APPENDICES

TECHNICAL SUPPORT MEMO FOR PROPOSED CATEGORICAL EXCLUSION B5.25

APPENDIX A

SUPPLEMENTAL CURRICULA VITAE
FOR EXPERT PANEL

APPENDIX A

SUPPLEMENTAL CURRICULA VITAE FOR EXPERT PANEL

A-1. Kurt W. Buchholz

A-2. Paul T. Jacobson, Ph.D.

A-3. Louise Kregting, Ph.D.

A-4. Dallas J. Meggitt

A-5. Rafael A. Olivieri, Ph.D.

A-6. Stephen W. Shaner, Ph.D.

A-1. Kurt W. Buchholz

Kurt W. Buchholz

Summary of Experience

Mr. Buchholz is a Lead Associate at Booz Allen with more than 28 years of service supporting environmental and human-health projects associated with acquisition and infrastructure development, grants administration, and regulatory compliance. His major U.S. Government clients include the U.S. Navy, Coast Guard, Federal Emergency Management Agency (FEMA), Department of Commerce (DOC), Environmental Protection Agency (EPA), Department of Interior (DOI), and U.S. Army Corps of Engineers (USACE). International and industrial clients have included universities, the oil and gas industry, port authorities, development agencies, and venture capital concerns.

Mr. Buchholz's multidisciplinary teams of environmental analysts and engineers analyze environmental data sets, assess risk, develop mitigation plans, and facilitate communication with regulators and stakeholders. Current and recent responsibilities include compliance reviews of Federal communication grants, PMO support for construction of a university campus, and program management of a Coast Guard environmental support contract.

One of Mr. Buchholz's current large projects is the FEMA/DOC Public Safety Interoperable Communications (PSIC) Grant Program (http://www.ntia.doc.gov/psic/), for which his team provides technical and regulatory support for acquisition of transmission and receiving sites, dispatch operations and response centers, incident command equipment, and mobile/portable communications equipment. Another of Mr. Buchholz's teams delivers similar work under the Department of Commerce NTIA's Broadband Technology Opportunities Program (BTOP, http://www.ntia.doc.gov/press/2010/BTOP_BIP_NOFAII_100115.html), which is disbursing $4.8 billion in American Recovery and Reinvestment Act (ARRA) grants and loans to expand broadband access and adoption in the Unites States. In 2009, Mr. Buchholz supported an operational readiness project for the PMO of King Abdullah University of Science and Technology (KAUST, http://www.kaust.edu.sa/), near Jeddah, Saudi Arabia, which opened in September 2009.

For the Coast Guard, Mr. Buchholz is the Deputy Program Manager for Booz Allen's Environmental Services BPA. His project teams support Coast Guard HQ and District programs with a diverse range of environmental and regulatory services and products, including technology-evaluation assistance and Federal facility NEPA compliance. For previous Federal programs and projects, Mr. Buchholz's teams have provided data quality reviews, internal assessments, and management system plans (EQA, IAP, EMS, SWPPP, etc.) for the U.S. Navy; investigated probabilistic models to control invasive species along U.S. transportation corridors for Department of Transportation; and helped develop a science plan for the South Florida Ecosystem Restoration Task Force and Everglades National Park.

Mr. Buchholz's long-term assignments have been in coastal New England, mid-Atlantic region, South Florida, Great Lakes, Alaska, Saudi Arabia, and the Caribbean. Short-term assignments include research and business-development projects in Taiwan, Italy, and the South Pacific. His onshore and offshore field experience includes assessment and treatment of oil spills, laboratory stand-up, power-plant effluent permitting, natural-resource management actions, and aquaculture projects.

Mr. Buchholz holds a DSS Secret security clearance.

Work History

Booz Allen Hamilton ***11/98 through present***

National Telecommunications and Information Administration (NTIA) Department of Commerce (DOC), Headquarters, Washington, DC ***1/10 through present***

Mr. Buchholz and members of his regulatory support team assist the NTIA Broadband Technology Opportunities Program (BTOP) with National Environmental Policy Act (NEPA) compliance reviews of proposed broadband projects nationwide. BTOP is a $4.7 billion Federal grant program for the deployment of broadband infrastructure in unserved and underserved areas, to enhance broadband capacity at public computer centers, and to encourage sustainable adoption of broadband service. As a major initiative of the American Recovery and Reinvestment Act of 2009, BTOP's other objectives include spurring job creation and stimulating long-term economic growth and opportunity (http://www.ntia.doc.gov/broadbandgrants/). With the scope and urgency of the BTOP program, fast and accurate reviews of grant applications are a requirement of program success. Mr. Buchholz is responsible for conducting objective, consistent, and accurate reviews of grant applications for infrastructure development projects costing from $1M or over $100M/each.

Headquarters Environmental Compliance Support – Federal Emergency Management Agency (FEMA) and Department of Commerce (DOC), Headquarters, Washington, DC ***2/08 through present***

Mr. Buchholz manages a team that assists FEMA and DOC Headquarters staff with NEPA compliance for its Public Safety Interoperable Communications (PSIC) grants program (http://www.ntia.doc.gov/psic/) and Grants Program Division (GPD) Environmental Planning and Historic Preservation (EHP) program (http://www.fema.gov/plan/ehp/). His staff develops and reviews scopes of work (SOW), environmental assessments (EA), environmental impact statements (EIS), and categorical exclusion (CATEX) determinations for more the 3,600 Federally-funded equipment and infrastructure acquisition and development projects. Mr. Buchholz's support to FEMA and DOC is direct growth of his work for the U.S. Coast Guard during which he managed a team of Booz Allen SMEs who surveyed 90 antenna sites around country for the Nationwide Automatic Identification System (NAIS) program. As of June 2010, Mr. Buchholz's PSIC team has evaluated more than 2,500 communication projects, including radio towers, mobile commence equipment, first-responder exercises, and strategic equipment reserves.

PMO Operational Readiness Support for King Abdullah University of Science and Technology (KAUST), Thuwal, Saudi Arabia ***1/09 through 5/09***

In 2009, Mr. Buchholz provided on-site PMO support to proponents of the King Abdullah University of Science and Technology (KAUST), Thuwal, Saudi Arabia, on the coast of the Red Sea, 80 km north of Jeddah, KSA. With strategic assessment specialists from Booz & Co, and construction engineers and commissioning experts from Booz Allen Hamilton, Mr. Buchholz assisted KAUST construction proponents with sequencing materials and construction work for operational readiness (university opening) in September 2009. Mr. Buchholz primarily supported the Residential Buildings Division, which is developing over 3,000 residential units for the university students, faculty, and professional staff. He also conducted readiness assessments of nearly 100 retail properties, warehouses, waste management facilities, a marina, and recreational infrastructure. The KAUST homepage is found at http://www.kaust.edu.sa/.

Environmental Compliance Support – U.S. Coast Guard, Headquarters, Washington, DC ***8/07 through present***

Under a compliance support contract, Mr. Buchholz manages a team of professionals that assists Coast Guard Headquarters staff with a range of environmental research, guidance, data management, and outreach tasks. Tasks have included revision of the Coast Guard's hazardous waste management manual, support to the Great Lakes Dry Cargo discharge rulemaking and ballast water Shipboard Technology Evaluation Program (STEP), and a noise analysis evaluation for a proposed international bridge in Detroit, MI. In April 2010, Mr. Buchholz's team completed a review Flag Administration type-approvals and IMO/GSAMP approvals for ballast water management systems (BWMS) (http://www.imo.org/environment/mainframe.asp?topic_id=548).

NPDES Permit Support for Offshore Oil Platform – U.S. EPA Region 10, Seattle, WA — ***12/07 through 2/09***

For EPA Region 10, Mr. Buchholz led a team of technical staff that developed a Biological Evaluation (BE), Essential Fish Habitat (EFH) Assessment, and Environmental Assessment (EA) for NPDES permit re-issuance for an offshore oil and gas production platform in central Cook Inlet, AK. Mr. Buchholz's team evaluated ten discrete discharges produced by the industrial and hotel operations on the platform, including sanitary wastes, graywater, deck drainage, cooling waters, desalination and filter backwashes, and seafloor disposal of muds, drill cuttings, and cement. Following review and acceptance of the regulatory support documents by EPA, Alaska DEC, National Marine Fisheries Service, Fish and Wildlife Service, and other agencies, Mr. Buchholz's team assisted EPA with the public notice of the permit re-issuance as well as responses to stakeholder comments. This project was conducted under a firm-fixed-price deliver order through Booz Allen's EPA Office of Federal Activities (OFA) contract.

Nationwide Automatic Identification System – U.S. Coast Guard, Headquarters, Washington, DC and Naval Sea Logistics Center (NAVSEALOGCEN), Mechanicsburg, PA — ***10/06 through 02/09***

For the Coast Guard's Nationwide Automatic Identification System (NAIS, http://www.uscg.mil/hq/g-a/AIS/), and working with NAVSEALOGCEN engineers, Mr. Buchholz supervised field teams that conducted NEPA environmental surveys, and historic structure assessments at NAIS antenna sites in the continental United States, Puerto Rico, Alaska, and Hawaii. His teams collected field data, conducted desktop research, and developed detailed reports that facilitated the Coast Guard's evaluation of health and safety issues, environmental impacts, coastal zone affects, endangered and threatened species, migratory birds, and floodplain issues associated with candidate antenna sites. Mr. Buchholz's team also provided Environmental Due Diligence Audits (EDDA), National Historic Preservation Act Section 106 assessments, viewshed analyses, State Historic Preservation Office (SHPO) coordination, and cultural resource assessments for this Coast Guard customer.

Uniform National Discharge Standards (UNDS) Program – U.S. Navy NAVSEA and EPA, Headquarters, Washington, DC — ***11/98 through present***

Mr. Buchholz has supported the UNDS Program since 1998. He presently provides senior oversight and management of technical and rulemaking work delivered to the Navy customer. Mr. Buchholz contributed to the framework and processes of major elements of the UNDS program, including discharge characterization methods, environmental effects assessment of marine pollution control devices, and use of toxicological endpoint concentrations (TEC) to calculate constituent hazard quotients (HQ) and discharge hazard indices (HI). Mr. Buchholz is presently supporting and advising the Navy on development of the Federal rule for the first batch of discharges, which include bilgewater, deck runoff, and underwater ship husbandry. Simultaneously, Mr. Buchholz's team is conducting discharge characterization and MPCD option assessment for the second batch of discharges, composed of aqueous film-forming foam (AFFF), compensated fuel ballast, graywater, and seawater piping biofouling prevention. UNDS Program information available at: http://unds.bah.com/ and http://www.epa.gov/owow/oceans/regulatory/unds/index.html.

Strategic Programmatic and Technical Support for South Florida Ecosystem Restoration Task Force – U.S. Department of Interior (DOI), Washington, DC and Homestead, FL ***01/05 through 06/06***

Mr. Buchholz co-led work teams that supported the South Florida Ecosystem Restoration Task Force (Task Force) and it's Science Coordination Group (SCG) with implementation of the first phase of an ecosystem-wide plan for coordinating science among the Federal, State, and Tribal partners in South Florida. The plan identified needs to develop "compatibility" indicators for the built system (to assess the compatibility of the build system with ongoing restoration of the natural environment), establish procedures to check and maintain quality of the science on which restoration decisions are based, promote improved information sharing among scientists and regulators, and develop means to track and report restoration progress. Mr. Buchholz's technical work included an assessment of impacts of South Florida restoration projects (that are being implemented to restore the degraded ecosystem) on built systems (e.g. water delivery infrastructure, flood control structures) on which the human population and economy of South Florida depend.

Natural Infrastructure Capabilities Assessments – Office of Secretary of Defense (OSD), U.S. Department of Defense (DoD), Washington, DC ***06/05 through 1/06***

Mr. Buchholz provided technical and programmatic services to the Natural Infrastructure Capabilities (NIC) initiative at Office of the Secretary of Defense (OSD). This initiative is an element of the broad Department of Defense (DoD) effort to integrate elements of mission support, environmental management, and strategic planning to meet current and future military mission requirements. A principal concept of NIC is that air, land, and water resources required for military operations and training can be quantified and valued so that informed and defensible decision-making can be conducted with respected to utilization, consumption, and protection of the resources. Natural assets include ecological communities (e.g., wetlands, streams, forests) and subsurface features (e.g., aquifers, mineral-bearing geologic structures). Statutory assets include emission and discharge permits, landfill permits, pollution credits, and restoration credits. Mr. Buchholz supported military installation surveys and evaluations that are enabling DoD to assess and manage natural infrastructure (NI) according to environmental, community, and military function and values. Additional information available at: http://proceedings.ndia.org/jsem2005/wednesdayam/session4/Phillips.ppt.

Probabilistic modeling of invasive species spread by transportation systems – U.S. Department of Transportation (DOT), Headquarters, Washington, DC ***12/04 through 06/05***

For the U.S. Department of Transportation, Mr. Buchholz led a technical team that provided ecological analyses and guidance in a study that investigated use of transportation system data in a probabilistic model of the spread of invasive species. The GARP (Genetic Algorithm for Rule-set Production) model used in the study simulated organism distribution according to environmental parameters known to be associated specific plans and animals. Land, waterway, and air transportation were evaluated, with results presented on GIS overlays. Further development and application of this model could demonstrate its potential to guide nonindigenous species control/mitigation projects and demonstrate agency compliance with Executive Order 13112.

Environmental and Natural Resources Program Support – Naval Research Laboratory (NRL), Washington, DC ***07/02 through 05/05***

Mr. Buchholz was the program manager supporting NRL under contract to Indian Head Division/Naval Surface Warfare Center (IHD/NSWC), Indian Head, MD. He managed a team of technical staff who assisted NRL with the development and implementation of an Environmental Quality Assessment (EQA), Internal Assessment Plan (IAP), and an Environmental Management System (EMS) plan for NRL-DC and subordinate commands. This work included updating NRL's facility plans, such as the Spill Prevention Control and Countermeasures (SPCC) plan, the Integrated Pest Management Plan (IPMP), and drafting environmental permit renewals and reports. Permit support included the renewal of NRL's Title V Operating permit and developing an Accidental Spill Prevention and Slug Control Plan for NRL's Wastewater permit. Additionally, Mr. Buchholz supervised the development of NRL's Storm Water Pollution Prevention Plan (SWPPP) and provided guidance on the National Pollutant Discharge Elimination System (NPDES) stormwater permit application process (i.e., Notice of Intent; NOI). NRL infrastructure details and mission capabilities available at http://www.nrl.navy.mil/.

Pier Rehabilitation and Dredging Permit Support – Naval Research Laboratory (NRL), Washington, DC — ***10/01 through 02/04***

Also under Booz Allen's IHD/NSWC contract, Mr. Buchholz managed a team that provided regulatory and permit support necessary to conduct dredging and rehabilitation of NRL's 700-ft Potomac River T-head pier. Support included conducting environmental research, sampling and chemical analysis of sediments, assessing endangered species and fish habitats, recommending project alternatives to reduce environmental impact/secure permits, and communicating with representatives of the USACE, USFWS, DCRA, and other regulators. The pier work included removal of derelict fuel lines and utilities, replacement of creosote-treated structural timber, and fire safety upgrades. The maintenance dredging was necessary to allow safe mooring of vessels up to 108 ft with drafts to 12 ft. Booz Allen's support ensured Navy compliance with the National Environmental Policy Act of 1969 (NEPA), the Clean Water Act (CWA), the Rivers and Harbor Act of 1899 (RHA), Migratory Bird Treaty Act of 1918, and other pertinent laws, regulations, and executive orders. The rehabilitated pier was rededicated in October 2003. Booz Allen's final reports supporting the NRL's DCRA water quality certification were delivered in February 2004.

EIS Ecological and Biological Assessment of Management and Acquisition Alternatives of the Chenier Plain National Wildlife Refuge, Texas – U.S. Fish and Wildlife Service (USFWS) — ***9/02 through 11/04***

Mr. Buchholz was the task manager supporting an analysis of potential impacts to ecological and biological resources for five management alternatives and four land acquisition alternatives associated with the USFWS Comprehensive Conservation Plan (CCP) and Environmental Impact Statement (EIS) for the Chenier Plain National Wildlife Refuge. Work included independent research of information and data necessary for evaluating a matrix of biological and ecological impacts that correspond to the alternatives. Data sources included technical literature of coastal plain research projects, and personal communication with government and academic professionals with functional expertise pertinent to the Chenier Plain National Wildlife Refuge. The results of the project were used to support resource-management and acquisition decisions, and cited in the USFWS EIS for the refuge.

Science Planning Support – Everglades National Park (ENP), South Florida Natural Resources Center (SFNRC), Homestead, FL — ***05/02 through 10/02***

Mr. Buchholz assisted the South Florida Natural Resources Center (SFNRC) with development of a Science Plan for Everglades National Park. Work included comprehensive understanding of SFNRC mission, current natural resource-management responsibilities, restoration-project research, outreach activities, and forecasted science needs. The task required facilitating SFNRC staff meetings and developing a science project database, which allowed SFNRC to objectively evaluate the performance of on-going projects and prioritize funding for future essential projects.

Environmental Performance Measure Development – Everglades National Park (ENP), South Florida Natural Resources Center (SFNRC), Homestead, FL — ***08/01 through 06/02***

As task leader, Mr. Buchholz supervised the research and evaluation of candidate environmental performance measures for SFNRC in support of the Comprehensive Everglades Restoration Plan (CERP). Work included: (1) researching and forecasting environmental changes associated with restoring natural water flows and water quality to the Everglades, (3) developing criteria and recommending draft performance measures, and (3) facilitating workshops with SFNRC staff and regional scientists.

Battelle Memorial Institute, Duxbury, MA, and Arlington, VA — ***06/89 through 11/98***

Program Support – EPA Office of Wetlands, Oceans, and Watersheds (OWOW), Ocean and Coastal Protection Division (OCPD), Washington, DC — ***06/89 through 11/98***

As Work Assignment Leader and Technical Area Leader, Mr. Buchholz provided nine years of technical support to EPA OCPD in the area of marine coastal protection. Major projects included development of national testing guidance for dredged material management, NEPA documents for closure of New York Bight Mud Dump Site and NEPA designation of Historic Area Remediation Site (HARS), no-discharge zone guidance and rule-making support, canceled pesticide analysis for the Great Lakes, development of ecological definitions and economic measurements of isolated waters and wetlands, risk assessment methods for dioxin-contaminated sediments (see: http://www.epa.gov/region02/water/dredge/intro.htm), and Uniform National Standards (UNDS) Phase I peer review and rulemaking support (see: http://unds.bah.com/ and http://www.epa.gov/owow/oceans/regulatory/unds/index.html).

Development of Ballast Water Testing and Treatment Technologies – EPA, USCG, NGO — ***01/97 through 08/98***

For EPA, U.S. Coast Guard, and Northeast-Midwest Institute, Mr. Buchholz conducted feasibility and efficacy analyses of candidate ballast water testing and treatment technologies, as well as nonindigenous species (NIS) invasion risk analyses. These projects were in response to the National Invasive Species Act of 1996 (NISA) and the U.S. Coast Guard's April 1998 proposed NISA implementation regulations under 33 CFR 151 (63 FR 17782-17792). The testing project evaluated field-tests used to determine whether ballast is exchanged in the open sea. The treatment technology evaluations included UV, ultrasonic, heat, EMIS, and ozonation. The preliminary risk assessment of NIS-invasion was conducted for major commercial U.S. Gulf of Mexico ports, many of which received severe infrastructure and environmental perturbation by Hurricane Katrina in August 2005.

NAVFAC RI/FS Technical Reviews – U.S. Navy — ***06/97 through 07/97***

Under Battelle's Naval Facilities Engineering Services Center contract, Mr. Buchholz conducted technical reviews of prime contractor RI/FS for Bolling AFB in Washington, DC, and Engineering Evaluation/Cost Analysis for Pearl City Landfill, Pearl Harbor, HI.

Coastal Waste Disposal Analyses – EPA — ***1990 through 1998***

On behalf of various government entities, Mr. Buchholz conducted evaluations and reports on the disposal of clay sediments, "red mud," sewage sludge, wood wastes, fish waste, and vessels-containing asbestos. The clay project involved technical analysis of natural geologic clay in the deep sediment layer of the Port of New York and New Jersey. Ocean disposal of this clay material presented both regulatory and ecological problems. The red mud project was an international survey of the disposal of this byproduct of bauxite production, conducted for an Italian firm. The sewage sludge and woodburning reports where for the U.S. delegation to the London Dumping Convention (LC'72). The projects on the disposal of fish waste from processing vessels and the sinking of vessels containing asbestos for artificial reefs were policy analyses for EPA.

Education and Technology Transfer – various clients ***1990 through 1998***

For various government clients and technical associations Mr. Buchholz participated in technology/information transfer projects. At a 1998 conference of the American Association of Port Authorities, he presented a paper on the relationship of NPDES permits and State TMDLs to liabilities and costs associated with contaminated dredged material. For EPA Office of Water, Mr. Buchholz managed the development of a manual for State officials regulating sewage discharges from boats, increasing compliance with no-discharge regulations. Also for EPA, he produced two training videos for dredged material testing.

Oil-Spill Cleanup Evaluations – industrial client ***06/89 through 09/90***

Mr. Buchholz was chief scientist and researcher for several research-vessel cruises involved in the assessment and cleanup of oiled shorelines in Prince William Sound and Shelikof Strait, Alaska. Projects included assessments of farfield oil impact, nearfield treatment techniques, and bioremediation-treatment of weathered oil. Shoreline and subsurface sampling was conducted. Technical evaluations were used in litigation, public outreach, and technical articles.

Smithsonian Institution, Marine Systems Laboratory, Washington, DC ***10/87 through 06/89***

King Crab Mariculture Research Laboratory, British West Indies ***10/87 through 10/88***

For the Smithsonian Institution's Marine System Laboratory (MSL), Mr. Buchholz built and managed an overseas research laboratory in Grand Turk, BWI, under a U.S. Agency for International Development (USAID) contract. Major projects involved researching mariculture feasibility of Caribbean king crab *Mithrax spinosissimus* and the West Indian top shell, *Cittarium pica.* The projects required close cooperation of local and British authorities for construction permits, equipment importation, and personnel work and travel authorizations necessary for the operation of the laboratory. Among the many technical challenges at this research facility were maintenance of undersea animal cages, biofouling control of seawater systems, and delivery of utility services to an under-developed foreign property of disputed ownership.

Mesocosm Research Facility, Goodland, FL ***10/88 through 06/89***

Also for the Smithsonian's MSL, Mr. Buchholz built and managed a coastal Everglades field station in Goodland, Florida, for the purpose of large-scale flora and fauna sampling, holding, and shipping for mesocosm development at Biosphere II (Tucson, AZ; see http://www.bio2.com). The project required interaction and communication with wide range of land-use and natural resource regulators, for securing necessary construction and collection permits.

Long Island University, Southampton, NY ***06/85 through 09/87***

Water Quality Instructor and Laboratory Manager ***06/85 through 09/87***

From 1985-1987, Mr. Buchholz operated a water-quality analysis laboratory and a marine-science teaching laboratory. Responsibilities included maintaining analytical equipment, leading field trips, building and maintaining an aquaculture laboratory, teaching seminars, and supervising laboratory staff. The seawater system and wet-laboratory that Mr. Buchholz constructed has been in operation for more than 25 years.

NOAA and University of Connecticut, Groton, CT — ***06/82 through 05/85***

Various Coastal Research Projects — **06/82 through 05/85**

While completing graduate studies, Mr. Buchholz was employed by NOAA's National Undersea Research Center (NURC) and the University of Connecticut to conduct biological evaluations of dredged material disposal sites; analyze coastal data from submersibles, ROVs, and SCUBA collections; and assist with Sea Grant outreach activities with the local fishing industry. Under a research contract to the USACE Waterway Experiment Station (WES), Mr. Buchholz led a University of Connecticut team that harvested and maintained wetland vegetation, and helped construct an experimental beneficial-use project using contaminated dredged material to build a coastal wetland in Bridgeport, CT < http://el.erdc.usace.army.mil/dots/pdfs/d-88-7.pdf >.

University of California, San Diego, CA — ***01/81 through 05/81***

Natural Products Organic Chemistry Research — **01/81 through 05/81**

While participating in an internship at Scripps Institution of Oceanography, Mr. Buchholz isolated and elucidated natural organic products for bioactivity and toxicity testing and commercial uses.

Education

B.S.	Marine Science/Biology, Cum Laude	Long Island University	1982
M.S.	Ecology/Marine Science	University of Connecticut	1985

Professional Associations

- Society of Environmental Toxicology and Chemistry (SETAC), since 1999
- Society of American Military Engineers, since 1997
- Water Environment Federation (WEF), since 1995
- Virginia Water Environment Association, since 1995.
- American Society for Testing and Materials (ASTM), E47 and E50, since 1993
- Coastal & Estuarine Research Federation (CERF), since 1983

Citizenship

U.S.

Clearances

DSS Secret
DHS Suitability

Professional Certifications

None

A-2. Paul T. Jacobson, Ph.D.

PAUL T. JACOBSON, PH.D.

EXPERTISE

Quantitative ecological assessment (including ecological risk assessment) with emphasis on aquatic ecosystems, water quality monitoring and management, and effects of electricity generation on aquatic resources.

EDUCATION

Ph.D., Oceanography and Limnology, University of Wisconsin-Madison, 1990.
M.S., Oceanography and Limnology, University of Wisconsin-Madison, 1987.
Graduate student, Forestry and Environmental Studies, Duke University, 1982-83.
B.A., Biology, Cornell University, 1981.

PROFESSIONAL EXPERIENCE

SENIOR PROJECT MANAGER

Electric Power Research Institute, Glenelg, Maryland. September 2009-Present

Leading EPRI's marine and hydrokinetic energy research program. Managing EPRI's ongoing, DOE-funded wave energy resource assessment. Also contributing to EPRI's conventional hydropower program activities related to environmental impacts associated with conventional hydro-electric power generation.

CO-FOUNDER AND MANAGING PARTNER

Langhei Ecology, LLC, Glenelg, Maryland. July 1996-September 2009

Clients included the U.S. Environmental Protection Agency (USEPA); the Federal Energy Regulatory Commission (FERC); the National Oceanic and Atmospheric Administration (NOAA), the Electric Power Research Institute (EPRI); the American Petroleum Institute (API); the Chesapeake Bay Program Office; major civil and environmental engineering firms; state, county, and municipal government agencies; and private companies and individuals. Ecological assessment for these clients encompassed a broad range of technical subjects including water quality monitoring, modeling, and criteria development; fisheries; ecological modeling and risk assessment; landscape ecology; mercury bioaccumulation; and other subjects.

CHAIRMAN, BOARD OF DIRECTORS

Maryland Water Monitoring Council January 2005-December 2007

Elected Chairman of the Board of Directors. The Council was chartered by the Maryland DNR to facilitate coordinated water monitoring activities across all levels of government and to encourage the transfer of information among governmental and non-governmental organizations. The 22-member Board comprises representatives of federal, state, county, and municipal government agencies, non-governmental organizations, and industry engaged in water resources research and management.

LECTURER

Advanced Academic Programs, Johns Hopkins University January 1998-Present

Faculty member, Environmental Sciences & Policy. Teach a course on quantitative ecological assessment to graduate students, many of whom are professionals working in the environmental field.

ASSOCIATE

The Cadmus Group, Inc., Germantown, Maryland. September 1994-July 1996

Developed watershed-scale ecological risk assessment methodologies and case studies for USEPA's Office of Water, Health and Ecological Criteria Division/Risk Assessment Forum. Served as Deputy Program Manager for the firm's prime, task order contract with the USEPA, Office of Water, Office of Science and Technology, Standards and Applied Science Division. Managed projects, including the Water Quality Standards Academy, development of training materials on water quality management for the Natural Resources Conservation Service, and an assessment of human health and environmental risks associated with mercury contamination in fish. Managed subcontracts including a project to enhance an aquatic ecosystem fate and effects model, and a water quality benefits analysis of proposed effluent guidelines for the coastal subcategory of the oil and gas extraction industry.

Served as an author for a USEPA–Water Environment Research Foundation project evaluating the value of an ecological risk assessment approach to watershed-level ecosystem protection. Under a contract with USEPA's Office of Ground Water & Drinking Water, provided technical oversight for regulatory and economic impact analyses for the proposed arsenic standard.

SENIOR SCIENTIST
Versar, Inc., Ecological Sciences & Analysis, Columbia, Maryland. 1990-1994

Principal quantitative ecologist and ecological modeler. Developed and applied a wide range of mathematical models and analyses for municipal, state, and federal government and commercial clients, including assessment of effects of hydro- and steam-electric power plants on various fish species of the Susquehanna, Roanoke, Youghiogheny, Connecticut, Delaware, Nanticoke, Arkansas, Penobscot, and Columbia Rivers. Provided technical support and advice to these clients on a variety of environmental matters.

Served as a fisheries specialist supporting FERC in review of license applications for new and existing hydroelectric facilities throughout the U.S. Identified and conducted analyses to quantify effects of dam construction and operation on fish populations. Activities included whole-basin and other cumulative impact analyses, and preparation of Environmental Assessments and Environmental Impact Statements.

Served as in-house statistical consultant. Performed ecological risk assessments and conducted quantitative analyses supporting human health risk assessments.

SELECTED PUBLICATIONS

Bedard, R., P. T. Jacobson, M. Previsic, W. Musial and R. Varley. 2010. An Overview of Ocean Renewable Energy Technologies. *Oceanography* **23**(2): 22-31.

Jacobson, Paul T. 1986. Nuclear energy. Pages 259-283 in C. A. S. Hall, C. J. Cleveland, and R. Kaufman, eds. *Energy and Resource Quality: The Ecology of the Economic Process*. John Wiley & Sons, New York. (also 2nd edition, 1992, University Press of Colorado)

Jacobson, Paul T. 1990. Pattern and process in the distribution of cisco, *Coregonus artedii*, in Trout Lake, Wisconsin. Doctoral Dissertation. University of Wisconsin-Madison. 137 pp.

Jacobson, Paul T., C.S. Clay, and J.J. Magnuson. 1990. Size, distribution, and abundance of pelagic fish by deconvolution of single-beam acoustic data. - *Rapp. P. -v. Réun. Cons. int. Explor. Mer*, 189:304-311.

Jacobson, Paul T. 2000. Evaluation of multi-metric bioassessment as an approach for assessing impacts of entrainment and impingement under Section 316(b) of the Clean Water Act. *Environmental Science and Policy* 3: S107-S115.

Jacobson, Paul T. 2000. Risk assessment of a proposed introduction of Pacific salmon in the Delaware River basin. Pages 59-76 in S. Ferson and M. Burgman, eds. *Quantitative Methods for Conservation Biology*. Springer-Verlag, New York.

Jacobson, Paul T. 2002. Assessment of Spawning and Nursery Habitat: Review and Evaluation of Methods Potentially Applicable to Regulation of Cooling Water Intake Structures. Prepared for the Electric Power Research Institute, Palo Alto, California. TR 1000732.

Jacobson, Paul T. 2004. Comprehensive Monte Carlo Simulation of Multi-metric Biological Assessment: A Framework for Investigating Causality and Sources of Uncertainty. Prepared for the Electric Power Research Institute, Palo Alto, California. TR 1009446.

