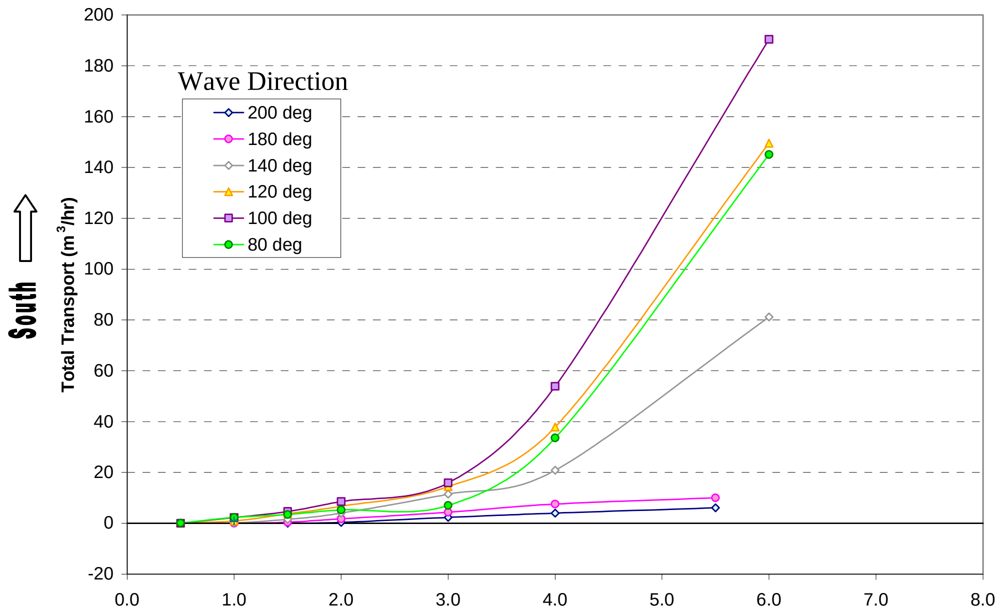


Figure D12 Longshore Sand Transport Rate Vs Wave Height (Recommended Design)

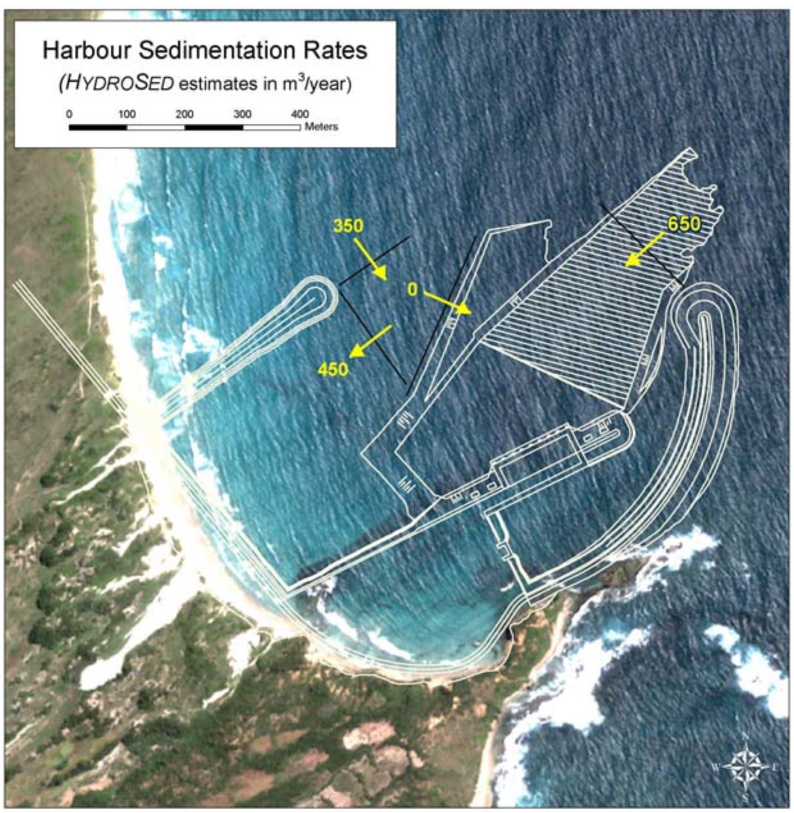


Figure D13. Sand Transport Rate at Different Transects in the Harbour

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APPENDIX E
WIND-BLOWN SEDIMENT TRANSPORT

1.0 INTRODUCTION AND BACKGROUND

1.1 Introduction

Sand transport by wind blowing across the above water beach is likely to be an important component of sand transport in Fausse Baie des Galions and in estimating a sediment budget. As noted in Section 2.0 in the main body of the report and Appendix C, there is evidence of wind transport of sand, and sand being blown into the vegetation behind the beach. Figure 1 shows elongated dunes created by this process aligned with the direction of the wind on the March 28th, 2004 QuickBird satellite image. Figure 4.5 in the main body of the report shows a photo of the wind-blown sand along the beach.

1.2 Wind-Blown Sand Transport Equations

Three different equations were used to predict the sand transported by wind at this site: Hsu's 1973 equation, which is recommended in the procedure for calculating wind-blown sand transport in the Coastal Engineering Manual of the US Army Corps of Engineers; Kawamura's 1951 equation recommended in the procedure for calculating wind-blown sand transport by Horikawa (1988); and Bagnold's equations (from references in 1936 and 1954, the latter being a republication of a 1941 reference), which is similar to both equations, and was used for comparative purposes. The total amount of sediment transported by wind was calculated for all winds above the critical threshold (i.e., the wind speed that initiates sand transport). A flat beach with sufficient width to reach potential transport was assumed for calculations.

1.2.1 Bagnold's Wind-Blown Sand Transport Equation

Bagnold's equation is based on considerations of the turbulent kinetic energy relationship and is written by:

$$q = B\frac{\rho_a}{g}\sqrt{\frac{d}{D}}u_*^3$$

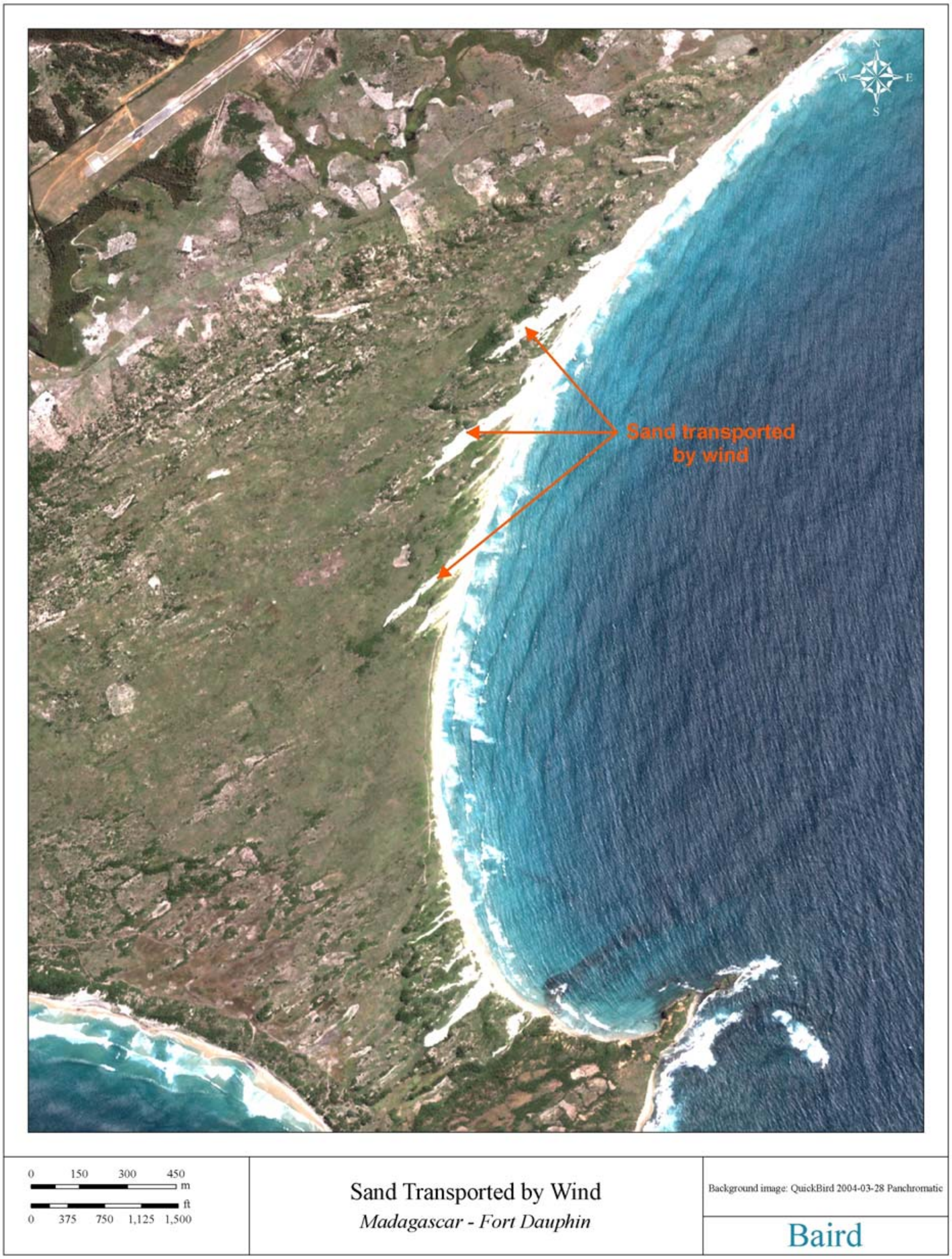

Figure E1 Sand Transported by Wind

Where:

q = sand transport rate in gm/cm-s

B = an empirical coefficient

ρ_a = the mass density of air = 0.001226 gm/cm^3

d = a standard grain size = 0.25mm

D = grain size in mm

μ_* = the shear velocity in cm/s.

Bagnold found through his experiments that $B' = B\sqrt{\frac{d}{D}} = 0.8$ and that the sand transport moving by saltation was about three times more than that moving with surface creep. Therefore, Bagnold's equation can be rewritten as:

$$q = q_s + q_c = \left(1 + \frac{1}{3}\right) 0.8 \frac{\rho_a}{g} u_*^3 = 1.1 \frac{\rho_a}{g} u_*^3$$

1.2.2 Kawamura's Wind-Blown Sand Transport Equation

Kawamura's equation is similar to Bagnold's except it includes the threshold shear velocity. Kawamura's equation is written as follows:

$$q = K \frac{\rho_a}{g} (u_* + u_{*c})^2 \left(u_* - u_{*c}\right)$$

Where:

q = sand transport rate in gm/cm-s

K = an empirical coefficient = 1.05

ρ_a = the mass density of air = 0.001226 gm/cm^3

g = acceleration of gravity

μ_* = the shear velocity in cm/s

μ_{*c} = the threshold shear velocity in cm/s.

1.2.3 Hsu's Wind-Blown Sand Transport Equation

Hsu's equation is also based on considerations of the turbulent kinetic energy relationship and is presented below:

$$q = K\left[\frac{\mu_*}{\sqrt{gD}}\right]^3$$

Where:

q = sand transport rate in gm/cm-s

μ_* = shear velocity

g = acceleration of gravity

D = mean sand grain diameter

K = dimensional aeolian sand transport coefficient (D in mm)

$= e^{-9.63 + 4.91D}$

2.0 GENERAL PROCEDURE

The various steps required to estimate the wind-blown sand transport rate are listed below:

6) Obtain wind speed and direction data,

7) Obtain precipitation and evaporations data,

8) Obtain median grain size of the beach,

9) Compute the critical shear velocity,

10) Compute the potential sand transport if the wind exceeds the critical threshold and the precipitation does not exceed evaporation.

3.0 WIND-BLOWN SAND CALCULATION FOR FAUSSE BAIE DES GALIONS

3.1 Wind Data

Two sets of wind data (wind speed and direction) were available for this site: hourly wind data from August 1st to October 31st 2004; and daily wind data from January 1st 1993 to November 30th 2004. It was assumed that the data sets were both measured by the anemometer at the airport, which is located 11.2 m above the ground at the airport. Since the airport is 7 m above Chart Datum, the anemometer is located 18.2 m above CD. The wind rose for the three months of hourly data is shown in Figure 2. It can be seen that the dominant wind direction is 60 degrees from North. This corresponds to the orientation of the sand transport paths in Figure 1.

3.2 Precipitation and Evaporation Data and Grain Size

Daily data on precipitation and evaporation were also available between January 1st 1993 and November 30th 2004. Days where the precipitation exceeded evaporation were assumed to have no sediment transport by wind, which may under-estimate the actual wind transport. The daily evaporation and precipitation data were applied to the hourly data in the sand transport calculations. The calculations were carried out using a sediment grain size of 0.4 and 0.2mm to determine a range of values.

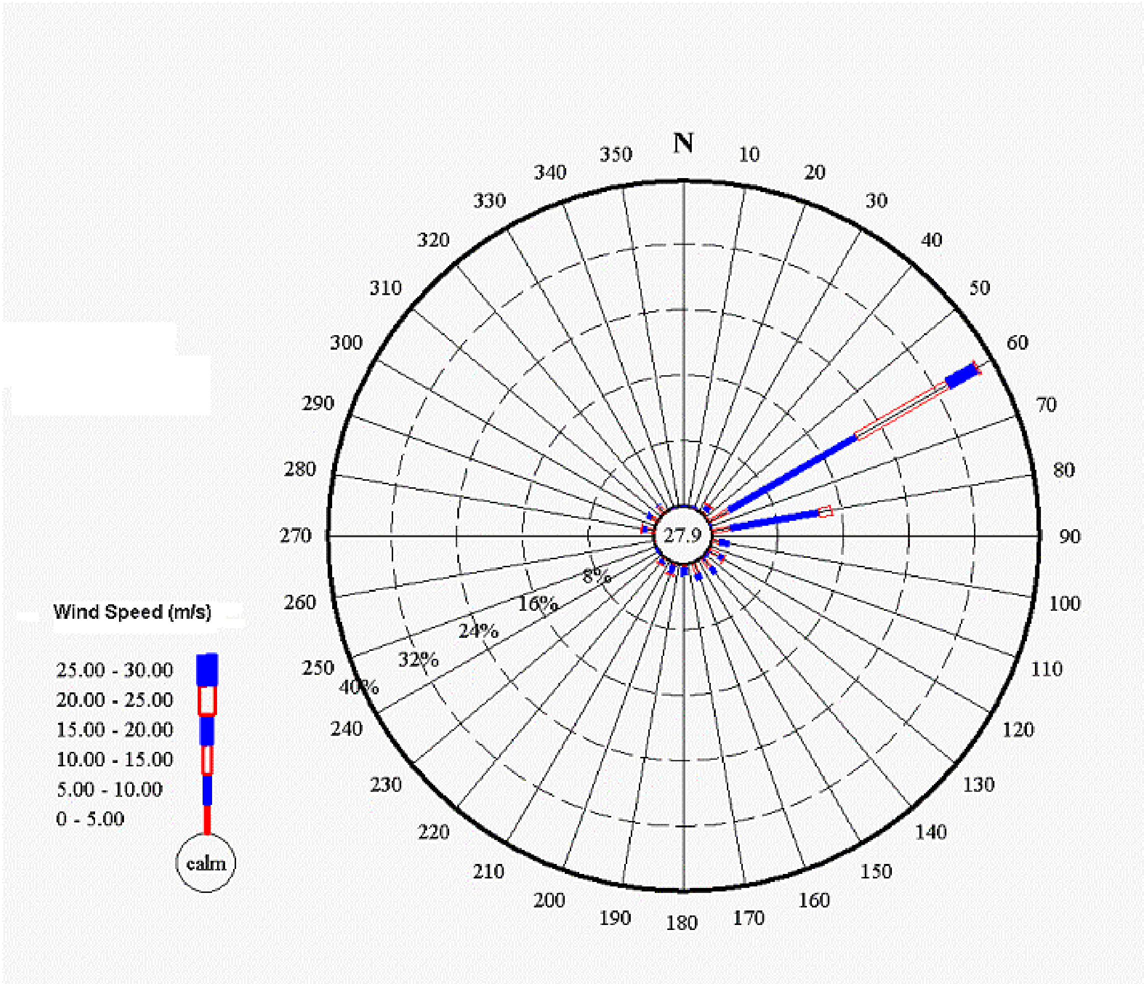

Figure E2. Wind Rose for Hourly Wind Data (August – October 2004)

3.3 Wind-Blown Sand Transport Calculation

The sand transported by wind was initially calculated using the three months of hourly data. Sand transport was only calculated when the hourly wind speed exceeded the critical threshold. The critical wind speed threshold at the anemometer height (18.2 m above CD) was calculated using the two different methods recommended in the CEM and by Horikawa and were found to be 9.7 m/s and 10.8 m/s for a grain size of 0.4 mm and 6.9 m/s and 7.3 m/s for a grain size of 0.2 mm, respectively. The three-month hourly winds are above these thresholds 25% and 18% of the time for a 0.4 mm grain size and 52% and 33% of the time for a 0.2 mm grain size.

Twenty-three hours over this three-month period did not have any data available and were not accounted for in the calculations. Days with rain (days where the daily precipitation exceeds the daily evaporation) and winds between 135 and 315 degrees from North were also not included in the calculations. Excluding days with rain reduced the three-month totals by 10% and excluding the winds between 135 and 315 degrees reduced these totals further by less than 1%. Table 1 lists the three-month total and annual sediment transport values obtained from the selected hourly data. The total and annual sediment transport values for the same period (August to October 2004) were then calculated using the daily data. Very similar results were obtained when the corresponding daily average winds for the same period (August to October 2004) were used. Therefore, daily average values could confidently be used to evaluate transport over longer periods.

Table 1. Total and Annual Sediment Transport Obtained from Hourly Data (August To October 2004)

Equation	D_{50} (mm)	Critical Threshold (m/s)	Total Sediment Transport (q_v in m^3/m/3 months)	Yearly Sediment Transport (m^3/m/year)
Hsu (1973)	0.4	9.7	20.7	82.8
Hsu (1973)	0.2	6.9	26.3	105.4
Bagnold (1954)	0.4	10.8	21.4	85.4
Bagnold (1954)	0.2	7.3	30.9	123.5
Kawamura (1951)	0.4	10.8	19.9	79.7
Kawamura (1951)	0.2	7.3	31.7	126.7

The sand transported by wind was then calculated using the daily data between January 1st 1993 and November 30th 2004. The total and annual sediment transport values are shown in Table 2. The annual sediment transport rates over this period are significantly smaller than those calculated previously (70%+ smaller). There are two explanations for the smaller annual sediment transport rates. The three-month period from August to October 2004 features above average wind speeds. Figure 3 shows the daily time-series from 1993 to 2004 with the 3-month period highlighted in pink. From the plot, it can be seen that the year 2004 has higher wind speeds than the rest of the dataset. The second reason for the discrepancy is that these moths of the year tend to feature higher wind speeds than the rest of the year. Therefore, wind speeds above the critical threshold are more likely to occur during these months than earlier in the year. Figure 4 shows the number of occurrences per year that the wind speed exceeded the critical threshold of 9.7 m/s (critical threshold at 18.2 m above CD for a 0.4 mm grain size). The year 2004 is shown in the figure with a red line. In August through to October 2004, the occurrences above the critical threshold are high when compared to the rest of the time-series. Therefore it is clear why the estimates obtained from the daily time-series are significantly smaller than those obtained from the hourly three-month period.