Luecke, Chris, Michael J. Vanni, John J. Magnuson, James F. Kitchell, and Paul T. Jacobson. 1990. Seasonal regulation of Daphnia populations by planktivorous fish: Implications for the spring clear-water phase. *Limnology and Oceanography*. 35(8):1718-1733.

Stranko, S. A., R. H. Hilderbrand, R. P. Morgan, II, M. W. Staley, A. J. Becker, A. Roseberry-Lincoln, E. S. Perry and P. T. Jacobson. 2008. Brook trout declines with land cover and temperature changes in Maryland. *North American Journal of Fisheries Management* **28**(4): 1223-1232.

A-3. Louise Kregting, Ph.D.

Curriculum Vitae

Personal details			
Full name	Dr	Louise	Kregting

Present position	Research Fellow		
Organisation/Employer	Queens University Belfast		
Contact Address	12-13 The Strand		
	Portaferry		
	County Down	**Post code**	BT22 1PF
Work telephone	+442842727808	**Mobile**	+447771305773
Email	l.kregting@qub.ac.uk		

Academic qualifications

2007, PhD, Botany, University of Otago
2002, Masters, Marine Science, University of Otago
2000, Diploma in Marine Science, Distinction, University of Otago
1999, Bachelor of Science, Botany, University of Otago

Professional positions held

2009- Present, Post Doctorate Research Fellow, Physical influences on primary productivity, Queens University Belfast, Northern Ireland
2008, Research assistant, Biominearlization of coralline algae in New Zealand for Dr. Abigail Smith, University of Otago
2006-2008, Post Doctorate Research Fellow, Hydrodynamic influences on sea urchin fertilization, Jointly with University of New England and University of Hawaii
2005, Field assistant, Biosecurity work of *Undaria pinnatifida* in Stewart Island, Kingett Mitchell and Associates
2004, Research Diver, Enhancement project of invertebrates in Lake Mahinerangi, Kingett Mitchell and Associates
2002, Project Leader, Serpulid Reef Survey with Dr. Abigail Smith, University of Otago
2001, Research Diver, 4 weeks biosecurity work of *Undaria pinnatifida*, Department of Conservation
2000, Project supervisor, Blue Cod survey in Doubtful Sound, Kingett Mitchell and Associates Ltd.
1999-2005, Research Diver, Environmental monitoring of the subtidal macrofauna and flora of Doubtful Sound, Marine Science, University of Otago

Present research/professional speciality

My research interests lie in how organisms operate and interact in marine environments. In particular I focus on how they work in turbulent boundary layers. When I started my career this topic was considered somewhat esoteric but even in this brief intervening period it has become apparent that this interdisciplinary work is vital for understanding systems and change. This is entirely relevant as food and energy production systems encroach on the marine environment and seek to do so in a manner underpinned by knowledge. My present postdoctoral work at the Queens University Belfast in the Department Of Civil Engineering at Portaferry Marine Laboratory seeks to predict if marine energy converters will influence the growth and productivity of kelp forests, namely *Laminaria hyperborea* and *L. digitata*. This work is funded by the UK GBP £4.5M SUPERGEN marine energy consortium (http://www.supergen-marine.org.uk/news.php) of which I am part of Workstream 10. This work is an integration of the physical influences (water motion) on the biological aspects (nutrient uptake, growth rate and population stability of macroalgae) of kelp productivity through both laboratory and field work.

Research publications and dissemination

Kregting, L. T., Hepburn, C. D., Hurd, C. L. and Pilditch, C. (2008) Seasonal patterns of growth and nutrient status of the macroalga *Adamsiella chauvinii* (Rhodophyta) in soft sediment environments. *Journal of Experimental Marine Biology and Ecology*. 360:94-102

Kregting, L. T., Hurd, C. L., Stevens, C. L. and Pilditch, C. (2008) The relative importance of water motion on nitrogen uptake by the subtidal macroalga *Adamsiella chauvinii* (Rhodophyta) in winter and summer. *Journal of Phycology*. 44:320-330

Kregting, L.T., Gibbs, M.T. (2006) Salinity controls the upper depth limit of black corals in Doubtful Sound, New Zealand. *New Zealand Journal of Marine and Freshwater Research*. 40:43-52

Smith, A.M., McGourty, C.R., **Kregting, L**., and Elliot, A. 2005. Subtidal *Galeolaria hystrix* (Polychaeta: Serpulidae) reefs in Paterson Inlet, Stewart Island, New Zealand. *New Zealand Journal of Marine and Freshwater Research* 39:1297-1304

Refereed conference proceedings

Yund, P.O., **Kregting, L.T**., Bass, A.L., Aveni-Deforge, K., Tilburg, C.J., and Thomas, F.I.M. (2009) Flow and fertilization in sea urchins: A combined flume and field approach. *Integrative and Comparative Biology*. 49:E188-E188.

Kregting, L.T., Yund, P.O., Thomas, F.I.M., and Grabowski, R.C. (2006) Position, distance and hydrodynamic effects and fertilization success of the green sea urchin *Strongylocentrotus droebachiensis*. *Integrative and Comparative Biology*. 46:E78-E78.

Other forms of dissemination (reports for clients, technical reports, popular press, etc)

Kregting, L.T., and Stevens, C. (2008) Marine energy influences on subtidal benthic communities. NIWA Internal Report.

A-4. Dallas J. Meggitt

Dallas J. Meggitt, P.E.
Technical Director
Sound & Sea Technology, Inc.
Lynnwood, WA 98087-5524
dmeggitt@soundandsea.com

Education and Training
California Institute of Technology, Engineering, BS, 1965
California Institute of Technology, Aeronautical Engineering, MS, 1966
California Institute of Technology, Environmental Engineering Science, MS, 1972
Numerous professional development short courses, seminars and conferences concentrating on renewable marine energy technologies and environmental aspects of renewable marine energy

Qualifications
Mr. Meggitt has over 40 years of experience designing, developing, installing and operating equipment and systems in the marine environment in all water depths and at worldwide locations. His professional experience includes development and validation of methodologies for analysis of the installation and operation of anchor-cable-buoy systems that are now used for the assessment of the behavior of floating renewable energy systems. He participated in the design and development of undersea sensor systems, including the assessment of the potential environmental impacts of those systems. He has consulted on the design of wave, tidal and Ocean Thermal Energy Conversion systems, and has participated in the development and installation of pilot and demonstration projects.

Mr. Meggitt is the author or co-author of over 30 technical papers and presentations to professional groups.

Member, American Society of Civil Engineers (ASCE)
Member, Marine Technology Society (MTS)

Professional Experience
March 1999 to Present, Sound & Sea Technology, Inc., Technical Director/Senior Program Manager
Mr. Meggitt is the Technical Director of Sound & Sea Technology, Inc., responsible for technical execution and quality of SST projects. The mission of Sound & Sea Technology is to provide ocean engineering expertise to the U. S. Navy, other government agencies and the undersea telecommunications industry. Mr. Meggitt is responsible for technical oversight of SST's marine renewable energy projects, including specifically mooring, anchoring and ocean engineering related to those projects.
April 1999 to April 2001, Strategic Marine Resources Division, Natural Resources Consultants, Managing Director
Established and managed a division of a consulting company to provide cable system planning and installation services to the undersea telecommunications cable industry and Government agencies.

August 1992 to March 1999, Raytheon Systems Company, Naval and Maritime Systems, Program Manager

Managed the Raytheon Sea Sentinel Undersea Coastal Surveillance System (UCSS) program, a port and harbor maritime security system utilizing advanced acoustic sensor and processing technology. Provided senior ocean engineering technical oversight for Raytheon U. S. Navy undersea surveillance programs.

October 1989 to August 1992, Western Instrument Corporation, Director of Programs

Overall management responsibility for all programs in a small-business ocean engineering organization. Responsible for development and execution of programs in surveillance, special projects and related areas.

August 1974 to October 1989, Naval Civil Engineering Laboratory, Director, Ocean Systems Division (1980-1989)

Managed a diversified Navy R&D organization of 25 professionals with an annual budget of $15 million. Responsible for business development, technical accomplishments, budget, schedule and line management. Projects executed by this Division included ocean engineering for Project Ariadne, Low Frequency Active Adjunct, CNO Urgent ASW Program (CUARP), Arctic surveillance, SOSUS, IUSS and special projects. This included development of specialized finite-element computer models for prediction of the performance of moored systems in seaways. These models are the predecessors to such models as AQWA and OrcaFlex.

A-5. Rafael A. Olivieri, Ph.D.

Rafael A. Olivieri, Ph.D.

EDUCATION: Ph.D. Biology
University of California Santa Cruz, Santa Cruz, CA 1996

M.S., Marine Sciences
University of Puerto Rico, Mayagüez Campus, Mayagüez, PR 1987,

B.S., Biology,
University of Puerto Rico, Mayagüez Campus, Mayagüez, PR 1982,

SUMMARY: Dr. Olivieri is a fully bilingual (English and Spanish) and bicultural professional with over 21 years of combined professional experience in the areas of environmental protection, policy and regulatory process, biological oceanography and marine ecology research; and science education. Before pursuing his Ph.D. studies, Dr. Olivieri held various regulatory, technical, and educational positions in Puerto Rico. As a consultant, Dr Olivieri has provided support to multiple clients including the U.S. Navy, U.S. Environmental Protection Agency (EPA), U.S. Commission on Ocean Policy, South Florida Ecosystem Restoration Task Force, Everglades National Park, National Marine Fisheries Service (NMFS), United Kingdom Ministry of Defense (UK MOD), U.S. Coast Guard, and the Monterey Bay Aquarium. His consulting experience includes leading the development, review, and the scientific, technical, and policy analysis of complex National Environmental Policy Act (NEPA) and Executive Order 12114 (*Environmental effects abroad of major Federal actions*) projects; support of a joint U.S. Navy/EPA rulemaking program, science coordination programs, review of ballast water management technologies, enforcement of wetland regulations, fish and wildlife management plan development, and evaluation of potential incidental take of marine mammals and endangered species during weapon effect tests and shock trials. Dr. Olivieri has also facilitated scientific, policy implementation, and outreach workshops. Dr Olivieri has conducted research in the areas of marine primary production, structure and function of coastal and oceanic ecosystems, ecological models, impacts to coral reefs, and effects from power plant thermal effluents on tropical planktonic species. His field research experience includes more than seven months at sea participating in oceanographic research cruises to the Antarctic Weddell Sea, Sargasso Sea, Caribbean, and Eastern Pacific Ocean sponsored by diverse organizations including the Office of Naval Research (ONR) and National Science Foundation (NSF). Dr. Olivieri field experience also includes identification of marine mammals and sea turtles as part of his duties as a longline fisheries observer in the Caribbean Sea and conducting biological field surveys for the development of a fish and wildlife management plan for a U.S. Naval Station. His international experience includes participation in scientific workshops, conferences, and training in Nigeria, the Philippines, Mexico, and Bermuda, and the Caribbean. Dr. Olivieri has completed an Underwater Acoustic and Signal Processing course at Penn State, and an Ammunition, and Explosive Certification Training in accordance with AMC-R 350-4, DAP 385-64 DOD 4145.26 and OSHA CFR 29.

CLEARANCE: Secret

EXPERIENCE:
Booz Allen Hamilton, *Arlington, VA*
June 1999 through Present, *Associate*

Programmatic Environmental Assessment (PEA) for US Coast Guard Interagency Operations Centers (IOC) Project- Dr Olivieri is the Program Manager (PM) leading a team of subject matter experts (SME) on U.S. Coast Guard operations and NEPA process that are developing a PEA for the IOC. This task, being developed under a very aggressive schedule, applies to 35 IOC proposed for high-risk priority ports across the nation. The general analysis provided by the PEA will enable the US Coast Guard to tier additional Environmental Assessments (EAs) and Categorical Exclusions (CATEXs) as needed to facilitate site-specific implementation. The IOC project implements the mandates of the SAFE Port Act to improve tactical decision-making, situational awareness, operations monitoring/interoperability, rules-based processing, and joint planning in a coordinated interagency environment. IOC comprises three distinct areas of capability designed to enhance unity of effort among maritime stakeholders: Integrated Vessel Targeting, Operations Planning, and Operations Monitoring/Interoperability. Because of the nationwide footprint of this task, Dr. Olivieri teams is implementing an effective project scoping and outreach effort to ensure IOC stakeholders have adequate participation in the PEA development process.

Littoral Combat Ship (LCS) Environment, Safety, and Occupational Health Support, U.S. Navy - Dr Olivieri is the PM for Booz Allen's ESOH support to the LCS Program. This ESOH support is provided in accordance with the requirements of DoD Regulation 5000.2 and SECNAVINST 5000.2. Support provided under this task include acquisition and technical analysis support to the LCS Program for any planning, test, operational, and disposal actions potentially affected by ESOH regulations. Specifically, his team provides ESOH documentation analysis and development support as required by the NAVSEA Environmental Manager for Acquisition and the LCS Program Office including support of the DoD milestone decision authority review process, risk identification, implementation of programmatic ESHO evaluation (PESHE) requirements and updates, and ensuring NEPA compliance. In addition, Booz Allen supports the monthly Environmental Working Group meetings for the two shipbuilding teams. Included with this task is a recently completed Overseas Environmental Assessments (OEA) for High Speed Sea Trials to be conducted during the next five years in the Gulf of Mexico on vessels under construction at the Austal USA facilities in Mobile Alabama. This OEA required informal consultation with NMFS Southeast Regional Office under Section 7 of the Endangered Species Act. Dr Olivieri's team also developed an operational site analysis (OSA) for the shock trial of LCS vessels. This OSA is the first step of the required technical and policy support to the LCS program office with the development NEPA and Executive Order 12114 environmental compliance documents required for the shock trials of LCS vessels. The OSA evaluates the logistic support required to successfully conduct the test, and feasibility characteristics of potential alternative areas to conduct the shock trials.

Review and Analysis of IMO and International Flag Administrations Approval of Ballast Water Management Systems Review – Dr. Olivieri was the PM leading a team of SME that review and evaluated the degree to which decisions, test protocols, and underlying technical information indicated that approvals of the Ballast Water Management Systems (BWMS) were scientifically valid and would meet the requirements of relevant U.S. statutes and regulations. Internationally, BWMS are being approved by the Marine Environment Protection Committee (MEPC) of the International Maritime Organization (IMO) with respect to biocide issues and by foreign flag States with respect to treatment efficacy in accordance with the procedures established under the 2004 International Convention for the Management of Ships' Ballast Water and Sediments.

National Environmental Policy Act Compliance for the Advanced Radar Detection Laboratory at PMRF – Dr. Olivieri was the technical lead of a team that developed for Navy Program Executive Office Integrated Warfare System 2.0 (PEO IWS) an Environmental Assessment (EA) for the construction of the Advance Radar Detection Laboratory (ARDEL) at the Pacific Missile Range Facility (PMRF) Barking Sands, Kauai, Hawaii. The ARDEL facilities will test and evaluate a new Air and Missile Defense Radar (AMDR) system that is planned for installation in next generation Navy surface combatant vessels, such as the CGX cruiser. The AMDR consists of the AMDR-S (S-Band), the AMDR-X (X-Band) radars, and a Radar Suite Controller (RSC). This radar system is referred to as the AMDR Suite. The EA evaluated potential effects of the (a) radio frequency (RF) radiation emissions from system operations on humans in recreational boats and personnel in the vicinity of the radar; (b) RF radiation emissions from system operations on wildlife, including species protected by Endangered Species Act (ESA), the Marine Mammal Protection Act (MMPA), the Migratory Bird Treaty Act (MBTA), and the Magnuson Stevens Fisheries Conservation Management Act (MSA); (c) RF radiation hazards on fuels and ordnance; (d) facility's aesthetics with the existing landscape and infrastructure; and (e) archaeological resources, air quality, wetlands, floodplains, and minority and low income populations. The EA also ensured compliance with the enforceable policies of the Hawaii Coastal Zone Management Plan, including impacts on surrounding environments. The EA include a Biological Evaluation (BE) developed in support of Section 7 informal consultation under the ESA.

Shipboard Technology Evaluation Program (STEP), USCG – Dr. Olivieri was the deputy program manager for the review and update of STEP, a U.S. Coast Guard program designed to facilitate the research and development of effective shipboard technologies for ballast water treatment (BWT). STEPS aims to create more options for vessel owners seeking alternatives to the current procedures set by the regulations for ballast water exchange. The purpose of this regulations is to control the invasion and spread of aquatic nuisance species into waters of the United States by vessels discharging ballast water. Project support included review and revision of STEP guidance documents, review of vessel application process, development of an interim report, evaluation of implication of program expansion, assessment of manpower and resources requirements, evaluation of NEPA compliance requirements, and development of final Assessment Report with recommendations on how to improve and expand program.

LPD 19 Shock Trial Overseas Environmental Impact Statement, U.S. Navy - Dr. Olivieri provided technical support to U.S. Navy SEA04R (Environmental Protection, Occupational Safety and Health) with the development of the LPD 19 Shock Trial Overseas Environmental Impact Statement (EIS). Dr. Olivieri was responsible for the calculation of surveillance effectiveness estimates for the evaluation of potential incidental takes under the Marine Mammals Protection Act and the Endangered Species Act during the shock trials of the LPD 19, a SAN ANTONIO Class vessel. This scientific analysis is a central component of the EIS and required evaluation of multiple aerial and shipboard monitoring scenarios for the optimization of surveillance effectiveness to ensure the protection of marine mammals and sea turtles. Dr Olivieri also participated as a marine mammals and sea turtle observer onboard the LPD 19 during the shock trial completed during August and September of 2008.

Overseas Environmental Assessment for Weapon Effect Tests, U.S. Navy - Dr. Olivieri provided technical support to U.S. Navy SEA04R with the development of OEAs for Weapon Effect Tests (WET) conducted on decommissioned Navy vessels. For these efforts, Dr. Olivieri designed environmental mitigation operational procedures, including aerial survey flight patterns, calculated surveillance effectiveness, and evaluated potential incidental exposures of marine mammals and sea turtles that may occur during these tests. This evaluation required the integration of marine mammal and sea turtle density estimates, acoustic model results developed by U.S. Navy experts, and mitigation measurements for the determination of Level B and Level A takes under the Marine Mammals Protection Act and the Endangered Species Act. Two WETs (Ex-NICHOLSON and Ex-INCHON) were successfully conducted during the summer and fall of 2004, and included the controlled sinking of the vessels. A third WET (Ex-THORN), a joint exercise by the U.S. Special Operation Command and the UK Ministry of Defense, was conducted during the summer of 2006 and included the controlled sinking of the vessel. A fourth OEA for a WET conducted on the Ex-SAIPAN, a large Amphibious Assault ship, during the summer of 2007 was completed in March 2007. For this last WET, Dr. Olivieri also participated during the mission at sea as a marine mammals and sea turtle observer.

Development of a Plan for Coordinating Science – Department of Interior, South Florida Ecosystem Restoration Task Force - Dr. Olivieri provided technical support for the development of a plan for coordinating science activities that support the restoration of the South Florida Ecosystem. This plan focuses on the Everglades ecosystem, from the wetlands regions north of Okeechobee Lake to the waters of Florida Bay and Florida Keys. The plan will coordinate the science activities of multiple Federal and state agencies, and local jurisdiction including Native American tribes. The development of the plan include identification of science needs to ensure restoration that will be effective under future environmental scenarios, including those caused by climate change. In addition, the work included gap analysis of the current science programs, and recommendations on how to address those gaps.

Environmental Assessment for NPDES permits for Offshore Aquaculture Projects – U.S. EPA Region 2- Dr. Olivieri was the technical leader for the development of two environmental assessments (EAs) that evaluates the environmental consequences of establishing concentrated aquatic animal production (CAAP) facilities in the offshore waters off the coast of Puerto Rico. These EAs were required for the National Pollution Discharge Elimination System (NPDES) permits application submitted to the U.S. EPA by two commercial aquaculture projects. These projects, proposed for the east and west coast of Puerto Rico would deploy multiple 3,000 m^3 Ocean Spar Sea Station™ finfish cages that could produce annually more than a half a million pounds of Cobia (*Rachycentron candum*). Major environmental considerations for the projects include, but are not limited to fate and impact of nutrients on oligothrophic coastal waters, impacts on sensitive communities (e.g., coral reefs, seagrass beds), potential degradation of water quality, impacts to essential fish habitats and species protected by the Endangered Species Act and Marine Mammal Protection Act, impacts on Marine Protected areas, and environmental justice considerations.

Uniform National Discharge Standards (UNDS) Program, U.S. Navy - Dr. Olivieri has served multiple roles including functional leader for environmental effect analysis and discharge characterization efforts for Phase II of the Uniform National Discharge Standards (UNDS) rule-making program. In support of this task, Dr. Olivieri manages a database of Armed Forces vessels, boats, and craft, and associated discharges, operational profiles, and engineering characteristics. Dr. Olivieri has authored multiple technical and policy documents including an environmental effect analysis report for one of the UNDS discharges, two technical guidance documents, and a review of Federal and international regulations for air emissions from marine engines and incinerators.

Caribbean – Atlantic Regional Workshop on Coral Reefs and Land-Based Pollution – U.S. EPA/USDA/NOAA - Dr. Olivieri facilitated a two-day bilingual (English and Spanish) workshop on coral reefs and land-based pollution held on May 18 and May 19, 2004 in San Juan, Puerto Rico. The workshop was co-sponsored by the U.S. EPA and USDA with additional sponsorship by NOAA. The purpose of the workshop was to facilitate the development and implementation of local action strategies (e.g., in situ and remote sensing monitoring program, development of environmental performance measures and best management practices) to address land-based sources of pollution impacting coral reef ecosystems, and to share information and strengthen communications among the Atlantic and Caribbean Area jurisdictions on coral reef issues. The format of the workshop was informal and included plenary presentations, breakout groups, and training. The workshop participants included approximately 75 scientists and ecosystem managers from Washington DC, Florida, U.S. Virgin Island, Puerto Rico, and Jamaica. In addition to facilitating the workshop, Dr. Olivieri reviewed both the English and Spanish versions of the workshop final report.

Inventory Assessment of Nation's Facilities that Support Coastal and Ocean Activities – U.S. Commission on Ocean Policy - Dr. Olivieri was the technical leader for the development of Appendix 5 *Inventory of U.S. Ocean and Coastal Facilities* of the 2004 U.S. Commission on Ocean Policy Report. This appendix provides an inventory assessment of the Nation's facilities that support coastal and ocean activities. The inventory included the infrastructure and human capacity that the Nation has to conduct maritime activities, research, exploration and monitoring of coastal and ocean waters including the Great Lakes, and marine education. Dr. Olivieri was responsible for leading the research efforts and synthesis of information.

Science Planning Support and Environmental Performance Measure Development – Everglades National Park (ENP), South Florida Natural Resources Center (SFNRC) - Dr. Olivieri provided technical assistance to SFNRC with development of a Science Plan for the Everglades National Park including developing candidate environmental performance measures in support of the Comprehensive Everglades Restoration Plan (CERP). Work included comprehensive evaluation of SFNRC mission, current natural resource-management responsibilities, restoration-project research, outreach activities, and forecasted science needs. In addition, Dr. Olivieri supported the research and forecast of environmental changes associated with restoring natural water flows and water quality to the Everglades considering such variables as climate change and urban development, developing criteria and recommending draft performance measures, and, facilitating workshops with SFNRC staff and regional scientists.

American Association for the Advancement of Science/ U.S. EPA, Washington DC
June 1997 through July 1999 *Risk Assessment Fellow and Environmental*

Dr. Olivieri was a Fellow with the Science and Engineering Policy program of the American Association for the Advancement of Science (AAAS) at the EPA National Center for Environmental Assessment (NCEA) and the EPA Office of Coastal Protection of the EPA Office of Water the EPA. Dr. Olivieri provided technical support to EPA about the topic of harmful algal blooms, participated as a member of an inter-agency team that drafted a National research and monitoring strategy for *Pfiesteria*, and served on Maryland's Harmful Algal Technical Advisory Committee. During the fellowship, Dr. Olivieri completed ESRI Introduction to Arc View GIS and USDA Introduction to Risk Assessment courses. In addition, Dr. Olivieri gave a presentation during the August 1998 Conference of the Society of Environmental Toxicology and Chemistry (SETAC), and participated in the 1999 Harmful Algal Management and Mitigation Conference in Subic Bay, Philippines. As an Environmental Fellow with the Science and Engineering Policy program of AAAS at the Office of Coastal Protection of the EPA Office of Water in Washington DC. Dr. Olivieri prepared a scientific literature review about coral reef eutrophication in support of the EPA coral reef protection program.

Monterey Bay Aquarium, *Monterey, CA*
April 1997 through August 1999, *Educational Consultant*

Dr. Olivieri supported the development of environmental educational materials for the Monterey Bay Aquarium (by providing technical expertise in the areas of wetland ecology and global system. This work was a joint effort of the MBA and an association schoolteachers from the Monterey Bay area.

Monterey Bay Aquarium Research Institute, *Moss Landing, CA*
June 1989 through May, 1997, *Research Assistant*

Dr. Olivieri collaborated on multiple research projects at the Monterey Bay Aquarium Research Institute (MBARI) while holding both paid and volunteer positions. A major project he conducted was the modification of a plankton ecosystem model of the subtropical open ocean for the development of a planktonic primary production model of the upwelling ecosystem of Monterey Bay. The work required extensive collaboration with software engineers and database specialists, and the process and analysis of large oceanographic data sets used as model parameters, and to validate simulation outputs. Another project he worked on was the characterization of marine aggregates using image analysis techniques. This aggregate sever a mechanism to the rapid export of carbon from surface to deep waters. For this project Dr. Olivieri frame-grabbed video images, processed, quantified, plotted and analyzed data, and produced preliminary reports from video footage of mid water marine aggregates filmed with a remote operated vehicle (ROV). Dr. Olivieri also developed a food web model of the Monterey Bay ecosystem. In addition, Dr. Olivieri participated in multiple scientific cruises in the Monterey Bay and adjacent California current, many of them joint collaborations between MBARI and the Navy Naval Post Graduate School. During these cruises, Dr. Olivieri collected and processed oceanographic data such as chlorophyll, nutrients, and primary production and supported the deployment of two permanent surface instrumented moorings and various drifters in support of the MBARI ocean observing program. One of the oceanographic cruises was an ONR sponsored research expedition aboard the AGOR 23 Class RV THOMAS G. THOMPSON to investigate the circulation and pelagic ecosystem of a submerge seamount. In 1996 Dr. Olivieri was one of only two United States scientists invited to participate in an international workshop on continental shelf fluxes of carbon, nitrogen, and phosphorus. The Land-Ocean Interaction in the Coastal Zone (LOICZ) and the Joint Global Ocean Flux Study (JGOFS) programs of the International Geosphere-Biosphere Programme (IGBP) sponsored the workshop held in Lagos Nigeria. A workshop report published in 1996 included a biogeochemical mass balance model for the Peru-Chile coastal upwelling system developed by Dr. Olivieri. The goal of these projects was to advance the understanding the ecological and biogeochemical processes operating in upwelling regions of the ocean and the impact they have on large scale process such as climate change. In addition, while working as a research assistant Dr. Olivieri was invited to participate as a member of the support and mentoring team for the Universidad Metropolitana (San Juan, Puerto Rico) under the program of Model Institutions for Excellence of the Geoscience Directorate of the National Science Foundation

University of California Santa Cruz, *Santa Cruz, CA*
September 1988 through June 1995, *Graduate Research and Teaching Assistant*

Dr. Olivieri participated in multiple projects related to primary production and fluxes of particulate matter in marine ecosystems. He collaborated with the development of a model used to calculate *in situ* sinking rates of marine aggregates. He gained extensive experience in the use of light and scanning electron microscopes while researching the composition and abundance of particulate material collected with sediment traps from Monterey Bay. Results from his electron microscopy work earned him Best Student Poster award by the Foundation for Advances in Medicine and Science awarded during the Scanning 95 conference. Dr. Olivieri also participated on an eight weeks research expedition to the Weddell Sea, Antarctica, aboard the Research Vessel-Ice Breaker NATHANIEL B. PALMER. He collected salinity, oxygen, temperature, carbon dioxide, nutrients, and chlorophyll samples in support of ocean circulation and climate change investigations. As result of his participation in on the expedition to the Weddell Sea, Dr. Olivieri received as a civilian, the US Antarctica Service Medal, awarded by the U.S. Navy, and presented by the National Science Foundation (NSF). Dr Olivieri also received a Graduate Mentorship Award ($12,000), and Graduate Opportunity Fellowship ($13,700) from the UCSC. As a teaching assistant for the UCSC Biology Board Dr. Olivieri directed laboratories and discussion sessions, prepared test, and evaluated more than 400 students for upper and lower division courses, such as biological oceanography, genetics, introductory biology series, and psychobiology.

U.S. Army Corps of Engineers, *San Juan, PR*
January 1988 through August 1988. *Biologist*

Dr. Olivieri worked as a biologist with the Regulatory Office of US Army Corps of Engineers, San Juan, Puerto Rico. Dr. Olivieri reviewed permit applications and NEPA compliance document including complex environmental impact statements, performed field investigations including aerial surveys, and determined areas of jurisdiction of projects proposed for waters of the United States including navigable waters and wetlands. In addition, Dr. Olivieri conducted investigations of suspected unauthorized activities, assessed the ecological impact of these activities to sensitive ecosystems such as coral reefs, mangroves, and sea-grasses beds, and prepared cease and desist orders. Dr. Olivieri also reviewed and conducted inspections field inspections for wetland mitigation and restoration plans.

U.S. Fish and Wildlife Service, *Boquerón, PR*
January 1987- September 1987, *Biologist*

Dr. Olivieri worked as a biologist with US Fish and Wildlife Service (USFWS) Ecological Service, Caribbean Field Office preparing and drafting a fish and wildlife management plan for the U.S. Navy Roosevelt Roads Naval Station (RRNS), Puerto Rico. He researched, conducted field surveys of flora and fauna, compiled and verified all available information on fish, wildlife, and their habitat on RRNS, and advised USFWS endangered species (ES) staff on proposed and/or ongoing Navy projects at RRNS that involved ES or their critical habitats. He discussed the potential impact of these projects and provided mitigation alternatives and conservation recommendations.

Universidad Interamericana de Puerto Rico, Ponce Campus – *Ponce, PR*
August 1986 through December 1986. Science Lecturer

Dr. Olivieri was taught two sessions of an 8 ½ undergraduate credits introductory biology class. This class, designed for non-science majors, included both class room lectures and laboratory work. Dr. Olivieri was responsible for developing class lectures and directing all laboratory work, and evaluating students.

National Marine Fisheries Service/University of Puerto Rico, *San Juan PR*
December 1985 through March 1986, *Fisheries Observer*

Dr. Olivieri worked as a swordfish fisheries observer under a contract with the University of Puerto Rico and NOAA National Marine Fisheries Service (NMFS) during the 1986 winter season. As part of his duties, Dr. Olivieri logged more than 30 days at sea in Caribbean waters adjacent to Puerto Rico and the U.S. and British Virgin Islands. Dr Olivieri collected fisheries data (e.g., identified and sized fish caught, fishing gear used, and environmental variables), and identified and recorded information about marine mammals and sea turtles observed. In addition, Dr. Olivieri collected fish tissue samples for molecular and ontogenic studies. A detailed report of data collected was prepared and submitted to NMFS.

University of Puerto Rico Mayagüez Campus, - Mayagüez PR

August 1982 – July 1985, Research and Teaching Assistant

Dr. Olivieri held multiple research and teaching assistant positions while conducting his master research. Examples of his duties include teaching assistant to Dr. Juan Gonzalez during National Science Foundation Chautauqua and Sea Grand courses that focused on tropical marine ecology. These courses were given to high school teachers from Puerto Rico and U.S. mainland. Other experience included research assistant to Dr. Winfield Sylvester (New York City College) during a one-week oceanographic cruise aboard the sailboat Doggersbank. Dr Olivieri collected sea surface temperature, air velocity, direction and temperature for ground truth data collected with the SIR-B radiometers aboard the Challenger space shuttle.

NASA Goddard Space Flight Center/Morgan State University, *Greenbelt Maryland*
May 1984 through August 1984, *Science an d Engineer Summer Intern*

Dr. Olivieri participated in the Summer Intern Program in Research in Science and Engineering at NASA Goddard Space Flight Center, sponsored by Morgan State University. Dr. Olivieri processed AVHRR and CZCS ocean remote sensing temperature and phytoplankton pigment data collected with the satellites NOAA-7 and NIMBUS-7 from diverse coastal systems including the Gulf of Mexico Loop Current and Florida's west coast, Rias of Western Spain, and Antarctic Ocean.

Publications

Olivieri, R.A., and F.P. Chavez. 2000. A model of plankton dynamics for the coastal upwelling system of Monterey Bay, California. Deep-Sea Research II 47, 1077-1106

Olivieri, R.A. 1996. Plankton dynamics and the fate of primary production in the coastal upwelling ecosystem of Monterey Bay, California. Ph.D. Dissertation University of California Santa Cruz. 316 pp.

Olivieri, R. A., and F. P. Chavez. 1996. Preliminary regional biogeochemical budgets for the Peru-Chile Coast. *In* J. Hall, S. V. Smith and P. R. Boudreau (eds.), Report on the International Workshop on Continental Shelf Fluxes of Carbon, Nitrogen, and Phosphorus. October 14-18, 1996, Lagos, Nigeria. LOICZ Report & Studies No. 9 JGOFS Report No. 22, pp. 20-25.

Olivieri, R. A., and C. H. Pilskaln. 1993. Scanning electron microscopy of particulate organic matter from Monterey Bay, California: Relative abundance and condition of major components. Scanning 17 suppl. V:134-135.

Olivieri R. A., A. Cohen, and F. P. Chavez. 1993. An ecosystem model of Monterey Bay, California. In V. Christensen and D. Pauly (eds.) Trophic models of aquatic ecosystems. ICLARM Conf. Proc. 26, pp. 315-322.

Olivieri, R. A. and C. H. Pilskaln. 1993. Estudio con microscopía electrónica del material orgánico particulado de la bahía de Monterey, California. V Congreso Latinoamericano de Ciencias del Mar. Asociación Latinoamericana de Investigadores en Ciencias del Mar. Resumen de presentaciones, O-219.

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A-6. Stephen W. Shaner, Ph.D.

RESUME

Stephen W. Shaner, Ph.D.

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2 June 2008

AREAS OF EXPERTISE

ENVIRONMENTAL / ECOLOGICAL RISK ASSESSMENTS
WATER QUALITY CRITERIA AND STANDARDS
AQUATIC TOXICOLOGY, WATER POLLUTION
ENVIRONMENTAL PERMITTING
BIOASSESSMENTS AND BIOCRITERIA
STATISTICAL ANALYSIS AND EXPERIMENTAL DESIGN

Dr. Shaner is a marine biologist/ecologist with 30 years of professional experience in academia, government, and environmental consulting positions. His 20 years of environmental project experience includes coastal pollution studies, environmental monitoring programs and assessments, including sewage outfall impacts, oil spill damage assessments, military exercise impacts, non-point source pollution prevention planning, and water quality and sediment contamination studies and risk assessments for heavy metals, conventional pollutants, petroleum hydrocarbons, PCBs, pesticides, and other organic pollutants. He has managed biological and oceanographic surveys for pollution impacts and fisheries assessments in the Arabian Gulf and off the coast of Chile. For the State and Regional Water Quality Control Boards of California, he developed water quality criteria methods for bioaccumulative pollutants, and designed and implemented the water quality toxicity survey and assessment program for surface waters in the Central Valley region. Dr. Shaner supported the U.S. Navy in the development of CWA §312 Uniform National Discharge Standards (UNDS) for the vessels of the U.S. Armed Forces, and recently served as principal biologist for an EIS for expanding four US Fish and Wildlife Service refuges in Texas. He also performs reviews of ecological risk assessments and regulatory analysis for a wide variety of clients. He recently performed ecological analyses in a pilot project for US DOT for developing methodology for incorporating transportation system data into a probabilistic model (Genetic Algorithm for rule-set prediction). He is presently an extension instructor in marine biology for the University of California, and a certified senior ecologist through the Ecological Society of America.

PROFESSIONAL EXPERIENCE

ASSOCIATE III (BIOLOGIST), November 1998 – present. Booz-Allen and Hamilton.

Peer review of EIS prepared for the US Coast Guard and US EPA, regarding rule-making for dry cargo discharges in the Great Lakes. Environmental Survey for siting of US Coast Guard facilities for the National Automatic Identification System, including threatened and endangered species, critical habitats, hazardous materials, migratory flyways, aesthetics, historic and cultural resources, and other environmental permitting issues. Water and wastewater specialist for a pilot project for the Secretary of Defense, consisting of a Natural Infrastructure Capability assessment for the Defense logistics Agency, San Pedro, California. This project evaluated the water supply and wastewater infrastructure and natural resource encroachments to the DLA facility in San Pedro, California. A second project evaluated the water supply and wastewater infrastructure and natural resource encroachments to the US Marine Corps base at Camp Pendleton (California). Principle ecologist for US DOT sponsored project to develop methods for probabilistic modeling of invasive species using both transportation and ecological data; Biology and toxicity specialist for development of program specific water quality criteria for U.S. military ship effluent discharges under the Uniform National Discharge System (UNDS) program. Analyses considered the effects of a wide variety of chemical and physical stresses on the biota in the ports and harbors used nationwide by the US military fleet. On-site reviews of environmental problems associated with construction activities at several US Coast Guard stations in California. Also performed reviews of ecological risk assessments for US EPA, wrote biological and ecological sections of an Environmental Impact Statement for US Fish and Wildlife Service refuges in Texas (expansions), and reviewed new EPA methodology for deriving water quality criteria using the biotic ligand model. Peer reviews of several Ecological Risk Assessments (under RCRA) for the US EPA.

INSTRUCTOR, Jan. -Feb. 2009. California State University, Monterey Bay extension. Designed and taught three field courses on biodiversity, conservation biology, and ecological research methods.

INSTRUCTOR, July 1997 - present. University of California Extension. Designed and currently teaching an extension course in Marine Biology.

ENVIRONMENTAL CONSULTANT, May 1996 - present. Independent consultant for biological, ecological, and habitat assessments for projects in California and internationally. Projects completed for a variety of clients, primarily risk assessments for coastal and harbor sites with water and sediments contaminated by petroleum hydrocarbons, heavy metals, PCBs, PAHs, dioxins, and pesticides. Also peer review of research proposals for CALFED and for the University of Nevada (Tahoe Regional Planning Agency). Shipboard monitoring of environmental program on a cable-laying ship in the Santa Barbara channel.

SENIOR SCIENTIST, June 1994 - April 1996. ChemRisk, Alameda, Calif. Provided ecological risk assessment services, primarily in water quality and contaminated sediment issues, biological community analyses, and water and sediment chemistry. Participated in the sediment toxicity identification effort at sites contaminated by chemical manufacturing, petroleum products storage facilities, and wastewater discharges. Project/Task manager for complex and integrated studies of water and sediment quality in aquatic systems heavily contaminated with petroleum hydrocarbons, organochlorines, and metals.

LECTURER, May - June 1992. Designed and taught an upper division course in Marine Biology at the University of Alaska, Anchorage.

ENVIRONMENTAL SCIENTIST, May 1991 - June 1994. Dames and Moore, Inc. Anchorage, Alaska. Project manager and/or chief scientist on a wide variety of projects in Alaska and elsewhere, including; Chief scientist for marine biological, chemical, and oceanographic baseline studies of two coastal bays in Chile, - this project conducted an assessment of water quality and sediment quality impacts at a port facility, and a predictive risk assessment for contamination, including supervision of Chilean scientists and other staff, and writing of the Environmental Impact Statement required for World Bank funding; Biological assessment of oil spill related petroleum hydrocarbon residues in tissues of rockfish from Prince William Sound; Ecological risk assessment of a spill at nearshore oil production facility in Cook inlet; Ecological risk assessment for a petroleum pipeline spill at Indian Creek, Alaska; Federal, State, and local permitting requirements for petroleum facilities; Environmental assessments for heavy metal contamination in Denali National Park; Manager of Programmatic Environmental Impact Statement preparation for military training operations throughout Alaska; Environmental assessment for a transmission line on the Kenai Peninsula, Alaska; Environmental Impact Statement for a salmon hatchery expansion project in Prince William Sound.

CONSULTING BIOLOGIST, March 1990 - April 1991. Consultant to Aecos Inc. in Honolulu Hawaii. Prepared a Sea Grant funded survey and report on aquaculture development in Hawaii.

SENIOR SCIENTIST, July 1988 - February 1990. Kinnetic Laboratories, Inc., Carlsbad, California, Anchorage, Alaska. Involved with a variety of consulting projects, including biological, water, and toxicity project planning for the Exxon Valdez oil spill ; site specific criteria development for heavy metals from sewage outfalls in San Francisco Bay, California, and Cook Inlet, Alaska; marine biological surveys near marine outfalls for fish, invertebrates, benthic infauna, kelp, water quality and toxic pollutants; Contamination and cleanup assessments in San Diego Bay shipyard facilities; EIR,EIS, and NPDES monitoring reports for marine sewage outfalls (Cities of Anchorage, Alaska, and San Diego, San Elijo, and Escondido, California), including biological assessments, health risk assessments from bacterial and chlorination byproducts, and heavy metals, pesticides, petroleum hydrocarbons, and other toxic pollutants..

ENVIRONMENTAL SPECIALIST, June 1986 - December 1987. State Water Resources Control Board, Sacramento, California. Development of methods for setting ambient water quality criteria for the State of California; development of water quality criteria for boron, molybdenum, manganese, and principal author of the State criteria document on selenium (bioaccumulative effects) for the protection of fish, wildlife, and human health. Planning of inland water environmental survey program. Provided assistance to the Regional Water Quality Control Board concerning their environmental monitoring program and water quality testing requirements for NPDES dischargers. Advisor for the development of new residual chlorine discharge requirements for sewage outfalls.

ENVIRONMENTAL SPECIALIST, July 1985 - June 1986, California Regional Water Quality Control Board, Sacramento, California. Contract manager for the Regional Board's contracts with six analytical laboratories. Designed and implemented a quality assurance program for awarding contracts and monitoring the performance of contract laboratories. Manager of the Board's laboratory and chemical analyses, as well as field sampling and safety equipment. Technical advisor on sampling and chemical analysis of waters and wastes for toxic substances and conventional pollutants. Prepared a manual on guidelines for sampling and analysis of water, sediments, and wastes, and advised the engineering staff on biological effects and toxicity testing, as well as waste discharge and NPDES permit requirements for biological effects at sewage outfalls. Designed and managed an ambient water environmental testing program for the region.

STAFF RESEARCH ASSOCIATE, June 1985 - November 1985. University of California, Davis. Worked on a project analyzing and assessing the accumulation of heavy metals in the tissues of Corbicula fluminea in the San Francisco Bay-estuary.

CONSULTING BIOLOGIST, August 1984 - February 1985. Consultant for Tetra Tech, Inc. Prepared a report for the Electric Power Research Institute on biological processes in fish compensation (primarily striped bass biology, physiology, and ecology), for the development of a mechanistic model for predicting power plant impacts on striped bass populations.

CONSULTING BIOLOGIST, March - June 1984. Reviewed research proposals for the government of Bahrain, and made recommendations for improving the experimental designs of proposals submitted to the government for funding. The projects reviewed were concerned with (1) development of a coastal oyster fishery, (2) stock assessment of a commercially important nearshore fish species, and (3) the toxic effects of oil refinery discharge on a local nearshore fish species.

ASSISTANT PROFESSOR OF BIOLOGY, September 1983 - July 1984. University College of Bahrain. Taught courses in marine biology, invertebrate biology, advanced invertebrate biology, underwater research techniques, and team taught a course in genetics. Conducted research on near shore fauna in the waters of Bahrain.

LECTURER, January - March 1982. University of California at Davis. Designed and taught an upper division course in invertebrate zoology for zoology majors. Responsible for both lectures and laboratory sections.

POSTDOCTORAL RESEARCH ASSOCIATE, April 1982- June 1983. University of California, Davis. Managed a project (funded by the U.S. Environmental Protection Agency) to develop a methodology for determining the toxicity of heavy metals in sediments, and determine the relationships between pH, alkalinity, and other water quality parameters on the acute toxicity of copper to selected benthic invertebrate fauna. I supervised the work of seven technicians and was responsible for project design, implementation, data analysis, and final written and oral reports.

POSTDOCTORAL RESEARCH ASSOCIATE, October - January 1981. University of California, Davis. Worked on a project analyzing heavy metal concentrations in the freshwater clam Corbicula fluminea.

RESEARCH ASSISTANT, September 1977- July 1981. University of California, Davis. Performed doctoral research on the ecology and physiology of the estuarine shrimp Crangon franciscorum.

LECTURER, June - July 1977. San Francisco State University. Designed and taught a course in general zoology for biology majors. Responsible for both lectures and laboratory sections.

TEACHING ASSISTANT, January 1975 - June 1977. San Francisco Stae University. Taught several laboratory sections in general zoology and general biology.

EDUCATION

Ph.D. Biological Ecology, University of California at Davis, 1981
B.A. Biological Sciences, San Francisco State University, 1975

PROFESSIONAL AFFILIATIONS: Ecological Society of America (Certified Senior Ecologist)

LANGUAGES: English, Spanish
PUBLICATIONS: (Available on request)

REFERENCES

Professional references may be obtained from:

Dr. David Armstrong, School of Fisheries, WH-10, University of Washington, Seattle, WA.98195. Tel. (206) 543-6132

Dr. Peter B. Moyle, Department of Wildlife and Fisheries Biology, University of California, Davis, CA. 95616.

Dr. Christopher Foe, Regional Water Quality Control Board, 3443 Routier Rd., Sacramento, CA. (916) 255-3113

APPENDIX B

SUPPORTING DOCUMENTS

APPENDIX B

SUPPORTING DOCUMENTS

B-1. Wave Energy Technology Project, Kaneohe Bay, HI, Environmental Assessment (Jan. 2003)

B-2. SeaFlow Project, Environmental Statement, Non-Technical Summary (Nov. 2001)

B-3. Siadar Wave Energy Project, Environmental Statement (2008)

B-4. ScottishPower Renewables & Pelamis Wave Power (formerly Ocean Power Delivery Ltd.), Multiple Wave Energy Converter Project, Environmental Report (2007)

B-5. English Translation, *Declaración de Impacto Ambiental* (DIA) for Cultivation of Macroalgae in a Suspended Mariculture System (Sept. 2010)

Original available at: https://www.e-seia.cl/archivos/DIA_Planchada_-_210103056__2_.pdf

B-1. Wave Energy Technology Project, Kaneohe Bay, HI, Environmental Assessment (Jan. 2003)

Environmental Assessment

OFFICE OF NAVAL RESEARCH

Proposed Wave Energy Technology Project

MARINE CORPS BASE HAWAII, KANEOHE BAY, HAWAII

Department of the Navy

January 2003

DEPARTMENT OF DEFENSE
DEPARTMENT OF THE NAVY

FINDING OF NO SIGNIFICANT IMPACT FOR THE PROPOSED WAVE ENERGY TECHNOLOGY TEST PROJECT AT MARINE CORPS BASE HAWAII, KANEOHE BAY, OAHU, HAWAII

Pursuant to Section 102(2)(c) of the National Environmental Policy Act (NEPA) of 1969 and the Council of Environmental Quality regulations (40 CFR Parts 1500-1508) implementing the procedural provisions of NEPA, the Department of the Navy gives notice that an Environmental Assessment (EA) has been prepared, and that an Environmental Impact Statement is not required for the proposed installation and testing of a Wave Energy Technology project at Marine Corps Base Hawaii, Kaneohe Bay (MCBH Kaneohe Bay).

The Navy proposes the phased installation and operational testing of up to six Wave Energy Conversion (WEC) buoys off of North Beach at MCBH Kaneohe Bay, over a two to five year period. Operational testing of the buoys at MCBH Kaneohe Bay would provide data to validate the WEC technology developed by Ocean Power Technologies, Inc. This innovative, non-polluting energy technology, if demonstrated to be efficient, reliable, and cost-effective, could be used to provide supplemental electrical power to suitable coastal Department of Defense sites. Congressional appropriation language stipulates that this testing is to occur in Hawaii.

The EA evaluates and compares the potential environmental impacts of: (1) the Proposed Action, which is to conduct field tests of the WEC buoy system at North Beach, MCBH Kaneohe Bay; (2) an alternative site at Pearl Harbor; and (3) a No Action alternative. After considering the alternatives for the Proposed Action, the Pearl Harbor site was rejected because it has only a minimal wave energy environment and would not adequately meet the objectives of the project. The No Action alternative (i.e., not testing the WEC system in Hawaii) would not meet any of the objectives, and, therefore, was also rejected.

The first two buoys, to be installed no earlier than Spring 2003, would be anchored in about 100 feet (30.5 meters) of water at a distance from shore of approximately 3,900 feet (1,189 meters). Mechanical energy generated from the up and down motion of the buoy would be converted into electrical energy. The power would be transmitted to shore via an armored and shielded undersea power cable connected to a land transmission cable and routed to the existing MCBH Kaneohe Bay electrical grid system. Submerged equipment would be weighted down and secured to the seafloor with rock bolts and protective split pipe sufficient for maintaining system integrity in a 500-yr storm event. The land cable would be elevated above grade by a pedestal support system across sensitive areas of the Mokapu Burial Area. Each WEC buoy is expected to produce an average of 20 kW of power (sufficient to power approximately four to six typical, single-family residences), with 40 kW as the peak output for each buoy.

Ten potentially affected resources were identified for this project and none were found to be significantly impacted by the proposed installation and operational testing of the WEC buoy and ancillary equipment. These resources are: shoreline physiography, oceanographic conditions, marine biological resources, terrestrial biological resources, land and marine resource use compatibility, cultural resources, infrastructure, recreation, public safety, and visual resources. Installation procedures would be designed to minimize impacts to living coral and benthic communities by avoiding areas of rich biological diversity and high coral coverage. The undersea cable would be laid with adequate tension to follow the contour of the seafloor and to resist forming loops that could otherwise entangle marine mammals. Entrapment of marine mammals and sea turtles within the buoy is unlikely because the interior of the structure is without obstructions, sharp edges, or corners and the opening in the bottom provides a path for ready egress.

Potential impacts on marine biota from operation of the WEC system would not be significant. Organisms sensitive to electric or magnetic fields may be able to detect emissions when very close to the undersea cable. However, the effects would be minor and temporary. In the unlikely event that damage to the cable causes an electrical fault or short, transient effects on marine organisms and divers (mild discomfort) may be experienced. Installation noise produced by drilling holes for installing rock bolts would be intermittent and of short duration. Operation of the WEC system is expected to produce a continuous acoustical output similar to low-grade noise associated with light to normal ship traffic. Noise from system installation or operational testing is not likely to adversely affect humpback whales, dolphins, and green sea turtles that may happen to be in the immediate area.

Growth of benthic organisms, such as corals and sponges, on the new substrate provided by the undersea cable, buoy anchor base, concrete moorings may end up benefiting the ecosystem. At close of the testing period, the Navy will meet with the Hawaii Department of Land and Natural Resources, U.S. Fish and Wildlife Service (USFWS), and the National Marine Fisheries Service (NMFS) to decide whether this equipment should be removed as planned or left in place. The buoys, equipment canister, and all onshore equipment would be removed at the close of the testing period.

In informal consultation under Section 7 of the Endangered Species Act, the USFWS and NMFS have both concurred with the Navy that the Proposed Action is not likely to adversely affect the threatened green sea turtle, endangered humpback whale, endangered hawksbill turtle, endangered Hawaiian monk seal or any other listed species. The taking of any marine mammal covered under the Marine Mammal Protection Act of 1972, as amended, is not likely to occur under the Proposed Action. Best Management Practices to avoid "taking" of threatened and endangered marine species that may enter the area during installation of the cable, buoys, and mooring will be developed and implemented.

There will be no significant impacts to recreation and public safety, although recreational activities in the immediate vicinity of the buoy array would be somewhat curtailed for the two to five-year test period. Access to the area around the buoy array will not be restricted, but signage will be installed advising of the dangers associated with the equipment. Potential hazards to mariners at the buoy array site would be mitigated by installing navigational aids and safety lights on the mast of the WEC buoys, filing a Notice to Mariners with the United States Coast Guard, and issuing additional public announcements. At the proposed distance from shore, impacts on the view plane by the buoy mast assembly (i.e., superstructure extending above the waterline) on each buoy would not be significant.

There would be no significant impact on land use. Under the Proposed Action a utility vault would be installed within the "clear zone" of a runway at MCBH Kaneohe Bay. The "clear zone" is an area adjacent to the runway with special restrictions to provide aircraft overrun areas and unobstructed visibility of airfield lighting. Since the vault would be in a low spot such that it would not be an obstruction, a waiver was approved by the Navy's airfield safety office.

Under Section 106 of the National Historic Preservation Act, the State Historic Preservation Officer has concurred with the Navy's determination that no historic properties would be affected.

The Hawaii Department of Business, Economic Development and Tourism, Office of Planning, has accepted under its Coastal Zone Management Program the Navy's Notice of Negative Determination.

Based on information gathered during preparation of the EA, the Navy finds that the proposed phased installation and operational testing of up to six WEC buoys at MCBH Kaneohe Bay, Oahu, Hawaii will not significantly impact human health or the environment. No significant socioeconomic impacts are anticipated, and there should be no disproportionately high and adverse human health or environmental effects from the Proposed Action on minority or low-income populations or children. There will be no cumulative impacts from the Proposed Action.

The Environmental Assessment addressing this action may be obtained from: Commander, Pacific Division, Naval Facilities Engineering Command (PACNAVFACENGCOM), 258 Makalapa Dr., Suite 100, Pearl Harbor, Hawaii 96860-3134. Attention: Ms. Connie Chang (PLN231), telephone (808) 471-9338, facsimile transmission (808) 474-5909. A limited number of the EA on compact disc is available to fill single-unit requests.

4/10/03

Date

Ronald E. Tickle
Head, Operational Environmental Compliance and Planning Branch
Environmental Readiness Division (OPNAV N45)
Deputy Chief of Naval Operations (Logistics)

4/18/03

Date

J.C. McABEE
Brigadier General, U.S. Marine Corps
Commanding General, Marine Corps Base Hawaii

COVER SHEET

Proposed Action: Installation and Operational Testing of Wave Energy Converter Buoys at Marine Corps Base Hawaii, Kaneohe Bay, Hawaii

Lead Agency: Department of the Navy

Coordinating Agency: Pacific Division, Naval Facilities Engineering Command

Contact: Mr. Gary Kasaoka, PLN231GK
PACNAVFACENGCOM
258 Makalapa Dr STE 100
Pearl Harbor, Hawaii 96860-3134
Telephone (808) 471-9338; Fax (808) 474-5909

This Environmental Assessment (EA) evaluates the potential environmental impacts of the proposed phased installation and operational testing of up to six Wave Energy Conversion (WEC) buoys off North Beach at Marine Corps Base Hawaii (MCBH) Kaneohe Bay (the Proposed Action). The EA has been prepared in accordance with the National Environmental Policy Act of 1969 (NEPA), 42 USC §4321 et seq.; regulations promulgated by the Council on Environmental Quality (CEQ) (40 CFR §§1500-1508); Chief of Naval Operations Instruction (OPNAVINST 5090.1B CH-2); and U.S. Marine Corps Order (MCO P5090.2A).

In addition to the Proposed Action, two alternatives were evaluated: No Action, where the wave energy technology test would not be implemented in Hawaiʻi, and an alternative site at a location outside the entrance to Pearl Harbor, Hawaiʻi.

The potential impacts of each alternative were analyzed for the following resources/issues: shoreline physiography, oceanographic conditions, marine biological resources, terrestrial biological resources, land and marine resource use compatibility, cultural resources, infrastructure, recreation, public safety, and visual resources. The analyses indicate that there would be no impacts from the No Action alternative, and that the potential impacts from having the project at MCBH Kaneohe Bay or at the Pearl Harbor site would be similar and not significant for the following areas: coral and benthic communities, potential entanglement of marine life with the undersea cable, potential entrapment of marine mammals and sea turtles within the buoy, electromagnetic radiation, potential electrical leakage, installation and operational noise, and views. There would be only temporary impacts to recreation and public safety at North Beach, in areas not currently restricted by MCBH Kaneohe Bay in the vicinity of the buoy array. No cumulative impacts from the WET (Wave Energy Technology) test would occur.

The Navy has completed informal consultation under Section 7 of the Endangered Species Act (ESA) with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service regarding threatened and endangered species at the project area off MCBH Kaneohe Bay. The Navy also consulted with the State Historic Preservation Officer (SHPO), native Hawaiian organizations, and some individuals known to attach religious and cultural significance to that part of the base. Informal consultation with SHPO was carried out under Section 106 of the National Historic Preservation Act (NHPA) and its implementing regulations in 36 CFR Part 800.

Should the Pearl Harbor site be chosen for the project instead of the MCBH Kaneohe Bay location, the Navy would at that time initiate informal consultation under ESA and NHPA for siting the project at Pearl Harbor.

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Acronyms and Abbreviations

°	degree
A	amperes
A/m	amps per meter
AC	alternating current
ACHP	Advisory Council on Historic Preservation
AFB	Air Force Base
AFS	Air Force Station
APE	area of potential effect
AUVs	Autonomous Underwater Vehicles
dB	decibel(s)
BMPs	Best Management Practices
C	Celsius
CAA	Clean Air Act
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cm	centimeter(s)
CRAMP	Coral Reef Assessment and Monitoring Program
CWA	Clean Water Act of 1977
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act of 1972
CZMP	Coastal Zone Management Program
DA	Department of the Army
DAR	Division of Aquatic Resources (State of Hawaii, Department of Land and Natural Resources)
dB	decibels
DBEDT	Department of Business, Economic Development and Tourism (State of Hawaii)
DC	direct current
DGPS	Differential Global Positioning System
DLNR	Department of Land and Natural Resources (State of Hawaii)
DoD	Department of Defense
DOH	Department of Health (State of Hawaii)
EA	Environmental Assessment
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EM	electric and magnetic
EMR	electromagnetic radiation

EO	Executive Order
EPA	Environmental Protection Agency
ESA	Endangered Species Act of 1973
ESQD	explosive safety quantity distance
F	Fahrenheit
FAD	fish aggregating device
FIP	Federal Implementation Plan
FMP	Fisheries Management Plan
FONSI	Finding of No Significant Impact
ft	feet
FWCA	Fish and Wildlife Coordination Act of 1934
FWPCA	Federal Water Pollution Control Act of 1948
GPS	Global Positioning System
h	hour(s)
HAPC	Habitat Areas of Particular Concern
HAR	Hawaii Administrative Rules
HECO	Hawaiian Electric Company
HERF	EMR hazards to fuel
HERO	EMR hazards to ordnance
HERP	EMR hazards to personnel
HFD	Honolulu Fire Department
HRS	Hawaii Revised Statutes
in	inches
ICRMP	Integrated Cultural Resources Management Plan
INRMP	Integrated Natural Resources Management Plan
kg	kilogram(s)
km	kilometer(s)
km/h	kilometer(s) per hour
kW	kilowatt(s)
kV	kilovolt(s)
kVA	kilovolt-amperes
lb	pound(s)
Ldn	day-night equivalent sound levels in units of the decibel or dB
m	meter(s)
MBA	Mokapu Burial Area
MBTA	Migratory Bird Treaty Act of 1918
MCBH	Marine Corps Base Hawaii
mi	mile(s)
MILCON	military construction

mm	millimeter(s)
MMPA	Marine Mammal Protection Act of 1972
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
ms	millisecond(s)
MSDS	Material Safety Data Sheet
mV	millivolt(s)
mV/m	millivolt per meter
MV	megavolt(s)
MVA	megavolt-amperes
mW	milliwatt(s)
NAF	Non-Appropriated Fund
NAGPRA	Native American Graves Protection and Repatriation Act
NAAQS	National Ambient Air Quality Standards
NAVMAG	Naval Magazine
Navy	U.S. Department of the Navy
NDSA	Naval Defensive Sea Area
NEPA	National Environmental Policy Act of 1969
NHPA	National Historic Preservation Act of 1966
NMFS	National Marine Fisheries Service
NRHP	National Register of Historic Places
OA/FA	oil-cooled ambient/forced air
ONR	Office of Naval Research
OPNAVINST	Office of the Chief of Naval Operations Instruction
OPT	Ocean Power Technologies, Inc.
PA	Programmatic Agreement
PACDIV	Pacific Division (U.S. Navy)
PAR	Precision Approach Radar
PBZ	Prohibited Buffer Zone
PMRF	Pacific Missile Range Facility
PVC	polyvinyl chloride
s	second(s)
SCUBA	self-contained underwater breathing apparatus
SHPO	State Historic Preservation Officer
SIP	State Implementation Plan
sq	square
State	State of Hawaii
U.S.	United States
USACE	United State Army Corps of Engineers

USC	United States Code
USCG	United States Coast Guard
USFWS	United States Fish and Wildlife Service
v	volt(s)
W	watt(s)
WEC	Wave Energy Conversion
WET	Wave Energy Technology
WPRFMC	Western Pacific Regional Fishery Management Council
yd	yard(s)

Executive Summary

EXECUTIVE SUMMARY

PURPOSE AND NEED

The Office of Naval Research proposes the phased installation and operational testing of Wave Energy Conversion (WEC) buoys off North Beach, Marine Corps Base Hawaii, Kaneohe Bay (MCBH Kaneohe Bay). This action is being proposed to test wave energy as a renewable, non-polluting power source. Department of Defense (DoD) installations are vulnerable during times of national conflict due to their reliance on conventional fuels for electrical power generation. Coastal DoD sites with suitable wave energy potential could obtain supplemental power using wave energy if it can be demonstrated to be efficient, reliable, and cost-effective. Testing is needed to obtain operational data to validate the WEC technology developed by Ocean Power Technologies, Inc. The Congressional appropriation to conduct this test stipulates that testing is to occur in Hawaiʻi, which has coastal locations with high wave energy potential.

The objectives of the Proposed Action are the following:

Objective 1. Conduct the test in a high wave energy density environment, characterized by an average annual wave height of 3 feet (ft) or 1.0 meter (m) (minimum) to 5 ft or 1.5 m (optimum), which is a likely characteristic of the environment for future operational use of the WEC technology at other locations.

Objective 2. Challenge the system under variable conditions, such as winter storms, to investigate the survivability of the system.