Table 2 Total and Annual Sediment Transport obtained from Daily Data (Jan 1993 - November 2004)

Equation	D_{50} (mm)	Critical Threshold (m/s)	Total Sediment Transport (q_v in m^3/m/3 months)	Yearly Sediment Transport (m^3/m/year)
Hsu (1986)	0.4	9.7	126.2	10.6
Hsu (1986)	0.2	6.9	357.0	30.0
Bagnold (1941)	0.4	10.8	70.2	5.9
Bagnold (1941)	0.2	7.3	395.6	33.2
Kawamura (1951)	0.4	10.8	59.8	5.0
Kawamura (1951)	0.2	7.3	359.0	30.1

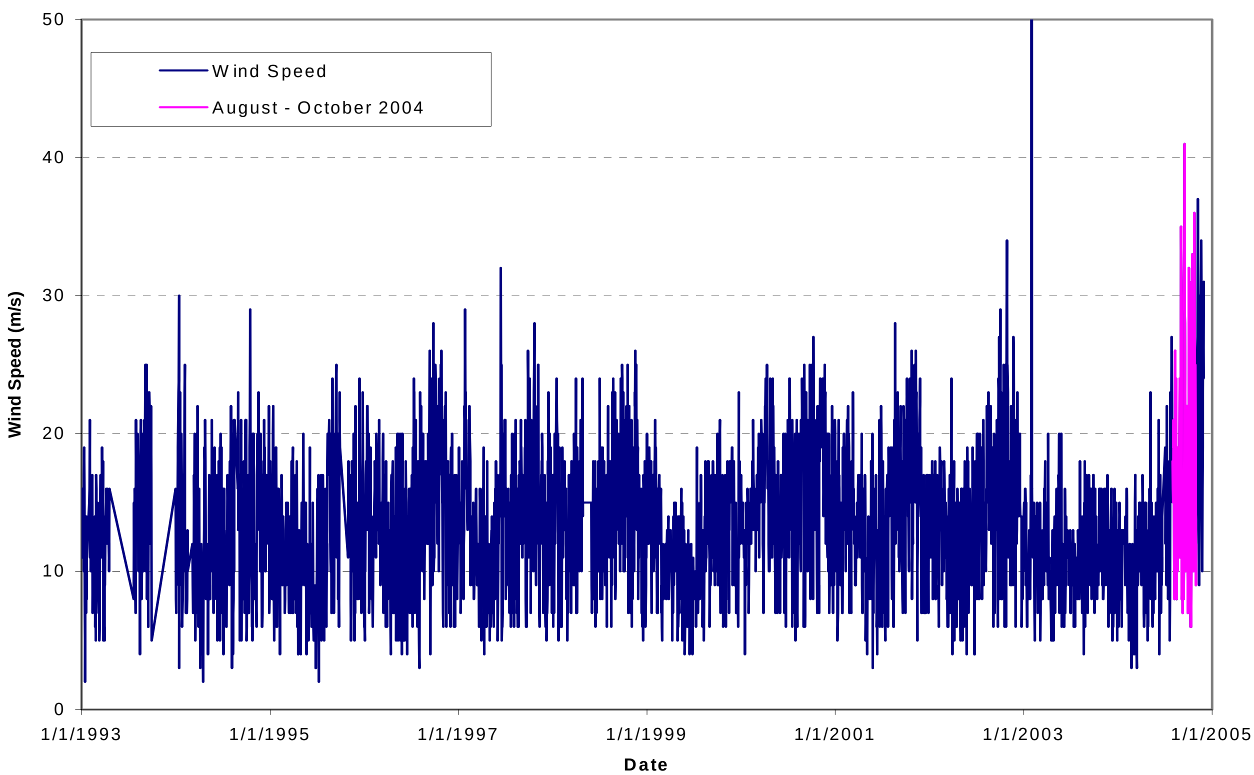

Figure E3 Daily Data Time Series (1993-2004)

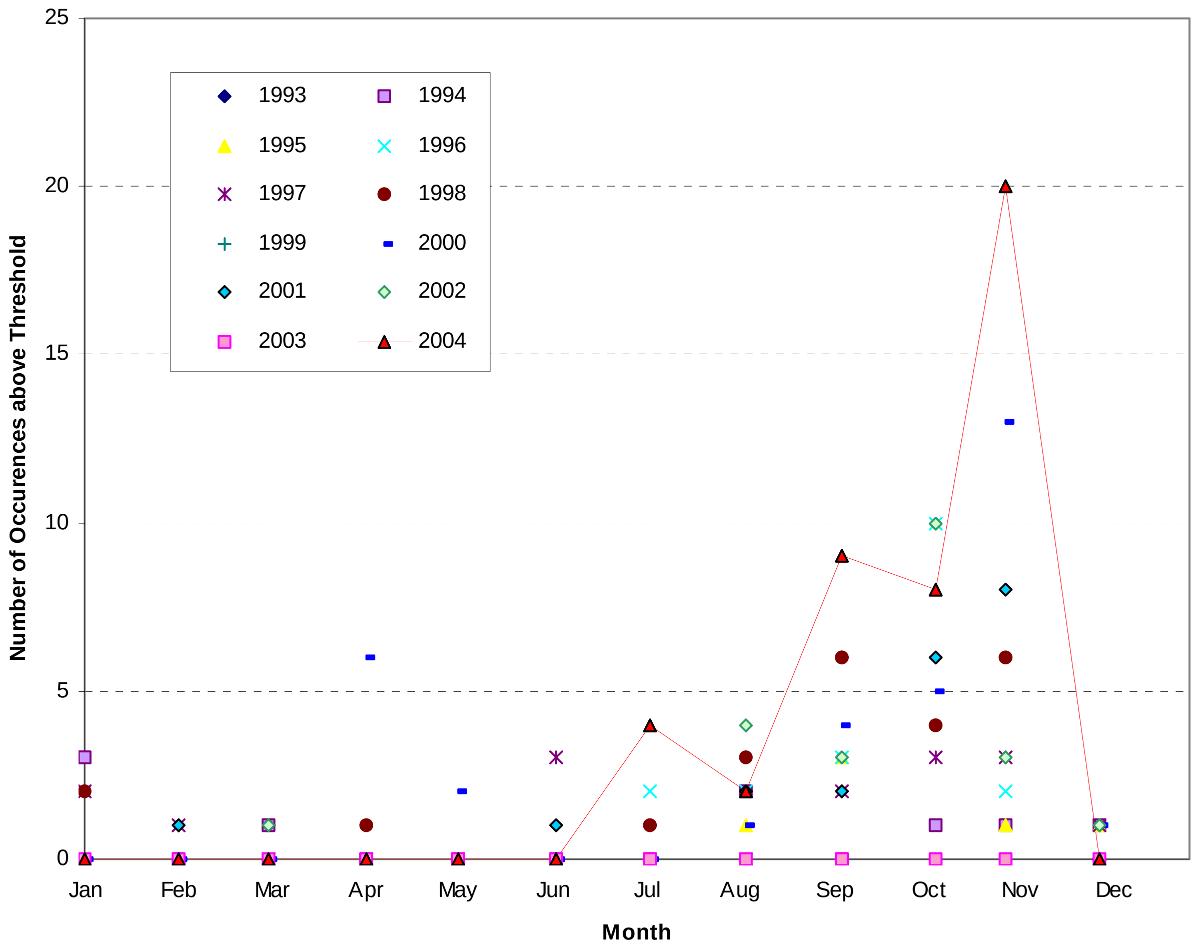

Figure E4 Wind Speeds Exceeding Critical Threshold for A 0.4 Mm Sand at 18.2 Above CD (9.7 M/S)

It is also clear from Figure 4 that the last half of the year (July to December) exceeds the critical threshold value more often than the first half of the year. However, as the threshold value decreases (as it does for decreasing grain sizes) the difference between the two halves of the year decreases. Figure 5 shows the variation in the number of occurrences for the first half of the year (January to June) with different threshold values. Thresholds values below 900 cm/s or 9 m/s feature more continuous winds throughout the year. This observation explains why the annual estimates for the 0.2mm grain size (which has a critical threshold value approximately 1.5 times smaller than the 0.4mm grain size critical threshold) are 3 to 6 times greater than those for the 0.4mm grain size and illustrates the importance of grain size and critical wind threshold values.

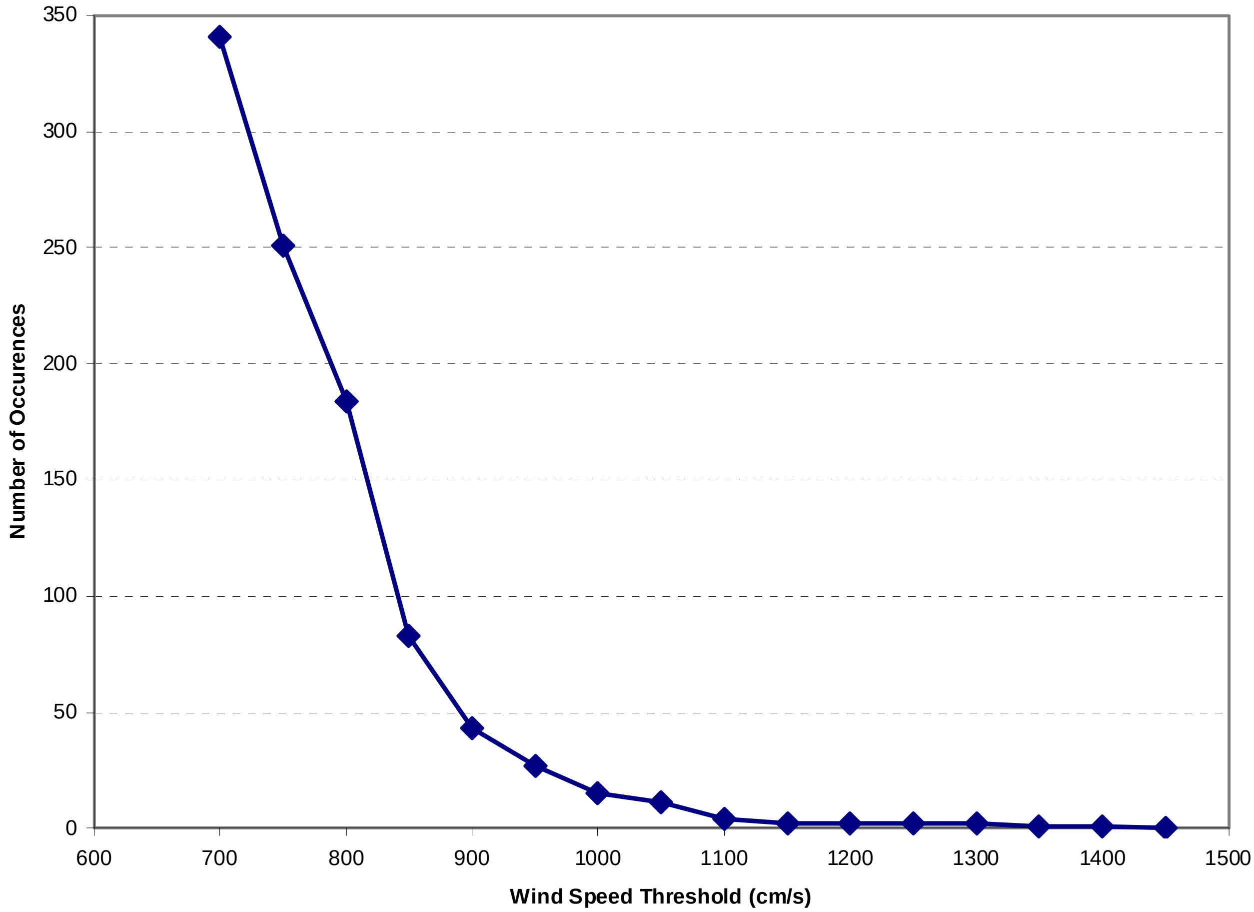

Figure E5 Variation in Exceedence of Wind Speed Threshold (January to June)

Considering, the different grain sizes and thresholds, it was concluded that 7 m^3/m/year was a reasonable estimate for a grain size of 0.4mm and 31 m^3/m/year was a reasonable estimate for a grain size of 0.2 mm. The average transport rate is approximated to be 20 m^3 per m of beach per year. Over a 1.5 km reach of shoreline (projected distance measured perpendicular to the wind direction), this leads to approximately 30,000 m^3/year of sand being transported by wind per year into the upland areas. At the location of the proposed harbor, sand transport by wind would take place once a wide enough beach is formed updrift of the proposed groyne. This will retard the development of the fillet beach and final equilibrium shape updrift of the groyne.

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APPENDIX F
HSU AND EVANS SHORELINE PREDICTION

1.0 INTRODUCTION AND BACKGROUND

Both the north and south ends of the Fausse Baie des Galions shoreline exhibit characteristics of what is known as an equilibrium or crenulate bay shape. These curved bay shorelines have been studied at many locations around the world and have been found to exhibit similarities that can be related to the nature of the local physiographic features (headland shape, etc) and the prevailing wave conditions.

Hsu and Evans (1989) equations give a reasonable approximation of the equilibrium beach planform for a certain, known set of conditions. Essentially, the equations developed by Hsu and Evans (1989) predict a parabolic shape between a selected control point and the headland, and a straight line that is parallel to the wave crests beyond the selected control point. This approach assumes that the shoreline orientation will everywhere be parallel to the nearshore wave crest line for a dominant wave direction after the influence of refraction/diffraction processes associated with the presence of the headland.

The equations for the curved/parabolic and straight section of shore are shown below respectively and their variables are plotted in Figure 1. The equations for C_0, C_1 and C_2 and their values for different β, are shown in equations 3-5 and Table 1 below. The coefficients of Equations 1 and 2 (given in Equations 3 to 5) have been determined empirically using measurements of many bay shapes and the determining physiographic features and wave conditions. Therefore, on the one hand they are very robust and likely to work relatively well at any location, yet on the other hand may be imprecise given the specifics of a given site (such as the form of the headland, extent of underwater shoals, etc.).

$$\frac{R}{R_0} = C_0 + C_1\left(\frac{\beta}{\theta}\right) + C_2\left(\frac{\beta}{\theta}\right)^2, \qquad \theta \geq \beta \qquad (1)$$

$$\frac{R}{R_0} = \frac{\sin\beta}{\sin\theta}, \qquad \theta < \beta \qquad (2)$$

Where:

R_0 is the distance between the diffraction point and the control point

R is the distance between the diffraction point and a point on the equilibrium shoreline

β is the angle between the wave crest line and R_0

θ is the angle between the wave crest line and R

C_0, C_1 and C_2 are constants related to β with equations listed below

$$C_0 = 0.0707 - 0.0047\beta + 0.000349\beta^2 - 0.00000875\beta^3 + 0.00000004765\beta^4 \quad (3)$$

$$C_1 = 0.9536 - 0.0078\beta + 0.00004879\beta^2 - 0.0000182\beta^3 + 0.000001281\beta^4 \quad (4)$$

$$C_0, = 0.0214 - 0.00787\beta + 0.0003004\beta^2 - 0.00001183\beta^3 + 0.00000004765\beta^4 \quad (5)$$

Table 1 Constants Related to β in Hsu and Evans Equations

β	10	15	20	25	30	35	40	45
C_0	0.036	0.05	0.055	0.054	0.045	0.029	0	-0.039
C_1	1.011	0.998	1.029	1.083	1.146	1.22	1.326	1.446
C_2	-0.047	-0.049	-0.088	-0.142	-0.194	-0.253	-0.332	-0.412

β	50	55	60	65	70	75	80
C_0	-0.088	-0.151	-0.227	-0.315	-0.409	-0.505	-0.6
C_1	1.588	1.756	1.93	2.113	2.284	2.422	2.52
C_2	-0.507	-0.611	-0.706	-0.8	-0.873	-0.909	-0.906

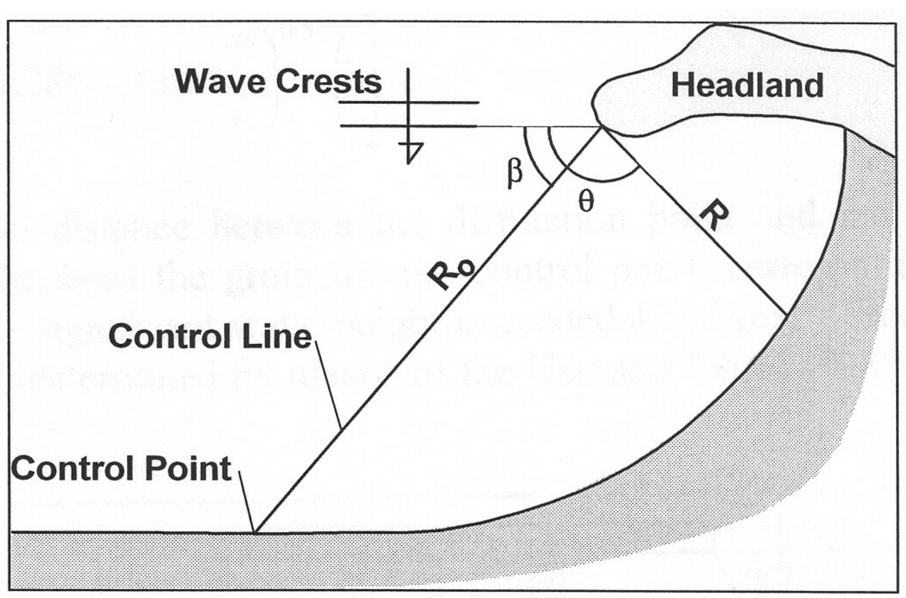

Figure F1 Variables in the Hsu and Evans Equations (Hanson and Kraus 2001)

2.0 GENERAL APPLICATION

The method developed by Hsu and Evans was evaluated using six steps. These steps are listed below:

1) A diffraction and control point were selected and a control line with length R_o was drawn between them,
2) A line parallel to the shoreline down coast of the control point was drawn at the diffraction point and selected as the representative wave crest line,
3) The angle β between the wave crest line and control line was measured,
4) The shoreline was estimated for a range of θ by the corresponding radii, R,
5) The estimated shoreline was drawn on the aerial photograph,
6) And the fit to the shoreline was evaluated.

Selecting a control point is simpler when the beach is situated between multiple structures, or headlands and when there is only one dominant direction of wave attack. Selecting a control point when there is no down-drift LST barrier, and/or where there are two dominant directions of wave attack is more difficult and becomes an iterative process. Different control points and wave crest lines are selected for each diffraction point until the predicted shoreline is aligned with the existing shoreline. When this occurs, the equations are calibrated indicating that the bay is stable or in static equilibrium and the effect of changes in the bay can then be tested (addition of structures, extension of headlands, etc). If the predicted and existing shorelines do not line up, the bay is in dynamic equilibrium and may be unstable.

One shortcoming of the Hsu and Evans approach is that there is not a unique solution, in other words there may be more than one combination of the three main variables (position of the diffraction and control points and angle of wave attack) that allows a match to the bay shape. Judgment must be exercised in choosing the most appropriate combination of these three variables and where possible, validation against other nearby bays is an important step. The next two sections describe the calibration (initial fitting) and verification of the approach.

3.0 METHOD APPLICATION TO EXISTING SHORELINE AT FAUSSE BAIE DES GALIONS

The Hsu and Evans equations were applied in Fausse Baie des Galions to determine the effect the breakwater would have on the equilibrium beach planform. The equations were first calibrated to fit the shoreline in the March 28th, 2004 QuickBird satellite image and then the effect of the breakwater was calculated using the calibrated equations. This section describes the method used to fit the equations to the existing shoreline.

At Fausse Baie des Galions four diffraction points were selected to consider the full range of reasonable locations for these points: one onshore (at the most seaward point of land); one offshore at the 10m contour (where the southerly swell waves appear to begin diffracting in the available aerial images); one halfway between these two points; and finally, one halfway along the exposed side of the breakwater (where the waves were observed to converge in the physical model study). The four diffraction points are shown with contours on the satellite image in Figure 2.