Objective 3. Collect statistically significant data sets to validate assumptions and findings. Increasing the period of collection, e.g., up to five years, would increase the likelihood of obtaining statistically significant data sets for various test parameters, such as seasonal changes and their effects on the system.

Objective 4. Observe the effect on system performance when more than one buoy is present.

Objective 5. Use a test site for the system that minimizes the costs of installation, operations, and maintenance.

Objective 6. Minimize the risk of system failure, to optimize the collection of data, by maximizing the survivability of the system.

PROPOSED ACTION AND ALTERNATIVES

WEC system components include the buoy, anchor base, hydraulic lines, equipment canister, undersea cable, land cable, utility vault to house the connection of the undersea and land cables, and equipment shelter. In addition to the WEC system, the project proposes the installation of four mooring clumps within the buoy field for anchoring workboats. Installation and operational testing would occur over a two- to five-year time period with the first two buoys installed no earlier than the beginning of calendar year 2003.

Alternative A: Proposed Action. This alternative is the phased installation and operational testing of up to six WEC buoys off North Beach, MCBH Kaneohe Bay. The undersea cable would enter the water east of the main runway and extend approximately 3,900 ft (1,189 m) to the approximate depth of 100 ft (30.5 m), the site of the proposed buoy array. On shore, the utility vault would be located above the high water mark and Battery French, located on a hillside behind the Officers' Family Housing area, would serve as the equipment shelter. The land cable would be secured to the utility vault, encased in a conduit, and be elevated on pedestals along its route to Battery French. This site location meets all of the project objectives.

Alternative B: Pearl Harbor. This alternative is the phased installation and operational testing of up to six WEC buoys outside the entrance channel to Pearl Harbor. The undersea cable (approximately 12,000 ft [3,658 m]) would be installed on the western side of the Pearl Harbor entrance channel along the junction of the channel slope and bottom. The proposed buoy array would be in the open coastal waters outside the channel in the approximate area of the 100-ft (30.5-m) contour. The cable landing site would be located on the shoreline adjacent to Building 562, just northeast of the Iroquois Point housing. The utility vault would be placed on the lawn of Building 562, which would serve as the equipment shelter. This site meets the project objectives but would provide only a minimal wave energy environment to test the WEC technology.

Alternative C: No Action. The No Action alternative would not implement the proposed Wave Energy Technology (WET) test in Hawaiʻi. The operational test data would not be obtained and the objectives of the WET test would not be achieved.

ENVIRONMENTAL CONSEQUENCES

This document evaluates and compares the potential environmental impacts of the three alternatives. The affected resources or issues analyzed in detail include: shoreline physiography, oceanographic conditions, marine and terrestrial biological resources, land and marine resource use compatibility, cultural resources, infrastructure, recreation, public safety, and visual resources. The findings for Alternatives A and B are summarized below. Alternative C: No Action would not implement the proposed WET test in Hawaiʻi. Therefore, no affected resources or impacts to affected resources would result from this alternative.

Shoreline Conditions. Minimal impacts would occur to shoreline conditions at North Beach, MCBH Kaneohe Bay and the Pearl Harbor site due to the proposed installation. The WEC system would not alter currents or wave directions, and there would be no effects on shoreline erosion or change in sand deposition patterns. At the end of the test period, land equipment would be removed.

Oceanographic Conditions. No impacts on oceanographic conditions are expected. Implementing the WET test would not affect wave scattering and energy absorption.

Marine Biological Resources. Minor impacts would occur to marine biological resources along the cable route and buoy array site at North Beach, MCBH Kaneohe Bay, and the Pearl Harbor site. Installation of the WEC system at the two sites would avoid areas of rich biological diversity and high percentages of coral coverage. No Habitat Areas of Particular Concern (HAPC) have been identified or designated at either site.

Marine species listed under the Endangered Species Act as threatened or endangered and that are known to occur at North Beach include the green sea turtle, hawksbill turtle, Hawaiian monk seal, and humpback whale. The U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) concur with the Navy that the Proposed Action is not likely to adversely affect threatened and endangered species under their jurisdictions. The taking of marine mammals protected under the Marine Mammal Protection Act (MMPA) is unlikely during the installation and operation of the WEC system. The potential growth of benthic organisms such as corals on the WEC cable and anchor during the test period would be a beneficial impact.

A biological monitoring plan for fish and benthic organisms will be developed, as part of the Navy's Best Management Practices (BMPs). In consultation with the NMFS, USFWS and State of Hawaii (State) Department of Land and Natural Resources, Division of Aquatic Resources (DAR), the Navy would determine at the end of the test period whether equipment installed on the seafloor (i.e., cable, buoy anchor system from the universal joint down, mooring clump base and anchoring system) should be removed or left in place. All other WEC equipment such as the buoys and equipment canisters would be removed following completion of the test.

The following potential effects from entanglement, entrapment, electromagnetic radiation (EMR), electrical current leakage, heat release, and noise from installation and operation of the WEC system would be similar for the MCBH Kaneohe Bay and Pearl Harbor sites.

- **Entanglement.** Entanglement would be a minimal concern, as installation would occur in shallow water with adequate tension to allow the cable to resist forming loops and contour to the seafloor. Divers would inspect the cable route once it is in place. There would be no risk of entanglement once the cable is rock-bolted to the seafloor. Mooring lines and anchor chains for the four mooring clumps would be pulled taut during installation, minimizing risks of entanglement.

- **Entrapment.** There is minimal potential for entrapment of marine mammals or sea turtles within the buoy since the interior of the structure is free of obstructions, sharp edges, or corners. The size of the opening in the bottom of the WEC buoy provides a ready egress path. As part of the Navy's systems monitoring plan, the system will be examined for entrapment of marine species.
- **EMR.** The small scale and limited area of disturbance indicate that impacts from EMR on marine organisms would be minor and temporary. Impacts of EMR on marine organisms can be expected to range from no impact to avoidance (for bottom-dwelling organisms only) of the vicinity of the WEC cable.
- **Electrical Leakage.** In the unlikely event that damage to the cable causes an electrical fault or short, transient effects on marine organisms and divers (mild discomfort) could occur. Electroreceptive species would likely detect the field and be diverted away from the vicinity of the fault during the short period that the ground fault system actuates.
- **Heat Release.** There would be no impacts to marine life from potential heat release.
- **Noise.** Installation noise produced by drilling holes for rock bolts would be localized, intermittent, and of short duration. Operation of the WEC system is expected to produce a continuous acoustic output similar to that of ship traffic. It is unlikely that noise from system installation or operation would have adverse effects on humpback whales, dolphins, and green sea turtles.

Terrestrial Biological Resources. No Federally listed threatened or endangered terrestrial species occur at the North Beach, MCBH Kaneohe Bay, and Pearl Harbor sites. The land cable routes would traverse environmentally non-sensitive areas, and existing structures would be used as equipment shelters.

Land and Marine Resource Use Compatibility. Land use incompatibilities are not anticipated at North Beach, MCBH Kaneohe Bay, and the Pearl Harbor site where sitting on military property minimizes security risks. At Pearl Harbor, the offshore component of the project is located within restricted waters. At MCBH Kaneohe Bay, incompatible marine resource uses where the buoy array would be installed include limited subsistence fishing, commercial fishing, and recreational boating and fishing.

The proposed WET test project would not interfere with mission operations at MCBH Kaneohe Bay or the Pearl Harbor site.

Cultural Resources. Although the land based segment of the WEC system would be sited within the Mokapu Burial Area, the State Historic Preservation Officer (SHPO) concurred with the Navy that the project would have no effect on historic properties. There would be no effect on cultural resources at the Pearl Harbor site.

Infrastructure. There would be no adverse impacts to existing infrastructure resulting from the installation and operation of the WEC system at North Beach, MCBH Kaneohe Bay, or at the Pearl Harbor site.

Recreation. At MCBH Kaneohe Bay, there would be no impacts on recreation within the 500-yd (457-m) buffer zone. There would be impacts to recreational activities presently conducted outside the 500-yd (457-m) buffer zone in the vicinity of the buoy array for the two- to five-year duration of the WET test, but these impacts would not be significant. At the Pearl Harbor site, there would be no impacts to recreation because the area is off-limits to public access and recreational activities.

Public Safety. At MCBH Kaneohe Bay, there would be no impacts on public safety within the 500-yd (457-m) buffer zone. There would be potential impacts to public safety outside the 500-yd (457-m) buffer zone due to the presence of the buoy array over the two- to five-year duration of the WET test. The potential hazards will be mitigated by providing appropriate markings on the buoys, implementing a plan to respond to system failures, and implementing communication procedures to increase public awareness of the WET system. At the Pearl Harbor site, there would be no impacts to public safety because the area is off-limits to public access.

Visual Resources. Impacts on scenic views would be minimal at both North Beach, MCBH Kaneohe Bay, and the Pearl Harbor site. Navigational aids from the buoys would extend approximately 30 ft (9 m) above sea level. At night, safety lights on the navigational aids would be visible in the distance.

Cumulative Impacts. No cumulative impacts are anticipated at the North Beach, MCBH Kaneohe Bay and Pearl Harbor sites.

Chapter 1

Purpose of and Need for the Proposed Action

CHAPTER 1
PURPOSE OF AND NEED FOR THE PROPOSED ACTION

This Environmental Assessment (EA) for the Wave Energy Technology (WET) test project was prepared in accordance with the National Environmental Policy Act of 1969 (NEPA), as amended, 42 United States Code (USC) §4321 *et seq.*; regulations of the Council on Environmental Quality (CEQ) (40 Code of Federal Regulations [CFR] §§1500–1508) implementing NEPA; *Environmental and Natural Resources Program Manual*, Chief of Naval Operations Instruction (OPNAVINST) 5090.1B, Chapter 2; and *Environmental Compliance and Protection Manual*, Chapter 12, Marine Corps Order P5090.2A.

Identified in this EA are the need for installation and operational testing of up to six Wave Energy Conversion (WEC) buoys off the coast of Hawai‘i for the WET project, existing environmental conditions at the proposed site and an alternative site, potential environmental impacts, and mitigation measures to avoid or minimize these potential impacts. The document provides the U.S. Department of the Navy (Navy) decision makers with information needed to determine whether to prepare an Environmental Impact Statement (EIS) or issue a Finding of No Significant Impact (FONSI).

1.1 PROPOSED ACTION

The Office of Naval Research (ONR) proposes the phased installation and operational testing of up to six WEC buoys off North Beach, Marine Corps Base Hawaii, Kaneohe Bay (MCBH Kaneohe Bay) (Figures 1-1 and 1-2). The project would occur over a two- to five-year time period, with the first two buoys installed no earlier than the beginning of calendar year 2003.

1.2 NEED FOR THE ACTION

The Navy is operating coastal facilities using electrical power from conventional diesel-powered generators. These facilities use fossil fuels that are subject to fluctuations in availability and price, and require relatively large storage/supply areas. Dependencies on fossil fuels make the operation of coastal Department of Defense (DoD) facilities vulnerable, particularly during times of national conflict. To reduce this vulnerability, alternative power sources are being sought and include the generation of supplemental power harnessed from the energy of waves. Coastal DoD sites with suitable wave energy potential could obtain supplemental power with this innovative, non-polluting power source if it can be demonstrated to be efficient, reliable, and cost-effective.

Previous to the Proposed Action, Ocean Power Technologies Inc. (OPT) developed and refined their power conversion technology under the Small Business Innovation Research program sponsored by ONR. Early efforts included investigating the feasibility of efficiently transforming the mechanical energy in ocean waves into electrical power to be used by the Navy to recharge the batteries of Autonomous Underwater Vehicles (AUVs). A series of analyses and experiments led to preliminary design of a buoy-like WEC system that produced up to 1 kilowatt (kW) of electrical power. Subsequent efforts evaluated various technologies for efficiently converting wave energy on a large scale. A single first-generation WEC buoy deployed off Tuckerton, New Jersey, produced an average of 250 watts (W) of power. Further refinements to the technology resulted in a design for more efficient extraction of the energy from a wider range of wave conditions. The increase in efficiency resulted in expansion of the WEC's capability from AUVs recharging to mission-critical large power output. The Proposed Action would be the first deployment of a fully instrumented, full-scale buoy designed for large power output. Preliminary performance data gathered during this action would be used to base engineering models for operational availability and hydrodynamic analyses. In addition, this action would demonstrate the survivability and maintainability of the system.

The Proposed Action is needed to obtain operational data to validate the WEC technology developed by OPT. The Congressional appropriation to conduct this test stipulates that testing is to occur in Hawaiʻi, which has coastal locations with high wave energy potential.

1.3 OBJECTIVES OF THE ACTION

The objectives of the Proposed Action are as follows:

Objective 1. Conduct the test in a high wave energy density environment, characterized by an average annual wave height of 3 feet (ft) or 1.0 meter (m) (minimum) to 5 ft or 1.5 m (optimum), which is a likely characteristic of the environment for future operational use of the WEC technology at other locations.

Objective 2. Challenge the system under variable conditions, such as winter storms, to investigate the survivability of the system.

Objective 3. Collect statistically significant data sets to validate assumptions and findings. Increasing the period of collection, e.g., up to five years, would increase the likelihood of obtaining statistically significant data sets for various test parameters, such as seasonal changes and their effects on the system.

Objective 4. Observe the effect on system performance when more than one buoy is present.

Objective 5. Use a test site for the system that minimizes the costs of installation, operations, and maintenance.

Objective 6. Minimize the risk of system failure, to optimize the collection of data, by maximizing the survivability of the system.

1.4 SCOPE OF THIS ENVIRONMENTAL ANALYSIS

1.4.1 Agency Scoping

Scoping letters were forwarded to the following Federal and State of Hawaiʻi agencies to solicit their comments regarding the Proposed Action and the Pearl Harbor alternative:

- United States (U.S.) Army Corps of Engineers (USACE),
- U.S. Department of Commerce – National Marine Fisheries Service (NMFS),
- U.S. Fish and Wildlife Service (USFWS),
- U.S. Coast Guard (USCG),
- State Department of Land and Natural Resources – Division of Aquatic Resources (DLNR-DAR),
- State Department of Business, Economic Development and Tourism (DBEDT), State Office of Planning, Coastal Zone Management Program (CZMP),
- State DLNR – Division of Boating and Ocean Recreation, and
- U.S. Air Force – Hickam Air Force Base.

Copies of the scoping letters and agency responses on the Proposed Action are provided in Appendix A, and on the Pearl Harbor alternative, in Appendix B.

Additionally, this EA provides agency comments on the Draft EA, along with the Navy's responses to these comments. These correspondences are provided in Appendix C.

1.4.2 Issues Studied in Detail

The scoping process, which included input by regulatory agencies listed above and MCBH Kaneohe Bay environmental staff, revealed that environmental concerns focus on the protection of marine biota and habitats, as well as preservation of cultural resources present within the project area. The potential issues and concerns are summarized below.

- **Shoreline Physiography**

Assess impacts to the shoreline caused by altered wave and current patterns that may result from installation of the buoys.

- **Installation and Anchorage Effects on Coral and Benthic Communities**

Evaluate impacts of the buoy anchors, moorings, and undersea cable on the substrate, including possible damage to coral communities should one or more of the buoys be cast adrift during winter storms.

- **Habitat Areas of Potential Concern**

Determine the presence of Habitat Areas of Particular Concern (HAPC) within the proposed project site. HAPC are a subset of Essential Fish Habitat (EFH), which are areas considered "rare, particularly susceptible to human-induced degradation, especially ecologically important, or located in an environmentally stressed area" (50 CFR 600.815(A)(9)).[1]

- **Threatened and Endangered Species**

Evaluate the potential for adverse effects on threatened and endangered species within the proposed project site.

- **Marine Mammals and Marine Turtles**

Assess project impacts on marine mammals and marine turtles within the proposed project area.

- **Entanglement/Entrapment**

Assess whether the presence of WEC equipment and cables in the marine environment would pose a potential risk to marine life by entanglement with the cables or entrapment within the buoy.

- **Electromagnetic Radiation**

Analyze whether electric or magnetic fields created by the WET project have the potential to adversely impact marine life in the vicinity of the project.

- **Potential Electrical Current Leakage**

Assess the impacts of potential electrical current leakage from the undersea cable on marine biota.

- **Potential Heat Release**

Evaluate the potential for heat to be released by the generator contained in the equipment canister and by the undersea transmission cable, and the possible impact of heat release on marine biota.

- **Noise**

Assess the impacts of potential acoustic emissions from the system on marine biota.

- **Recreation**

Assess potential impacts to recreational users of the project area such as fishers, boaters, and self-contained underwater breathing apparatus (SCUBA) divers.

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[1] NMFS EFH Web site http://www.nmfs.noaa.gov/habitat/habitatprotection/essentialfishhabitat5.htm; accessed July 25, 2002.

- **Public Safety**

Provide for public safety associated with the placement of the buoy array, and high voltage undersea and land based cables.

- **Visual Resources**

Assess visual impacts of placing the buoys off shore where nothing like it currently exists.

- **Cultural Resources**

Evaluate impacts to cultural resources within the proposed project area.

1.5 DECISIONS THAT MUST BE MADE

The ONR, as the action proponent, is responsible for the preparation of this EA in compliance with NEPA. ONR and MCBH Kaneohe Bay (the potential Host Installation) are responsible for ensuring that the project is executed in compliance with all applicable environmental laws and regulations including NEPA. Therefore, both agencies must make decisions based on the outcome of this EA.

The decisions to be made by the Navy are whether to:

- issue a FONSI;
- direct the preparation of an EIS for the Proposed Action; or
- take no action (i.e., do not proceed with the installation and testing of the WEC technology).

The decisions to be made by the Commanding General, MCBH Kaneohe Bay are whether to:

- endorse and co-sign the FONSI issued by the Navy or recommend the preparation of an EIS;
- approve installation and testing of the WEC system at North Beach, MCBH Kaneohe Bay.

1.6 APPLICABLE LEGAL AND REGULATORY REQUIREMENTS AND COORDINATION

1.6.1 Legal Requirements

Executive Orders[2] (EO) and Federal laws applicable to this project are described below.

[2] Executive Orders are regulations issued by the president, governor, or other chief executive and having the force of law.

1.6.1.1 NEPA of 1969, as amended (42 USC §4321 *et seq.*)

NEPA requires Federal agencies to prepare an EA or EIS for Federal actions that have the potential to significantly affect the quality of the human environment, including both natural and cultural resources. The Act establishes Federal agency procedures for preserving important aspects of the national heritage and enhancing the quality of renewable resources. This document has been prepared in compliance with NEPA and CEQ regulations (40 CFR §§1500–1508).

1.6.1.2 Clean Water Act (CWA) of 1977, as amended (33 USC §§1251–1387 *et seq.*)

The CWA is a compilation of decades of Federal water pollution control legislation. In 1987, the Act amended the Federal Water Pollution Control Act (FWPCA) requiring Federal agency consistency with state nonpoint source pollution abatement plans, and strengthening enforcement mechanisms and regulations for storm water runoff. Sections 401, 402, and 404 of the Act require permits for Proposed Actions that involve wastewater discharges or discharge of dredged or fill material into waters of the United States.

Wastewater discharges and discharge of dredged or fill material into waters of the U.S. would not occur with the testing of the WEC technology at either North Beach, MCBH Kaneohe Bay, or the Pearl Harbor site .

1.6.1.3 Rivers and Harbors Act (33 USC §403)

In accordance with Section 10 of the Rivers and Harbors Act, 33 USC §403, a Department of the Army (DA) permit is required for any activity that obstructs or alters navigable waters of the U.S., or the course, location, condition, or capacity of any port, harbor, refuge, or enclosure within the limits of any breakwater, or of the channel of any navigable water.

Both the Proposed Action and Pearl Harbor site would require a DA permit.

1.6.1.4 Coastal Zone Management Act (CZMA) of 1972 (16 USC §§1451–1465 *et seq.*)

To the maximum extent practicable, Federal actions affecting any land/water use or coastal zone natural resources, must be consistent with the enforceable policies of an approved state coastal zone management program. The CZMA requires a consistency determination from DBEDT for actions within the coastal zone, as defined by Hawai‘i Revised Statutes (HRS) §205A-1. Coastal Zone Management (CZM) consistency determinations are not required for actions on Federal property that would not have reasonably foreseeable direct and indirect effects on any use or resource in the coastal zone.

The DBEDT, State Office of Planning, CZMP has accepted the Navy’s Negative Determination Notices that consistency determinations are not required under the CZMA for the Proposed Action (Appendix A-3), and Pearl Harbor alternative (Appendix B-3).

1.6.1.5 Endangered Species Act (ESA) of 1973 (16 USC §§1531–1544 *et seq.*)

The ESA requires Federal agencies to assure that their actions are not likely to jeopardize the continued existence of any threatened or endangered species, or result in destruction or adverse modifications of habitat critical to those species. Federal agencies are required to consult with the USFWS and NMFS wherever they propose actions that may affect listed species or their habitat.

The Navy and MCBH Kaneohe Bay have completed an informal consultation under Section 7 of the ESA. The USFWS and NMFS concur with the Navy that the Proposed Action is not likely to adversely affect threatened and endangered species under their jurisdictions (Appendix A-4). Should the Pearl Harbor alternative be selected, the Navy would initiate an informal Section 7 consultation for that site.

1.6.1.6 Fish and Wildlife Coordination Act (FWCA) of 1934, as amended (16 USC §§661–666[c] *et seq.*)

The FWCA provides for consultation with the USFWS and other relevant agencies when a Federal action proposes to modify or control U.S. waters for any purpose. The reports and recommendations of the head of the state agency exercising administration over the wildlife resources of the state are to be made an integral part of any report prepared or submitted by a Federal agency.

The Proposed Action at MCBH Kaneohe Bay and Pearl Harbor alternative, if selected, would consider recommendations made by appropriate agencies.

1.6.1.7 Magnuson-Stevens Fishery Conservation and Management Act (16 USC §1801 *et seq.*)

The Magnuson-Stevens Act (16 USC §1801 *et seq.*), as amended by the Sustainable Fisheries Act, PL 104-297, calls for action to stop or reverse the loss of marine fish habitat. The waters out to 200 miles (mi) (321.80 kilometers [km]) around the Hawaiian Islands are under the jurisdiction of the Western Pacific Regional Fishery Management Council (WPRFMC). The WPRFMC has approved Fisheries Management Plans (FMPs) designating EFHs and HAPC. WPRFMC has designated all the ocean waters surrounding O‘ahu, from the shore to depths of over 100 ft (30.5 m) as EFH. As defined in the 1996 amendments to the Act, HAPC are a subset of EFH which are habitat areas that are "rare, particularly susceptible to human-induced degradation, especially ecologically important, or located in an environmentally stressed area."

No HAPC are designated at either MCBH Kaneohe Bay or the Pearl Harbor sites.

1.6.1.8 Marine Mammal Protection Act (MMPA) of 1972, as amended (16 USC §§1361–1421(h) *et seq.*)

Reauthorized in 1994, the MMPA establishes a moratorium, with certain exceptions, on the taking of marine mammals in U.S. waters and by U.S. citizens on the high seas, and on importing of marine mammals and marine mammal products into the U.S.

The project has been designed in a manner that complies with the MMPA. Design of the WEC buoys and associated equipment incorporated input from marine scientists to minimize risks to marine mammals.

1.6.1.9 Migratory Bird Treaty Act (MBTA) of 1918, as amended (16 USC §§703–712 *et seq.*)

The MBTA is a bilateral migratory bird treaty with Canada, Mexico, Japan, and Russia. Sections 703 to 712 of the Act prohibit the taking of migratory birds in the absence of a permit.

No bird takes are anticipated due to the proposed WET test; therefore, a permit under the MBTA is not required.

1.6.1.10 National Historic Preservation Act (NHPA) of 1966 (16 USC §470 *et seq.*)

The Proposed Action has been evaluated for potential effects on historic properties. Section 106 of the NHPA of 1966, 16 USC §470(f), as amended, requires Federal agencies having direct or indirect jurisdiction over a Federal undertaking to take into account effects on any district, site, building, structure, or object that is included or is eligible for inclusion in the National Register of Historic Places (NRHP), prior to the approval of expenditure of any funds or issuance of any license or permit.

In accordance with the regulations implementing Section 106 of the NHPA, 36 CFR Part 800, the Hawaii State Historic Preservation Officer (SHPO) was consulted on the Proposed Action and concurred with the Navy's finding of "no historic properties affected." Notification of this finding was also provided to Native Hawaiian organizations and individuals that have previously expressed an interest in actions involving the Mokapu Burial Area. Section 106 correspondence are provided in Appendix A-5.

1.6.1.11 Native American Graves Protection and Repatriation Act (NAGPRA) of 1990 (25 USC §3001)

NAGPRA provides for the protection and repatriation of Native American and Native Hawaiian human remains and cultural items discovered on Federal lands. The Proposed Action was reviewed and determined unlikely to result in the discovery of Native Hawaiian human remains or cultural items. Should such items be discovered during project implementation, NAGPRA regulations pertaining to inadvertent discoveries (43 CFR 10.4) will be followed.

1.6.1.12 EO 13089, Coral Reef Protection (63 FR 32701)

EO 13089, dated June 11, 1998, directs all Federal agencies whose actions may affect U.S. coral reef ecosystems to:

- identify their actions that may affect U.S. coral reef ecosystems;
- utilize programs and authorities to protect and enhance the condition of such ecosystems; and
- to the extent permitted by law, ensure that any actions they authorize, fund, or carry out will not degrade the conditions of such ecosystems.

Marine biological consultants and agency personnel conducted underwater site assessments for the Proposed Action to identify suitable cable routes and locations for the buoy array to minimize impacts to coral reefs. This document discloses the finding from these site assessments.

1.6.1.13 EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds (16 USC §§ 703–711) (66 FR 3853)

Under EO 13186, dated January 10, 2001, all Federal agencies taking actions that have, or are likely to have, a measurable negative impact on migratory bird populations are directed to develop and implement a Memorandum of Understanding (MOU) with USFWS that promotes the conservation of migratory bird populations.

The Proposed Action would avoid interaction with habitat used by migratory bird populations; hence, testing of the WEC system is not anticipated to have a measurable negative impact on those populations.

1.6.1.14 EO 12898, Environmental Justice

Under EO 12898, dated February 11, 1994, Federal agencies are required to address the potential for disproportionately high and adverse environmental effects of their actions on minority and low-income populations. Agencies are required to ensure that their programs and activities that affect human health or the environment do not directly or indirectly use criteria, methods, or practices that discriminate on the basis of race, color, or national origin. NEPA documents are specifically required to analyze effects of Federal actions on minority and low-income populations and, whenever feasible, to develop mitigation measures to address significant and adverse effects on such communities. The EO states that the public, including minority and low-income communities, should have adequate access to public information relating to human health or environmental planning, regulation, and enforcement.

With both sites, the land component of the proposed WET test would be located on military property where access and use of resources are restricted. At Pearl Harbor, the offshore component of the project is located within restricted waters. At MCBH Kaneohe Bay, the WEC buoy array would be located outside the 500-yard (yd) (457-m) buffer zone within the Naval Defensive Sea Area (NDSA) established by EO 8681. Although the area outside the buffer zone is subject to access limitation, there are no plans to restrict public access into the area, which includes the proposed buoy area.

If the restricted area off MCBH Kaneohe Bay were to be extended to provide security for the WEC buoy array, there would be loss of access to the area and use of the resources for the two- to five-year duration of the project. The impacts of the temporary closure of a relatively small area are not anticipated to be significant. Therefore, the project would not impose disproportionately high, adverse effects on minority or low-income populations that may use the area.

1.6.1.15 EO 13045, Protection of Children from Environmental Health Risks and Safety Risks

Under EO 13045, dated April 21, 1997, Federal agencies are required to address the potential for disproportionately high and adverse environmental effects of their actions on children. Agencies are required to identify and, if necessary, mitigate health and safety risks with the potential to disproportionately affect children. The EO requires that agencies ensure that their policies, programs, activities, and standards address such risks.

Testing of the WEC system would not disproportionately affect children. The sites being considered do not contain schools, playgrounds, or similar areas where children are frequently present. Recreational areas where children may be present are at MCBH Kaneohe Bay. Because no significant health and safety risks are anticipated from the proposed WET test, and the affected areas are not frequented by children, no mitigation is needed.

1.6.1.16 EO 13123, Greening the Government Through Efficient Energy Management (65 FR 24595)

EO 13123, Part 2, Section 204, dated April 21, 2000, states “each agency shall strive to expand the use of renewable energy within its facilities and in its activities by implementing renewable energy projects and by purchasing electricity from renewable energy sources.” The WET test would be consistent with this goal and with the policy mandated by the Energy Policy Act of 1992, which states that “it is the goal of the U.S. to carry out energy supply and energy conservation research and development to meet a number of goals, including the strengthening of national energy security by reducing the dependence on imported oil.”

1.6.2 Regulatory Requirements

Government permits and consultations identified during the scoping process and development of this document are identified in Table 1-1. This table provides a quick reference but is not meant to be a comprehensive listing of all approvals that may be eventually required.

The Navy will be responsible for obtaining permits and completing consultations for work at MCBH Kaneohe Bay or Pearl Harbor. Any necessary consultations associated with the MCBH

Kaneohe Bay site will be conducted in conjunction with the MCBH Kaneohe Bay. The project is being proposed within Federally owned submerged property; therefore, State permits are not applicable.

Table 1-1. Summary of Possible Government Permits and Consultations

Permit, Consultation, or Concurrence	Regulatory Agency
DA Permit as required by Section 10 of the Rivers and Harbors Act	USACE
Negative Determination under the CZMP	DBEDT, State Office of Planning, CZMP
Informal consultation in accordance with Section 7 ESA	U.S. Department of Commerce, NMFS U.S. Department of the Interior, USFWS
Consultation in accordance with Section 106 of the NHPA	State DLNR, SHPO
Local Notice to Mariners	USCG
Navigational aids on buoys	USCG
Site approvals from MCBH Kaneohe Bay	U.S. Marine Corps

1.6.3 Coordination Requirements

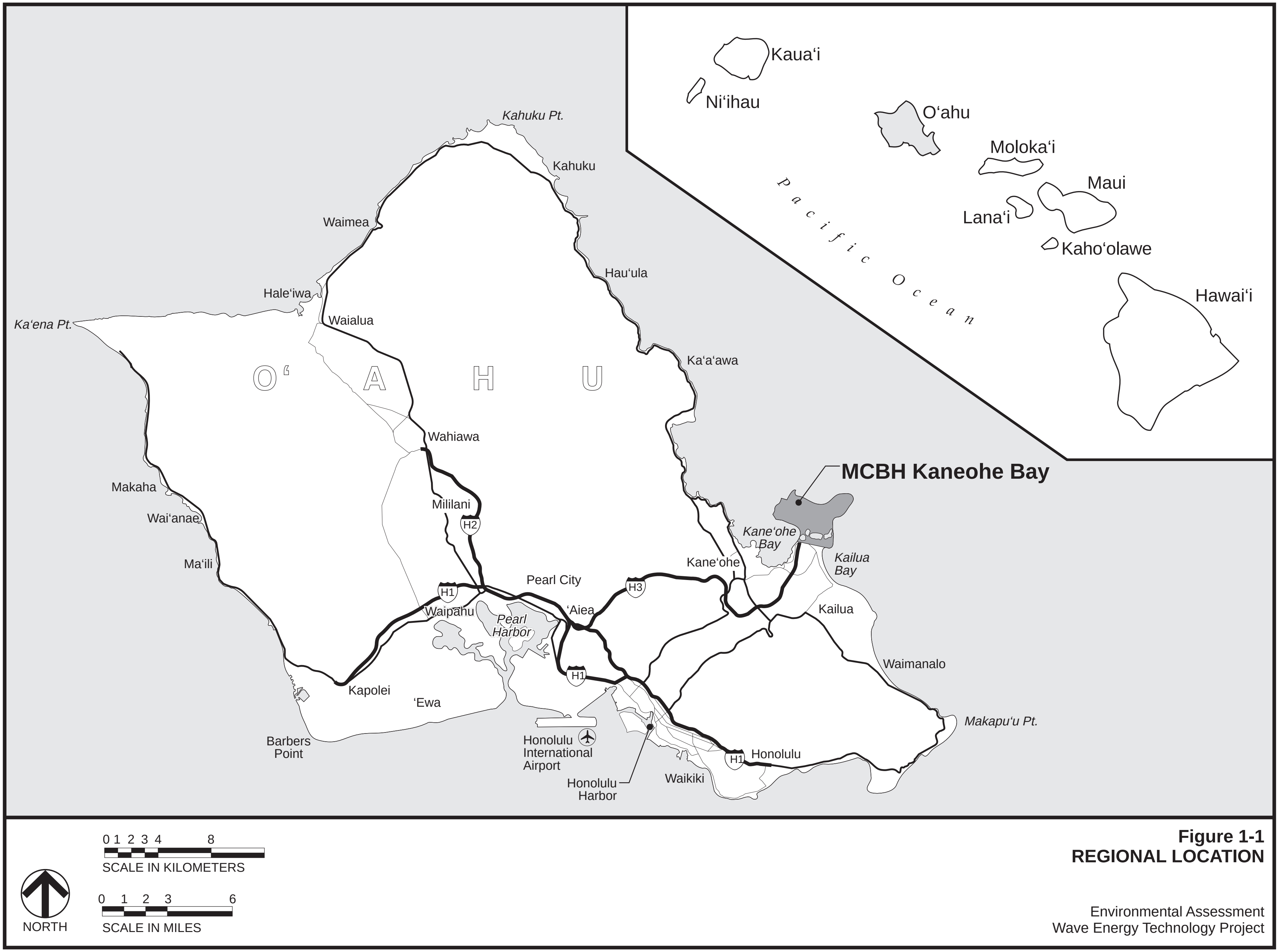
Applicable requirements for this project include coordination with NMFS, USFWS, and State DLNR regarding protection and conservation of fish and wildlife resources.

1.7 CONSISTENCY WITH LAND USE PLANS, POLICIES, AND CONTROLS

Planning documents that were used as reference material in this EA for the Proposed Action include the following: *Marine Corps Base Hawaii Integrated Natural Resources Management Plan and Environmental Assessment* (Marine Corps November 2001)*; Marine Corps Base Hawaii Master Plan, Volume I* (Marine Corps June 1999)*;* and *A Natural Resources Survey of the Nearshore Waters of Mokapu Peninsula, Kaneohe Marine Corps Air Station* (Marine Corps Air Station 1992). Documents used as reference material for the Pearl Harbor alternative include the *Final Environmental Impact Statement, Outfall Replacement for Wastewater Treatment Plant at Fort Kamehameha, Navy Public Works Center, Pearl Harbor, Hawaii* (Navy March 2001); *Pearl Harbor Naval Complex Integrated Natural Resource Management Plan* (Navy October 2001); and “Marine Natural Resources Insert for the WET EA” (Navy July 2002a) (Appendix D). Full citations for these documents can be found in Chapter 6, References.

Applicable land use plans, policies, and controls are those required for Federal lands, specifically MCBH Kaneohe Bay, and Naval Magazine (NAVMAG) Pearl Harbor, West Loch Branch. Each alternative will comply with base specific land use plans, policies, and controls. State and City and County of Honolulu land use plans, policies, and controls are not applicable because all project alternatives are on Federal property.

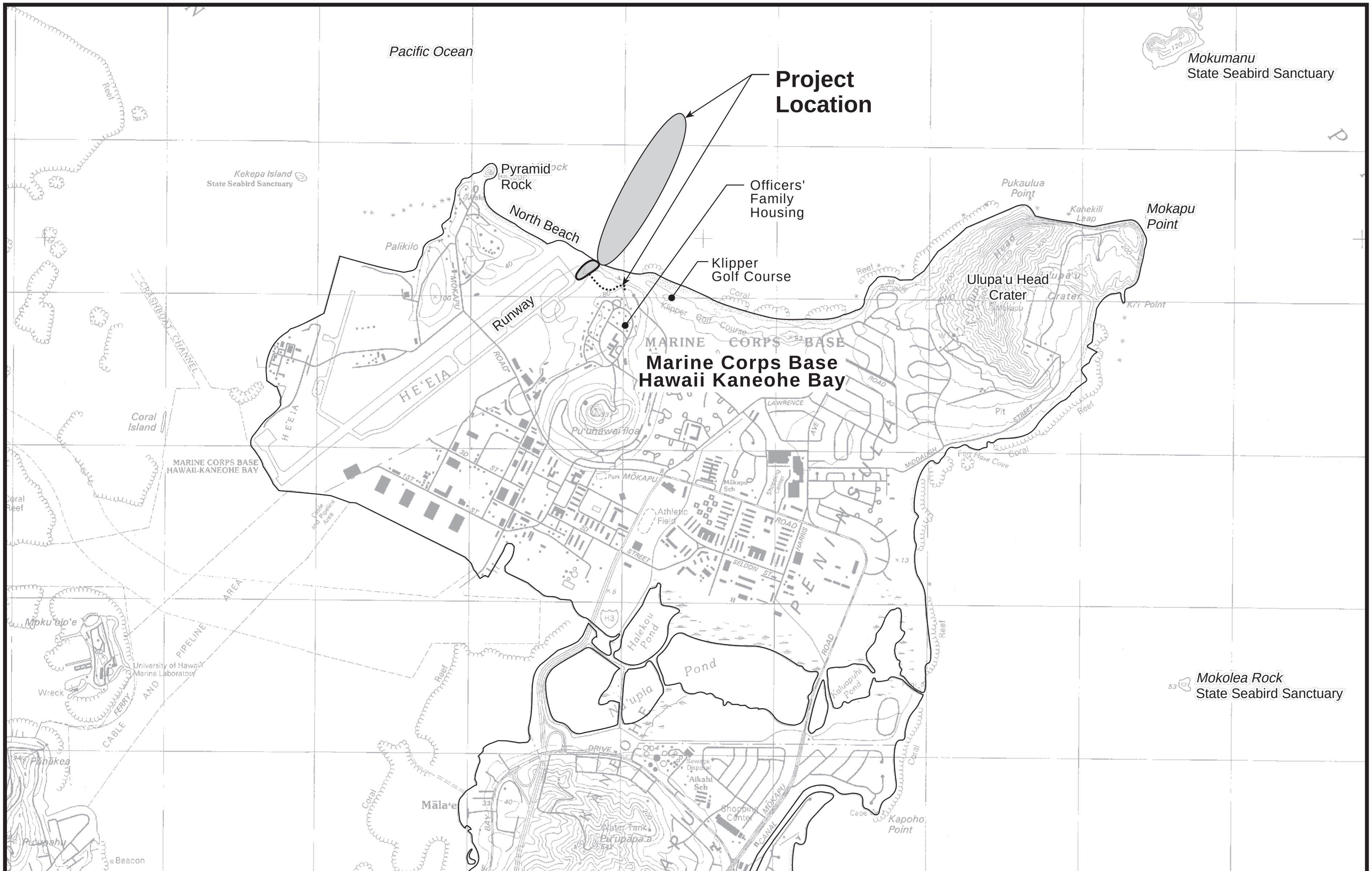
Land use documents consulted for preparation of this EA include the MCBH and Pearl Harbor Integrated Natural Resource Management Plans (INRMPs). These were prepared in cooperation with USFWS, NMFS, and State DLNR as required by the Sikes Act Improvement Act of 1997.



1999.82.0624/001-4 k09.11.02 10

Figure 1-1
REGIONAL LOCATION

Environmental Assessment
Wave Energy Technology Project



0 500 1000
SCALE IN METERS

0 1000 2000 3000
SCALE IN FEET

NORTH

Source: NAVFAC Dwg.No. 7,011,984

Legend

Proposed Land Cable Route

Figure 1-2
PROJECT VICINITY
North Beach, MCBH Kaneohe Bay

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Chapter 2

Alternatives Including the Proposed Action

CHAPTER 2
ALTERNATIVES INCLUDING THE PROPOSED ACTION

2.1 INTRODUCTION

This chapter describes the Proposed Action (the preferred alternative) and alternatives, including the screening process used to determine which alternative sites would be evaluated in detail. The Congressional appropriation to conduct the WET test stipulates that testing is to occur in Hawai‘i, which has coastal locations with high wave energy potential. To minimize security risks to the WEC system and maximize system survivability, only coastal DoD sites were considered. The screening process focused on comparing the objectives of the Proposed Action with alternative site locations in the state. Information on these alternative sites is summarized from the report, *A Preliminary Site Assessment of Wave Power Buoy Locations* (Sea Engineering, Inc. and Makai Ocean Engineering 2000). This report reviewed wave climate, suitability of the sites relative to the cost of installation, operations and maintenance, and potential conflicts.

2.2 PROCESS USED TO FORMULATE THE ALTERNATIVES

Various locations at coastal DoD installations within the state of Hawai‘i were identified during the planning phase of the project. Sites selected for preliminary screening included the Pacific Missile Range Facility (PMRF) at Nohili Point and Makaha Point, Kaua‘i; Bellows Air Force Station (AFS), Waimanalo, O‘ahu; and NAVMAG Pearl Harbor, West Loch Branch, O‘ahu (Figure 2-1). A preliminary screening of the physical characteristics of these locations was completed relative to their ability to fulfill the objectives outlined in Section 1.3 (Sea Engineering and Makai Ocean Engineering 2000).

Sites were reviewed for their wave energy characteristics, costs associated with installation considerations (such as cable length, shore side grid connection, and proximity to initial staging area), and land use compatibility to optimize data collection and minimize the risk of system failure. An additional objective of site selection was the need to challenge the WEC system under winter storm conditions while providing some shelter or reduced exposure to Kona storm[3] or hurricane waves to avoid excessive maintenance. Although the system was designed to a 500-year storm, extreme Kona storm and hurricane waves could exceed the design capability of the system, increasing concerns about public safety and system survivability. Kona storm waves can

[3] Kona storms are low pressure areas (cyclones) of subtropical origin which usually develop northwest of Hawai‘i in winter and move slowly eastward, accompanied by southerly winds, from whose direction the storm derives its name (Kona means “leeward” in Hawaiian) and by the clouds and rain that have made Kona storms synonymous with bad weather in Hawai‘i (Atlas of Hawaii 1983).

occur throughout the year but are most common from October through April. Typical wave heights are from 10 to 15 ft (3 to 4.5 m) with periods from 8 to 10 seconds.[4]

Hurricanes, while infrequent in Hawai‘i, can produce extremely high winds and wave conditions. Hurricane Nina brought surf conditions of 35 ft (10.7 m) to Kaua‘i’s southern coast in late November 1957.[5] An analysis of waves generated by two recent hurricanes that impacted O‘ahu (Hurricane ‘Iniki in 1992 and Hurricane ‘Iwa in 1982) indicates that the waves approached from the southeast through west directions. While the WEC system has been designed to withstand the maximum conditions of a design scenario hurricane, exposure to Kona storm and hurricane waves is not a desired objective of the proposed test. The model hurricane developed for the WET test is defined as the probable hurricane that will strike the Hawaiian Islands and is based on the characteristics of hurricanes Dot (1959) and ‘Iwa, both of which impacted the islands. For this project, the hurricane’s approach is assumed to be from the east through southeast direction. The calculated maximum deepwater wave height is 48.9 ft (14.9 m), and the associated maximum height in 98.4 ft (30 m) of water is 44.6 ft (13.6 m) (Appendix E).

Results of the initial screening of coastal DoD installations with the project’s objectives (Section 1.3) are summarized in Table 2-1. Based on the results of Table 2-1, three sites were eliminated from further detailed study. These sites are discussed in the following section.

2.3 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED STUDY

The following alternative site locations were eliminated from further detailed study:

- PMRF (Makaha Point, Kaua‘i),
- PMRF (Nohili Point, Kaua‘i), and
- Bellows AFS (Waimanalo, O‘ahu).

The advantages and disadvantages of each of these sites are discussed below, relative to their ability to fulfill the objectives of the Proposed Action identified in Section 1.3. Because the wave energy density objective is fulfilled at all alternative site locations, it is not discussed.

4 Hawaii Coral Reef Assessment and Monitoring Program (CRAMP) Web site. <http://cramp.wcc.hawaii.edu/Results/Forcing_Functions/Wave_Energy/Kona_Storm_Waves>; accessed August 23, 2002.

5 Hawaii Coral Reef Assessment and Monitoring Program (CRAMP) Web site. <http://cramp.wcc.hawaii.edu/Results/Forcing_Functions/Wave_Energy/Hurricane_Waves>; accessed August 23, 2002.

Table 2-1. Site Evaluation Matrix

Factor	Threshold (minimum requirement)	Objective (optimal requirement)	PMRF Nohili Point, Kaua'i	PMRF Makaha Point, Kaua'i	Bellows AFS, Oah'u	NAVMAG Pearl Harbor, West Loch Branch	MCBH Kaneohe Bay
Wave Climate Conditions							
Nominal operating wave climate (frequency/ amplitude)	6- to 12-s period 3.3-ft (1.0-m) wave height or greater all year	5- to 10-s period 4.9-ft (1.5-m) wave height or greater all year	Poor	Reasonable waves in late fall, winter	Excellent	Partially sheltered from prevailing trade wind waves. Marginal wave conditions.	Excellent
Hurricane/ Kona exposure	Limited exposure	Sheltered from hurricane swells	Direct exposure	Partial exposure/ Direct exposure	Sheltered	Full exposure	Direct approach of hurricane waves unlikely/ Sheltered
Cost Considerations—Installation, Operations, and Maintenance							
Bottom conditions	Minor relief or irregularities, minimum coral that can be avoided	Relatively flat sandy bottom with little to no relief or irregularities	Flat bottom with some vertical relief up to 3 to 5 ft (0.9 to 1.5 m)	Unknown	Mix of sand and hard limestone bottom with some coral. Need to find suitable passage through the fringing reef 1.23 mi (1.1 NM) offshore.	Central portions of the entrance channel are flat and composed primarily of sand and rubble. Channel edges include areas with high relief and coral.	Relatively flat bottom, 3 to 4 ft (0.9 to 1.2 m) irregularities between approximately 15 to 35 ft (4.6 to 10.7 m) depths
Length to run cable	3.79 mi (6.1 km)	Max 0.95 mi (1.5 km)	1.4 mi (2.2 km)	4.03 mi (6.5 km)	3.03 mi (4.9 km)	2.41 mi (3.9 km)	0.74 mi (1.2 km)
Proximity to initial staging area (Honolulu Harbor)	Less than 1-day transit time	Less than 1-hr transit time	138.1 mi (222 km) 24 hrs for barge; 17 hrs for workboat	143.8 mi (231 km) 25 hrs for barge; 18 hrs for workboat	21.9 mi (35.2 km) 5 hrs for barge; 3 hrs for workboat	1.2 mi (1.9 km) 1 hr each for barge or workboat	28.8 mi (46.3 km) 7 hrs for barge, 5 hrs for workboat

Table 2-1. Site Evaluation Matrix *(continued)*

Factor	Threshold (minimum requirement)	Objective (optimal requirement)	PMRF Nohili Point, Kaua'i	PMRF Makaha Point, Kaua'i	Bellows AFS, Oah'u	Pearl Harbor (NAVMAG West Loch), Oah'u	MCBH Kaneohe Bay
Cost Considerations—Installation, Operations, and Maintenance *(continued)*							
Shoreside grid connection	Must be easily accessible by vehicle without damage to environment	Must be accessible by vehicle without damage to environment and in close proximity to facilities	Acceptable	Unknown, probably difficult	Acceptable	Excellent	Excellent
Accessibility to ocean site for visual inspection and maintenance	Accessible for visual inspection and less than 1-day transit time	Personnel available for visual inspection and less than 1-hr transit time	Moderately difficult for inspection, very difficult for maintenance	Moderately difficult for inspection, very difficult for maintenance	Acceptable	Acceptable	Acceptable
System Survivability							
Compatibility with current operations and activities	Such that other activities will not impact schedule or equipment	No other activities in immediate area	High risk for schedule delays	High risk for schedule delays	Amphibious landing exercises, high risk for schedule delays	Acceptable	Acceptable

ft = feet
hr(s) = hour(s)
km = kilometer
mi = mile(s)
s = second(s)

2.3.1 PMRF (Makaha Point, Kaua‘i)

An approximate 2-mi (3.2-km) long sector off the west coast of Kaua‘i, about 4 to 5 mi (6.4 to 8.0 km) north of the PMRF, was considered in the preliminary screening process (Figure 2-1). PMRF is the world’s largest instrumented, multi-environment, military test range capable of collecting data on the performance of a variety of weapons systems that operate underwater, on the surface, in the atmosphere, and in space. The shoreline and offshore areas at PMRF contain an extensive offshore test range and hydrophone array. This military testing environment is not duplicated anywhere in the world. The location would allow favorable exposure to waves during the late fall and winter, increasing the potential for testing the system’s operation under variable conditions. Despite this favorable condition, the PMRF Makaha Point alternative was eliminated for reasons summarized in the following paragraphs.

- The site provides partial exposure to trade wind generated waves and full exposure to the winter season north Pacific swells that create very rough coastline conditions in the winter. It has a high probability of being directly exposed to Kona storm waves and has been at least partially exposed to hurricane waves during the last two major hurricanes to hit Hawai‘i. While the site would challenge the system under winter storm conditions, the exposure to both Kona storm waves and hurricane waves could exceed the design capability of the system and hence, reduce the suitability of the site for operational use of the WEC technology.
- Due to the military testing environment of PMRF, there is very little certainty that WEC system testing could occur for up to a five-year period. Similarly, there is little certainty that there would be an opportunity to deploy more than one buoy.
- The required length of undersea cable, 4.03 mi (6.5 km), and the distance from the initial staging area at Honolulu Harbor or Barbers Point would raise the costs of installation to prohibitive levels. In addition, access to the site for maintenance would be very difficult.
- Incompatible land uses in the project area, such as recreation, would jeopardize the security of the system and threaten system survivability. Offshore, tour boats of up to 50 ft (15 m) in length, pass during the summer months on sightseeing tours of the Na Pali coastline. Near shore and onshore activities include swimming, surfing, and camping.

2.3.2 PMRF (Nohili Point, Kaua‘i)

Nohili Point is located on the west coast of Kaua‘i, directly off PMRF (Figure 2-1). While this location is sheltered from much of the trade wind energy, it would allow favorable exposure to waves during the late fall and winter, increasing the potential for testing the system’s operation under variable conditions. Installation considerations are acceptable relative to seafloor conditions and an undersea cable length of approximately 1.4 mi (2.2 km). Accessibility to a shoreside grid connection is unknown, but power poles should be accessible in the immediate area of Nohili Point. Despite these favorable conditions, the PMRF Nohili Point alternative was eliminated from further study for the following reasons.

- As with PMRF Makaha Point, a high probability of having direct exposure to both Kona storm and hurricane wave conditions reduces the suitability of the area.
- Due to the sensitivity of the existing cables at PMRF, installation of the WEC cable could create the potential for cross-talk that could impact range activities. Such impacts would not be tolerated by the range and could result in schedule delays or project cancellation. Delays or cancellations would reduce the potential for consistent data collection and could preclude installation of more than one buoy during the five-year testing period.
- The distance from the initial staging area at Honolulu Harbor or Barbers Point would raise the costs of installation to prohibitive levels. Access to the site for inspection and maintenance is considered difficult.
- Incompatible land uses in the project area, such as recreation, would jeopardize the security of the system and threaten system survivability. Offshore, tour boats of up to 50 ft (15 m) in length pass during the summer months on sightseeing tours of the Na Pali coastline. Nearshore and onshore activities include swimming, surfing, and camping.

2.3.3 Bellows AFS (Waimanalo, Oʻahu)

On the windward coast of Oʻahu, Bellows AFS (Figure 2-1) provides excellent wave climate conditions, especially during the winter months, thus enabling the WEC system to be challenged under variable conditions. The site is sheltered from both Kona storm and hurricane waves, promoting survivability of the system. It has good access for installation, operations, and maintenance activities, as well as power grid connections, and is located within one day of travel time from the initial staging area of Honolulu Harbor or Barbers Point. Despite these favorable conditions, Bellows AFS was eliminated from further study for the following reasons.

- Marine Corps training could interfere with data collection over a two- to five-year period and the installation of more than one buoy. Marine Corps units use some of the joint-use public beach for amphibious training on weekdays. Assault on the beachhead exercises are conducted on the more southern part of the beach. Water parachute drops and helicast (the use of helicopters to drop swimmers and equipment into the water for clandestine beach entry) by reconnaissance swimmers are additional means of assault beach entry. These activities would threaten WEC system survivability, especially in the area of the buoy array.
- The required length of undersea cable, 3.03 mi (4.9 km), would raise the costs of installation to prohibitive levels.
- Incompatible land use in the project area, such as Marine Corps amphibious landing exercises, could be hampered by the presence of the WEC buoy array.

2.4 DESCRIPTION OF PROPOSED ALTERNATIVES

2.4.1 Alternative A: Proposed Action

2.4.1.1 General Description and Site Selection Factors

The Proposed Action is the phased installation and operational testing of up to six WEC buoys off of North Beach, MCBH Kaneohe Bay, over an approximate time frame of two to five years. Figure 2-2 depicts the proposed undersea cable route and buoy array. The buoys would be anchored in approximately 100 ft (30.5 m) of water using a heavily ballasted anchor base, rock-bolted to the seafloor. A nearby equipment canister, fixed to the seafloor, would convert the mechanical energy into electrical energy for the first two buoys. It is anticipated that the last four buoys would be connected to a second canister. If design improvements do not provide this efficiency, a maximum of three canisters would be required, each serving two buoys. Hydraulic lines would run from each buoy and have separate designated attachment points to the equipment canister. An armored and shielded undersea power cable, connected to the canister(s), would transmit electrical power to land. The cable would be stabilized on the seafloor using grouted rock bolts and protective split pipe (Figure 2-2).

On shore, the undersea cable would be spliced to a land transmission cable inside a concrete utility vault, located above the high water mark. From the utility vault, the land cable contained in a conduit would be elevated off the ground using pedestals placed at intervals. The cable would be routed to Battery French, located on the side of the hill behind the Officers' Family Housing area. Figure 2-3 shows the proposed land cable route. From Battery French, used to house the onshore electrical power and control equipment, the power cable would be routed to the base electrical grid system using an existing underground duct system. Each WEC buoy is expected to produce an average of 20 kW of power (sufficient to power approximately four to six single-family residences). The peak output for each buoy is 40 kW.

Installation of the first two buoys, scheduled for no earlier than the beginning of calendar year 2003, is intended to verify the installation procedures and operational performance characteristics of the WEC system. If funding availability allows, additional buoy installation would focus on ongoing design upgrades and on performance and reliability testing. A potentially beneficial impact would result from the growth of benthic organisms such as corals on the WEC cable and anchor during the test period. In consultation with NMFS and DLNR, the Navy will determine at the end of the test period whether the material installed on the seafloor should be removed or left in place. Land equipment would be removed.

The MCBH Kaneohe Bay site is best suited to accomplish the project objectives. The site provides a high wave energy density environment to test the WEC technology (the site is exposed to waves with average heights greater than the minimum 3 ft [1 m], and optimum 5 ft [1.5 m], required for testing); is periodically exposed to winter storms but completely sheltered from Kona storms; and the direct approach of hurricane waves is unlikely. The site is conducive to installation of multiple buoys, presenting the opportunity to observe the effects of more than one buoy on system performance. It also provides good access for installation, operations and maintenance activities, and power grid connections. Part of the undersea cable route and the land based components would be within a restricted area minimizing risks to WEC system security and optimizing data collection. Onshore and nearshore recreational activities within the restricted area include beachcombing, surfing, swimming, fishing, and SCUBA diving. The proposed buoy array site is currently open to public access, and incompatible activities include fishing, boating, and diving.

2.4.1.2 WEC System Components

WEC Buoy

The WEC buoy is comprised of a cylinder, buoyancy tank, and central rigid spar buoy (Figures 2-4 and 2-5), which are described below. The buoyancy tank and its attached cylinder are designed to float 3 to 13 ft (1 to 3.9 m) below the surface.

Buoyancy Tank. The buoyancy tank, attached to the top of the buoy cylinder, is the same diameter as the cylinder and approximately 11 ft (3.4 m) in length. It is designed to provide enough buoyancy to float itself and the attached cylinder.

Buoy Cylinder. The buoy cylinder is a hollow steel unit approximately 15 ft (4.6 m) in diameter and 39 ft (11.9 m) long. It moves up and down the spar buoy, creating motion that is converted to useable energy. The buoy cylinder is connected to a hydraulic cylinder. As the buoy cylinder oscillates on the spar buoy, the hydraulic cylinder acts as a hydraulic pump. Pressurized fluid is passed from the cylinder to a power conversion module located in the equipment canister. The hydraulic system converts the linear motion of the buoy to rotary motion to spin the generator, housed in the equipment canister.

The interior structure of the buoy is comprised of conventional round, cross-section circumferential rib stiffeners that are approximately 4 inches (in) (100 millimeters [mm]) in diameter, and round, cross-section vertical stringer assemblies approximately 3 in (75 mm) in diameter (Figure 2-5 and Appendix F). Three-arm spider assemblies with arms approximately 6 in (150 mm) in diameter support the skin of the buoy at three locations, and the buoy head assembly at the top of the buoy. The interior of the buoy is free of obstructions, sharp edges, or corners. A minimum water depth of 90 ft (28 m) would be required to accommodate the required length and stroke of the oscillation section of the buoy.

Spar Buoy. The spar buoy, constructed of steel, is positively buoyant. Fixed to a ballasted anchor, it keeps the system upright while swaying back and forth with the motion of the waves. A universal joint located at the bottom of the spar buoy allows motion of the buoy on two axes.

An antifouling finish would be used on the exterior of the buoys, applied from the universal joint to the top of the system, to prevent accumulation of marine organism deposits. No ecological hazards are indicated post-application. The Material Safety Data Sheet (MSDS) provided in Appendix G, states that there is no marine pollution hazard from the applied product. The antifouling finish would not be applied to the anchor base.

Wave Buoy Array

The configuration and proposed location of the wave buoy array would be chosen such that the effect of energy extraction from the waves by the seaward buoys on the shoreward buoys could be investigated (Figure 2-2). This would demonstrate the effect of buoy placement on WEC power generation.

Buoy Anchor

Each WEC buoy would be anchored using a heavily ballasted anchor assembly consisting of two components: an anchor base plate and anchor weights (Figure 2-4). The anchor base plate would be ringed by a flange frame that would be rock-bolted to the sea floor (Figure 2-6a). The anchor base plate would be loaded with 35 to 75 tons (32 to 68 metric tons) of anchor weights. The anchor weights would prevent vertical movement of the base, and the rock bolts on the anchor base plate would prevent horizontal movement under design wave conditions with a holding force up to 100 tons (91 metric tons). The anchor assembly would be designed to resist the hurricane scenario described in Section 2.2 in order to prevent the buoy from detaching from the moorings and creating a public safety hazard.

Mooring Clumps

In addition to the buoy anchors, four “mooring clumps” would be placed on the sea floor to allow stable mooring of the workboats required for installation and periodic inspection of the WEC system (Figure 2-7). Each mooring would consist of a 7,000-pound (lb) (3,175.1-kilogram [kg]) maximum concrete block, attached to a 100-ft (30.5-m) maximum length of anchor chain secured taut to a grouted rock bolt sunk into the substratum (Figure 2-8). The chain and rock bolts are safety measures to prevent the mooring from being dragged long distances across the bottom if extreme loads are applied to the mooring lines. Calculated maximum area of movement of the anchor chain is about 1 ft (0.3 m) in the unlikely event that the concrete block is moved.

During installation, and every other month after installation for the duration of the test period, an 80-ft (24.4-m) boat would transit to the site and attach mooring lines to each of the four floats. This configuration would provide stability for use of the vessel as a dive platform. The mooring would ensure that there is no contact with the WEC boys during installation and maintenance.

Equipment Canister

The equipment canister (Figure 2-4) is a conventional underwater pressure vessel that contains components to produce and control power, including hydraulics, generator, resistors, transformers, circuit breaker, and computer and data acquisition equipment. Its dimensions are 9 by 7 by 7 ft (2.7 by 2.1 by 2.1 m). The equipment canister would be attached to a base that would be rock-bolted to the seafloor in a central location between buoys number 1 and 2 (Figure 2-2), and would have attachment points for the first and second buoys. If required, up to three canisters would be installed for service to all six buoys, with two buoys attached to each canister.

Power generated by the components of the equipment canister would be transmitted to shore via the undersea transmission cable.

The working fluid for the buoy's power generating system would be a biodegradable hydraulic fluid consisting of a chemically stable, vegetable oil based liquid. There would be approximately 13.2 to 26.4 gallons (50 to 100 liters) of hydraulic fluid per buoy. The MSDS for the hydraulic fluid is provided as Appendix G. Antifouling finish would be applied to portions of the equipment canister including its base.

Undersea Transmission Cable

The generator and high-voltage transformer would be connected to a waterproof and electrically insulated undersea power transmission cable with an outside diameter of approximately 2.6 in (66.4 mm). The cable would be enclosed in armoring and covered with an outer sheathing made of synthetic materials. The cable materials are inert or non-toxic.

In addition to transmitting power to the utility vault, the cable would contain fiber optic or twisted pair communication lines to transfer data to and from shore equipment. The undersea cable would be designed to carry 250 kW and transmit power for up to six buoys, as well as resist the design scenario hurricane described in Section 2.2.

Utility Vault

An onshore concrete utility vault would serve as a junction box between the undersea transmission cable and the land transmission cable. The vault would be approximately 4 ft wide by 2 ft long by 3 ft high (1.2 m wide by 0.6 m long by 0.9 m high), maximum size, and weigh 450 lb (204 kg). The cables would be bolted to the utility vault at the entrance and exit points to prevent movement or tampering. The vault would be placed on a bed of gravel or other porous material to provide a level surface and adequate drainage.

Land Transmission Cable

The land transmission cable would be encased in a polyvinyl chloride (PVC) conduit and elevated off the ground using pedestals placed at intervals along the cable route. The conduit would run from the utility vault to the equipment shelter at Battery French, following the route shown in Figure 2-3. The route proceeds east over the slope of the hill behind the Officers Family Housing area. Where it crosses the dirt path, the conduit would be protected by either gravel or concrete.