The Hsu and Evans equations were applied to the four diffraction points described above. Different control points and wave crest orientations were selected at each diffraction point until the shoreline predicted by the Hsu and Evans equations lined up with the existing shoreline. Figure 3 shows: the location of the diffraction point and control point; the wave crest line orientation; and the shoreline predicted by R for θ increments of 1 degree for each diffraction point. The onshore diffraction point and its control point, wave crest line and predicted shoreline are shown in red. The offshore diffraction point, the point between the onshore and offshore diffraction point and the point along the breakwater and their associated features are shown in blue, green and purple respectively.

The shorelines predicted for the existing conditions assume that the shoreline is in a state of dynamic equilibrium (Klein, 2004). The red and green solid lines indicate that some additional accretion has occurred in the shelter zone of the headland (since the lines are landward of the existing shoreline behind the headland). The solid blue line and purple lines (calibrated for the offshore diffraction point and point along the breakwater respectively) are located further offshore than the existing shoreline in the satellite image. This calibration is satisfactory even though it does not line up with the existing shoreline in the groyne area because Hsu and Evans' equations assume that there is no net transport. The offshore location of the blue and purple predicted shorelines therefore takes the net south longshore transport rate that may exist at this site into account.

The fact that the four calibrations use four different representative wave crest lines highlights the difficulty and uncertainty in applying this approach to a condition of bimodal wave attack in terms of wave direction. The wave directions that correspond to the onshore diffraction point, the offshore diffraction point, the point between and the point along the breakwater are 109°, 141°, 129°, and 119° from North respectively. The most reasonable wave direction is likely between 109 and 129° (probably closer to 129°, green line) since this wave direction may represent the balance between sea and swell waves (it is perpendicular to the wave crest line drawn through the intersection of .sea and swell wave crests in the 2004 image).

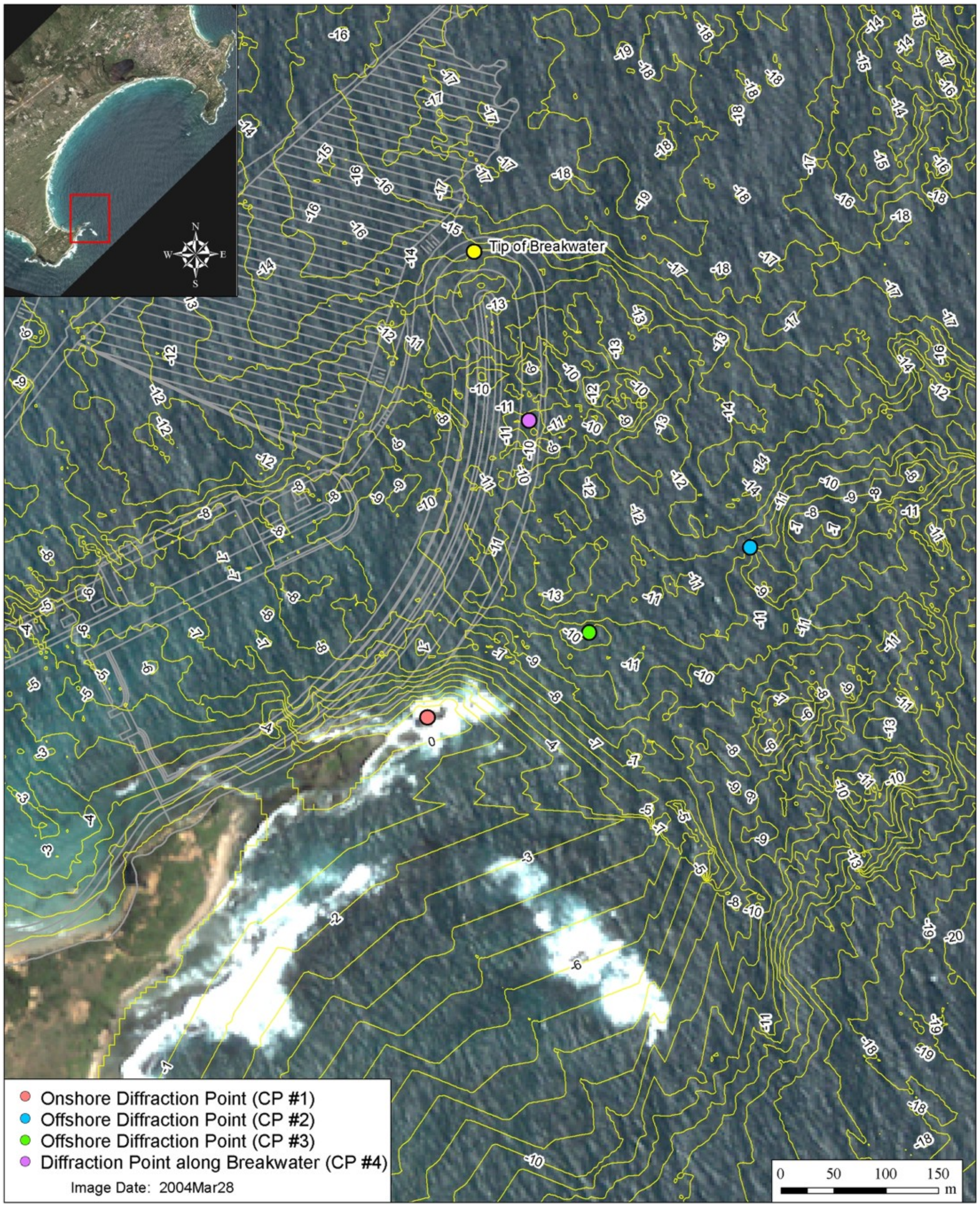

Figure F2 Diffraction Points Used for Hsu and Evans Analysis

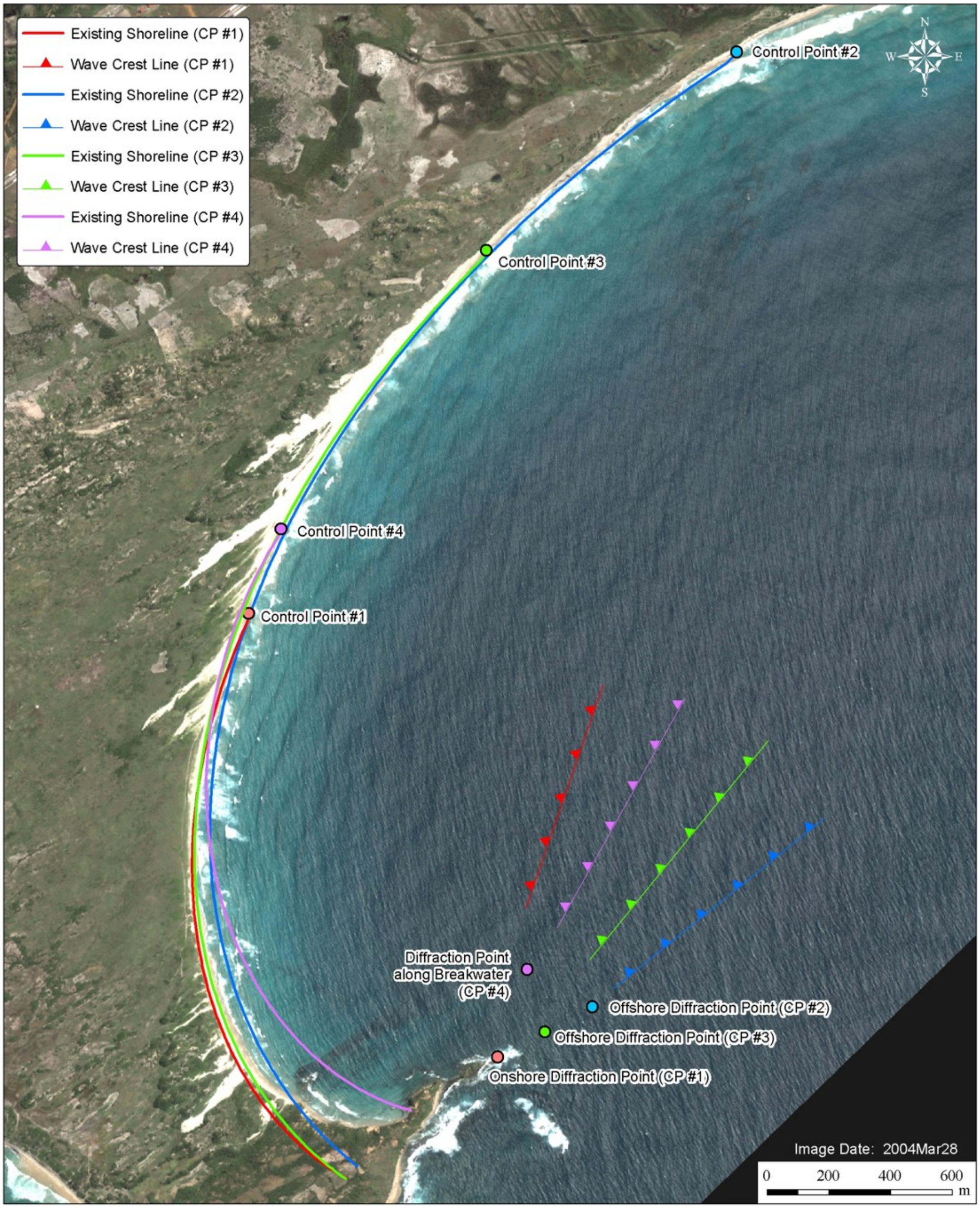

Figure F3 Existing Planform Beach Predicted by Hsu and Evans' Equations for Varying Wave Direction

4.0 METHOD VERIFICATION AT BAIE DE FORT DAUPHIN

The Hsu and Evans equations were applied to Baie de Fort Dauphin, the bay north of Fausse Baie des Galions for verification. The March 28th, 2004 QuickBird satellite image for Fausse Baie des Galions does not cover the bay to the north. However, the Dec 17th, 2003 IKONOS satellite image covers a portion of the south end of Baie de Fort Dauphin. The preview for the Dec 17th, 2003 satellite image extends a little beyond the purchased image and was also used in the analysis (see Figure 5). The 1951 Chart covers the entire Baie de Fort Dauphin. Figure 4 shows the 1951 Chart with the 2003 shoreline overlaid on it in the western part of the bay. It is apparent from this figure that the shoreline has accreted significantly since 1951 (approximately 50m) in the north half of the west bay and eroded in the south half near the headland. Some of this accretion may be due to the large shipwreck present directly offshore of the south end of the bay. The shipwreck occurred approximately 10 years ago and was added to the 1951 chart and can be seen to be influencing the waves in the 2003 satellite image in Figure 5.

The Hsu and Evans equations were applied in Baie de Fort Dauphin using the same wave crest orientations as in Fausse Baie des Galions. The waves coming into the bay at 109° from North (the red wave fronts in Figures 3 and 5) are associated with a diffraction point at the tip of the headland. The waves corresponding to a wave direction of 129° from North (the green wave fronts in Figures 3 and 5) are associated with a diffraction point that has a depth of approximately 10m, a little further offshore than the diffraction point at the tip of the headland. These wave directions and corresponding diffraction and control points produce shorelines that reasonably resemble the existing conditions in the Dec 27, 2003 satellite image (see Figure 6.). The predicted shoreline for the red diffraction point is more curved than the beach in the satellite image. Moving the diffraction point offshore would likely correct this discrepancy, however, due to a lack of detailed bathymetry information around the headland, this point was not moved. These observations confirm the Hsu and Evans equations are valid for use in this area and provide an indication of the most appropriate wave approach directions for Fausse Baie des Galions to the south (i.e. the red and green wave fronts with approach directions of 109° and 129°, respectively).

The two other wave conditions were not tested in the north bay because the bathymetry around the headland is different than that in Fausse Baie des Galions. The most offshore diffraction point and the point halfway along the headland (blue and purple points in Figure 2) were not analyzed in the bay to the north because the headland drops off more steeply.

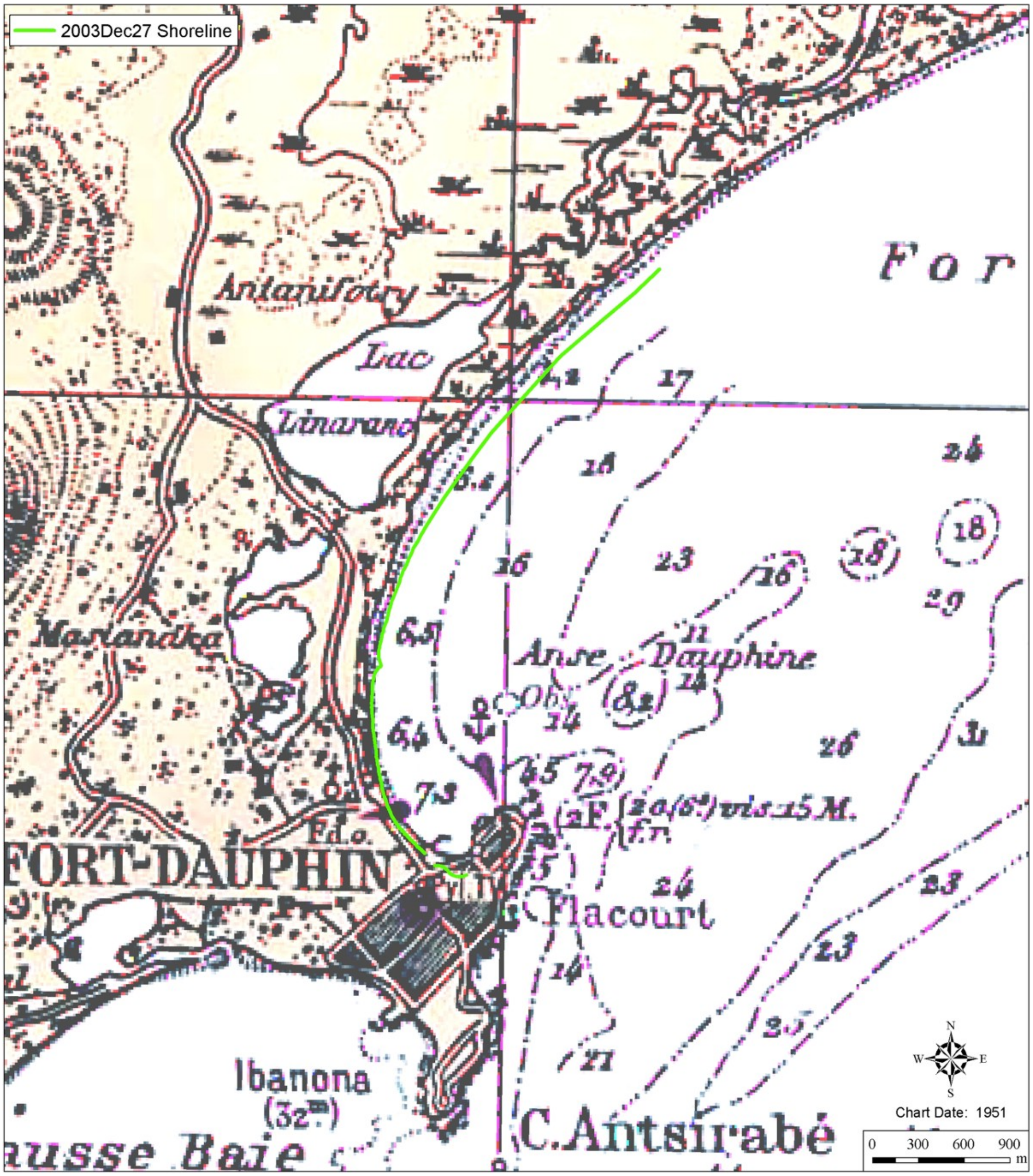

Figure F4 1951 Chart of the Western Part of Baie De Fort Dauphin with Dec 27th, 2003 Shoreline

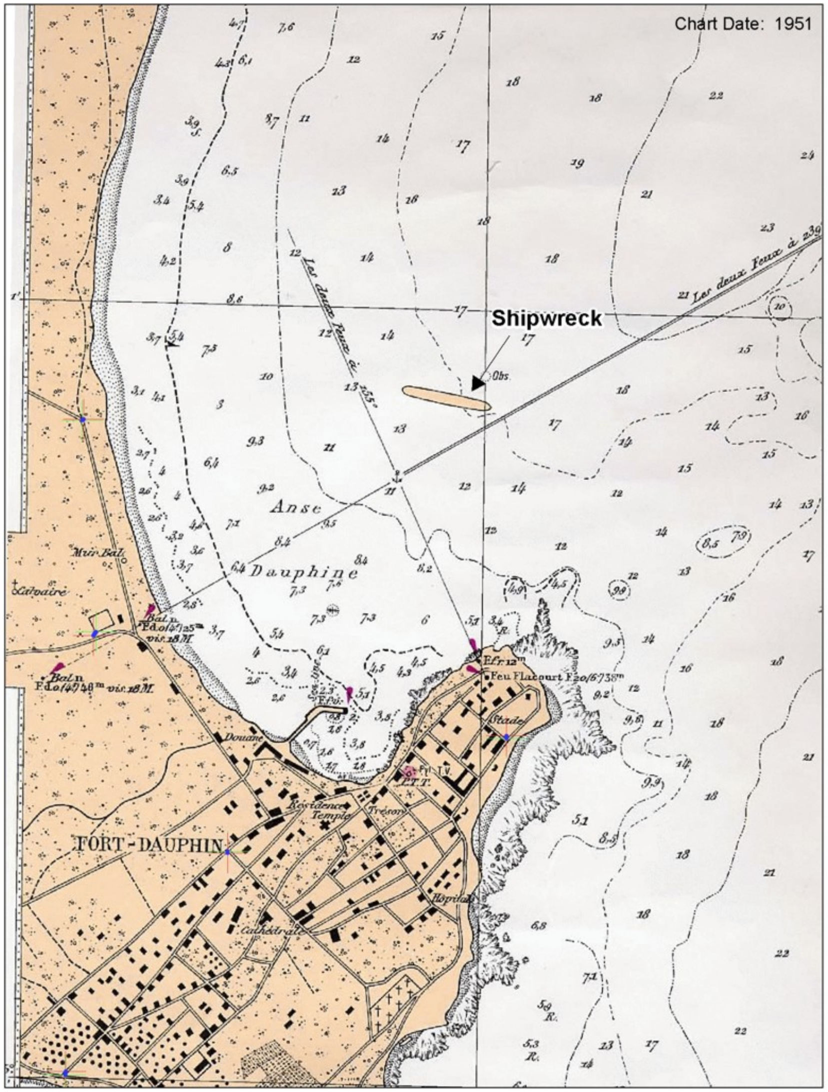

Figure F5 Shipwreck Location in Baie De Fort Dauphin.

Figure F6 Predicted Beach Planform using Hsu and Evans Equations for Varying Wave Directions

5.0 PREDICTED SHORELINE CHANGE WITH BREAKWATER IN PLACE

Once the equations were calibrated to fit the shoreline in the March 28th, 2004 QuickBird satellite image, the effect of the breakwater was calculated with a new diffraction point located at the tip of the breakwater using the calibrated control points and wave crest line orientations associated with each of the four diffraction points. The diffraction point at the tip of the breakwater is shown with contours on the 2004 satellite image in Figure 2.

The effect of the breakwater on the beach planform for each calibration is shown in Figure 7 by dashed lines. The shorelines predicted from the onshore diffraction point, the point between the offshore and onshore point, and the point along the breakwater show a shift in the equilibrium beach planform offshore of the existing equilibrium, indicating that the addition of the breakwater will cause the beach to accrete in response to the enlarged sheltering zone created by the new breakwater. The offshore diffraction point shows a similar trend near the groyne but shows erosion of the shoreline north of the groyne. As noted above, the predicted erosion (or shoreward position of the predicted shoreline) is likely due to the fact that the Hsu and Evans approach does not account for the net southerly transport that is believed to exist at this location.

According to this analysis, the addition of the breakwater will cause the shoreline to adjust to a new equilibrium beach planform (or dynamic equilibrium). This shoreline will likely be seaward of the existing shoreline position. Based on the validation presented in Section 4, and considering the closeness of fit as part of the calibration of Section 3, it is likely that the influence of the breakwater is best predicted as somewhere between the dashed red and green lines (associated with the 109° the 129°approach directions, respectively). Nevertheless, as noted in Section 1, this is an imprecise approach and simply provides an indication of possible range of response to the breakwater extension. In other words, there is sufficient uncertainty to state that these results are neither definitive nor conclusive, when considered on their own.

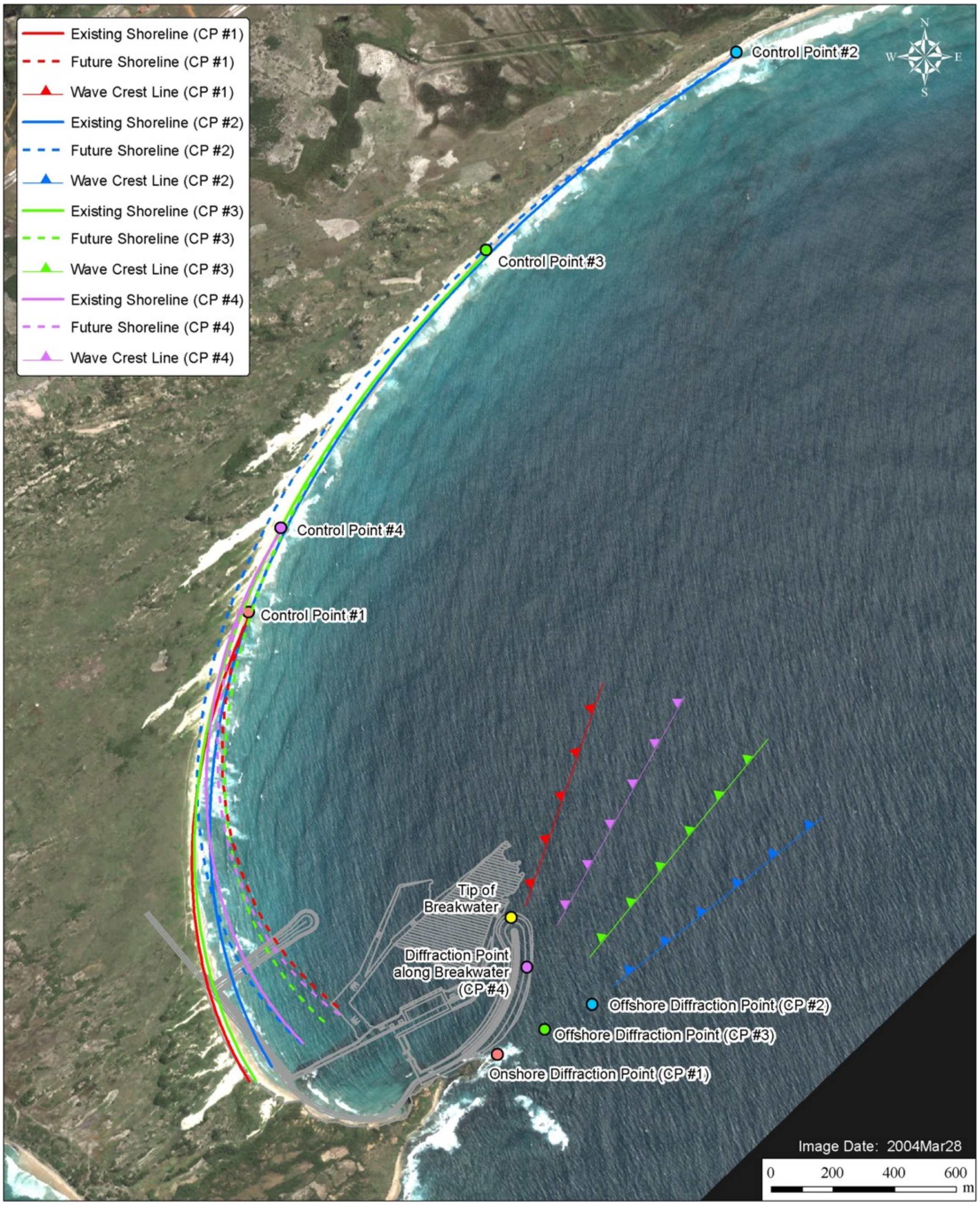

Figure F7 Effect o Breakwater on Planform Beach Predicted by Hsu And Evans' Equations for Varying Wave Direction

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ANNEXE 6

QMM ILMENITE PROJECT, MADAGASCAR. PROPOSAL FOR THE ENVIRONMENTAL COMPLIANCE MONITORING PROGRAM-MARINE ENVIRONMENT OF THE PORT AT EHOALA. JACQUES WITHFORD ENVIRONMENT. 2004

ANNEXE 7

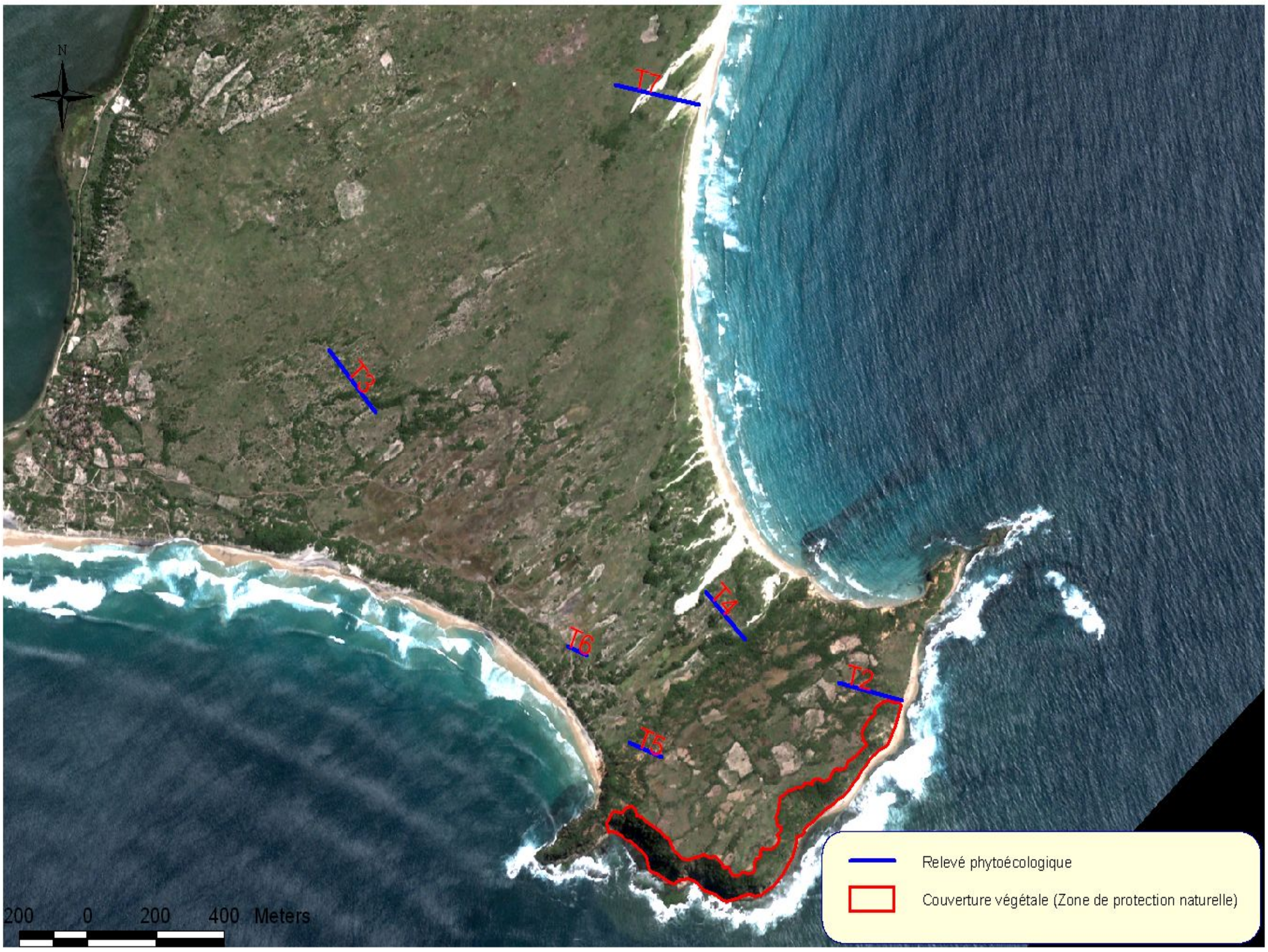
LISTE DES PLANTES INVENTORIÉES DANS LE SECTEUR DE LA PÉNINSULE D'EHOALA

Liste floristique de la péninsule d'Éhoala

Numero	Noms scientifiques	Famille	Anaran-kazo	Station				
				T7	T6	T5	T4	T3
1	Abrus littoralis	Fabaceae	Masokoaky					
2	Alchornea	Euphorbiaceae	Tsingafiafy					
3	Asparagus declinatus		Asparagus					
4	Azima tetracantha	Salvadoraceae	Fantsiny					
5	Bauhinia madagascariensis	Fabaceae	Banaky					
6	Brexia madagscarienisis	Celastraceae	Voakarepoka					
7	Buddleya fragifera	Buddleyaceae	Sariseva					
8	Caesalpinia bonduc	Fabaceae	Basiboka					
9	Canavalia obtusifolia	Fabaceae	Lalanda					
10	Canthium sp	Rubiaceae	Fantsikahitra					
11	Capparis	Capparaceae	Roy					
12	Cassine	Celastraceae	Haramboanjo					
13	Cassita filiformis	Lauraceae	Tsihitafototra					
14	Catharanthus roseus	Apocynaceae	Tonga					
102	Centella asiatica	Umbelliferae	Talapetraka					
15	Cinnamosma madagscariensis	Cannellaceae	Vahabahatra					
16	Commelina nudiflora Lim	Commelinaceae	Lavarefy					
17	Crataeva obovata	Capparaceae	Belataka					
18	Cyperus martimus	Cyperaceae	Akatamaimbo					
19	Desmodium	Fabaceae	Desmodium					
20	Digitaria horizontalis	Poaceae	Akatatsipirintsy					
21	Dracaena reflexa	Conavallariaceae	Falinandro					
22	Dyospiros gracilipes	Ebenaceae	Forofoky					
23	Dyospiros myriophylla	Ebenaceae	Forofoky					
24	Erythroxylum corymbosum	Erythroxylaceae						
25	Erythroxylum nitidilum	Erythroxylaceae	Menavoa					
26	Euphorbia intisyi	Euphorbiaceae	Famanta					
27	Euphorbia pulcherina	Euphorbiaceae						
28	Fernelia axillaris	Rubiaceae	Hazongalala					
29	Ficus sp	Moraceae	Nonoka					
30	Flacourtia ramountchi	Salicaceae	Lamonty					
31	Garcinia		Ditsaky					
32	Garcinia	Clusiaceae	Ditsaky Betsivory					
33	Grewia	Malvaceae	Hafotry					
34	Hydrophylax madagascariensis	Rubiaceae						
35	Hypharrenia	Poaceae						
36	Hypoestes	Acanthaceae						
37	Hypoestes	Acanthaceae						
38	Imperata cylindrica	Poaceae	Tegny					
39	Ipomoea purpurea	Convolvulaceae	Vahy hondro					
40	Jasminium kicthingi	Oleaceae	Vahihazo					
41	Lasiosiphon madagascariensis	Thymelaceae	Hafodramena					
42	Launaea bellidifolia	Asteraceae						
43	Ludia	Salicaceae	Soaravy					
44	Mapouria aegialoides	Rubiaceae	Hazombato					
45	Marsdenia cordifolia	Rubiaceae	Premina					
46	Memecylon delphinense	Melastomaceae	Tomizo					
47	Mimosa latispinosa	Fabaceae	Rakaraka					
48	Mimusops commersonii	Sapotaceae	Nato					
49	Mystroxylon aethiopicum	Celastraceae	Voavoa					
50	Oeniella polystachys	Orchidaceae	Velomihantona					
51	Ophiocolea delphinensis	Bignoniaceae	Akondronala					
52	Oplonia vincoides	Acanthaceae	Taisanda					
53	Oprculicarya decaryi	Anacardiaceae						
54	Opuntia	Cacataceae	Raketa					
55	Paederia	Rubiaceae	Laigomantsy					
56	Pandanus sp	Pandanaceae	Pandanus					
57	Panicum parvifolium	Poaceae	Ahipody					
58	Panicum umbelatum	Poaceae	Volonanondry					
59	Penissetum	Poaceae	Fantakabe					
60	Phyllanthus	Rubiaceae						
61	Phyllanthus decipiens	Euphorbiaceae	Sanira					
62	Phyllanthus sp1	Euphorbiaceae	Ambanivoa					

63	Phymatodes	Polypodiaceae	Sariboreko
64	Plagioscyphus sp		Ambiripiso
65	Poupartia minor	Anacardiaceae	Sakoa
66	Psiadia ultisima	Asteraceae	Volovohitra
67	Radamae	Scrophulariacea	Vilonandroy
68	Ramirea maritima	Cyperaceae	Akatamaimbo
69	Rhodocolea racemosa	Bignoniaceae	Somontsoy
70	Rhus tarantana	Anacardiaceae	Varongy
71	Salacia madagascariensis	Celastraceae	Voavahy
72	Scaevola taccada	Godniaceae	Lokaza
73	Scutia martima	Rhamnaceae	Senty
74	Secamone	Asclepiadaceae	Vahigonenina
75	Senecio	Asteraceae	Akata gisa
76	Senecio	Asteraceae	Sofimboalavo
77	Senecio	Asteraceae	Tsimenamena
78	Senecio	Asteraceae	Zira
79	Smilax kraussandra	Liliaceae	Fandrikatany
94	Solanum		Anambe
80	Stephanotaphrum dimidiatum	Poaceae	Ahipisaka
81	Streblus dimepate	Moraceae	Sarizaky
82	Strichnos spinosa	Celastraceae	Votaky
83	Tambourissa religiosa	Monimiaceae	Ambora
84	Tephrosia	Fabaceae	Tsilo
85	Tephrosia purpurea	Fabaceae	Akatafotsy
86	Terminalia catapa	Combretaceae	Katafana
87	Thuarea involuta	Poaceae	Mandavohita
88	Vanilla madagascariensis	Orchidaceae	Vaho
89	Vepris elliotii	Rutaceae	Ampoly
90	Vernonia	Asteraceae	Famonty
91	Vigna	Fabaceae	Famehivanemba
92	Vigna	Fabaceae	Teloravy
98	Weinnmania	Cunoniaceae	Laloa
93	A déterminer		Ahipatrafotsy
95	A déterminer		Anambotaky
96	A déterminer		Angama
97	A déterminer		Hazondambo
99	A déterminer		Menaravy
100	A déterminer		Bozaka
101	A déterminer		Taritarika
102	A déterminer		Vahimamy
103	A déterminer		Zamana

EMPLACEMENT DES RELEVÉS PHYTOÉCOLOGIQUES



ANNEXE 8

LISTE DES ESPÈCES FAUNIQUES INVENTORIÉES DANS LE SECTEUR DE LA PÉNINSULE D'EHOALA

Espèces recensées dans le secteur de construction des infrastructures portuaires

TAXON	Site d'Ehoala	Forêt littorale	Prairie	Marécage	Rivière	Milieu marin	Priorité UICN
AMPHIBIENS							
Heterixalus boettgeri							
Scaphiophryne calcaratus							
Ptychadena mascareniensis							
Tomopterna labrosa							
REPTILES							
Caretta caretta							
Erethmochelys imbricata							
Hemidactylus mercatorius							
Phelsuma lineata							
Phelsuma modesta							
Chamaeleo lateralis							
Chamaeleo oustaleti							
Cryptoblepharus boutoni							
Mabuya elegans							
Mabuya gravenhorsti							
Chalarodon madagascariensis							
Typhlops arenarius							
Dromicodryas bernieri							
Leioheterodon madagascariensis							
Leioheterodon modestus							
Liophidium vaillanti							
Liopholidophis lateralis							
Madagascarophis colubrinus							
Mimophis mahfalensis							
OISEAUX							
Bubulcus ibis							
Ardea purpurea							
Milvus migrans							
Numida meleagris							
Turnix nigricollis							
Dryolimnas cuvieri							
Streptopelia picturata							
Centropus toulou							
Caprimulgus madagascariensis							
Cypsiurus parvus							
Merops superciliosus							
Mirafra hova							
Motacilla flaviventris							
Hypsipetes madagascariensis							
Saxicola torquata							
Cisticola cherina							
Neomixis tenella							
Terpsiphone mutata							
Nectarinia souimanga							
Nectarinia notata							

Espèces recensées dans le secteur de construction des infrastructures portuaires

	Site d'Ehoala	Forêt littorale	Prairie	Marécage	Rivière	Milieu marin	Priorité UICN
Zosterops maderaspatana							
Cyanolanius madagascarinus							
Dicrurus forficatus							
Egretta alba							
Dendrocygna viduata							
Charadrius marginatus							
Charadrius mongolus							
Corvus albus							
Foudia madagascariensis							
MAMMIFERES							
Setifer setosus							
Tenrec ecaudatus							
Suncus murinus							
Microcebus murinus							
Rattus rattus							
Fossa fossana							*K
TOTAUX							
Amphibiens	**4**	3	3	2	0	0	
Reptiles	**19**	4	15	2	0	3	
Oiseaux	**29**	15	22	16	1	4	
Mammifères	**6**	5	3	5	0	0	
TOTAL	58	27	43	25	1	7	