Equipment Shelter

The cable would enter Battery French through a hole cut into an existing wire mesh screen and doorway. It would be mounted along the length of the main interior corridor wall and exit through an existing doorway. Battery French would serve as the land based equipment shelter containing onshore electrical power and control equipment comprised of a computer, transformer, alternate current/direct current (AC/DC) and DC/DC converters, capacitor bank, battery bank and an inverter. Power would be transmitted to the existing electrical grid system via a cable, which could be installed in existing underground duct banks. Modifications to Battery French, expected to be minimal, would consist of installing air conditioning, replacing existing air ducts and improving ventilation, providing access to the shore-based transmission cable, providing EXIT signs, and reinstalling 115-volt (v) power outlets and lighting. General cleaning of floors and walls, and the removal of abandoned furnishings, equipment, and fixtures will occur in the rooms to be used. Interior doors and associated hardware may be replaced to ensure security.

2.4.1.3 Installation Procedures

Undersea Transmission Cable

Cable installation procedures are described for the entire cable route with detailed description provided for the shore-based activities and the first 700 feet. The day before laying the undersea cable, divers will lay a wire rope along the proposed cable route, determined by previous surveys, from about the 18- to the 30-ft (5.5- to 9.1-m) water depth, a distance of 700 ft (213.4 m). Using a Differential Global Positioning System (DGPS), the rope will be placed along the pre-surveyed cable route. Divers will reposition the wire rope, as needed, to avoid as much vertical relief and live coral as possible. The wire rope will serve to guide the divers in positioning the main cable during installation.

The proposed landing point for the cable is adjacent to the northeast corner of the shoreline revetment at North Beach (Figure 2-9). On the day of installation, a vessel would be anchored with a four-point mooring directly off the landing site as close as the surf permits (10- to 15-ft [3- to 4.6-m] water depth, approximately 450 ft [137 m] off shore). The land end of the cable would be fastened to a cable sled to protect the cable from entangling with undersea boulders while transiting through the surf zone (Figure 2-6b). The floats on either side of the sled would assure that the end of the cable floats on the surface as it is pulled to shore. The skid plate on the bottom of the sled would assist in pulling the cable over the exposed rip-rap and boulders that are in shallow water. Small floats would be attached to the cable along its length as it is pulled toward shore to assure that the cable does not contact or drag along the bottom. The sled would be pulled to shore with a wire winched from the cable-laying vessel and guided by the long arm of a crane positioned on the revetment. After successful transit through the surf zone, the sled would be removed and the wire attached directly to the cable.

A turning sheave (right-angle guide), consisting of a 4-ft (1.2-m) wide by 1-ft (0.3-m) high concrete block, would be placed on shore one day prior to installation. The turning sheave allows the cable to turn through the angle from the landing point to the utility vault. Once the cable is temporarily secured at the anchor block, a crew at the vault would strip the armor layer from the cable and anchor it to the interior of the vault. Simultaneously, two other activities would occur: (1) a stopper would be placed on the cable to hold the cable and the first section of split pipe, and (2) divers would inspect the cable from the shoreline to approximately 500 ft (152.4 m) seaward of the initial mooring. The divers would remove the floats and guide the cable to the bottom, positioning it along the previously laid guide wire to assure that no living coral are damaged.

The vessel would then move seaward from the shore, deploying the cable as it follows the pre-planned cable route. The vessel's linear cable winch would allow the cable to be laid with either tension or slack to assist the divers in guiding the cable into position along the route marked by the wire rope. Once the vessel has reached the site of buoy number 1, the end of the cable would be lowered to the bottom.

The undersea cable would be anchored along its entire length by either rock bolts or protective split pipe, with the type of anchoring and spacing dependent upon the environmental conditions (e.g., the substrate) (Figure 2-2). The route selected avoids areas of vertical relief to the maximum extent practicable and utilizes branches of sand deposit that extend seaward from the beach through the sand channel zone whenever possible (Appendix E).

Divers would set the bolts and encase the cable in the split pipe depending upon seafloor conditions. The hollow, self-securing rock bolts would be filled with water-sealing grout which would set within 24 hours. No trenching is required. Anchoring of the cable along its entire route may be completed following the initial day of installation. During installation, excess cable would be placed on the seafloor in a figure eight configuration between buoys number 1 and 2 and secured with rock bolts.

Cable Beach Anchor

Once on shore, the cable would be anchored in the natural basalt outcropping using rock bolts and secured to the entrance of the utility vault (Figures 2-9 and 2-10).

Utility Vault

The utility vault would be constructed off site and trucked in using an existing dirt roadway leading from the runway. A crane would be used to place the vault onto a maximum 6-in (152-mm) thick gravel bed covering a maximum 8- by 8-ft (2.5- by 2.5-m) area. The vault box would be installed shoreward of the beach area, above the high water mark, in the location shown in Figure 2-9.

Land Transmission Cable

No heavy equipment (e.g., crane and backhoe loader) would be used to lay the land transmission cable. To avoid sensitive resources in the project area, equipment would be confined to the existing dirt roadway to the staging area and proposed staging platform.

Buoy, Anchor, and Canister Installation

The final assembly of the WEC buoys and anchors would occur on O‘ahu at either Honolulu Harbor or Barbers Point, which would serve as the initial staging area; all deployment activities and vessels would start out from this point. The selected site at MCBH Kaneohe Bay for the buoys and anchors would be pre-marked with a marking buoy and identified with latitude and longitude coordinates. The location would be pinpointed with Global Positioning System (GPS) navigational systems for accuracy. The actual method of deployment of the buoys and anchors is dependent on final design considerations and vessel capabilities.

The buoy and anchor would be ocean-towed, barged, or trucked from Honolulu Harbor or Barbers Point. The anchor may be trucked to Kane‘ohe Bay, as opposed to towed or barged, to avoid risk of damage to the buoy and anchor during towing and to avoid higher costs. After transport to Kane‘ohe Bay, the buoy and anchor may remain in the Bay overnight prior to installation. Prior to deployment, divers will choose the buoy and anchor locations and mark the sites with rock bolts that will be used to secure the anchors. At the deployment site, the ballast tanks in the anchor would be flooded with water and the anchor lowered to a pre-determined location on the seafloor. Tag lines running from the anchor to the rock bolts would be used to guide the anchor into position at the pre-selected site. Upon satisfactory positioning of the anchor base, a vessel would lower additional mass down onto the gravity base, and the anchor frame would be rock-bolted to the seafloor. Following anchor installation, the buoy column would be winched down from the deployment vessel and connected to the anchor base. Divers would assist in attaching the buoy column to the anchor.

The canister would be deployed separately from the anchor and buoy. It would be lowered with a winch to the seafloor and secured with rock bolts. Divers would connect electrical cables and hydraulic hoses to the canister.

2.4.1.4 System Monitoring and Protection

A monitoring plan would be developed for the project, subject to approval by the Navy. The WEC system would be monitored through a combination of automated systems and visual observations. An automated GPS system within each buoy would continuously provide location information and alert appropriate personnel if a buoy moves outside of a designated watch circle. The system would be automatically shut down by an on-board computer system should an electrical fault occur. The power system of the WEC system would be monitored through a variety of sensors allowing monitoring of key variables at the shore stations or via a modem. Presence of the system would be verified at least once every 24 hours through a visual inspection of the system and its navigational features. Each WEC buoy would have signage normally used by the USCG indicating, ‘Government Property, Submerged Obstruction.’ Buoys for the mooring clumps would likely be submerged.

Approximately once every two months, a diving inspection of the undersea systems would be conducted to observe and record system wear and to note potential safety issues not apparent from other visual and automated monitoring. The WEC system would also be inspected if the data acquisition and monitoring system indicates any abnormal operational parameters regardless of the time interval since the last inspection. Land based electrical equipment would be inspected on a routine basis, once per month or bi-monthly. Procedures for responding to critical alerts, in the case of a mooring break, electrical fault, or other alerts or maintenance observations, will be identified. Monitoring, protection, and response procedures will be identified in the WEC system operational monitoring and response plan to be approved by the Navy.

Finally, a Memorandum of Agreement (MOA) would be established between the ONR and MCBH Kaneohe Bay encompassing the WET project.

2.4.1.5 System Removal

Upon completion of the WEC system test, the equipment would be removed using operations similar to those used for installation. If the "ocean-towed" buoy and anchor system is used, the ballast tanks in the anchor would be filled with air and the buoy and anchor floated off the sea floor and towed to the staging area. If a non-floating gravity anchor is used, a barge or vessel with winches, a crane, or lift bags would be used to lift the system out of the water and return it to the staging area. A beneficial impact would result from the growth of benthic organisms such as corals on the WEC cable and anchor during the test period. In consultation with NMFS, USFWS, and DLNR, the Navy will determine at the end of the testing period whether the cable, buoy anchor system (from the universal joint down), and mooring clump base and anchoring system should be removed or left in place. All other WEC equipment (i.e., buoys, equipment canisters, and land based components) would be removed following completion of the test.

2.4.2 Alternative B: Pearl Harbor

Information for this alternative site was obtained from the following reports: *Final Environmental Impact Statement, Outfall Replacement for Wastewater Treatment Plant at Fort Kamehameha, Navy Public Works Center, Pearl Harbor, Hawaii* (Navy March 2001); *Pearl Harbor Naval Complex Integrated Natural Resource Management Plan* (Navy October 2001); and "Marine Natural Resources Insert for the WET EA" (Navy 2002a) (Appendix D).

2.4.2.1 General Description and Site Selection Factors

The Pearl Harbor site meets all of the project objectives identified in Section 1.3 and Table 2-1. As with MCBH Kaneohe Bay, this site is conducive to installation of multiple buoys, presenting the opportunity to observe the effects of more than one buoy on system performance. It provides good access for installation, operations, and maintenance activities, as well as power grid connections. The site, which is not a popular recreation area because of its location off of the Pearl Harbor entrance channel, is used primarily for military ship ingress and egress. The entire WEC system, including the buoy array, transmission cable, and shoreside equipment, would be within a restricted area, minimizing risks to system security.

Despite these favorable conditions, the Pearl Harbor site was not selected because it would provide only a minimal wave energy environment to test the WEC technology and is considered impractical. The site is exposed to waves with average heights in the range of the minimum 3 ft (1 m) and less than the optimum 5 ft (1.5 m). In addition, the site is relatively sheltered from winter storms, and the likelihood that the system would be challenged by storm conditions within the two- to five-year test period is low.

At the Pearl Harbor site, the undersea cable would be secured to the western side of the Pearl Harbor entrance channel along the side of the channel (Figure 2-11). The landing site would be located on the shoreline adjacent to Building 562. Installation of the buoy system would be conducted over a two- to five-year period, as described in Sections 1.1 and 1.3.

2.4.2.2 WEC System Components

The system components would essentially remain the same as those described in Section 2.4.1.2. There could be modifications to the design of certain components such as the anchoring of the undersea cable, buoys, and equipment canister relative to substrate found at the site. The equipment shelter would be housed at Building 562, on the west shore of the entrance channel.

2.4.2.3 Installation Procedures

Installation procedures would be similar to those described in Section 2.4.1.3. Installation operations would be coordinated with the appropriate authorities to avoid interference with harbor operations.

Undersea Transmission Cable

Installation procedures for the undersea transmission cable would be similar to those described in Section 2.4.1.3, however, they would be modified for site requirements unique to the Pearl Harbor location (e.g., type of anchoring and spacing needed to secure the cable).

Cable Beach Anchor

A concrete block would be placed on the lawn of Building 562 near the cable landing site to anchor the cable.

Utility Vault

The prefabricated concrete utility vault would be housed near Building 562.

Land Transmission Cable

The land transmission cable would be encased in a PVC conduit and follow the perimeter of Building 562 from the utility vault to the area designated as the equipment shelter (Figure 3-6). Heavy equipment would be used for installation as described in Section 2.4.1.3.

Buoy, Anchor, and Canister Installation

The final assembly of the WEC buoys and anchors would occur on O‘ahu at either Honolulu Harbor or Barbers Point, which would serve as the initial staging area; all deployment activities and vessels would start out from this point. The proposed buoy array site at Pearl Harbor would be pre-marked with marking buoys and identified with latitude and longitude coordinates. The location would be pinpointed with GPS navigational systems for accuracy. The actual method of deployment of the buoys and anchors is dependent on final design considerations and vessel capabilities.

The buoy and anchor would be ocean-towed, barged, or trucked from Honolulu Harbor or Barbers Point. Installation procedures would be similar to those described for the Proposed Action.

2.4.2.4 System Monitoring

Monitoring of the system components would be conducted as described in Section 2.4.1.4.

2.4.2.5 System Removal

System removal would be conducted as described in Section 2.4.1.5.

2.4.3 Alternative C: No Action

The No Action alternative would not implement the proposed WET test in Hawai‘i. With the No Action alternative, the Navy would neither satisfy stipulations of the Congressional appropriation nor meet the stated objectives (purpose) of the Proposed Action in Section 1.3. The No Action alternative would not prohibit testing of the WEC system elsewhere in the world. However, OPT would have to find another location, outside of Hawai‘i, to test the WEC system in a high average annual wave density environment.

2.5 SUMMARY OF THE PREDICTED ENVIRONMENTAL EFFECTS OF THE PROPOSED ALTERNATIVES

Table 2-2 presents a summary of project alternatives that were considered and their predicted environmental effects.

Table 2-2. Comparison of Predicted Environmental Effects

Potential Issue/ Impact	Alternatives		
	MCBH Kaneohe Bay Alternative A	Pearl Harbor Alternative B	No Action Alternative C
SHORELINE PHYSIOGRAPHY			
Impacts of installation and operation	No significant impacts are expected. The WEC system would not alter currents or wave directions and there would be no effects on shoreline erosion or sand deposition patterns. **Mitigation:** none proposed.	Same as Alternative A	No Impacts
Impacts of system removal	No significant impacts are expected. In consultation with the NMFS, USFWS, and DLNR, the Navy would determine at the end of the test period whether equipment installed on the seafloor should be removed or left in place. Land equipment would be removed. **Mitigation:** none proposed.	Same as Alternative A	No Impacts
OCEANOGRAPHIC CONDITIONS			
	No significant impacts are expected. Implementing the WET test would not affect wave scattering and energy absorption. **Mitigation:** none proposed.	Same as Alternative A	No Impacts
MARINE BIOLOGICAL RESOURCES			
Impacts to threatened and endangered species and marine mammals protected under the MMPA during installation and operation of the WEC system	No significant impacts are expected. The USFWS and NMFS concur that the Proposed Action is not likely to adversely affect threatened (green sea turtle) and endangered species (hawksbill turtle, humpback whale, and Hawaiian monk seal) under their jurisdictions. Protocols for avoiding impacts to listed protected species during installation activities would be specified in the construction contractor's Best Management Practices (BMPs). The taking of marine mammals protected under the MMPA is unlikely. **Mitigation:** none proposed.	If selected, the Navy would initiate informal Section 7 ESA consultation. The taking of marine mammals protected under the MMPA is unlikely. **Mitigation:** none proposed.	No Impacts

Table 2-2. Comparison of Predicted Environmental Effects *(continued)*

Potential Issue/ Impact	Alternatives		
	MCBH Kaneohe Bay Alternative A	**Pearl Harbor Alternative B**	**No Action Alternative C**
MARINE BIOLOGICAL RESOURCES *(continued)*			
Impacts of installation and anchoring on coral and benthic communities	No significant impacts are expected. Minor impacts would occur on coral and benthic communities along the proposed cable route and at the buoy array site. However, installation of the WEC system has been planned to avoid areas with high percentages of coral coverage. **Mitigation:** none proposed.	Minor impacts on coral and benthic communities would occur along the cable route. Installation would avoid areas with a high percentage of coral coverage. The buoy array site is essentially devoid of live coral. **Mitigation:** none proposed.	No Impacts
Impacts to HAPC	The site is not within an HAPC. **Mitigation:** none proposed.	Same as Alternative A	No Impacts
Impacts to marine mammals or turtles from the risk of entanglement with the cable and entrapment within the buoy	No significant impacts are expected. Entanglement would be a minimal concern as cable installation would occur in shallow water with adequate tension to allow the torque-balanced cable to resist forming loops and contour to the seafloor. Divers would inspect the cable route once it is placed. Entrapment of marine mammals or turtles within the buoy would be of minimal concern since the interior of the structure is free of obstructions, sharp edges or corners. As part of thesystems monitoring plan to be developed by the Navy, the system will be examined for entrapment of marine species. **Mitigation:** none proposed.	Same as Alternative A	No Impacts
Impacts to marine life from exposure to EMR	No significant impacts are expected. The small scale and limited area of disturbance indicate that impacts from EMR on marine organisms would be minor. Impacts of EMR on marine organisms can be expected to range from no impact to avoidance (for bottom-dwelling organisims only) of the vicinity of the WEC cable. **Mitigation:** none proposed.	Same as Alternative A	No Impacts

Table 2-2. Comparison of Predicted Environmental Effects *(continued)*

Potential Issue/ Impact	Alternatives		
	MCBH Kaneohe Bay Alternative A	**Pearl Harbor Alternative B**	**No Action Alternative C**
MARINE BIOLOGICAL RESOURCES *(continued)*			
Impacts to marine life and divers from potential electrical current leakage	No significant impacts are expected. In the unlikely event that damage to the cable causes an electrical fault, transient effects to marine organisms and divers (mild discomfort) could occur. Electroreceptive species would likely detect the field and be diverted away from the vicinity of the fault during the short period while the ground fault system actuates. **Mitigation:** none proposed.	Same as Alternative A	No Impacts
Impacts to marine life from potential heat release	There would be no impacts to marine life from potential heat release. **Mitigation:** none proposed.	Same as Alternative A	No Impacts
Impacts to marine life from noise generated by the system	No significant impacts are expected. Installation noise produced by drilling holes for rock bolts would be localized, intermittent, and of short duration. Operation of the WEC system is expected to produce a continuous acoustic output similar to, but in a higher frequency of, ship traffic. It is unlikely that noise from system installation or operation would have adverse impacts on humpback whales, dolphins, and green sea turtles. The USFWS and NMFS concur with the Navy that the Proposed Action is not likely to adversely affect threatened or endangered species. The taking of marine mammals protected under the MMPA is unlikely during the installation and operation of the WEC system. **Mitigation:** none proposed.	Same as Alternative A	No Impacts
TERRESTRIAL BIOLOGICAL RESOURCES			
	No threatened or endangered species exist on the proposed project site. **Mitigation:** none proposed.	Same as Alternative A	No Impacts

Table 2-2. Comparison of Predicted Environmental Effects *(continued)*

Potential Issue/ Impact	Alternatives		
	MCBH Kaneohe Bay Alternative A	**Pearl Harbor Alternative B**	**No Action Alternative C**
LAND AND MARINE RESOURCE USE COMPATIBILITY			
	No significant impacts to land and marine resource use are anticipated. Marine resource use incompatibility at the offshore buoy array may result in system security risks. The area is currently open to public access for fishing, boating, and diving. Presently, there are no plans to restrict public access to the buoy array site. The project would not interfere with mission operations at MCBH Kaneohe Bay **Mitigation:** none proposed.	No significant impacts to land and marine resource use are anticipated. The proposed project would not interfere with mission operations at Pearl Harbor. **Mitigation:** none proposed.	No Impacts
CULTURAL RESOURCES			
	There would be no effect on historic properties and no impacts to areas within the Mokapu Burial Area (MBA), NRHP Site 50-80-11-1017, where Native Hawaiian human remains are likely to be found. The Hawaii SHPO was consulted on the Proposed Action and concurred with the Navy's finding of no historic properties affected. **Mitigation:** none proposed.	No impacts on the Pearl Harbor National Historic Landmark. No other cultural resources present. **Mitigation:** none proposed.	No Impacts
INFRASTRUCTURE			
	No impact **Mitigation:** none proposed.	Same as Alternative A	No Impacts
RECREATION			
	There would be impacts to recreation outside the 500-yd (457-m) buffer imposed by the presence of the buoy array during the two- to five-year project duration. These impacts would not be significant. **Mitigation:** none proposed.	No impacts to recreation because the area is used primarily for military ship ingress and egress and the area is off-limits to public access. **Mitigation:** none proposed.	No Impacts

Table 2-2. Comparison of Predicted Environmental Effects *(continued)*

Potential Issue/ Impact	Alternatives		
	MCBH Kaneohe Bay Alternative A	**Pearl Harbor Alternative B**	**No Action Alternative C**
PUBLIC SAFETY			
	There would be potential impacts to public safety outside the 500-yd (457-m) buffer imposed by the presence of the buoy array during the two- to five-year test period. **Mitigation**: Each buoy would have safety lights and standard USCG signage. The system would be monitored through a combination of automated system and visual observations. A response plan would be developed.	No impacts to public safety because the area is off-limits to public access. **Mitigation**: similar to Alternative A.	No Impacts
VISUAL RESOURCES			
	Impacts on scenic views would be minimal. Navigational aids from the buoys would extend approximately 30 ft (9 m) above sea level. At night, safety lights on the navigational aids would be visible in the distance. **Mitigation:** none proposed.	Same as Alternative A	No Impacts

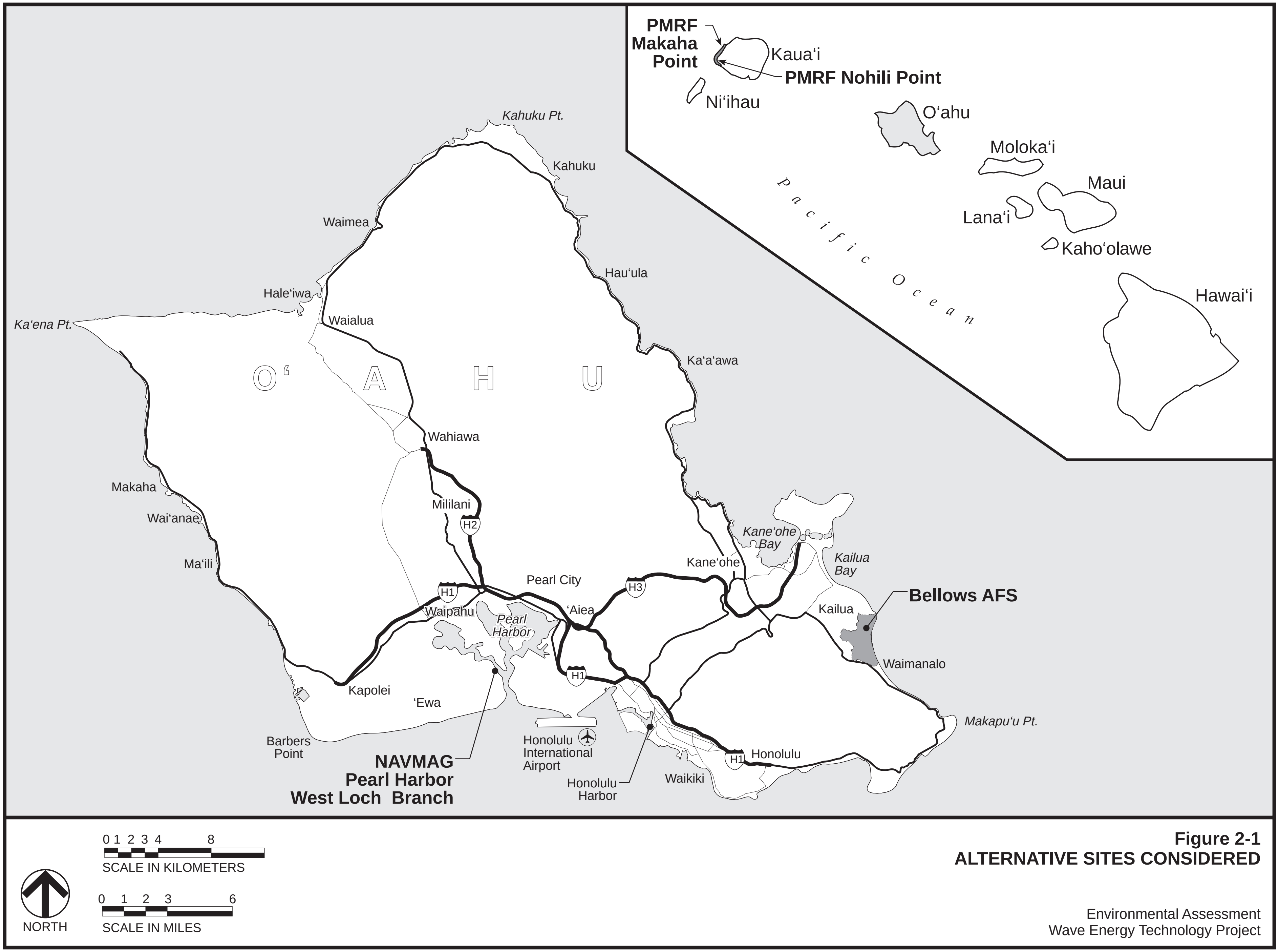

Figure 2-1
ALTERNATIVE SITES CONSIDERED

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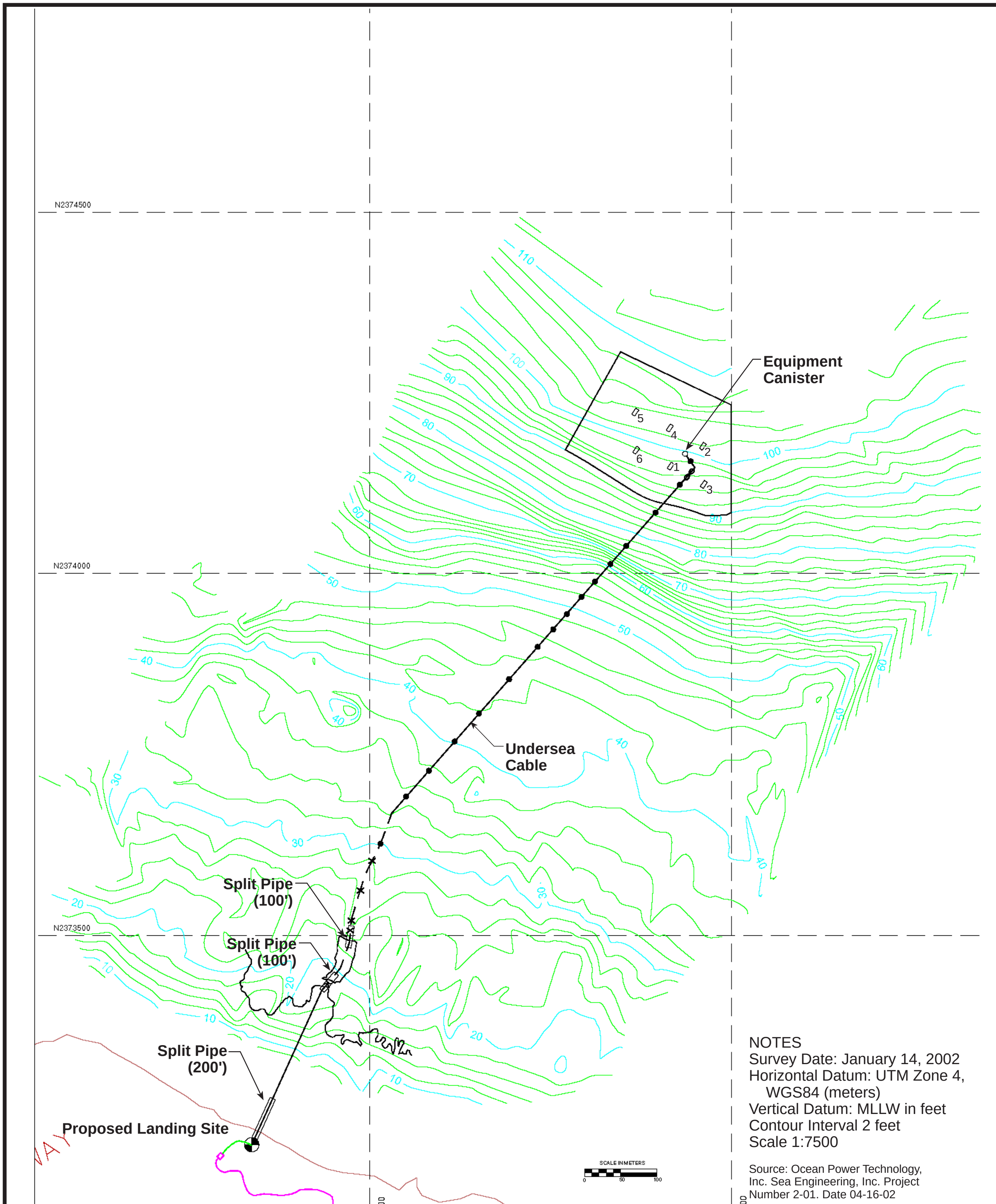
Wave Energy Technology Project



NOTES
Survey Date: January 14, 2002
Horizontal Datum: UTM Zone 4, WGS84 (meters)
Vertical Datum: MLLW in feet
Contour Interval 2 feet
Scale 1:7500

Source: Ocean Power Technology, Inc. Sea Engineering, Inc. Project Number 2-01. Date 04-16-02

NORTH

0 50 100 150 200
SCALE IN METERS

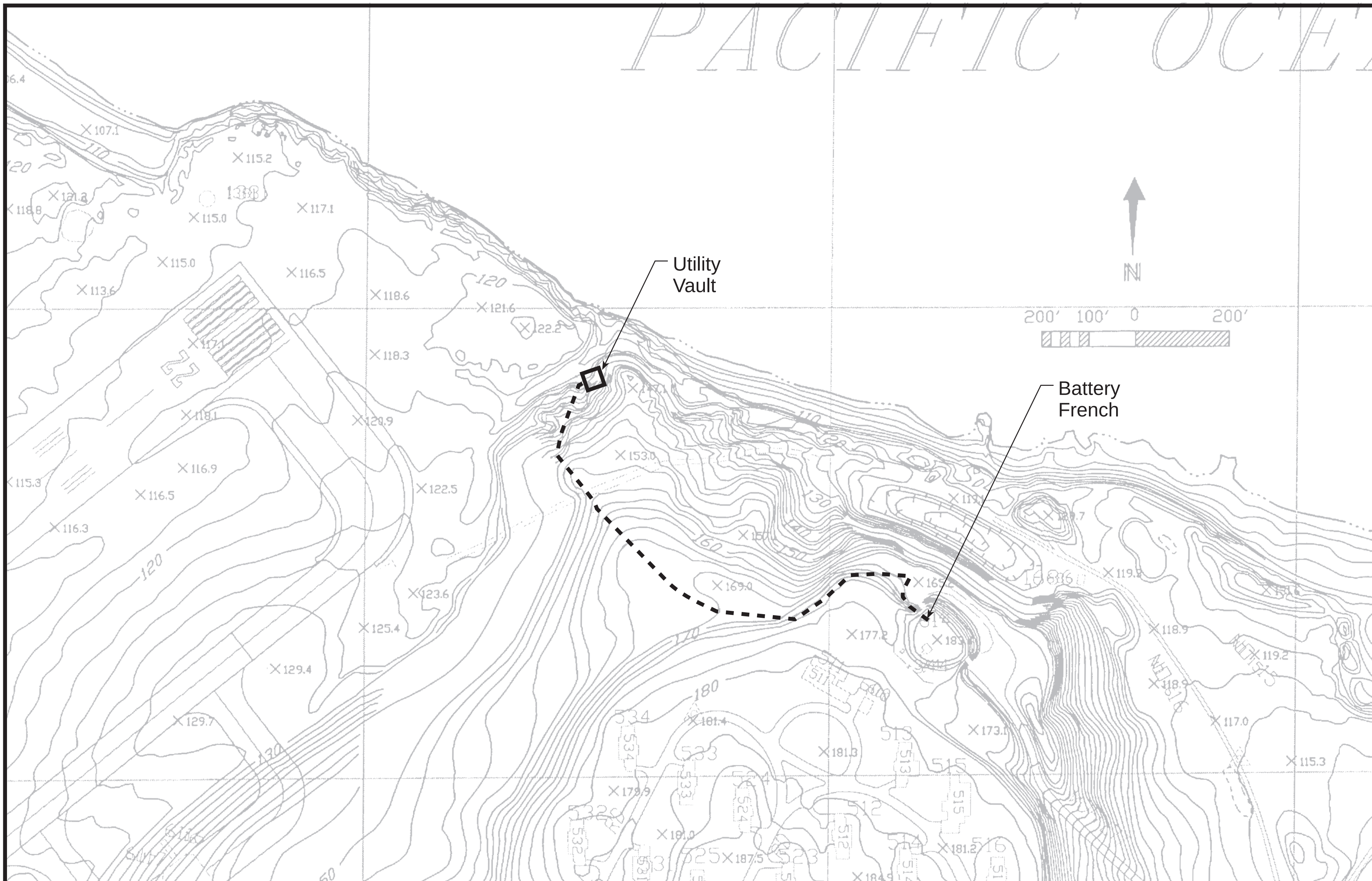
0 625
SCALE IN FEET

LEGEND

Rectangles represent the approximate anchor base.