ANNEXE 9

LISTE DES ESPÈCES DE POISSONS INVENTORIÉES DANS LE SECTEUR DE LA PÉNINSULE D'EHOALA

SPECIES NAME	FRENCH NAME	MALAGASY NAME	ENGLISH NAME
Acanthocybium solandri	Thazard-bâtard	Raznadramatra, angoho, lamatra	Wahoo
Anchoviella sp.	Anchois	Tovy	Anchovy
Aprion virescens	Vivaneau job, Chien vert	Fiandava	Green jobfish
Strongylura leiura	Aiguillette	Antseradava	Needlefish
Carangoides fulvoguttatus	Carangue à gouttes d'or, carangue pailletée	Faronandalitra, lanora	Yellowspotted trevally
Caranx ignobilis	Carangue têtue	Lanora	Giant trevally
Cephalopholis sonnerati	Vielle ananas	Horoamena, aloro	Tomato hind
Clupea harengus	Hareng	Pepe	Herring
Sprattus sprattus	Sprat	Pepe	European sprat
Coryphaena hippurus	Coryphène	Droaty	Dolphinfish
Dussumieria elopsoides	Sardine arc-en-ciel	Ampiny	Rainbow sardine
Echeneis naucrates	Rémora commun		Shark sucker
Elagatis bipinnulata	Comère saumon	Fiamandry	Rainbow runner
Epinephelus fasciatus	Vielle rouge	Alovo, borisy, tarataka	Redbanded grouper
Epinephelus multinotatus	Mérou plate grise	Alovo	White-blotched grouper
Etelis coruscans	Vivaneau flamme	Ambatsy riake/ Koanabe	Flame snapper
Euthynnus affinis	Bonite à dos rayé / Thonine orientale	Milanja, vohy, lamatra, angoho	Kawatsawa
Galeocerdo cuvier	Requin-tigre commun	Antsatsa	Shark
Gerres acinaces	Blanche gouvernail	Matsitsoke, ambariaka	Longtail silver-biddy
Gymnocranius grandoculis	Empereur tatoué	Lovoro, barialava, antsisy, tsivaravaramena	Blue-lined large-eye bream
Hemiramphus spp	Demi-bec	Antserapohy	Halfbeak
Herklosichthys quadrimaculatus	Hareng à bande bleue	Voivoy, pepe, geba, besisika, ampiny	Bluestripe herring
Katsuwonus pelamis	Bonite à ventre rayé	Von, lamatra	Skipjack tuna
Lethrinus harak	Empereur Saint-Pierre	Vaipatola, ambitsy, tapaporoa	Thumbprint emperor
Lethrinus mahsena	Empereur mahsena	Manahelika, angelika	Sky emperor
Lethrinus nebulosus	Empereur moris	Ambitsy, kotrokotro, angelika	Spangled emperor
Lethrinus rubrioperculatus	Empereur honteux	Vaindava, Ambitry	Spotcheek emperor,
Lutjanus bohar	Vivaneau chien rouge	Varavaraha mena	Two-spot red snapper
Lutjanus ehrenbergii	Vivaneau encrier	Fatola	Blackspot Snapper
Makaira mazara	Makaire bleu de l'Indo-Pacifique	Manambosambo, androaro tokapalaza	Indo-Pacific blue marlin
Liza macrolepis	Mulet à grandes écailles	Zompo/Tofoke	Largescale Mullet
Paracaesio xanthura	Vivanette queue jaune	Fitse	Yellowtail blue snapper
Pristipomoides filamentosus	Colas fil	Rehoreho	Crimson jobfish
Rhadbosargus sarba	Sargue doré	Vahoho, ambatovasena	Goldlined seabream
Sardina sardinops	Sardinelle	Pepe	Sardine
Scarus ghobban	Perroquet barbe bleue	Lavalia, bodoloha, fihambazaha	Blue-barred parrotfish
Scomberomorus commersoi	Thazard rayé Indo-Pacifique	Thon, Lamatra, Angoho	Narrow-barred spanish mackerel
Selar crumenophthalmus	Selar coulisou	Valahara, mahaloky bevava	Bigeye scad
Siganus rivulatus	Sigan marbré	Halalaza/Moramasaka	Marbled spinefoot
Sphyrna sp.	Requin marteau	Antsatsa	Hammerhead shark
Sphyraena barracuda	Barracuda	Aloalo	Great barracuda
Stegostoma fasciatum	Requin-zèbre	Antsatsa	Leopard shark

Jacques Whitford
Environment Limited

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Environmental Scientists
Risk Consultants

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Maine • New Hampshire • New York • Pennsylvania • Trinidad • Russia • Argentina

August 31, 2004

Mr. Jean C. Giroux,
Project Manager
QIT Madagascar Minerals Ltd.
770, rue Sherbrooke ouest
Bureau 1800
Montreal, Québec
H3A 1G1

Proposal No. NBF03478

Dear Mr. Giroux,

Re: QMM Ilmenite Project, Madagascar: Proposal for the Environmental Compliance Monitoring Program - Marine Environment of the Port at Ehoala

Jacques Whitford Limited is pleased to submit to QMM Madagascar Minerals (QMM) a revised proposal to conduct the Environmental Compliance Monitoring (ECM) Program for the port at Ehoala Peninsula. The proposed monitoring program (attached) is designed with considerations for World Bank guidelines and safeguards. The proposed ECM program addresses the baseline data for the future port at Ehoala Peninsula and prior to construction, and which will assess the predictions of the impacts and effectiveness of mitigation measures indicated in the Social and Environmental Impact Study of the QMM Ilmenite Project. It is also part of the overall monitoring programs that will involve work during and after construction of the port to ensure that all regulatory requirements and commitments made within the "Plan de Gestion Environnmental du Projet" (PGEP) for the QMM Ilmenite Project are met. These requirements include both national and international standards and obligations for similar projects.

Jacques Whitford would be pleased to provide you with a proposal for the Atmospheric Environment (Air Quality, Sound, Odour, and Climate) and Ecological Risk Assessment, including Human Health and the Radiological Environment. If required, I will also coordinate with QMM these and other environmental services of Jacques Whitford, including the production of complete Environmental Protection Plans (EPPs) and Emergency Response Plans (ERPs) for the port.

Our proposal is structured to provide flexibility to QMM. Mr. Sam Salley will be acting as overall Project Coordinator and Manager for this and other work performed by Jacques Whitford on behalf of QMM, and will actively seek opportunities to optimize work and costs.

Thank you for giving Jacques Whitford the opportunity to submit a revised proposal. Please feel free to call me at (506) 457-3272 should you have any questions about the proposed work scope or scheduling.

Sincerely,

JACQUES WHITFORD LIMITED

Sam Salley

Sam Salley, M.Sc.
Senior Consultant
Environmental Sciences

Attach.

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UPDATE BASELINE STUDY FOR MARINE ENVIRONMENTAL COMPLIANCE MONITORING OF THE PORT AT EHOALA IN FORT-DAUPHIN, MADAGASCAR

PROPOSAL NO. NBF03478

PROPOSAL NO. NBF03478

TO

QMM Madagascar Minerals

ON

UPDATE BASELINE STUDY FOR MARINE ENVIRONMENTAL COMPLIANCE MONITORING OF THE PORT AT EHOALA IN FORT-DAUPHIN, MADAGASCAR

Jacques Whitford Limited
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Revised August 31, 2004

PROPRIETARY STATEMENT

This proposal, including descriptions, methodologies and technologies described herein, shall not be distributed outside QMM Madagascar Minerals, and shall not be duplicated, used or disclosed in whole or in part for any purposes other than for evaluation. If, however, a contract is awarded to this offerer as a result of or in connection with the submission of this proposal, QMM Madagascar Minerals shall have the right to duplicate, use, or disclose the data to the extent provided in the resulting contract.

JACQUES WHITFORD LIMITED

Project Manager

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1.0 INTRODUCTION

This proposal has been prepared by Jacques Whitford in response to the request for proposals regarding the Environmental Compliance Monitoring (ECM) Program for the marine environment at Ehoala Peninsula and site of the future port (Jean Giroux, pers. comm.). Monitoring of the environment prior to port construction is a compliance activity as per the requirements stated in the "Plan de Gestion Environmental du Projet" (PGEP) for the Environmental Management Plan of the QMM Ilmenite Project (QMM 2001a). The PGEP was issued to QMM Madagascar Minerals on November 26, 2001, as a condition of Project acceptance and to fulfill ECM requirements for the environmental and mining permit issued by the Ministre de l'Environnement of Madagascar. As stipulated in the PGEP, these monitoring activities and collection of updated data are to be undertaken two years prior to port implementation, which is currently planned for 2006. The design and conduct of the ECM Program will assess anticipated (predicted) impacts of the port and effectiveness of mitigation measures (QMM 2001a,b).

The ECM Program is designed to minimize impacts of pre- and post-port activities on marine resources and the environment, as well as monitoring impacts of implementing and operating the port. This program requires baseline data prior to project implementation, such as baseline chemistry sediment data associated with dredging for the port for example, and baseline marine resource, environmental and socioeconomic (of fishers) survey data to assess potential positive or negative impacts of the port and of the effectiveness of mitigation measures. This proposal outlines the types of baseline and updated data needed to make defensible and robust impact predictions, the data collection methods, timing of surveys, location of sampling stations, and evaluation of impact significance (where available) required to conduct the monitoring program.

1.1 Anticipated Impacts of the Port at Ehoala

The identification and all anticipated impacts (environmental effects) on the marine environment as a result of the port at Ehoala Peninsula were provided in the Social and Environmental Impact Study of the QMM Ilmenite Project (QMM 2001b) and the PGEP (QMM 2001a). These impacts on the marine resources and environments and on the socioeconomics of fishers at Ehoala and Fort-Dauphin were evaluated for the port activities of the project, which included phases for construction and operation.

The construction phase of the port involves primarily the installation of the breakwater and port access roads of approximately 800 m along the frontal sand dunes on the western end of Fausse Baie des Galions (*i.e.*, near-shore access roads). Potential dredging at the location of ships berthing at the pier and channel approaches may also be required for the port construction and operation phases. The predicted marine environmental impacts of the construction and operation phases of the Ehoala Port are:

- Modifications to the profile of beaches along the Fausse Baie des Galions as a result of the access roads to the port and breakwater;
- modifications to hydrodynamic characteristics, water and sediment quality, and marine benthic habitats as a result of potential dredging for the port;
- erosion of the foreshore in the western sector of Fausse Baie des Galions and sedimentation in the area of the pier and northern point of Ehoala Peninsula as a result of the breakwater;
- modifications to the hydrodynamic characteristics in the Fausse Baie des Gallions and port site at Ehoala as a result of the breakwater;
- increase in turbidity in the Fausse Baie des Galions as a result of the breakwater (only construction phase) and dredging;
- risk of contamination in the marine environment as a result of accidental spills of hydrocarbons and other wastes;
- loss of coastal vegetation along the near-shore port access roads and facilities;
- loss of marine fauna and habitats at the location of the breakwater;
- modification of the composition of marine biota and populations;
- disturbance of marine mammals, particularly whales, from construction noises, dredging, shipping traffic and other activities in the vicinity of Fausse Baie des Galions;
- perturbation of marine habitat and of biodiversity;
- loss of marine resources, fishing grounds and beach access to fishing grounds (*i.e.*, loss of revenue for fishers);
- increase of marine habitat and resources near the Ehoala Peninsula in the area of the breakwater (only operation phase); and
- modification to existing and to potential development of marine ecotourism.

The above impact predictions in the SEIS and PGEP of QMM were described qualitatively, with no provision for threshold of significance of impacts. Mitigation measures to be implemented, however, were identified.

1.2 Objectives of the Update Baseline ECM Study

The objectives of the marine ECM Program are to fulfill the commitments made by QMM in the PGEP. These commitments include updating previous baseline studies and collecting additional baseline data to monitor impacts on the marine environment and to monitor the effectiveness of mitigation measures at the Ehoala port location and in the vicinity of the Ehoala Peninsula and adjacent Fausse Baie des Galions. To achieve these objectives, an ECM Program is established by developing and implementing practical monitoring indicators, or Environmental Performance Indicators (EPIs) using World Bank terminology (World Bank 1996a), to measure and evaluate environmental (including health and socioeconomic) changes brought about by the Ehoala Port. These monitoring indicators will also assist in assessing the effectiveness of proposed mitigation measures. The overall objective of performance monitoring is to identify predicted and unanticipated changes to the physical, biological and social environment brought about by the port. This requires baseline information, and the objective of this proposal, on pre-development environmental and social conditions, against which development and post-development impacts and mitigation measures can be measured and compared. Deviations from the baseline beyond predetermined limits should trigger corrective actions. Therefore, the objectives of the 2004-2005 update baseline ECM study for the port are as follows:

- to provide QMM with updated baseline ECM information from previous studies and additional baseline data to assess the magnitude and spatial extent of potential impacts of the port on the receiving environment of Ehoala Peninsula and approaches and of the effectiveness of mitigation measures;

- to monitor important harvestable marine resources, particularly the red alga *Gelidium madagascariensis* and spiny lobsters (*Panulirus homarus*, *P. penicillatus*, *P. longipes*, *P. ornatus*, and *P. versicolor*) as EPIs;

- to monitor fishers, their activities and landings as socioeconomic performance indicators;

- to monitor threatened marine species, primarily humpback whales (*Megaptera novaeangliae*) and the presence of sea turtles (*Caretta caretta*, *Chelonia mydas*, *Lepidochelys olivacea* and *Eretmochelys imbricata*) and of fish species (*Coryphaena hippurus*, *Euthynnus affinis*, *Katsuwonus pelamis*, *Galeocerdo cuvier* and *Makaira mazara*) as EPIs;

- to monitor coastal vegetation and sea birds as EPIs;

- to monitor marine biota in the Ehoala Sector and evaluate their response to the implementation of the port at the ecosystem (health of coral reefs), community (seaweed), population (*Tripneustes* spp. sea urchin) and biodiversity (seaweed) levels as EPIs;

- to monitor modifications to the hydrodynamic characteristics, water quality and sediment quality in Fausse Baie des Galions as EPIs; and

- to provide further guidance and training of the QMM technical staff in Fort-Dauphin to strengthen institutional capabilities and performance for ECM quality assurance/quality control purposes, including activities toward ISO 9001 and 14001 implementation. (This objective would be a continuation of objectives and follow-up to the Jacques Whitford site visit to Fort-Dauphin in August 2003, and for specific aquatic activities of the PGEP.)

The proposed 2004-2005 marine baseline ECM study will maximize on the information acquired from previous baseline studies and the marine surveys conducted by CSSA International Consultants in 2000

(CSSA 2001), and use those surveys as templates on which to design, conduct and update the Baseline ECM Program. The 2000 baseline studies were designed to determine the existing physico-chemical, biological, and marine and fisheries resource conditions of the waters for the environmental assessment of the QMM Ilmenite Project and port. The 2004-2005 ECM study is proposed to update the 2000 baseline data and to collect additional data to establish the database for the marine Baseline ECM Program. This database will be used to assess any possible changes resulting from port implementation on water quality, sediments, hydrodynamics, invertebrates, corals, seaweed, lobster, coastal vegetation, sea birds, and threatened marine species in the area, namely humpback whales, sea turtles and fish species. The monitoring of beach profiles, sedimentation and erosion in the marine environment will be undertaken by QMM (Fort-Dauphin) as one of the PGEP activities, and therefore is not an objective of the update baseline ECM study in this proposal. The results of the 2004-2005 ECM study for the port site will be compared to the previous results for the site (2000) to evaluate existing trends or variability of the marine environment.

The results of the 2004-2005 baseline ECM database will provide QMM with information that is needed in order to manage port operations, and to decide whether the objectives of the port operations have been achieved. In addition, the baseline ECM information will provide data to plan conservation measures and to assist in the development of community management plans to sustain harvesting of coastal marine resources in the vicinity of the port.

1.3 Approach to the Baseline ECM Program

The approach to the marine baseline ECM for the pre-construction of the port is adopted after the:

- *Environmental, Health and Safety Guidelines for Port and Harbor Facilities* developed by the International Finance Corporation (IFC 1998); and

- *Environmental Considerations for Port and Harbor Development* developed by the World Bank (1990).

These guidelines are to be used in carrying out policies set out in the Operational Policy on Environmental Assessment (World Bank and IFC OP 4.01) and related documents for port projects. These guidelines provide safeguard issues/criteria for project sponsors that must follow, and which are recognized as internationally accepted standards. In the context of pre-port construction and collection of baseline data to assess and minimize impacts on environmental resources, these guidelines include:

- evaluating changes in water quality and circulation, including depletions in dissolved oxygen concentrations;
- evaluating sediment erosion and accretion effects of constructed marine structures in zones of high littoral sediment transport;

- performing physical and chemical analyses of sediments prior to disturbance of material to be dredged;
- evaluating toxic contaminants from existing sediment deposits that may potential be resuspended;
- uptake by and accumulation in fish and shellfish of potential contaminants;
- increased turbidity causing decreased photosynthetic activity;
- disposal of dredged materials in sensitive habitats;
- dredging and disposal during critical spawn-and-set periods for shellfish;
- dredged material (wastes) managed and disposed of in accordance with international conventions and agreements and the obligations therein, including the London Dumping Convention 1972 and other pertinent regional waste management agreements;
- shoreline vegetation;
- wetlands;
- coral reefs;
- fisheries; and
- sea-birds.

Other key guidance documents that have been/will be followed in the design and implementation of the marine Baseline ECM Program that is site-specific for the port project in Fort-Dauphin include:

- Pollution Prevention and Abatement Handbook: Monitoring (World Bank 1998a);
- Environmental Performance Monitoring and Supervision (World Bank 1996a);
- Guidelines for Monitoring and Evaluation for Biodiversity Projects (World Bank 1998b);
- Plan de Gestion Environnementale du Projet Ilménite (QMM 2001a);
- Social and Environmental Impact Study of the QMM Ilmenite Project (QMM 2001b);
- Aquatic Ecosystem Study: Fort-Dauphin Region, Madagascar (CSSA 2001); and
- any Environmental Protection Plan documents that QMM may have prepared.

According to The World Bank (1998a), "Typical monitoring objectives include establishing a sound scientific basis for policy development; determining compliance with statutory criteria; assessing population and ecosystem exposure and risk; providing public information; identifying pollution sources as a part of air and water quality management systems; and evaluating long-term trends."

1.4 Organization of the Proposal

This proposal is organized into four sections. Following this introduction, Section 2.0 provides a detailed description of the Work Plan. Section 3.0 provides the Management Proposal, identifies staff who will be involved in the project, and presents a proposed schedule for completion of the work. References cited throughout this proposal are listed in Section 4.0, and Closure is in Section 5.0.

2.0 WORK PLAN

2.1 Study Design

To meet the objectives of this study, Jacques Whitford recommends that QMM follow the general guidelines and criteria provided by the World Bank and the International Finance Corporation for port and harbour facilities given in Section 1.3 for the 2004-2005 marine baseline ECM program for Ehoala Peninsula. The current study design for the baseline marine monitoring program is based on these recommendations. International standards, accepted also by the World Bank and the International Finance Corporation, are used with respect to marine dredging and disposal impact assessment, and physico-chemical and biological parameters to sample and monitor as per the criteria for the international London Dumping Convention.

The World Bank (1996a) recommends that an effective environmental monitoring program should consist of the following elements:

- monitoring objectives;
- description of performance indicators which provide linkages to impacts and mitigation measures identified in the Environmental Assessment;
- description of parameters to be measured, methods to be employed, sampling locations, frequency of measurements, detection limits (where appropriate) and definition of thresholds that will signal the need for remedial actions;
- institutional responsibilities, timing and timescales for monitoring (presented in the PGEP of QMM);
- reporting arrangements to the regulatory authorities and the Bank (not an element of this proposal); and
- costs and financing provisions (not an element of this proposal).

This proposal provides a list of established species identified by CSSA in 2000 (CSSA 2001) that are appropriate as monitoring indicators (Environmental Performance Indicators - EPIs). These indicator species to monitor are given below in Sections 2.2.4 to 2.2.8 for the surveys to be conducted in the marine environment, including rare and endangered species and species to monitor at the population, community, and ecosystem levels. The overall objectives to monitor these species as EPIs are provided in Section 1.2. The linkages of theses EPIs to predicted impacts of the port are provided in the respective sections (2.2.1 to 2.2.9).

A description of parameters to be measured, methods to be used, sampling locations, and frequency of measurements are also provided in Sections 2.2.4 to 2.2.9. The methodologies proposed to conduct the surveys and to collect monitoring data in the proposal are more of a quantitative than qualitative nature. Over the life of the port, spatial and temporal monitoring data in future rounds of the ECM program will be collected and which will be analyzed quantitatively. Not all data collected for the present Baseline ECM Program can be analyzed quantitatively (e.g., whale, sea turtle, endangered finfish, and sea bird survey data), except for temporal trends of species presence and abundance, because they will be more or less year-long surveys. Subsequent monitoring data will be required and collected during construction and operation phases of the port in order that a quantitative analysis and impact assessment/success of mitigation measures of port construction and operation can be undertaken. The primary objective of the current proposal is to collect baseline monitoring data and before implementation of the port, against which subsequent monitoring data will be compared to quantitatively. However, some of the baseline data can already be analyzed statistically to assess spatial differences (between Fort-Dauphin and Ehoala peninsulas and ECM sites) for lobster, *Gelidium*, seaweed, coral reefs, *Tripneustes* sea urchin, and physico-chemical parameters of sediment, water and biota. Temporal quantitative analysis of baseline data on the finfish surveys at Ehoala (fish catch per unit of fishing effort) can also be analyzed statistically. Replicate sampling of quadrats, transects, or time periods are proposed in the proposal (sections 2.2.4.1, 2.2.4.2, 2.2.4.3, 2.2.6, 2.2.7, 2.2.8, and 2.2.9), with the intention to subject the data to statistical testing for differences between sites or seasons for the 2004-2005 baseline ECM study.

The criteria for significant impacts and quantitative significance thresholds (e.g., how much of a significant change is required to be evaluated as an impact) are normally presented in the SEIA. If they have not been provided in the SEIA, then they are provided in the Environmental Protection Plans (EPPs) for the construction and operation of the port. Definitions of thresholds for significant impacts of the QMM port are currently available only for inherent ambient standards or guidelines for water quality and sediment quality to protect aquatic life, and for fish and shellfish destined for human consumption (e.g., USEPA, CEE, CCME, ANZECC). Where predetermined significance threshold of predicted impacts are not available, such as changes in biodiversity indicators, fishing effort or whale migration routes, the significance of predicted impacts should be discussed with key stakeholders with a view of building consensus (World Bank 1996b). Values, special interest considerations, and best professional judgment can be applied jointly to assign or re-assign significance (World Bank 1996b). Therefore, unavailable significance threshold values will be discussed with QMM with the objective of arriving at preliminary estimates during this baseline or future ECM studies.

Mitigation measures are also identified and proposed at the SEIA or EPP stages of the project. Generally, the primary objective of ECM programs is to verify if impacts have been detected and if mitigation practices are effective. Monitoring on its own does not minimize impacts, establish criteria or determine significant thresholds, but it does recommend modifications or adjustments to data collection, criteria and significance threshold values used for impact evaluation, and mitigation practices as the port and mine proceed through construction, operation, and decommissioning phases.

Any aquatic ECM program is typically completed in two stages: study design and field study. The study design stage provides QMM with an important opportunity to comment and to include the participation of key government agencies or institutions in the planning, participation or review phases of the project (*e.g.*, O.N.E., Ministère de la Pêche, C.N.R.E., FAO, WWF, World Bank). This mechanism helps to secure regulatory acceptance of the study design and objectives, and ensures that only work that is required to meet regulatory objectives is included in the program. The proposed study design is the first iteration judged to be the best site-specific and international approach without input from QMM on current issues. The study design can be refined by successive iterations through dialogue with QMM to a level acceptable in terms of stakeholders and of technical and financial considerations.

The study design phase also incorporates much of the "desktop" work required to review existing information and describe natural changes that may have occurred or be occurring in the Study Area. The field study includes the gathering and processing of field information for baseline ECM data, and the preparation of an interpretive report. The interpretive report contains the findings and conclusions of the ECM study, as well as any recommendations for modifications to future rounds of ECM.

2.2 Field Study

2.2.1 Delineation of the Port Zone of Influence

The objective to delineate the Port Zone of Influence by selecting sampling locations is to define the spatial boundary and extent of predicted or potential impacts as a result of implementation of the port.

The installation of the port during 2006 will require a breakwater extending from the eastern tip of Ehoala Peninsula into the Fausse Baie des Galions. The primary zone of influence is expected to remain within the port basin if mitigation measures and Environmental Protection Plans are effective. A secondary zone of influence that extends beyond the primary zone, including Ehoala Peninsula, and into the shipping lane(s) for the port may occur if there is interference with fishing activities or migration routes, such as that for the humpback whales that are known to occur in these waters. The secondary zone of influence may also include potential environmental impacts on adjacent shoreline vegetation, coral reefs, fisheries, bird life, and other sensitive aquatic and near-shore habitat. An access road to the port approximately 800 m in length along the shoreline in Fausse Baie des Galions is also being planned and will be included in the Port Zone of Influence. Wetlands are not found in the immediate vicinity of the port because of the cliff-like terrain of Ehoala Peninsula. Therefore the spatial boundary for the ECM field investigation will consider these zones in the collection of baseline data, and to monitor predicted and unpredicted impacts as well as success of mitigation measures of the port and operations. For purposes of this ECM Program, an upstream-downstream control-impact study design is adopted for the port, with the selection of the following sampling sites, illustrated in Figure 2.1.

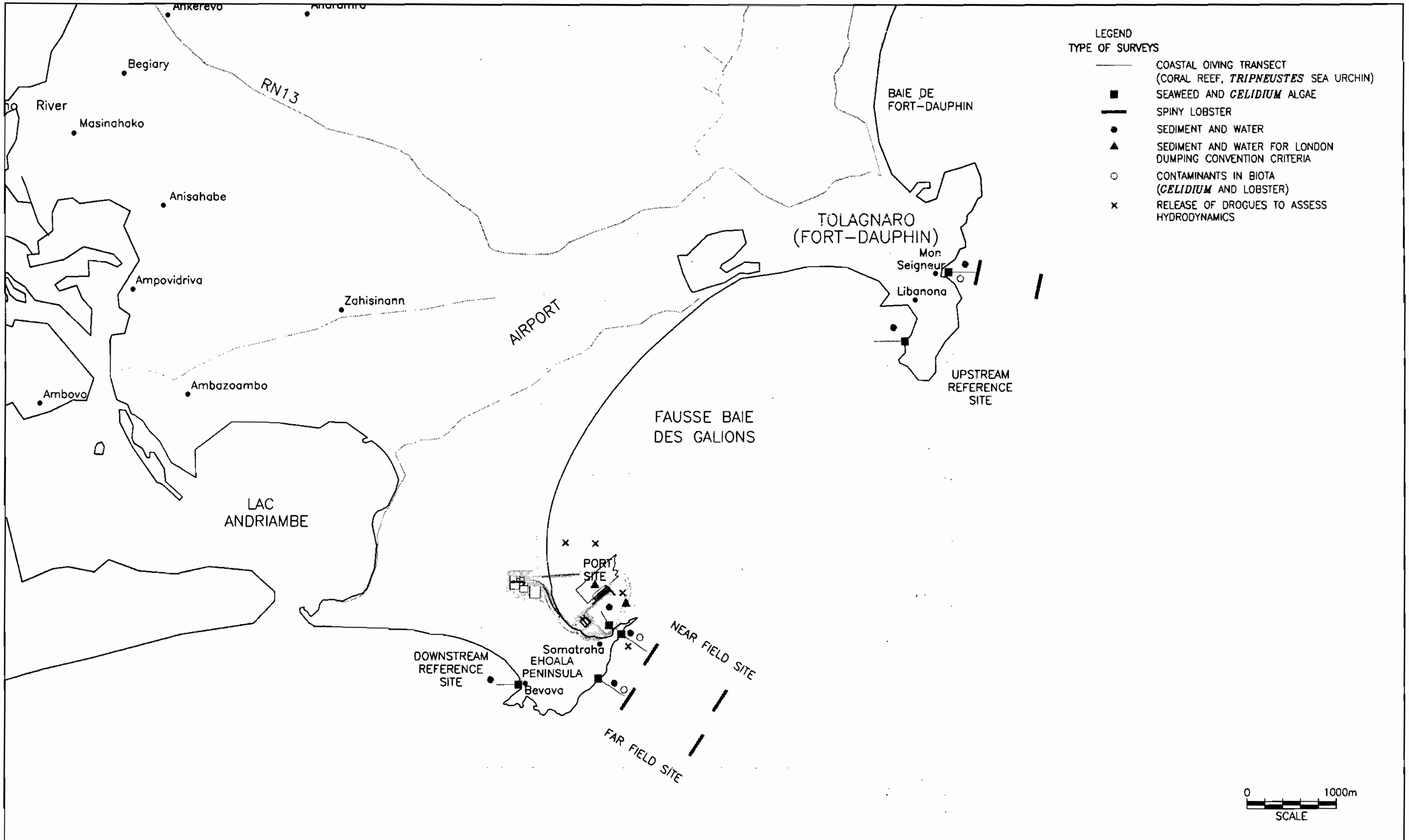
- **Upstream Reference Site**: This reference site is located at Fort-Dauphin Peninsula because it is upstream of the port site and the prevailing westward littoral drift for both the Fausse Baie des Galions and Baie de Fort-Dauphin. The substrate, bathymetry, marine habitat and resources, and local oceanographic and wave conditions in the waters surrounding the Fort-Dauphin Peninsula are very similar to that for Ehoala Peninsula (CSSA 2001). Two stations will be sampled at the upstream reference site. One is off the Fort-Dauphin Peninsula in the Indian Ocean (Mon Seigneur), and the second (Libanona) is inside Fausse Baie des Galions and northeast of Ehoala and the port. The Libanona station is selected because it is protected from the Indian Ocean where corals are more prevalent and the popular tourist beach is located. The upstream reference site and stations serve as one of the control areas for the study, the other being the downstream reference site (see below).

- **Port Site:** The port site is the marine environment in the harbour and protected by the breakwater. This site is comprised of a smaller segment of rocky coast followed by a longer segment of sandy beach on the western end of Fausse Baie des Galions. This area is also at a distance from the berthing of ships at the pier and the breakwater. It could be a primary zone of port influence, and therefore will be surveyed and monitored. There are fewer marine resources (*e.g.*, lobster) at this site than on the exposed ocean side of Ehoala Peninsula or the region of Fort-Dauphin (CSSA 2001). The monitoring surveys at this site will therefore concentrate more on the habitat than the resources.

- **Near Field Site**: The near field site is located approximately 100 m downstream from where the breakwater for the port is expected to extend from the Ehoala Peninsula into the Fausse Baie des Galions. Monitoring at this site will intercept the first signs of any potential impacts of the port outside the harbour because of prevailing southwestern currents.

- **Far Field Site**: The far field site is located approximately 500 m downstream from the near field site. This location was selected to assess potential magnitude and spatial extend of impacts of the port.

- **Downstream Reference Site**: This downstream reference site is located approximately 1,500 m downstream of the breakwater for the port and inside the western tip of Ehoala Peninsula and the next bay over to the west and before the entrance to Lac Andriambe. This site is more sheltered and not subjected to the same prevailing westward littoral drift as for the near and far field sites. This location was selected to be outside of the zone of port influence and as the downstream control site for the study. Another advantage to the selection of this site is that it is close to the entrance of Lac Andriambe, which contains important estuarine habitats and fishery resources for the region of Fort-Dauphin.



PROPOSED SAMPLING SITES ENVIRONMENTAL COMPLIANCE MONITORING QMM PORT PROJECT EHOALA	Date: 2004 08 31	Scale: 1 : 40,000	Jacques Whitford Consulting Engineers Environmental Scientists
	Job No.: 03478	Fig. No.: 2.1	

FILE: EFFECTS SEPT 2004

2.2.2 Habitat Inventory and Classification

The objective for habitat inventories is to identify sensitive and critical marine and coastal habitats that may be impacted by the port. Detailed habitat inventories were compiled during the sampling surveys in 1999 and 2000 by CSSA (1999, 2001); these habitat inventories will be updated where sites are re-sampled during 2004. New habitat inventories will be compiled for sites that have not previously been investigated. Another objective of habitat inventories includes the identification of existing pollution sources in the Port Zone of Influence and ECM sampling sites prior to port development and to establish a baseline of pollution sources.

Habitat inventory of the seabed will be assessed in 2005 using SCUBA diver observations and underwater photography. Still photographs and video of the sea bed will be taken by Jacques Whitford prior to conducting transects for coral surveys (see below) and at the location of the port breakwater/pier (the benthic habitat in this area may be completely buried to install the breakwater). The habitat information will be compiled in map form.

2.2.3 Resource Inventory

A resource inventory is a performance indicator that identifies marine resources and resource uses which may potentially be impacted by the construction and operation of the port. This information includes fisheries resources that are presently exploited in commercial or non-commercial fishing, that may potentially be exploited in future, and any species that are recognized by Malagasy or international authorities as rare, threatened, or endangered, as well as any species that may be present in sufficient numbers to be considered as a potential monitoring or indicator species. The objectives to monitoring marine resources, as a performance indicator, are to assess the following linkages to predicted impacts of the port:

- modifications to marine benthic resources as a result of potential dredging for the port;
- loss of marine resources, fishing grounds and beach access to fishing grounds (*i.e.*, loss of revenue for fishers);
- increase of marine habitat and resources near the Ehoala Peninsula in the area of the breakwater (only operation phase); and
- modification to existing and to potential development of marine ecotourism.

Marine resources have been identified by CSSA (2001), and will be updated through interviews with representatives from the Ministère de la Pêche, FAO, WWF, and QMM staff undertaking local fishers and fish landing surveys at Ehoala Peninsula.

The proposed reporting format for information from the Habitat Inventory and Resource Inventory is summarized in Table 2.1.

Table 2.1 Reporting Requirements for Habitat and Resource Inventory Information

Parameter	Description/Information to be Reported
Rivers, streams discharging into the sea.	Locations to be shown on maps.
Fish and invertebrate spawning grounds.	Locations of known areas to be shown on maps.
Fishing grounds	Locations of known areas by species to be shown on maps.
Water intakes, effluent discharges, stormwater discharges, sewer overflows, disposal sites, etc.	Locations of known areas to be shown on maps.
Marinas, boat launches, and public beaches or access points.	Locations of known areas to be shown on maps.
Dams and other barriers to fish and invertebrates.	Locations of known areas to be shown on maps.
Zones of mono-specific plant or algal species.	Identify areas where aquatic plant growth is significant that may be attributed to eutrophication, or appears to be modified from conditions at reference sites.
Marine resources	Locations of known areas to be shown on maps.
Marine-based ecotourism	Locations of known areas to be shown on maps.

2.2.4 Marine Resources Survey

The ecosystem study of CSSA (2001) identified four important marine resources for the Study Area that could be used as indicators for monitoring purposes. They are spiny lobsters, *Gelidium* algae (exported for agar extraction), pelagic finfish, and humpback whales (from an environmental conservation and ecotourism perspective). Jacques Whitford proposes to conduct baseline ECM surveys, either as a continuation of the surveys conducted in 2000 by CSSA and QMM (e.g. marine finfish and lobster), or as newly designed surveys to monitor these resources and assess predicted positive and negative environmental impacts of the port and effectiveness of mitigation measures provided in the SEIA and PGEP of the Project. The proposed methodologies, locations and timing of these surveys for each of these and other marine resources are provided below.

2.2.4.1 Spiny Lobster

The purpose to survey spiny lobster is to collect monitoring data for a commercial marine resource and as the EPI to assess the predicted impact and linkage to the port for:

- modifications to lobster resource as a result of potential dredging for the port;
- loss of an important marine resource (*i.e.*, loss of revenue for fishers) in the Port Zone of Influence; and
- increase of lobster resource and habitat near the Ehoala Peninsula in the area of the breakwater (only operation phase).

There are five species of lobster found in the region of Fort-Dauphin and that may be present at Ehoala. They are *Panulirus homarus*, *P. penicillatus*, *P. longipes*, *P. ornatus*, and *P. versicolor* (CSSA 2001). Monitoring of these lobster species will also contribute as a monitoring indicator for lobster biodiversity.

The assessment of lobster stocks in principal fishing grounds close to the Ehoala, Fort-Dauphin and Evatraha peninsulas were not undertaken by CSSA in 2000. Instead, the fishing effort (as number of fishers, pirogues, lobster traps, landings, location of traps in fishing grounds, and consultation with fishers) was assessed on a local and regional scale to investigate this resource. While this approach is useful to identify fishing grounds, intensity of fishing effort, landed lobster size and sex ratio statistics, and importance to fishers to earn a livelihood, it does not provide a reliable method to assess lobster stocks in the Port Zone of Influence at Ehoala and to monitor the stocks after implementation of the breakwater (creation of new lobster habitat) and port for an ECM Program. Underwater assessment of the Ehoala lobster stock using SCUBA is not practical because of their cryptic behaviour during daylight hours, and night diving would require a considerable expenditure of time and money, including safety issues of diving at night. Jacques Whitford therefore proposes that a lobster fishing permit be obtained from the Ministère de la Pêche of Fort-Dauphin to deploy lobster traps at Ehoala and Fort-Dauphin. The Canadian-made lobster traps will contain closed net bags baited with a fixed quantity and size of mussels, and deployed for 24 hours to standardize "attraction unit" of lobster to traps and fishing effort. The objectives of this controlled fishing method are to provide reliable statistics of relative lobster abundance with respect to fishing location and to monitor increases or decreases of lobster (in terms of standardized catch for the attraction unit) at fixed sites. Other statistics will also be collected such as lobster species (there are five species, but only one is common), size, weight, sex and presence of egg-bearing females (lobsters will be returned to the water after measurements have been taken).

It is proposed to deploy lobster traps at the beginning and at the end of the lobster season in April (2005) and December (2004), respectively, to assess the effects of fishing pressure by local lobster fishers and of lobster migration patterns. An additional sampling period in October 2004 will be undertaken during the fishing season when the waters are colder and during the dry and windy season (CSSA 2001). This additional sampling period will also be used to train and transfer technology to QMM in order that the lobster survey may continue in the absence of Jacques Whitford. If permission for scientific purposes can be obtained to fish outside the lobster season (i.e., January-March), then marking of lobsters by clipping a V-notch in the tail will be undertaken. This fisheries investigation method to mark and recapture can then be used to assess absolute lobster abundance. To monitor lobster stocks during each sampling period, traps will be deployed at Ehoala in the near field and far field ECM sampling sites (refer to Figure 2.1) and at the Fort-Dauphin reference site (Mon Seigneur). At each of these sites, five lobster traps (replicates) will be set in the in-shore area, and five other traps in deeper water (15-20m) in April, October and December. GPS coordinates at the location of the sampling sites will be taken to relocate the sites for the deployments at the end of December 2004 and early April 2005. In conjunction with lobster fishing activities, consultation and surveys of local lobster fishers at Ehoala and Fort-Dauphin by QMM will continue using the same methods as in 2000 (CSSA 2001).

2.2.4.2 *Gelidium* Seaweed

The purpose to survey *Gelidium madagascariensis* is to collect monitoring data for a commercial marine resource and a benthic floral population as the EPI to assess the predicted impact and linkage to the port for:

- modifications of *Gelidium* resource as a result of potential dredging for the port;
- loss of an important marine resource (*i.e.*, loss of revenue for fishers) in the Port Zone of Influence;
- increase of habitat near the Ehoala Peninsula in the area of the breakwater (only operation phase);
- modification of the *Gelidium* population; and
- perturbation of marine habitat.

Gelidium madagascariensis is another valued marine resource in the region of Fort-Dauphin, which would be a good indicator species to monitor impacts in the subtidal zone where it is commonly found. In 2000, *Gelidium* was more abundant along the Ehoala Peninsula than at either Fort-Dauphin or Evatraha peninsulas. The results from the 2000 study (CSSA 2001) demonstrate that *Gelidium* at Ehoala as well as at Mon Seigneur and Libanona beaches generally grows in areas about 100 m off the coast and at a depth of approximately 6 m. In addition, the results suggest that the wet season (around December – April) appears to be more favourable for the development and growth of *Gelidium* than in the dry season (around August to November). The biomass of *Gelidium* will be monitored at the sampling sites for the baseline ECM study (refer to Fig. 2.1), which at the Ehoala ECM sites were also found to have one of the highest biomass in the region (CSSA 2001). Assessment of *Gelidium* biomass will be conducted in April 2005 only (wet season) along with the quantitative survey for the seaweed community and monitoring of biodiversity species assemblages that is presented below.