Numbers indicate order in which buoys would be installed.

Figure 2-2
UNDERSEA CABLE ROUTE AND WAVE BUOY ARRAY
North Beach, MCBH Kaneohe Bay
Environmental Assessment
Wave Energy Technology Project



0 50 100
SCALE IN METERS

NORTH

0 100 200 300
SCALE IN FEET

Figure 2-3
LAND TRANSMISSION CABLE ROUTE
North Beach, MCBH Kaneohe Bay

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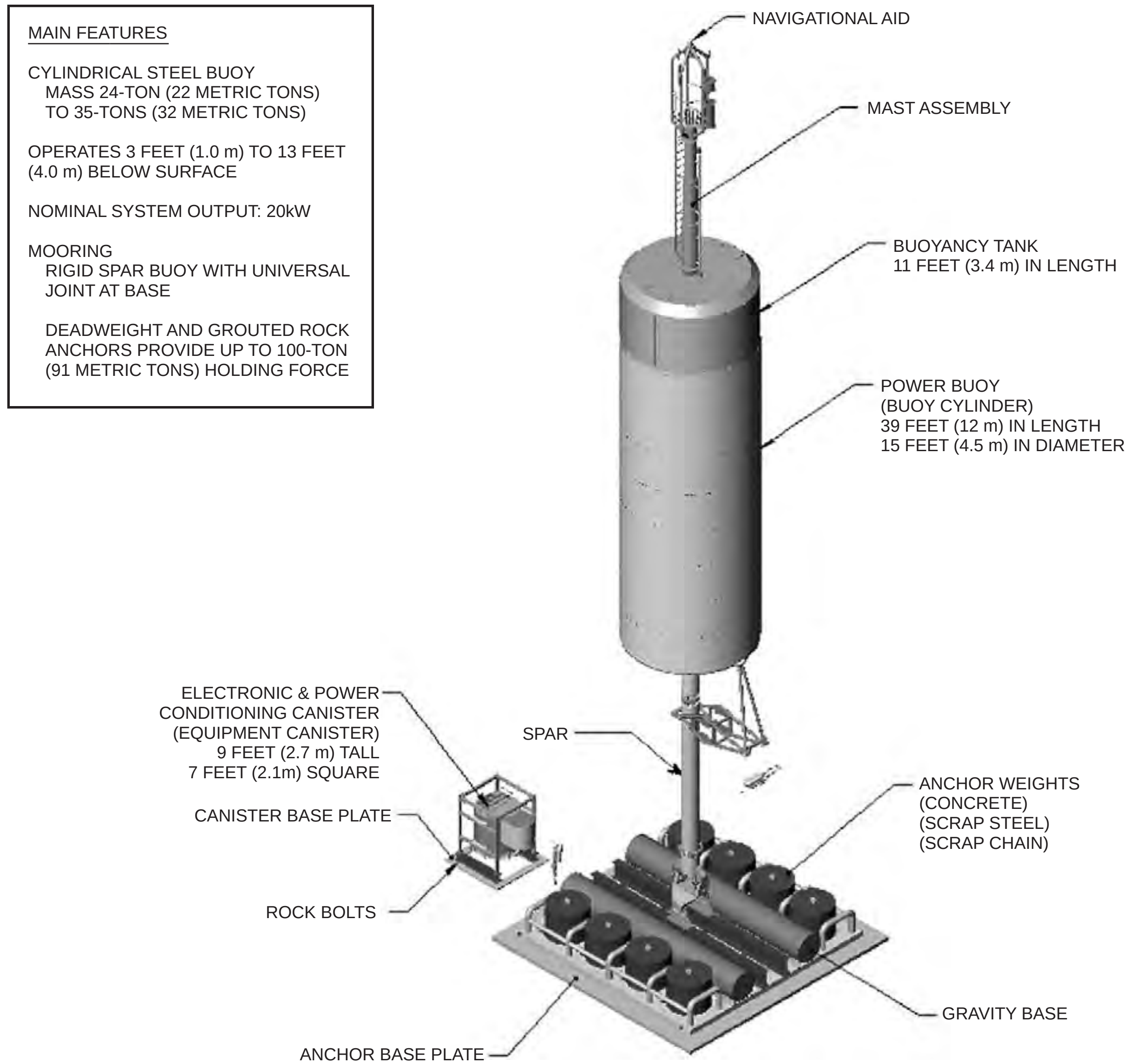
Wave Energy Technology Project

1999.82.0624/006-7 k09.13.02 8



1999.82.0624/001-8 k11.1.02 5

Figure 2-4
BUOY, ANCHOR AND CANISTER CONFIGURATION

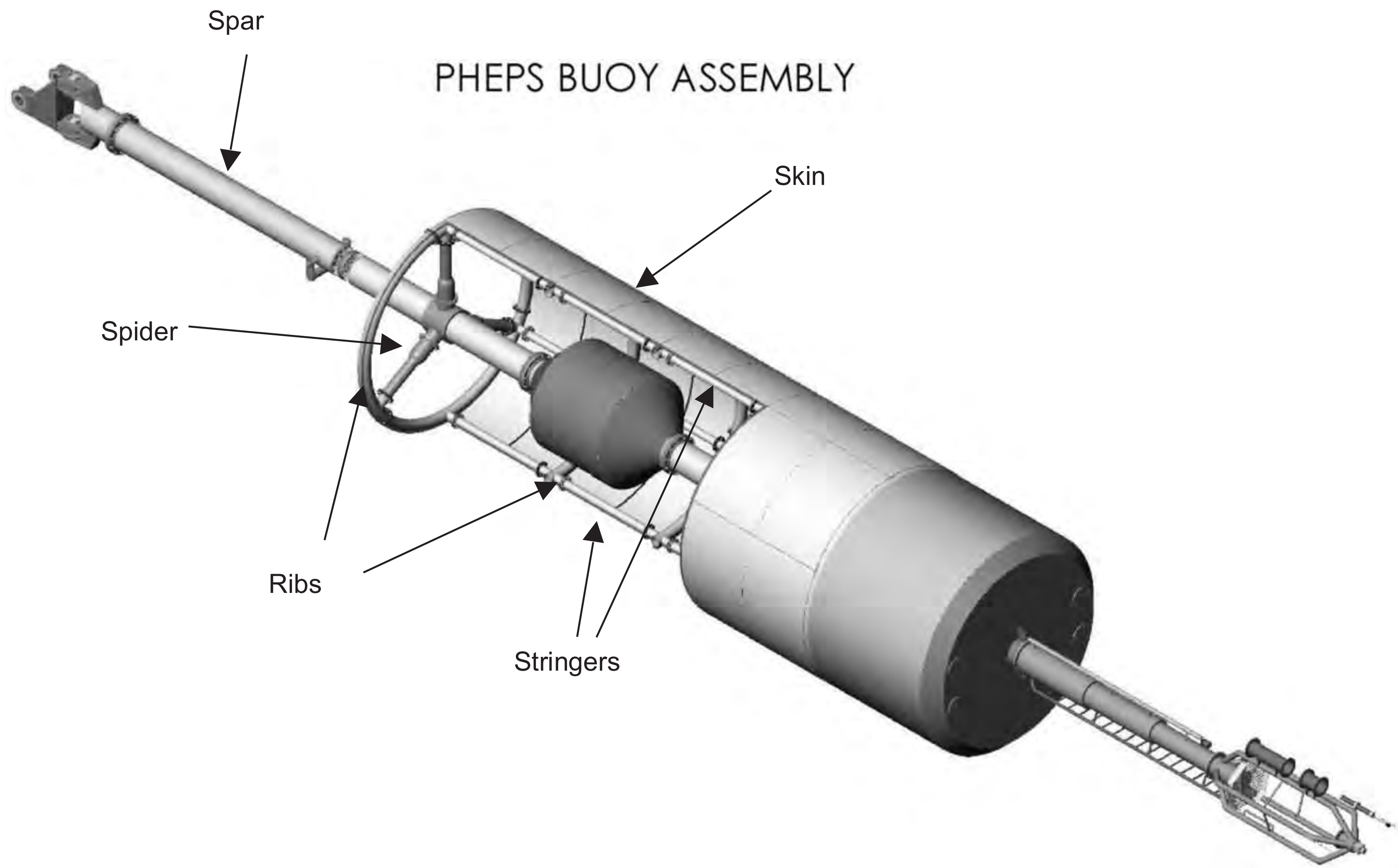
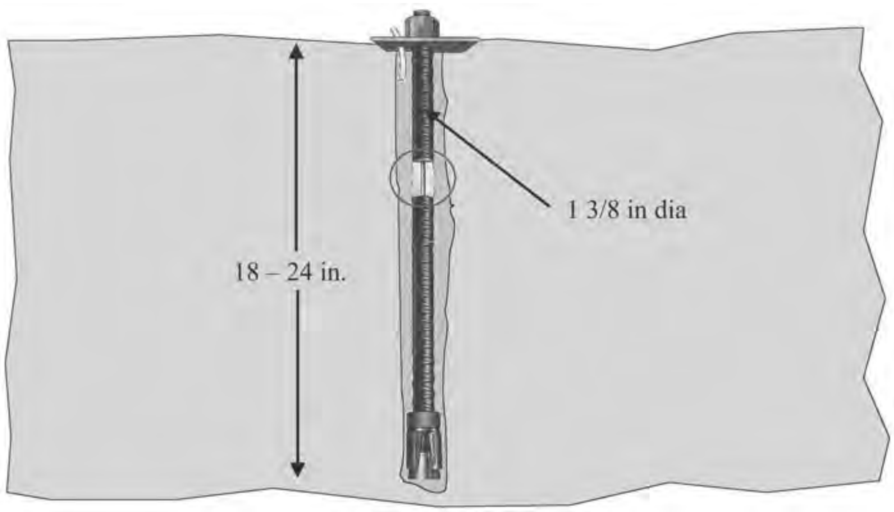


Figure 2-5
CROSS-SECTION OF WEC BUOY

GROUTED ROCKBOLT



CABLE SLED

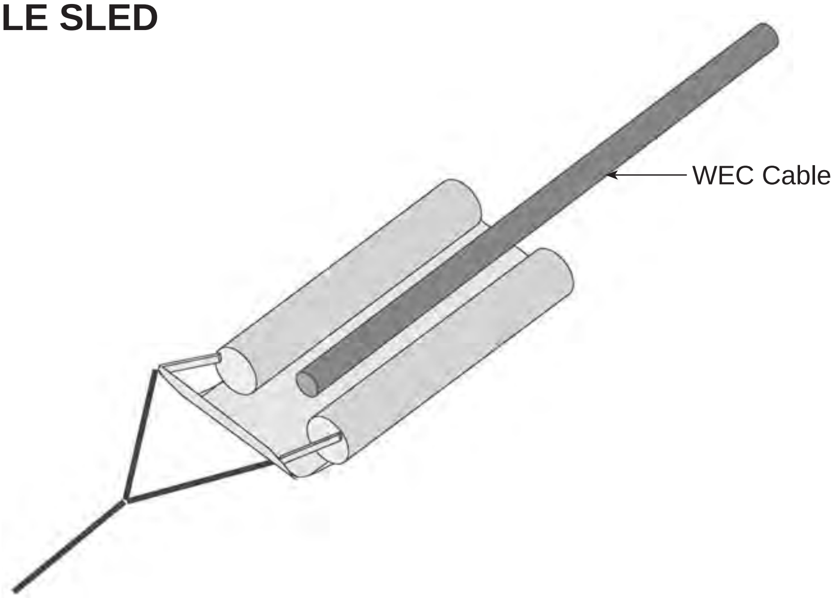
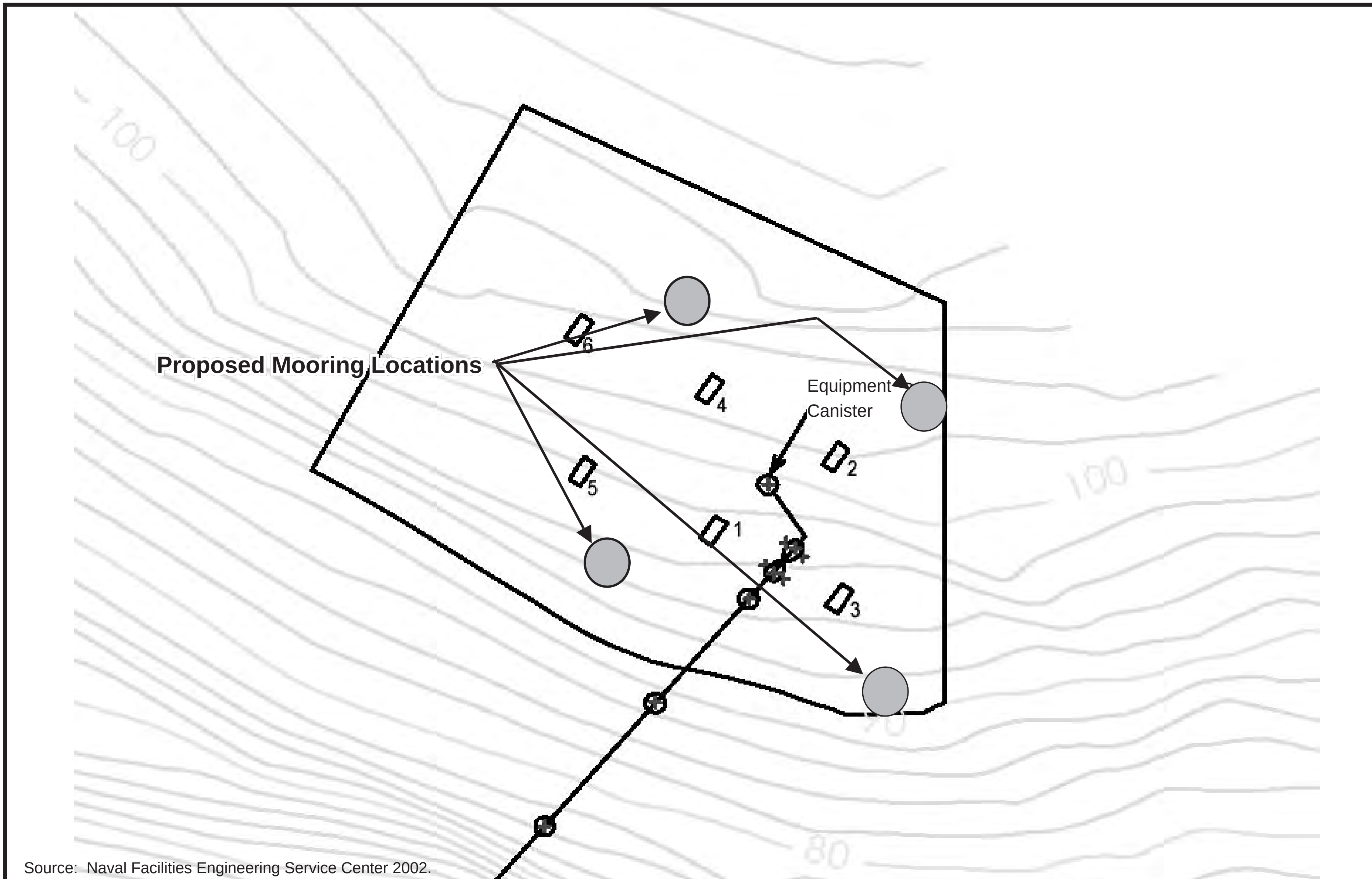


Figure 2-6
GROUTED ROCKBOLT AND CABLE SLED



Source: Naval Facilities Engineering Service Center 2002.

1999.82.0624/006-5 k12.03.02 4

LEGEND

Rectangles represent the approximate anchor base.

Numbers indicate order in which buoys would be installed.

Figure 2-7
PROPOSED 4 POINT BOAT MOORING LOCATION

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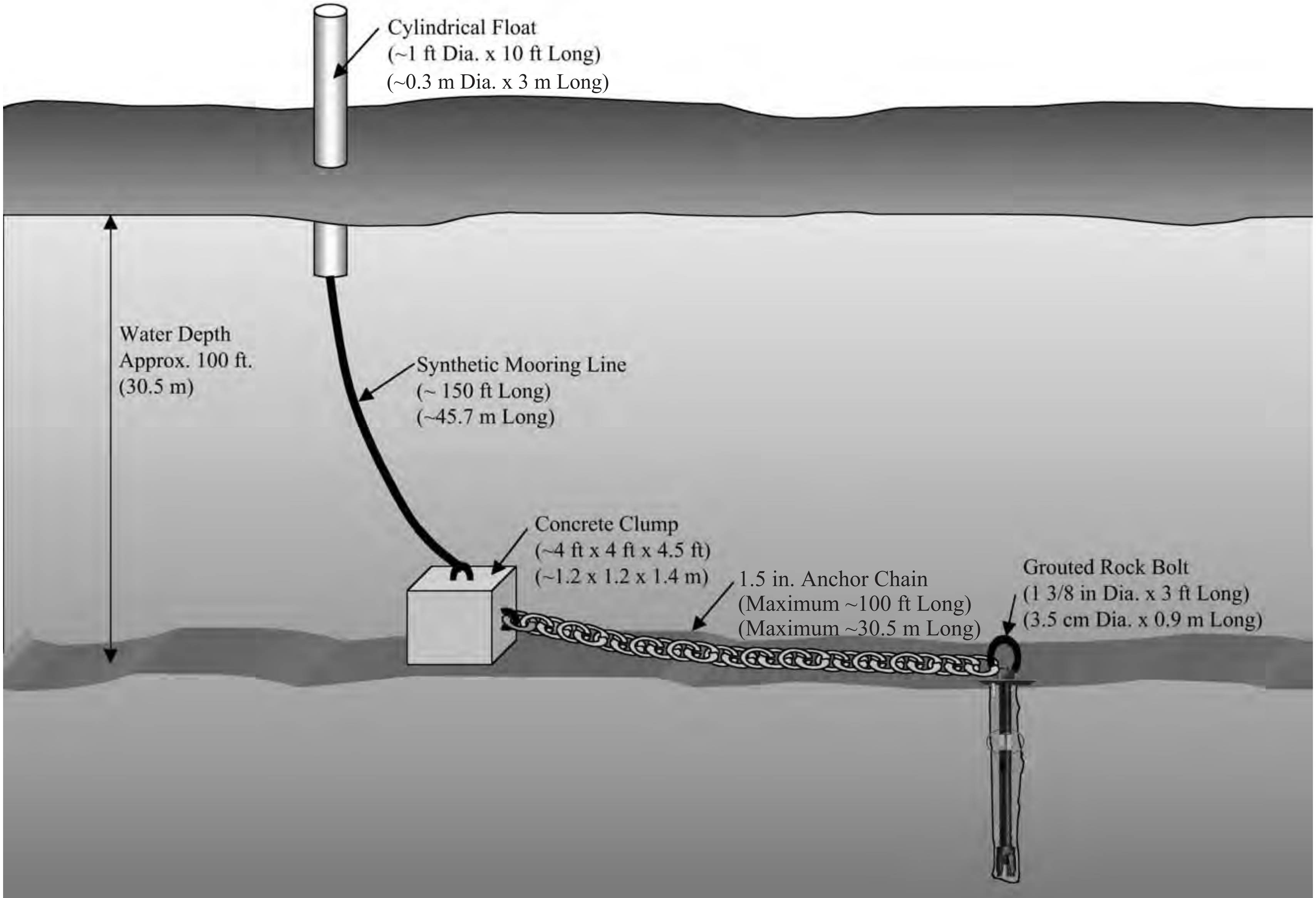
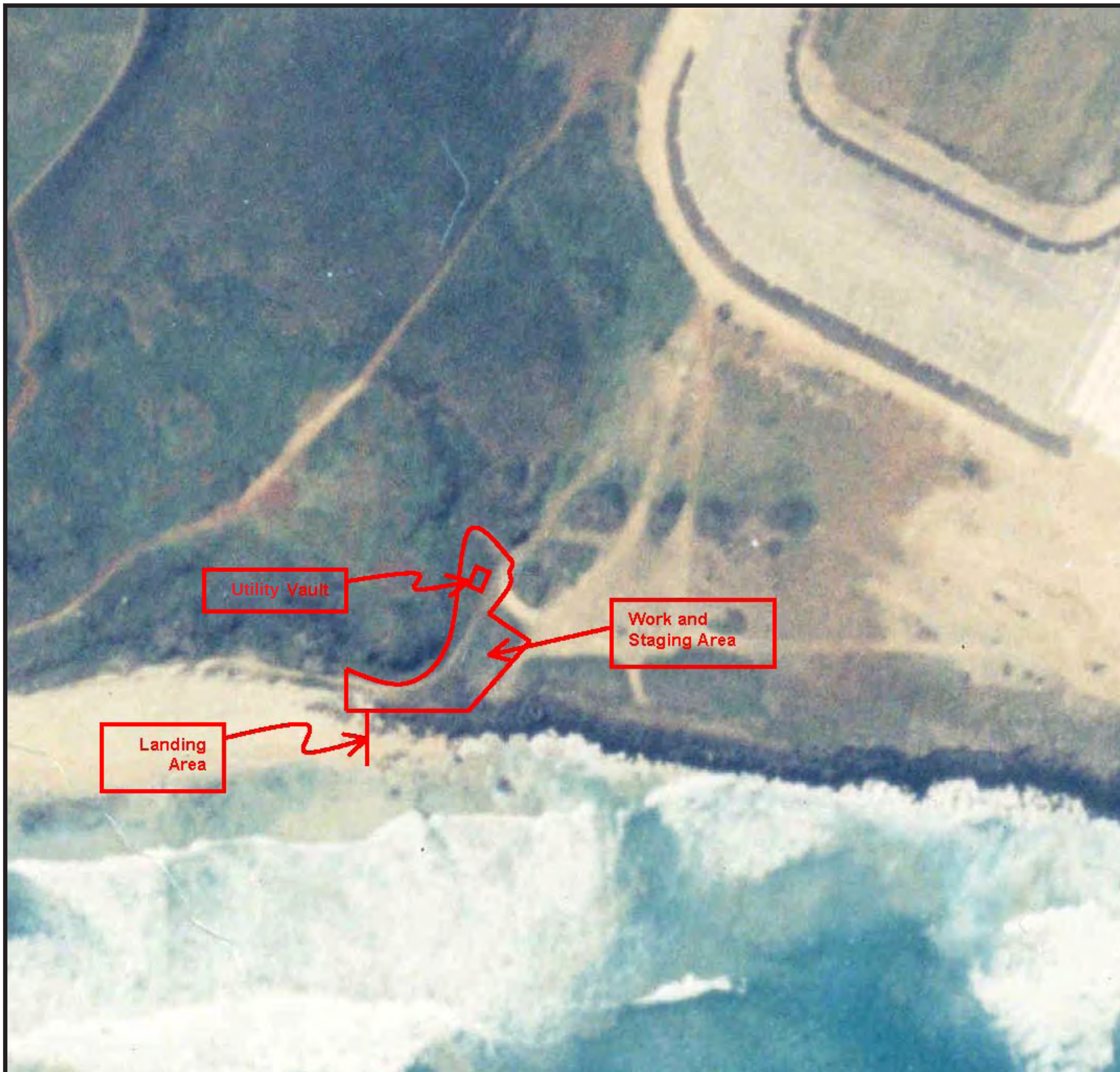


1999.82.0624/006-6 k11.05.02 3

Source: Naval Facilities Engineering Service Center 2002.

Figure 2-8
WORK BOAT MOORING CONFIGURATION



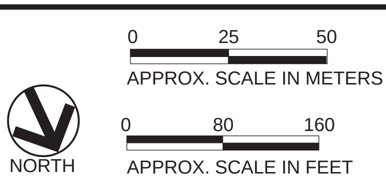


Figure 2-9
CABLE LANDING AND STAGING AREA
North Beach, MCBH Kaneohe Bay

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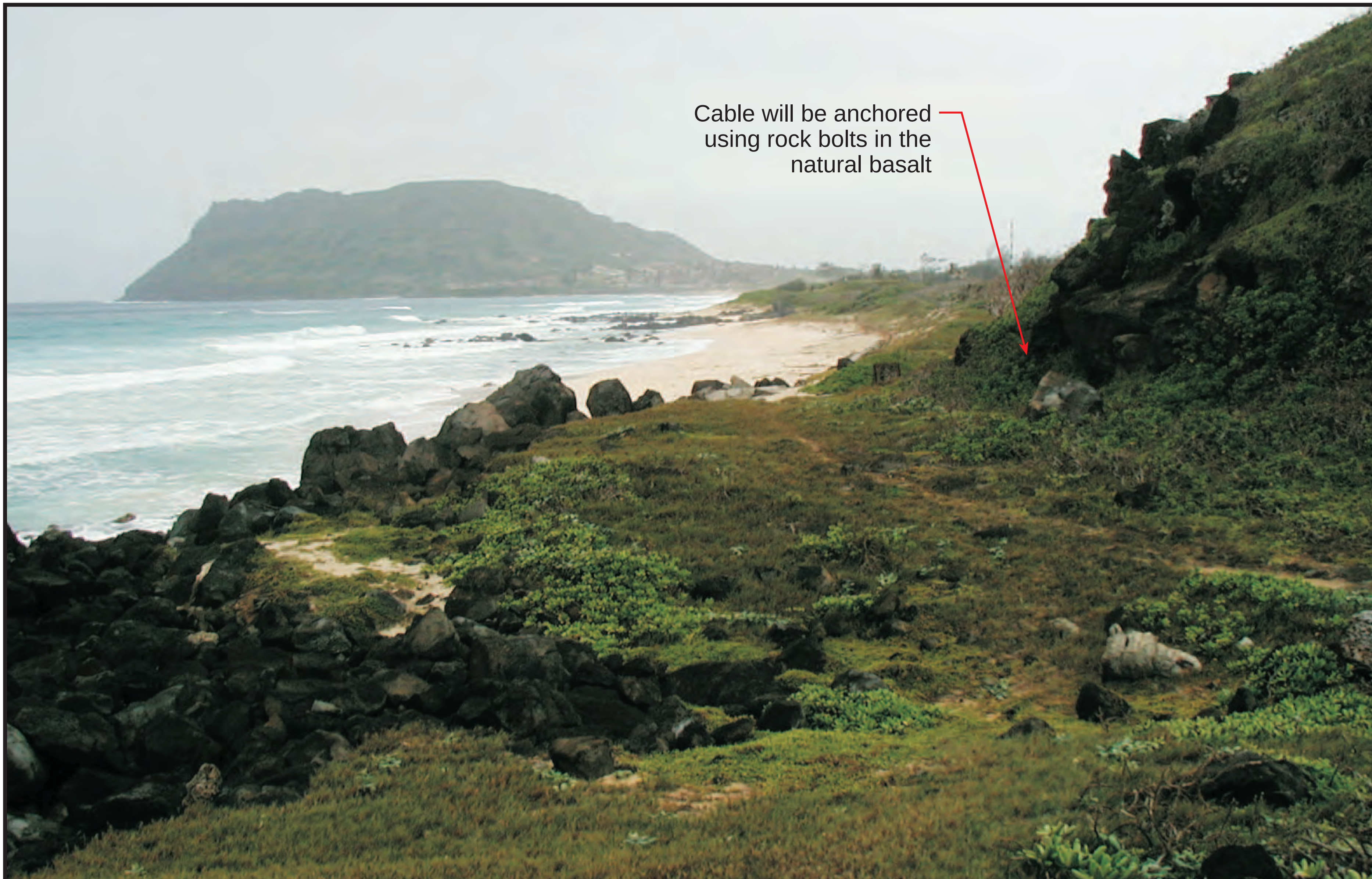

1999.82.0624/006-4 k09.09.02 4

Figure 2-10
LOCATION OF CABLE BEACH ANCHOR
North Beach, MCBH Kaneohe Bay

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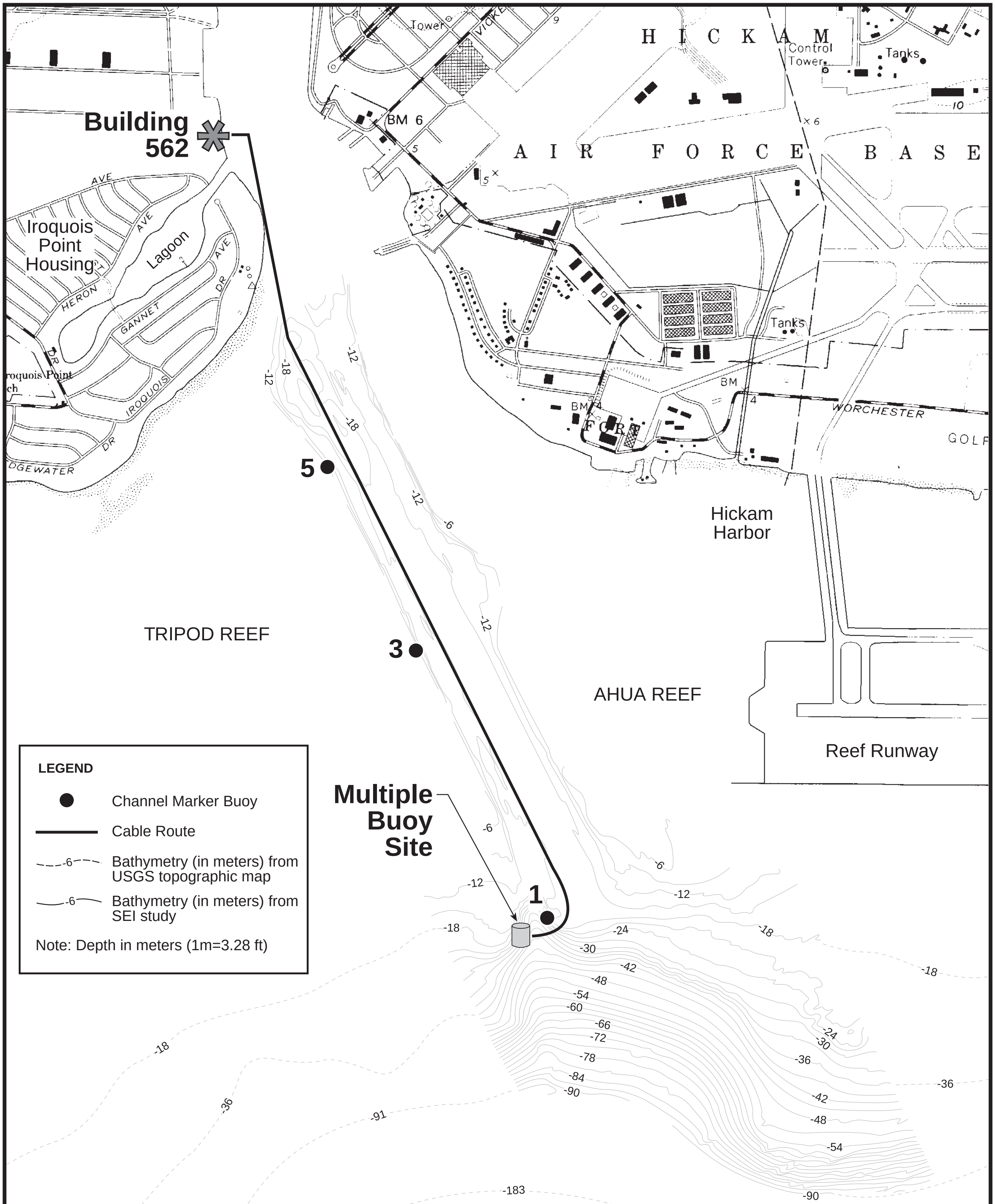

0 250 500
SCALE IN METERS
0 500 1000 2000
SCALE IN FEET
NORTH

Sources:
Base map from Pearl Harbor 7.5 minute Quadrangle (USGS, 1983), Bathymetry from MCON Project P-497 Oceanographic Study for Outfall Expansion for Wastewater Treatment Plant at Fort Kamehameha (SEI, 1996)

Figure 2-11
UNDERSEA CABLE ROUTE AND WAVE BUOY ARRAY
Pearl Harbor
Environmental Assessment
Wave Energy Technology Project

Chapter 3

Affected Environment

CHAPTER 3
AFFECTED ENVIRONMENT

3.1 INTRODUCTION

Chapter Three describes the affected environment and establishes baseline conditions that are compared to the alternatives in order to identify environmental consequences (Chapter 4). Relevant affected and non-affected resources are described for Alternative A: Proposed Action, Alternative B: Pearl Harbor, and Alternative C: No Action. Relevant affected resources include shoreline physiography, oceanographic conditions, marine biological resources, terrestrial biological resources, land and marine resource use compatibility, cultural resources, infrastructure, recreation, public safety, and visual resources. Relevant non-affected resources include climate and air quality, currents and tides, tsunamis, hurricanes, geology and soils, water quality, noise, electromagnetic radiation, and ordnance material.