2.2.4.3 Finfish

The purpose to survey pelagic finfish is to collect monitoring data for a marine resource and for pelagic finfish biodiversity as the EPI to assess the predicted impact and linkage to the port for:

- modifications to the finfish resource as a result of potential dredging for the port;
- modification of the composition of finfish species assemblages;
- perturbation of biodiversity;
- loss of a pelagic marine resource, fishing grounds and beach access to fishing grounds (*i.e.*, loss of revenue for fishers); and
- increase of pelagic finfish habitat and resources near the Ehoala Peninsula in the area of the breakwater (only operation phase).

Forty-two marine fish species, mostly pelagic species, have been inventoried and identified by CSSA (2001, Table 2.2) and that could be used as a monitoring indicator for biodiversity of pelagic finfish species.

QMM has monitored finfish landings. For the ECM study, a continuous survey of four days during good weather in October 2004, January 2005 (after the close of the lobster season), March 2005 (before the opening of the lobster season), and June 2005 should be conducted. QMM should camp at Ehoala Peninsula and note the number of fishers and pirogues leaving at all hours of the day, the time they left the shore and location at sea, and wait for their return to identify, measure and weigh their catch. This monitoring activity will assess the seasonal species being fished in the coastal waters and the fishing effort expended outside of the lobster season where it would be expected to be higher.

2.2.4.4 Threatened Species

a) Humpback Whales

The purpose to survey the number, behaviour and migration route(s) of humpback whales (*Megaptera novaeangliae*) is to collect monitoring data for a threatened species (including other marine mammals that are not threatened) as the EPI to assess the predicted impact and linkage to the port for:

- disturbance of primarily humpback whales from construction noises, dredging, shipping traffic and other activities in the vicinity of Fausse Baie des Galions; and
- modification to existing and to potential development of marine ecotourism (*i.e.*, whale watching).

Humpback whales are the only significant marine mammal species that frequently migrate through the region of Fort-Dauphin in relatively large numbers and listed as vulnerable by the IUCN Red List of Threatened Species™. They are also protected under Article 64 of the United Nations Convention on the Law of the Sea (1982). For the ECM study, it would be sufficient to assess from land (Gaskin 2000) the migratory route, behavior, and numbers of humpbacks during their migration period in the vicinity of the port area prior to the construction of the port. Potential impacts *(e.g.*, of noise and vessel traffic) during port construction, specifically construction of the breakwater, and after port implementation on humpacks should also be monitored. The ECM baseline data survey will be comprised of the direction whales are traveling and distance from shore during their migration. Other observations will be noted such as numbers sighted during the observation period, relative size (adult, juvenile, calf), distinct whale markings on adults for identification purposes, and behaviour of the whales if possible from a vantage point on the cliffs of Ehoala. Ehoala is well suited to sight whales to the west of the peninsula, which are not easily visible from Fort-Dauphin. However, whales in the Baie de Fort-Dauphin are easily visible from Ehoala. Jacques Whitford will provide the necessary equipment (e.g., binocular, compass, range finder, field sheet) and train QMM staff under the direction of Jean-Baptiste Ramanamanjato to

Table 2.2: Fish species found in marine waters of the Fort-Dauphin Region (after CSSA 2001)

SPECIES NAME	FRENCH NAME	MALAGASY NAME	ENGLISH NAME
Acanthocybium solandri	Thazard-bâtard	Raznadramatra, angoho, lamatra	Wahoo
Anchoviella sp.	Anchois	Tovy	Anchovy
Aprion virescens	Vivaneau job, Chien vert	Fiandava	Green jobfish
Strongylura leiura	Aiguillette	Antseradava	Needlefish
Carangoides fulvoguttatus	Carangue à gouttes d'or, carangue pailletée	Faronandalitra, lanora	Yellowspotted trevally
Caranx ignobilis	Carangue têtue	Lanora	Giant trevally
Cephalopholis sonnerati	Vielle ananas	Horoamena, aloro	Tomato hind
Clupea harengus	Hareng	Pepe	Herring
Sprattus sprattus	Sprat	Pepe	European sprat
Coryphaena hippurus	Coryphène	Droaty	Dolphinfish
Dussumieria elopsoides	Sardine arc-en-ciel	Ampiny	Rainbow sardine
Echeneis naucrates	Rémora commun		Shark sucker
Elagatis bipinnulata	Comère saumon	Fiamandry	Rainbow runner
Epinephelus fasciatus	Vielle rouge	Alovo, borisy, tarataka	Redbanded grouper
Epinephelus multinotatus	Mérou plate grise	Alovo	White-blotched grouper
Etelis coruscans	Vivaneau flamme	Ambatsy riake/ Koanabe	Flame snapper
Euthynnus affinis	Bonite à dos rayé / Thonine orientale	Milanja, vohy, lamatra, angoho	Kawatsawa
Galeocerdo cuvier	Requin-tigre commun	Antsatsa	Shark
Gerres acinaces	Blanche gouvernail	Matsitsoke, ambariaka	Longtail silver-biddy
Gymnocranius grandoculis	Empereur tatoué	Lovoro, barialava, antsisy, tsivaravaramena	Blue-lined large-eye bream
Hemiramphus spp	Demi-bec	Antserapohy	Halfbeak
Herklosichthys quadrimaculatus	Hareng à bande bleue	Voivoy, pepe, geba, besisika, ampiny	Bluestripe herring
Katsuwonus pelamis	Bonite à ventre rayé	Von, lamatra	Skipjack tuna
Lethrinus harak	Empereur Saint-Pierre	Vaipatola, ambitsy, tapaporoa	Thumbprint emperor
Lethrinus mahsena	Empereur mahsena	Manahelika, angelika	Sky emperor
Lethrinus nebulosus	Empereur moris	Ambitsy, kotrokotro, angelika	Spangled emperor
Lethrinus rubrioperculatus	Empereur honteux	Vaindava, Ambitry	Spotcheek emperor,
Lutjanus bohar	Vivaneau chien rouge	Varavaraha mena	Two-spot red snapper
Lutjanus ehrenbergii	Vivaneau encrier	Fatola	Blackspot Snapper
Makaira mazara	Makaire bleu de l'Indo-Pacifique	Manambosambo, androaro tokapalaza	Indo-Pacific blue marlin
Liza macrolepis	Mulet à grandes écailles	Zompo/Tofoke	Largescale Mullet
Paracaesio xanthura	Vivanette queue jaune	Fitse	Yellowtail blue snapper
Pristipomoides filamentosus	Colas fil	Rehoreho	Crimson jobfish
Rhadbosargus sarba	Sargue doré	Vahoho, ambatovasena	Goldlined seabream
Sardina sardinops	Sardinelle	Pepe	Sardine
Scarus ghobban	Perroquet barbe bleue	Lavalia, bodoloha, fihambazaha	Blue-barred parrotfish
Scomberomorus commersoi	Thazard rayé Indo-Pacifique	Thon, Lamatra, Angoho	Narrow-barred spanish mackerel
Selar crumenophthalmus	Selar coulisou	Valahara, mahaloky bevava	Bigeye scad
Siganus rivulatus	Sigan marbré	Halalaza/Moramasaka	Marbled spinefoot
Sphyrna sp.	Requin marteau	Antsatsa	Hammerhead shark
Sphyraena barracuda	Barracuda	Aloalo	Great barracuda
Stegostoma fasciatum	Requin-zèbre	Antsatsa	Leopard shark

monitor humpback whales using basic protocols developed by Gaskin (2000). The humpback whales arrive in the region by June and depart in November. Monitoring periods will be 1-2 hr per day three times a week during periods of frequent sightings, and weekly when sightings are less frequent or uncommon.

b) Sea Turtles

The purpose to survey sea turtles along the beach is to collect monitoring data for threatened species as the EPI to assess the predicted impact and linkage to the port for:

- Loss of beach turtle nesting sites along the near-shore port access roads at Ehoala.

Project Fanomena, Azafady, conducted sea turtle monitoring in November-December 2001 in southern Madagascar, including Ehoala (Gladstone 2001). WWF Madagscar also provided turtle tagging and genetic sampling equipment. Only one loggerhead turtle (*Caretta caretta*) was captured at sea at Ehoala. Other sea turtles found in southern Madagascar include green (*Chelonia mydas*), Olive Ridley (*Lepidochelys olivacea*) and hawksbill (*Eretmochelys imbricata*) turtles (Gladstone 2001). Except for the hawksbill turtle that is listed as critically endangered, all the other three species are listed as endangered by the IUCN Red List of Threatened Species™. A project component of Fanomena included community workshops and development of a booklet in Malagasy explaining nesting, life cycle and legal status of sea turtles. Jacques Whitford, with the participation from QMM, will develop sea turtle monitoring protocols specific to Ehoala and the port area, and build on the community consultation by drawing information and procedures from the Fanomena Project. Jacques Whitford will also provide the necessary equipment and train QMM staff under the direction of Jean-Baptiste Ramanamanjato to monitor sea turtle tracks and nesting activity on beaches using research and management techniques for the conservation of sea turtles prepared by the IUCN/SSC Marine Turtle Specialist Group (Eckert *et al.* 1999). The sea turtle surveys will concentrate in Fausse Baie des Galions and the continuous beach, with special emphasis along 800 m of proposed road access to the port close to beach level and Ehoala Peninsula. The migration routes and migration periods for turtles to Fort-Dauphin are not sufficiently know to develop a monitoring schedule, and will be determined on site by consulting local fishers. However, monitoring of the beaches will be periodic and particularly when a sighting has been mentioned.

c) Finfish

The following five coastal migratory species of fish are protected under Article 64 of the United Nations Convention on the Law of the Sea (1982) and which are believed to be present in the region of Fort-Dauphin:

- dolphin fish (*Coryphaena hippurus*);
- Little tuna *(Euthynnus affinis*);
- Skipjack tuna (*Katsuwonus pelamis*);
- Tiger shark (*Galeocerdo cuvier*); and
- Indo-Pacific blue marlin (*Makaira mazara*).

The purpose to survey these pelagic finfish is to collect monitoring data for these protected species as the EPI to assess the predicted impact and linkage to the port for:

- disturbance of migratory route; and
- perturbation of biodiversity.

These species will have special attention during the survey mentioned above for the finfish fishery at Ehoala. Laminated and coloured pictures of these fish species will be shown to fishers during the consultation to assess the likelihood of their presence / absence in the waters near Ehoala and period of the year.

2.2.5 Coastal Vegetation and Sea Birds

The purpose to survey coastal and shoreline vegetation and sea birds is to collect monitoring data for floral and sea bird communities and for biodiversity species assemblages as the EPI to assess the predicted impact and linkage to the port for:

- loss of coastal vegetation along the near-shore port access roads and facilities;
- modification of the composition and biodiversity of coastal flora, sea birds and populations;
- disturbance of sea birds from construction noises, dredging, shipping traffic and other activities in the vicinity of Fausse Baie des Galions;
- perturbation of sea bird habitat and of biodiversity;
- modification to existing and to potential development of marine ecotourism (*i.e.*, bird watching).

A coastal and shoreline vegetation survey will be developed by QMM floral specialists (Johny Rabenatoandro and Faly Randriatafika), with the assistance of Jacques Whitford, for monitoring purposes and to assess impacts of implementing the port. Particular attention will be paid to rare and endangered plants in the footprint area of the port facilities. Sea birds and migrating species will also be noted during the vegetation and humpback whale surveys at Ehoala. Sea bird surveys conducted during the vegetation survey may reveal birds utilizing coastal vegetation habitat for nesting, staging and/or breeding purposes. Further, sensitive coastal bird habitats and significant natural sites could be located. Attention will also be paid to rare and endangered bird species that may be foraging at sea or inhabiting the coastline in the port area. Anecdotal observations of bird species were presented by CSSA (2001), and a more complete inventory of species will need to be established.

2.2.6 Coral Reef Survey

The purpose to survey coral reefs is to collect monitoring data for the coverage of benthic marine habitat and health of a marine ecosystem, including corals, as the EPI to assess the predicted impact and linkage to the port for:

- modifications of marine benthic habitat as a result of potential dredging for the port;
- loss of marine benthic habitat at the location of the breakwater;
- modification of the composition of marine benthic habitat;
- perturbation of marine benthic habitat and of biodiversity; and
- increase of marine benthic habitat near the Ehoala Peninsula in the area of the breakwater (only operation phase).

As an indicator at the marine ecosystem level of impacts of the port, the coral reef community will be monitored by surveying the percent coral cover of the substrate and health of reef corals at the sites for the ECM study. Quantitative data collected by SCUBA diving will include the percent live and dead coral cover along a permanently marked transect centered on the 10-m depth contour and laid perpendicular to the shore. CSSA (1999, 2001) noted that corals, when present, were primarily found in water depths ranging from 5 to 15 m. The same line intercept method to quantify coral cover and type of benthic habitat encountered along a 30-m transect line will be used as that for the 2000 study (CSSA 2001). The permanent transect will be video taped, and still photographs taken at key locations along the transect showing different types of habitats encountered and as permanent records for repeat ECM surveys. A GPS position will be taken for both ends of the transect as well as a compass bearing from the northerly end of the transect. Two other replicate and unmarked transects will be conducted at each ECM site, for a total of 18 transects, to obtain data for statistical tests between sites and for comparison to ECM data collected in the future.

Other data to be noted will include:

- Recent coral death vs. older coral death;
- Type and amount of algal cover;
- Extent of algal mat cover or eutrophizing algae;
- Coral bleaching;
- Sand;
- Sea grass;
- Recent or old coral rubble; and
- Identification of the most common coral species and any unique or rare coral species.

The coral survey will be conducted annually during this and any other ECM surveys, and preferably sometime from January to April because of improved underwater visibility and sea conditions during this time of the year for Fort-Dauphin (*i.e.*, April 2005 for the baseline ECM study). The ECM coral survey should be conducted before and after the construction of the port, the first year after port operation, and every two years thereafter.

The data collected for the coral reef survey can contribute to the databases of coral reef status in Madagascar and East Africa, as well as contributing towards a world-wide database such as ReefCheck in the U.S.

In addition to the coral survey at the sampling sites for the ECM study, a survey at the location of the breakwater, the jetty extending and perpendicular to the shore, and pier area will be conducted (refer to Figure 2.1). The purpose of these surveys is to assess the significance of species and types of habitats encountered that will be impacted by these port structures. These surveys would also be required to fulfill the criteria to assess bottom characteristics of the dumping site under Annex III and amendments of the London Dumping Convention (1972).

2.2.7 Seaweed Community Survey

The purpose to survey the seaweed community is to collect monitoring data for a marine benthic community and for biodiversity of seaweed species assemblages as the EPI to assess the predicted impact and linkage to the port for:

- modifications of marine benthic habitat as a result of potential dredging for the port;
- modification of the composition of marine seaweeds and populations;
- perturbation of marine benthic habitat and of biodiversity; and
- increase of marine benthic habitat near the Ehoala Peninsula in the area of the breakwater (only operation phase).

Seaweeds are abundant and dominate the littoral zone of Ehoala and Fort-Dauphin peninsulas because they are exposed to high wave energy from the Indian Ocean and grow prolifically in this well-oxygenated environment. Therefore, seaweeds can be considered as good monitoring indicators at the community level and for biodiversity assessment of impacts of the port. Seaweed species where *Gelidium madagascariensis* is present in the subtidal area at approximately 5-6 m water depth will be monitored in the ECM study. Seaweeds in a quadrat will be collected at the ECM sites by diving, and analyzed similar to the methods employed in the 2000 study (CSSA 2001). GPS coordinates at the location of the sampling stations will be taken for repeat ECM surveys in the future. The seaweeds will be identified to the species level where possible, and their biomass measured as the unit for species abundance. A minimum of three replicate samples will be collected at each ECM sampling site, for a total of 18 samples. The schedule for the ECM seaweed survey will be the same as that for the coral survey (April 2005).

The analysis of the seaweed samples will include both univariate and multivariate approaches. The univariate approaches will be based on composite indices such as the Shannon-Weiner diversity index, species richness, and abundance data. Using these metrics, the sampling sites will be compared by Analysis of Variance (ANOVA) to evaluate upstream to downstream effects.

Multivariate techniques will also be applied to the data, to more closely investigate the nature of any changes in the seaweed community. The detailed taxonomic responses can often indicate whether responses are attributable to nutrient enrichment effects, and to the potential impacts of the port.

2.2.8 Sea Urchin Population Survey

The purpose to survey *Tripneustes* spp. is to collect monitoring data for a marine benthic faunal population as an indicator of pollution and as the EPI to assess the predicted impact and linkage to the port for:

- modification of *Tripeustes* population as a result of potential dredging for the port;
- modification of a marine benthic population; and
- perturbation of marine benthic habitat.

Jacques Whitford proposes to monitor *Tripneustes*, a detritivore feeding sea urchin found at Ehoala and Fort-Dauphin, as the indicator species at the population level. The abundance of *Tripneustes* generally indicates conditions of eutrophication and nutrient enrichment common to many port areas. Surveys using a 1-m belt transect along the same transects as those for the coral survey will be conducted in April 2005 to measure the density of *Tripneustes*. The diameter of a minimum of 15 individuals randomly sampled per transect will be measured to estimate the average size of the population at each site.

2.2.9 Receiving Environment Survey

The purpose to survey the hydrodynamic and physico-chemical characteristics of the water, sediment and biota is to collect monitoring data for the receiving environment as the EPI to assess the predicted impact and linkage to the port for:

- Modifications to the profile of beaches along the Fausse Baie des Galions as a result of the access roads to the port and breakwater (to be carried out by QMM);

- modifications to hydrodynamic characteristics and quality of water and sediment as a result of potential dredging for the port;
- erosion of the foreshore in the western sector of Fausse Baie des Galions and sedimentation in the area of the pier and northern point of Ehoala Peninsula as a result of the breakwater (to be carried out by QMM);
- modifications to the hydrodynamic characteristics in the Fausse Baie des Gallions and port site at Ehoala as a result of the breakwater;
- increase in turbidity in the Fausse Baie des Galions as a result of the breakwater (only construction phase) and dreding; and
- risk of contamination in the marine environment, particularly sediment and biota, as a result of accidental spills of hydrocarbons and other wastes.

Measurement of supporting environmental variables is important in order to provide data to help interpret the results of the biological surveys, and potentially to help explain any unusual observations. Assessment of predicted impacts and success of mitigation measures would also require measurement of environmental variables. The construction and operation of the breakwater and port could potentially modify the natural physical processes currently acting on the marine environment at Ehoala, as well as contributing to possible changes to the water and sediment quality. Dredging and physical structures in the water generally modify the bathymetry, and can result in changes to the hydrodynamic circulation pattern and to wind and wave energy transmitted to the sea floor and shoreline, with consequential change to erosional or depositional environments. Therefore bathymetry, water circulation, and water and sediment quality are important variables to monitor and to acquire for baseline ECM data. Bathymetric and hydrodynamic data will only be necessary before and after implementation of the port, whereas water and sediment quality should be monitored during all phases of the port (*i.e.*, prior, during and after breakwater and port construction activities). A bathymetric survey was recently conducted in 2003 for the design feasibility plans of the port and shipping approaches, and will not be required for this baseline ECM study. A hydrodynamic survey and physico-chemical survey of the quality of the water, sediment and biota, however, will be required and are outlined below.

Dredging at Ehoala of the ship approaches and berthing area at the pier may be necessary to increase water depth to 13 m to accommodate the draft of vessels. Dredging can cause dispersal and settlement of resuspended sediments on sensitive aquatic ecosystems that may be permanently damaged. Dredging can also release pollutants from the sediment. The disposal of the dredged material is adjacent to the breakwater area of the port. Therefore environmental effects monitoring of dredging and disposal in the marine environment at Ehoala will have to be undertaken. Baseline sediment quality monitoring will be undertaken for physical (grain size analysis) and chemical (metals and organic contaminants) characterization.

The proposed ECM program also takes into consideration dredging activities and permits issued for the dumping of matter at sea under the International Maritime Organization's London Dumping Convention (Annex III), if required (to be confirmed with Malagasy authorities, as well as other Malagasy national and international signatory agreements, laws and acts that may be applicable for environmental requirements to dredge and for disposal at sea). Madagascar became an IMO Member State in 1961, and has ratified the United Nations Convention on the Law of the Sea (UNCLOS) in 2001. Part XII of UNCLOS (articles 192 - 237) addresses Protection and Preservation of the Marine Environment and gives basic obligations to prevent, reduce and control pollution from land-based sources; pollution by dumping; pollution from sea-bed activities subject to national jurisdiction; pollution from activities in the Area; pollution from vessels; and pollution from or through the atmosphere (articles 207 - 212).

2.2.9.1 Hydrodynamics

For the baseline hydrodynamic circulation study to be carried out in April 2005, Jacques Whitford proposes to track drogues released in the Fausse Baie des Galions, including at the location of the breakwater, and off the ocean side of Ehoala Peninsula (refer to Figure 2.1). For the purposes of the ECM study, the use of drogues would be more cost-effective than deploying current meters (CSSA 2001) to assess hydrodynamic circulation. It is proposed that three drogues be released in Fausse Baie des Galions and one drogue off Ehoala (see Figure 2.1 for locations) at low tide and at high tide, and tracked over a tidal cycle. CSSA (2001) observed that tidal currents are relatively strong and regular at Ehoala compared to those at Fort-Dauphin or Evatraha. The drogue study should be conducted when the winds are from the northeast, which is the prevailing wind direction for the Fort-Dauphin area (CSSA 2001). The hydrodynamic survey will also provide dispersal characteristics (e.g., effects of currents, tides and wind on horizontal transport) at the dumping site of the port and breakwater of dredged sediments and breakwater material.

2.2.9.2 Physico-chemical

The proposed suite of supporting environmental variables that should be measured during the ECM program is summarized in Table 2.3. Environmental variables for characterizing the dredging and disposal sites, and criteria that could apply to dumping of matter under the London Dumping Convention, are also provided in Table 2.3.

The location of sites will be recorded using a GPS unit and the data collected will be transferred to a map of the area. The water depth, Secchi depth, DO (dissolved oxygen), temperature and salinity (conductivity) profiles will be recorded on site at each station to determine the presence of stratification at the time of sampling. A total of 8 stations will be sampled (Figure 2.1) for water and sediment quality. Water samples will be taken at the surface and 1-m off the bottom, for a total of 16 samples plus one for QA/QC. Only 8 sediment samples and one extra for QA/QC purposes, for a total of 9 samples, will be collected, each sample being comprised of composite sediment taken from three places within the site. All the analyses listed in Table 2.3 will be conducted on all the samples, except for two samples (breakwater and pier/port basin sites; Figure 2.1) that may be necessary to fulfill criteria with the London Dumping Convention and indicated in the table. The breakwater and pier sites at Ehoala are also assumed to receive adjacent dredged material during port construction. Therefore we will assume that the dredging and disposal sites share the same characteristics for sediment and water quality and take only one sample at each of these two sites.

It is proposed that microbiological analyses using HACH field units be carried out in Fort-Dauphin by QMM, under the guidance of Jacques Whitford, or if not feasible, at the CNRE - Eau or Louis Pasteur Institute in Antananarivo. An evaluation of QA/QC protocols of these laboratories will be undertaken by Jacques Whitford upon their first arrival to Madagascar end of September 2004 to plan for the second visit in March-April 2005 when the samples will be collected. It is also proposed that basic water and sediment chemistry (*e.g.*, nitrates, nitrites, phosphates, TSS, TVS, particle size analysis of sediment, TVS in sediments) also be carried out by QMM in Fort-Dauphin.

Table 2.3 Supporting Marine Environmental Variables for the Ehoala Port ECM Study.

Recommended Variables	Justification
Latitude/Longitude	Provides station location.
Depth	Water depth has a significant effect on benthic communities.
Secchi Depth	Dredging, construction of the breakwater and port, and operation of the port could cause changes in water transparency and limit growth of algae; characterization of dumping site.
Dissolved Oxygen Profile	Dredging, construction of the breakwater and port, and operation of the port could cause changes in dissolved oxygen concentration; characterization of dumping site.
Water Temperature and Salinity Profiles	The water within the port may become an "enclosed sea", which when flushed periodically could modify water temperatures and salinities outside the harbour; characterization of dumping site.
Water Microbiology (fecal coliforms, fecal *Streptococcus*)	Port operation may release bacteriological contaminants and degrade water quality.
Water Chemistry (pH, total suspended solids, total volatile solids, nitrate, nitrite, total ammonia, total phosphorus, chlorophyll "a"*, total Kjeldahl nitrogen (TKN)*, biochemical oxygen demand (BOD)*, chemical oxygen demand (COD)*).	Dredging and water within the port may contain substances that can be used to indicate site exposure; water may contain nutrients that could stimulate algal growth; characterization of dumping site.
Sediment grain size and total volatile solids where samples of unconsolidated sediment can be obtained.	Dredging, breakwater and port operation may modify deposition of resuspended sediments and of suspended organic matter; sediment grain size can have a strong influence on benthic community structure; characterization of disposal material (dredge spoil and breakwater) and of dumping site.
Sediment Microbiology* (presence of bacteria (fecal coliforms, fecal *Streptococcus*), viruses, yeasts, parasites)*.	Dredging may release microbiological contaminants in sediment that may have an influence on marine biota and resources, and modify community structure; characterization of disposal material (dredge spoil and breakwater).
Sediment chemistry where samples of unconsolidated sediment can be obtained. (Metals – arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, titanium, vanadium and zinc; Organics – PAHs, PCBs, oil and grease, fuel oil range, lube oil range, total petroleum hydrocarbons (TPH); nitrate*, nitrite*, total ammonia*, total phosphorus*, total Kjeldahl nitrogen (TKN)*, total organic carbon (TOC)*, biochemical oxygen demand (BOD)*, chemical oxygen demand (COD)*)	Dredging, breakwater and port operation may release contaminants in sediment or to sediment and have influence on uptake by and accumulation in marine biota and modify community structure; characterization of disposal material (dredge spoil and breakwater) and of dumping site.
Seabed Structure (functional description of substrate type and embeddedness).	Substrate type (boulder, rubble, cobble, gravel, sand, silt, clay) has a strong influence on benthic communities.

(* indicates additional provisions to be considered in establishing criteria governing the issue of permits for dumping of matter (*i.e.*, dredge and breakwater materials) at sea under Annex III and amendments (Annex 6) and Article IV (2) of the London Dumping Convention (1972) (required only for the ECM program and if necessary for Madagascar).

Jacques Whitford does not propose, at this time, to analyze for pesticides. Results from the 2000 study by CSSA (2001) showed no traces of pesticides in marine biota or sediments at Ehoala or Fort-Dauphin. In addition, there was no widespread use of pesticides for pest control or agricultural applications in the Fort-Dauphin Region. We do propose to sample *Gelidium* and spiny lobster (mussels or oysters if lobster cannot be caught at the ECM site) for baseline contaminants (e.g., metals, organics, PAHs, PCBs). These samples will be collected at the near field, upstream reference and downstream reference ECM sites only, for a total of 7 samples that includes one for QA/QC. Monitoring of contaminants in these marine species and the fishery has local, national and international importance, with potential implications from the port and to QMM.

Jacques Whitford will assess the QA/QC protocols of the CNRE, and possibly the Louis Pasteur Institute, laboratories to determine the feasibility of analyzing sediments and biota for metals and organic contaminants given in Table 2.3. If these institutions are assessed not to be feasible or reliable, then samples will be appropriately preserved and brought back by Jacques Whitford on their return trip to Canada for analysis.

Should a need for additional testing parameters be identified through subsequent discussions between Jacques Whitford and QMM, then a cost estimate to complete the additional required work will be developed.

2.2.10 ECM Quality Assurance/Quality Control and QMM Institutional Strengthening

Jacques Whitford in August 2003 initiated plans for QMM to develop quality assurance and quality control practices related to PGEP monitoring activities. The development plan for quality assurance includes defining monitoring objectives, the quality control procedures to be followed, and quality assessment. Quality assurance includes preparing protocols (including standard operating procedures and record keeping) for site operation and equipment maintenance; preparing protocols for equipment calibration; preparing site visit schedules; and preparing protocols for data inspection, review, validation, and usage. Quality assessment includes developing a schedule for audits and reports.

Jacques Whitford will continue on this objective and with plans to implement standard operating procedures (SOPs) with QMM staff. This will include training QMM in developing new SOPs for ECM studies.

If QMM has requirements for specific action items and based on the Jacques Whitford recommendations provided in the field report for the site visit in August 2003 (e.g., QMM requirements for equipment, *in situ* net design and specifications for tilapia aquaculture, pond water exchange), this will be considered as extra work and costs to this proposal.

Prior to the arrival of Jacques Whitford in Fort-Dauphin, QMM staff (Rémi, Solange and Beatrice) should be submitting a first draft of their understanding of SOPs further to the August 2003 field visit. This will provide an opportunity for Jacques Whitford to review and validate, and provide further guidance, if necessary, to produce a final version of the SOPs.

2.2.11 Reporting

The first report to produce will be an Interim Report that summarizes the ECM protocols developed up to that time; the data collected during the field visit in September-October 2004; methods used; preliminary survey results obtained by QMM staff; and preliminary recommendations for mitigation measures and environmental protection plans. This interim report could assist in identifying preliminary environmental specifications for the engineering design of the port. After the end of all the surveys in September 2005, the data collected during this ECM investigation will be used to prepare an interpretive report and produced as the Draft ECM Report. The Draft ECM Report will summarize the data since the previous 2000 study. Key components of the interpretive report will include:

- review of changes to the Ehoala and Fort-Dauphin peninsulas since 2000;
- updates to the resource inventory and habitat inventory information for the Port Zone of Influence; and
- results of the surveys and supporting environmental measurements to document baseline ECM conditions of the receiving environment and of the monitoring indicators (Environmental Performance Indicators) .

A draft report document will be prepared and submitted to QMM staff for review. Following review and approval by QMM, Jacques Whitford staff would be available to present the report and its findings to QMM. After comments have been received and incorporated in the report, a Final ECM Report will be produced. This final document will also serve to provide information for annual reporting on the state of the port environment for the Project. A proposed schedule for the performance and completion of the proposed work is presented in the Management Proposal, below.

ECM progress reporting and performance appraisals of collaborators (IHSM and QMM) to the ECM study will also be provided during the course of the study.

3.0 MANAGEMENT PROPOSAL

3.1 Project Management and Team

Sam Salley, Senior Marine Scientist with Jacques Whitford in Fredericton, New Brunswick will act as Project Principal and will manage the project on a day-to-day basis. Mr. Salley will be responsible for overall technical direction, and ensuring that project objectives are met. He will also undertake all the SCUBA survey work with the assistance of Mr. Sabatini as the diving partner, both certified divers and meeting the requirements of QMM's diving policy (First Aid, CPR and oxygen administration therapy certifications). Mr. Salley has conducted aquatic assessments and fieldwork in Fort-Dauphin since 1989 on the first EIA, and then in 1999 for the coastal environmental evaluations of port options, and in 2000 on the final EIA, including the Ehoala Peninsula and the location of the chosen port. His work with Jacques Whitford has included environmental effects monitoring for mining and food processing industries; site assessments to determine environmental sensitivity to development; and risk assessment/risk management for planning purposes.

Gino Sabatini, M.Sc., is a sub-consultant to Jacques Whitford. Mr. Sabatini will be a co-investigator on the study and will lead the fisheries surveys and assist with the SCUBA diving surveys. He will also assist Mr. Salley in overseeing the surveys by QMM and IHSM. Mr. Sabitini also has had fisheries assessment and fieldwork experience in Fort-Dauphin in 1989 and in 2000. His latest assignment was managing consultants and studies on-site in Damman, Kingdom of Saudia Arabia, to evaluate potential oil contamination in coastal environments along the Saudi Arabian peninsula and in the Persian Sea.

Dr. Malcolm Stephenson, Senior Aquatic Scientist with Jacques Whitford in Fredericton, New Brunswick will provide senior peer review. Dr. Stephenson's primary areas of specialization are environmental impact assessment and risk assessment, emphasizing multi-disciplinary linkages to environmental restoration, hydrology, ecological modeling, ecotoxicology, geochemistry and applied aquatic ecology.

Institut Halieutique et des Sciences Marines (IHSM), Universite de Toliara. Lanto (Lantoasinoro Ranivoarivelo) is a seaweed and algal specialist with the IHSM. She was a co-investigator with Dr. Rachel Rabesandratana (IHSM), during the 2000 aquatic assessment and QMM Ilmenite Project EIA in Fort-Dauphin for CSSA International Consultants. She has continued since 2000 to further investigate *Gelidium* on the Ehoala Peninsula for QMM.

QMM Fort-Dauphin. Jacques Whitford proposes that the following QMM specialists lead the port ECM data collection and surveys when Jacques Whitford personnel are not on site in Fort-Dauphin:

- Solange Andrianjohany – Lobster Fishery and Finfish surveys;
- Jean-Baptiste Ramanamanjato – Marine Mammal and Sea Turtle surveys;
- Johny Rabenatoandro and/or Faly Randriatafika – Coastal vegetation and Sea Bird surveys; and
- Rémi Heriarivo – Water and Sediment Quality Surveys.

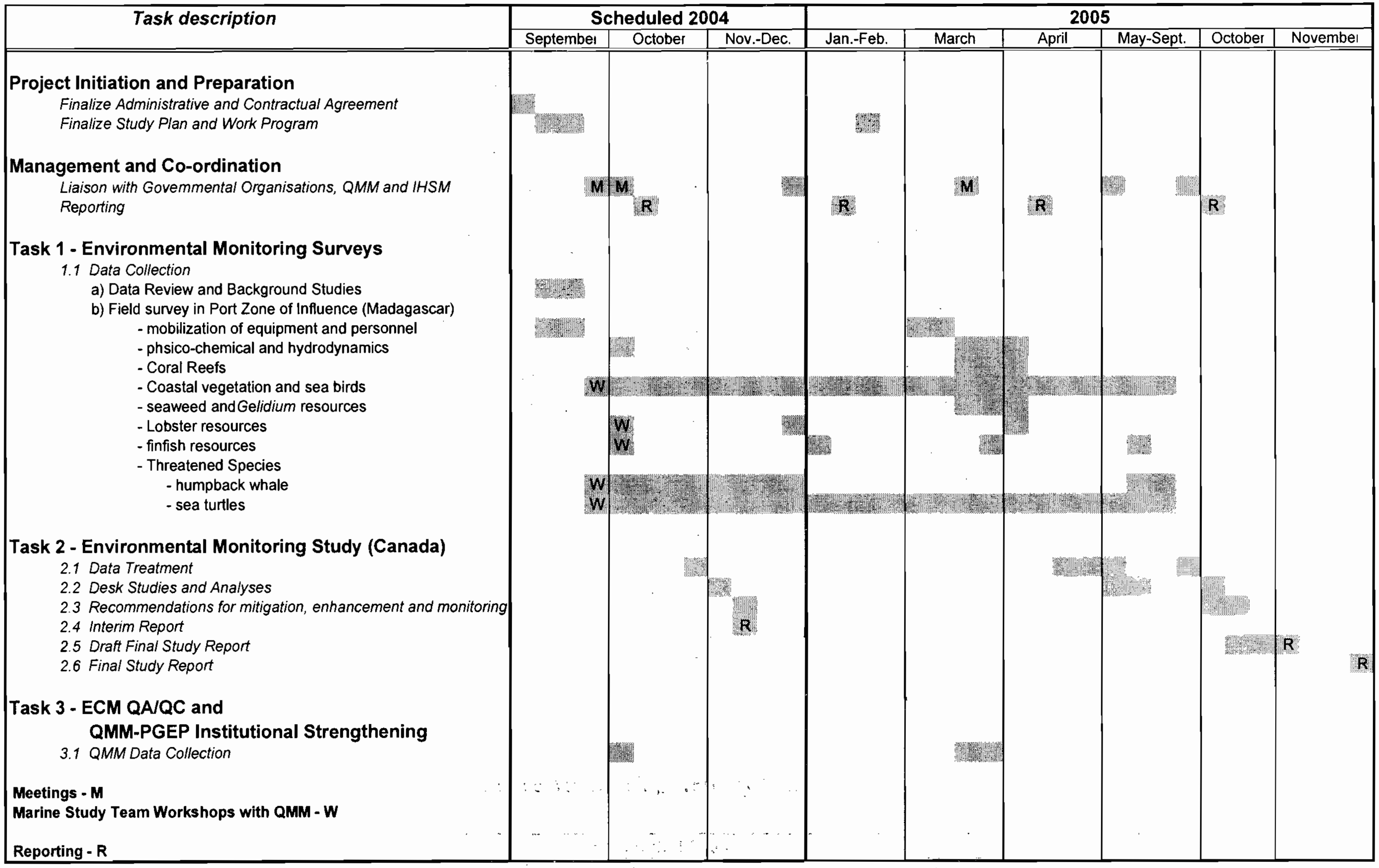
Ministère de la Pêche. Monsieur Alimosa Tsiriké Nambole is the Chef de circonscription de la pêche et des ressources halieutiques de Fort-Dauphin. He will assist in facilitating the lobster and finfish fisheries survey, with possible assistance from the FAO Fort-Dauphin Field Office.

3.2 Schedule

The proposed schedule for 2004 and 2005 is presented in Figure 3.1. After confirmation of a purchase order for the study in the second week of Septebmer 2004, or earlier, it is anticipated that the study plan and work program will be finalized in the third week of September 2004, after input from QMM. The fieldwork and mobilization of personnel will be conducted during two time periods to accommodate best environmental conditions, timing for the surveys, and presence of specific species to be surveyed. The first period for fieldwork in Fort-Dauphin for about 13 days is scheduled to begin end of September and continue until the first week of October 2004. This fieldwork will initiate the lobster, finfish, threatened species, coastal vegetation, and sea bird surveys. The second period for fieldwork in Fort-Dauphin for about 15 days is expected to occur from around mid March to the first week of April in 2005. This fieldwork will follow-up on the surveys initiated in 2004 and undertake the coral reef, sea urchin, seaweed, hydrodynamic and physico-chemical surveys.

After the first Fort-Dauphin visit by Jacques Whitford in 2004, an Interim Report containing ECM data collection activities, preliminary survey results obtained by QMM staff, and preliminary recommendations for other mitigation measures and environmental protection plans will be submitted by January 2005. The Draft ECM Report for review by QMM will be prepared and delivered by the beginning of November 2005 and after the end of all surveys in September 2005. A Final ECM report will follow the draft report in November 2005 after comments have been received from QMM and incorporated into the final report.

Figure 3.1. 2004 – 2005 Environmental Compliance Monitoring Activity Schedule.



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5.0 CLOSURE

Jacques Whitford is pleased to provide this proposal in response to the request from QMM. Should you have any questions regarding the proposed work, please contact me at (506) 457-3272.

We trust that this proposal meets you requirements, and look forward to having the opportunity to work with QMM Madagascar Minerals.

Sincerely,

JACQUES WHITFORD LIMITED

Sam Salley, M.Sc.
Senior Marine Scientist
Encl.

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Figure 3.1: 2004 – 2006 Environmental Compliance Monitoring Activity Schedule (Revised).