3.2 DESCRIPTION OF RELEVANT AFFECTED RESOURCES – ALTERNATIVE A: PROPOSED ACTION

3.2.1 Shoreline Physiography

The proposed project area comprises a portion of MCBH Kaneohe Bay known as “North Beach” (Figure 1-2). The 8,000-ft (2,439-m) long beach is continuous except for a rock revetment protecting the seaward end of the main base runway. The 1,100-ft (335-m) revetment protrudes past the strip of sand beach into the ocean. West of the revetment, the 2,000-ft (610-m) shoreline is generally undeveloped. East of the revetment, North Beach extends 5,500 ft (1,676 m) east to the base of the cliffs of Ulupa‘u Head Crater. The average width of the beach is 50 to 60 ft (15 to 18 m). A band of sand dunes line the shore side of the beach, extending to a military housing development situated on a bluff over the easternmost 1,000 ft (305 m) of the beach. A 600-ft (183-m) rock and concrete revetment has been built at the east end of this section.

3.2.2 Oceanographic Conditions

Hawaiian waters consistently have some of the highest wave energy measured in the world. Four primary wave types are used to characterize Hawai‘i’s wave climate: (1) northeast trade wind waves, (2) north Pacific swell, (3) south swell, and (4) Kona storm waves.

Northeast trade wind waves are present throughout the year but are most frequent in summer months (May to October). They result from steady trade winds which blow from the northeast over long stretches of ocean. Deepwater trade wind waves typically have periods[6] of 5 to 8 seconds (s) and heights of 3 to 10 ft (1 to 3 m). The proposed project site is fully exposed to trade wind waves.

The north Pacific swell is produced by severe winter storms in the Aleutian area of the north Pacific and by mid-latitude, low-pressure atmospheric systems. North swells may arrive in Hawaiian waters throughout the year but are largest and most frequent during the winter months of October through March. These swells approach from the sector west through north, with periods of 13 s to 20 s and typical deepwater heights of 4.9 to 9.8 ft (1.5 to 3 m). The proposed project site is partially sheltered from the approach of the north Pacific swell and only the more northerly of these swells influence the area.

In addition to the two predominate wave types affecting Hawaiʻi's waters, tropical cyclones or hurricanes generate large waves that impact Hawaiʻi. Although infrequent, these waves present the worst-case conditions for most coastal areas. Analysis of the waves generated by two recent hurricanes that impacted Oʻahu (Hurricane ʻIniki in 1992 and Hurricane ʻIwa in 1982) indicates that the waves approached from the southeast through west directions. The project site was relatively sheltered from severe waves during these two hurricanes.

Less intense low-pressure systems (cyclones) of subtropical origin, which usually develop northwest of Hawaiʻi in winter and move slowly eastward, are Kona storms. They are accompanied by southerly winds, from which the storm derives its name (Kona means "leeward" in Hawaiian), and by the clouds and rain that have made Kona storms synonymous with bad weather in Hawaiʻi (Atlas of Hawaii 1983). The project site is sheltered from direct Kona storm waves.

Wave heights measured during a 10-month period between August 2000 and June 2001 were extrapolated to the approximate conditions in 100 ft (30.5 m) of water at the project site (see Appendix E). The largest significant wave height was calculated to be 13.8 ft (4.2 m), with no severe storms or hurricanes occurring during the study period.

Estimates of extreme wave conditions, resulting from extreme wind waves and hurricane waves, predict maximum wave heights at the project site (a 100-ft [30.5-m] water depth) of 15.7 ft (4.8 m) and 44.6 ft (13.6 m), respectively.

Further information about the oceanographic conditions pertinent to the proposed installation of the WET system is provided in Appendix E.

3.2.3 Marine Biological Resources

The physical characteristics and associated marine biological resources of the nearshore ocean bottom off North Beach can be described by several bands, or zones, which approximately parallel the shoreline and are defined by water depth. The marine biological resources in the

6 A wave period is defined as the duration between two up- or two down-crossings of the mean sea level, e.g., the duration between two successive troughs or two successive crests.

nearshore ocean zones are described herein. Figure 3-1 provides a cross-sectional depiction of these zones. The general area of these zones relative to the depth contours are depicted in Figure 3-2. Further information regarding marine biota is provided in Appendices F and H.

3.2.3.1 Sand-Boulder Zone

The ocean bottom just seaward of the beach, from a depth of zero to approximately 12 to 15 ft (3.7 to 4.6 m), consists of a bed of coarse-grain carbonate sand that is kept in a state of continual resuspension by wave energy (see Appendix H, Figure 3). Interspersed on the sand bed are boulders that are continually swept by resuspended sand. Some of the boulder riprap that was used to construct the revetment securing the end of the runway has separated from the structure and is submerged in the nearshore area. The sandy area immediately off the base runway may shift seasonally, with the limestone outcrops alternately being buried and exposed. This zone ranges from a width of 400 ft (122 m) at the east end of the beach to 700 ft (213 m) near Pyramid Rock. As a result of continuous resuspension of sand with passing waves, the substrate from the shoreline through the sand-boulder zone contains little marine vegetation or coral.

No fish or other marine vertebrates were observed residing in the sand-boulder zone during the underwater site assessment. Green sea turtles (*Chelonia mydas*) are known to inhabit the waters around the project area and feed on *limu* (seaweed) growing near the shore. False green sea turtle nests (unfinished nest cavities) have been discovered in this zone. A dead hawksbill turtle (*Eretmochelys imbricata*) was reported on shore near the proposed project area. Hawaiian monk seals (*Monachus schauinslandi*) are occasionally sighted in the water and on shore near the project area. Humpback whales (*Megaptera novaeangliae*) have been observed in waters as shallow as 15 ft (4.6 m) and throughout the project area from November through April. Tail slapping, breaching, and pods are routinely observed off MCBH Kaneohe Bay shores. As many as 15 individuals have been observed at one time. On occasion, humpback whales have been observed in less than 15 ft (4.6 m) of water along the MCBH Kaneohe Bay coastline (MCBH 2002).

3.2.3.2 Sand Channel Zone

Farther offshore from the sand-boulder zone, the ocean bottom consists of consolidated limestone bisected by small channels, which vary in width and eventually end in ridge formations. These spur and groove formations are generally oriented perpendicular to the bottom contours and the shoreline. Generally 3 to 4 ft (0.9 to 1.2 m) of relief is present between the bottom of the channels and the adjacent ridges. While the channel bottoms typically consist of flat and scoured limestone with a thin veneer of sand, some live coral is present on the ridges. The sand channel zone transitions from the sand-boulder zone at approximately 12 to 18 ft (3.6 to 5.5 m) and extends to a depth of 30 to 35 ft (9 to 11 m).

The constant state of resuspension in the sand channel zone restricts settlement of bottom dwelling organisms on both the sand and limestone surfaces. Macrobiota observed in this zone were scattered heads of the branching coral *Pocillopora meandrina*, which grow along the vertical sides of the reef channels (see Appendix H, Figure 4).

3.2.3.3 Reef Flat Zone

Offshore from the sand channel zone, the emergent reef platform becomes more solid as sand cover decreases. The spur and groove formations end around the 30- to 35-ft (9- to 11-m) water depth, and the bottom from that point to approximately the 50-ft (15-m) depth is a wide plateau of relatively solid, flat limestone. Some scattered areas of vertical relief exist, generally due to potholing, coral growth, or the presence of small limestone ridges and ledges. The bottom slope in this zone is approximately 1 to 70 (rise to run).

The surface of the limestone reef flat consists of a short algal turf that binds a thin layer of carbonate sediment. Macrobiota in this zone include sporadic heads of the coral *P. meandrina* and flat encrustations of the corals *Porites lobata*, *Montipora capitata*, *Montipora patula*, and *Montipora flabellate* (see Appendix H, Figures 5 and 6). The dominant algae on the platform are clumps of the genera *Porolithon.* Coral growth is greater along the edge of the ledges than the flat areas, and fish are more likely to frequent the areas of coral growth. Colonies of the coral *Pocillopora eydouxi* up to 2 ft (0.6 m) in height occur infrequently in this zone; schools of alo‘ilo‘i or damselfish (*Dascyllus albisella)* reside within the coral. Damselfish are endemic to the Hawaiian Islands.

3.2.3.4 Escarpment Zone

The escarpment zone can be defined from of the 50-ft (15-m) contour to approximately the 90- to 95-ft (27- to 29-m) depth contour. At a depth of 50 to 65 ft (15 to 20 m), the angle of the bottom increases 25 to 30 degrees. While there are bottom slopes (rise to run) as steep as 1 to 7, no prominent vertical ledges or wave-cut notches are present in the project area. The bottom is relatively flat limestone with widely scattered areas of vertical relief.

In many areas around O‘ahu, wave-cut notches at the 60-ft (18-m) depth, created during a lower stand of sea level, serve as preferred habitat for fish and turtles. These areas are considered HAPC. However, as described above, the project site seafloor at this depth (escarpment zone) does not have the characteristics of a wave-cut notch. Hence, the escarpment zone is not considered an HAPC.

The primary macrobiota on the escarpment is the flat encrusting coral *M. capitata*. In some localized areas, this species covers up to 50 percent of the substrate (see Appendix I, Figures 7 and 8). The following fish were observed in the escarpment zone during the underwater site assessments: ta‘ape or blue-lined snapper (*Lutjanus kasmira*), ala‘ihi or crown squirrelfish (*Sargocentron diadema),* yellowstripe squirrelfish (*Sargocentron ensiferum*), ‘u‘u or bigscale soldierfish (*Myripristis berndti*), kumu or whitesaddle goatfish (*Parapeneus porphyreus*), lauwiliwili or milletseed butterflyfish (*Chaetodon miliaris*), kikakapu or multiband or pebbled butterflyfish (*Chaetodon multicinctus*), lau‘i pala or yellow tang (*Zebrasoma flavescens*), papio or ‘omilu or bluefin trevally (*Caranx melampygus*), and damselfish. Of these species, the milletseed butterflyfish, multiband butterflyfish, and damselfish are known to be endemic to the Hawaiian Islands.

3.2.3.5 Deep Reef Platform Zone

From the bottom of the escarpment zone, the bottom slopes gradually to a depth of approximately 100 ft (30.5 m) where it becomes almost featureless (Appendix H, Figure 9). There is a thin veneer of sand 1 to 2 in (25.4 to 50.8 mm) thick bound to the pitted, flat limestone surface by a thin veneer of algal turf in some areas. The bottom topography remains relatively constant and barren through the depth range of the zone.

The predominant macrobiota are scattered heads of the coral *P. meandrina* and flat encrustations of the coral *M. capitata*. Macrobiotic composition varies from relatively high coral cover above the 95-ft (29-m) depth contour to relatively little cover below this boundary. Other species known to transit the area at this depth include humpback whales, green sea turtles, and Hawaiian monk seals. Fish and turtle species tend to aggregate in areas of higher relief than that found in the proposed project area.

3.2.3.6 Undercut Ledges

At several locations at the eastern end of the deep reef platform, a system of small undercut ledges runs parallel to the depth contours (Figure 3-2). A ledge with an approximate length of 25 ft (7.6 m) exists at the 93-ft (28.3-m) depth and a 150-ft (45.7-m) long ledge system exists around the 100-ft (30.5-m) depth contour.

Increased populations of fish and coral occur around the ledges (Appendix H, Figure 10). Species of reef fish observed during the underwater site assessments included blue-lined snapper, squirrelfish, goatfish, milletseed butterflyfish, multiband butterflyfish, and yellow tang. The predominant coral was the encrusting form of *M. capitata*, which covered large areas of the upper lips of the undercut ledges.

Undercut ledges can be designated as HAPC; however, based on the relatively small size of these ledges, they would not fall under this classification (Appendix H). While several species of sea urchins are present along these undercut ledges, other invertebrates have not been identified in the area.

3.2.3.7 Threatened or Endangered Species

Species listed under the ESA as threatened or endangered, and listed as threatened or endangered by the State, include the threatened green sea turtle, endangered hawksbill turtle, endangered humpback whale, and endangered Hawaiian monk seal.

The green sea turtle occurs commonly throughout the Hawaiian Islands. While no turtles were observed during the underwater site assessments, existence of the green sea turtle and hawksbill turtle in the waters and nearshore areas around the project area has been documented (MCBH 2002; MCBH 2001). Preferred forage species of algae were not found in the proposed project area, and the physical structures of the reef surface in the project area are not considered preferred resting habitat for turtles.

Endangered humpback whales transit the project area seasonally. Humpback whale activity in the project area is described in Section 3.2.3.1.

Endangered Hawaiian monk seals have infrequently been observed near the project area. An average of three sightings a year occur on the shoreline and in nearshore waters. No monk seals were observed during the underwater site assessments for this proposed project.

3.2.3.8 Commercial, Subsistence, and Recreational Species

Fish such as ono or wahoo (*Acanthocybium solandri*), aku or skipjack tuna (*Katsuwonus pelamis*), and moano ukali-ulua or goat fish (*Parupeneus cyclostomus*) typically occur along the 100-ft (30.5-m) depth contour in the project area. For this reason, commercial, limited subsistence, and recreational fishing is conducted near the project area at this depth. The bottom conditions at the proposed project site do not offer unique habitat for species occurring in the area, and the site is not considered highly productive for spear fishing or uniquely attractive for SCUBA diving (Appendix I).

3.2.3.9 Marine Mammals

The MMPA protects any ocean dwelling mammal that primarily inhabits the marine environment. Within the proposed project area, Kaneohe Bay, mammals possibly present in the area and protected under the MMPA include the endangered Hawaiian monk seal, the endangered humpback whale, and various species of dolphin, as identified in Table 7-1 of Appendix F.

3.2.4 Terrestrial Biological Resources

3.2.4.1 Flora

Native seastrand vegetation and non-native koa haole (*Leucaena leucocephala*) shrub land are dominant plant communities along the proposed onshore cable route. Native sea strand vegetation occupies the undeveloped shorelines of North Beach and the cable landing site shoreward of the sandy beach. Native coastal plants such as naupaka (*Scaevola sericea*), pa‘uohi‘iaka (*Jacquemontia ovalifolia*), ‘ilima (*Sida fallax*), hinahina (*Heliotropium anomalum var. argenteum*), and non-native species such as silky jackbean (*Canavalia sericea*) exist at the cable landing site. The primary vegetation along the length of the proposed route comprises koa haole shrub land (Figure 3-3) (MCBH June 1999 and 2001), which includes introduced grasses, koa haole, Christmas berry (*Schinus terebinthifolius*), sourbush (*Pluchea indica*), and Chinese violet (*Asystasia gangetica*).

3.2.4.2 Fauna

Waterbirds, migratory shorebirds, and seabirds frequent the shoreline of North Beach. ‘Ua‘u kani or wedge-tailed shearwater (*Puffinus pacificus chlororhynchus*) frequent the project area and seasonally use the area for nesting burrows (MCBH 2002). Wedge-tailed shearwaters have been observed in the general vicinity of the cable route.

While wetlands and Wildlife Management Areas on the peninsula provide breeding habitat for waterbirds, no such habitat exists within the narrow corridor of the land cable route. Species of migratory birds observed along the project area shoreline include ‘iwa or great frigate (*Fregata minor palmerstoni*), ‘auku‘u or black-crowned night heron (*Nycticorax nycticorax hoactli*), and kolea or Pacific golden plover (*Pluvialis fulva*).

Terrestrial mammals known to transit the project site include feral cats, dogs, mongoose, and rats.

3.2.4.3 Threatened or Endangered Species

Natural occurrences of plants currently listed or pending listing as threatened or endangered under the ESA or State law have not been observed on the proposed route for the land cable.

Several wetlands at MCBH Kaneohe Bay provide habitat for threatened and endangered waterbirds, including the ae‘o or Hawaiian stilt (*Himanoptus mexicanus knudseni*), ‘alae ‘ula or common moorhen (*Gallinule chloropus sandvicensis*), ‘alae ke‘oke‘o or Hawaiian coot (*Fulica alai*), and koloa or Hawaiian duck (*Anas wyvilliana*). However, no threatened or endangered waterbirds have been identified in the proposed project area.

3.2.5 Land and Marine Resource Use Compatibility

The MCBH Kaneohe Bay property surrounding the proposed project area is varied in use and development. Along the shore, land use is designated as recreational with areas of open space and constrained open space along the onshore cable route. Existing uses include a golf course to the southeast of the project site, Officers’ Family Housing atop the hillside directly south of the project area, and an aircraft runway to the south/southwest.

The offshore part of the proposed project area is located within the NDSA established by Executive Order 8681. MCBH Kaneohe Bay restricts access and use from shore to about 500 yards (457 m), an area designated as a Security Buffer Zone (hereinafter referred to as the 500-yd buffer zone). This zone is off-limits to public access (MCBH 1999). Active duty military personnel, MCBH civilian employees, retired members of the U.S. armed forces, reservists, families and sponsored guests are authorized to use North Beach, Pyramid Rock Beach, and the waters off the beach with the exception of a 300-ft (91-m) area on each side of the main runway. Other individuals or organizations must seek authorization from the Commanding General prior to accessing the area. Recreation along the shore and within the restricted access area is regulated by *MCBH Kaneohe Bay Base Regulations*, Chapter 11 Recreational Activities (MCBH 1999).

The area outside the 500-yd (457-m) buffer zone is subject to access limitation, but at the present time public access is unrestricted. Fishers, boaters, and divers currently use the area at which the buoy array is proposed.

The area outside the 500-yd (457-m) buffer zone is considered unrestricted waters open to public access. The proposed WEC buoy array site is currently used by fishermen, boaters, and divers.

3.2.6 Cultural Resources

Cultural resources the Proposed Action project area include one archaeological site, the Mokapu Burial Area, and one historic structure, Battery French. Much of the information provided below and additional information on these resources can be found in the Cultural Resource Management Plan for Marine Corps Base Hawaii, Kaneohe Bay (Schilz 1996).

Archaeological. The Mokapu Burial Area (Site 50-80-11-1017) is an extensive subsurface archaeological site containing ancient burials and funerary items. The site is listed in the NRHP and is recognized as being of religious and cultural significance to Native Hawaiians. The site is significant for its association with traditional Hawaiian burial practices, which occurred at this site over several hundred years and involved the interment of over 500 individuals. The site is also significant for the information it has yielded and is likely to yield that is important to understanding the prehistory of Mokapu and Hawaiʻi in general. The Mokapu Burial Area is situated on North Beach in a coastal dune setting that extends from Pyramid Rock in the west to Ulupaʻu Head Crater in the east (Figure 3-4).

Projects involving excavation, archaeological testing, and archival research have identified certain clusters or loci within the NRHP boundary where native Hawaiian human remains were buried over a period of several hundred years (Tuggle 1999; Prishmont 2000, Figure 13). In addition, ground-penetrating radar technologies have identified areas within and beyond the NRHP boundary that are likely to contain archaeological deposits (Williams and Patolo 1998). Based on these studies, a revised site boundary has been proposed (Williams and Patolo 1998; Prishmont 2000).

The Proposed Action is partially located within the boundary of the Mokapu Burial Area site, although outside the identified burial clusters and outside the proposed revised site boundary. A portion of the project area crosses the west end of an area with low to moderate potential for human burials (Prishmont 2000, Figure 13). Dunes in this area that have potential for human burials are deep and covered by fill. The fill in this area is about 2 ft (0.6 m) deep and composed of sand mixed with basalt gravel, pebbles, cobbles, and boulders. The material has become cemented, creating a firm ground surface, rocky near the shore, with an overlying thin layer (3/4 to 2-1/3 in or 19.1 to 58.4 mm) of loose sand. The fill is thought to be associated with construction of the runway and revetment.

Historical. Battery 301 Forrest J. French (Site 50-80-11-1432) is a concrete structure built during World War II. The structure is partly covered by earth and has two turrets for 6-in guns. This structure is eligible for listing in the NRHP. It is significant for its indirect association to the December 7, 1941 attack and possibly as a distinct type of architecture (Schilz 1996). The interior was modified during the late 1960s and early 1970s to provide offices for the Naval Ocean Systems Center Laboratory. Battery French is currently not used, and the modified interior has deteriorated. The basic structure and two gun turret foundations remain intact (Tuggle and Hommon 1986).

3.2.7 Infrastructure

The existing Battery French would be used to house the onshore electrical power and control equipment (see Section 2.5.1.1). The Battery has been tested for lead based paint and asbestos. A negative determination was provided for lead paint. Asbestos was detected only in the floor tiles and not in areas where project use is anticipated.

MCBH Kaneohe Bay purchases commercial power from the Hawaiian Electric Company (HECO). The Mokapu Substation is located near the main gate and contains two 10/12 megavolt-amperes (MVA) OA/FA[7] (Delta-Wye) transformers, which step down a sub transmission voltage 46 kilovolts (kV) to the on-base primary distribution voltage of 11.5 kV.

MCBH Kaneohe Bay's primary electrical distribution system is operated as a radial power system. Each 10/12 MVA transformer supplies power to a single bus in each switching station located on base. There are four switching stations referred to as the Main Substation and Substation Nos. 1, 2, and 3.

The Main Substation, located next to the Mokapu Substation, contains three switchgear busses referred to as A, B, and C. Only A and B busses are being utilized; C bus is provided for future expansion in the event a third 10/12 MVA (HECO) transformer is required. All three busses can be connected in parallel via tiebreakers. HECO's transformers and the Main Substation's busses are normally not operated in parallel. From the Main Substation, power is distributed radially to three downstream switching stations via dedicated circuits, referred to as tie circuits. There are two tie circuits between the Main Substation and each downstream substation. Also, there are tie circuits between the substations that are normally opened.

Current billing shows that the peak load demand is 17,971 kW or 18,917 kilovolt-amperes (kVA) at 95 percent power factor on the Mokapu Substation. Analyzing the future worst-case scenario, where all the planned Military Construction (MILCON) and Non-Appropriated Fund (NAF) projects are constructed by FY2009, another 4,634 kVA is added to the existing peak load to estimate a future peak load demand of 23,551 kVA.

3.2.8 Recreation

Interviews with resident and military recreational users of the project area were used to characterize existing recreation. The survey area comprises the shore of MCBH Kaneohe Bay including North Beach, the seaward edge of the MCBH Kaneohe Bay main runway, Pyramid Rock Beach, and the waters approximately 1 mi (1.6 km) off this shore. Further details of recreational activities near MCBH Kaneohe Bay are provided in Appendix I.

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[7] OA/FA. Oil-cooled ambient/forced air (10 megavolt [MV] rating at OA, 12 MVA at FA)

Recreational activities in the vicinity of the project area include beachcombing, boating, bodysurfing, bottom fishing, jet skiing, kayaking, outrigger canoe paddling, sailing, trolling, surfing, swimming, sunbathing, pole fishing, thrownet fishing, spear fishing, and SCUBA diving (Figure 3-4). Commercial fishing within the restricted access area (500-yd [457-m] buffer zone) is prohibited unless approved by the Commanding General, MCBH Kaneohe Bay. Active duty military personnel and MCBH civilian employees may boat within the restricted area without written approval from the Commanding General, but all boats are subject to inspection.

The waters near the project area are also the primary transit corridor for boats traveling between Kane‘ohe Bay and Kailua Bay (two of the largest ocean recreation sites on windward O‘ahu). The area is also used by boats traveling to Kane‘ohe Bay from other parts of O‘ahu (Figure 3-4).

Trolling and bottom fishing are popular in the project area outside the restricted access area. The area around the 100-ft (30.5-m) depth contour is known as “Ono Run” for the ono, or wahoo, that are attracted to the ledge. Fishing also occurs for skipjack tuna, uku or gray snapper (*Aprion virescens*), goat fish, and other species.

The channel between Mokumanu (an island off Ulupa‘u Head Crater) and Mokapu Peninsula is known as “The Slot.” It is a preferred route by boats transiting between the bays through the Sampan Channel. SCUBA diving boats frequently transit through the project area from Kane‘ohe Bay to dive locations in the waters off Mokumanu (Figure 3-4).

3.2.9 Public Safety

The following discussion on public safety is summarized from the public safety and recreational uses report provided in Appendix I. This report discusses interviews with emergency service providers and ocean users. The survey area comprises the area described for recreational activities.

Public safety considerations along the shore and within the nearshore portions of the project area are covered by *MCBH Kaneohe Bay Base Regulations*, Chapter 11 Recreational Activities (MCBH 1999). Lifeguards, security personnel from Waterfront Operations, and other security personnel from MCBH Kaneohe Bay enforce security in the restricted areas. Weather permitting, MCBH Kaneohe Bay lifeguards are on duty at North Beach and Pyramid Rock beach from 11:00 a.m. to 5:30 p.m. each day. Lifeguards have the authority to enforce laws and regulations pertaining to beach safety and patronage by authorized persons.

Public safety concerns are primarily related to poor signage identifying restricted areas and occasional high surf conditions. At present, this situation contributes to beachcombers, fishers, and surfers periodically entering the zone. During periods of high surf, powerful longshore currents, especially at Pyramid Rock Beach, occasionally sweep swimmers and surfers into the 300-ft (91-m) zone and off the rock revetment lining the main runway before lifeguards can reach them. High surf occurs during winter months when large north Pacific swells generate high surf conditions. High surf is also generated by less frequent large swells from the east or northeast.

Jurisdiction over marine safety issues in the offshore areas of the project area is shared between the Honolulu Fire Department (HFD) and the USCG. Generally, HFD responds to incidents within 3 mi (4.8 km) offshore, and USCG is responsible for emergencies beyond 3 mi (4.8 km) miles. However, the two agencies coordinate responses to public safety incidents. MCBH Kaneohe Bay lifeguards or Waterfront Operations personnel respond, if advised by HFD or USCG of a marine emergency.

3.2.10 Visual Resources

The Mokapu Peninsula is a very scenic and photogenic landscape, and the views from North Beach are quite remarkable. To the northeast, lies the Ulupa‘u Head Crater (Figure 2-10). To the north is a view of unobstructed ocean (Figure 3-3). From the Officers’ Family Housing area there is an impressive view of North Beach and Pyramid Rock (Figure 3-5).

3.3 DESCRIPTION OF RELEVANT AFFECTED RESOURCES – ALTERNATIVE B: PEARL HARBOR

Information in the sections below is based on the following reports: *Final Environmental Impact Statement, Outfall Replacement for Wastewater Treatment Plant at Fort Kamehameha, Navy Public Works Center, Pearl Harbor, Hawaii* (Navy March 2001); *Pearl Harbor Naval Complex Integrated Natural Resource Management Plan* (Navy October 2001); and “Marine Natural Resources Insert for the WET EA” (Navy 2002a) (Appendix D).

3.3.1 Shoreline Physiography

General site information for the WEC system at the Pearl Harbor location is shown in Figure 2-11. As shown in Figure 2-1, NAVMAG Pearl Harbor, West Loch Branch, fronts the Pearl Harbor entrance channel at the cable landing site for this alternative. The terrain is generally flat, ranging in ground elevation from 10 to 30 ft (3 to 9 m) above sea level, with a few sharp changes in grade occurring in abandoned quarry pits and local sinkholes. Much of the surface consists of broken to intact limestone.

Behind Building 562, the transition from groomed lawn to shoreline is delineated by a concrete berm. From the berm to the high tide line, the shoreline consists of a 10-ft (3-m) band of riprap covered with primarily non-native coastal vegetation. The proposed point of entry for the cable is adjacent to a dirt parking area and a concrete slab at the southern edge of the lawn.

3.3.2 Oceanographic Conditions

The open coastal waters in the vicinity of Pearl Harbor are subject to three types of large waves: southern swells, Kona storm waves, and hurricane-generated waves. However, Pearl Harbor is protected from ocean waves and swells because wave propagation through the 15,000-ft (4,570-m) long entrance channel is fully attenuated.

Southern swells generally occur in summer and early autumn and are generated by Antarctic winter storms. Wave heights are typically between 1 and 4 ft (.3 and 1.2 m), with periods of 14 s to 22 s (Atlas of Hawaii 1983). A description of Kona storm and hurricane-generated waves is provided in Section 2.2. At the proposed buoy location, wave heights are approximately 3 ft (1.5 m) for the majority of the year; however, heights of approximately 7 ft (2 m) do occur and are most frequent during the summer months (Navy 2002b).

3.3.3 Marine Biological Resources

The major components or zones of the Pearl Harbor entrance channel used to characterize marine biological resources are the channel bottom, channel slope, channel wall, fossilized reef platform, and sand-rubble zone, although components of the channel wall and fossilized reef platform are not present along the entire entrance channel. The proposed undersea cable route would be along the junction of the channel bottom and slope. The proposed location of the buoy array would be outside the entrance channel in the sand-rubble zone.

Marine biological resources in the Pearl Harbor entrance channel zones are described herein. Further information regarding marine biological resources is summarized in Appendix D.

3.3.3.1 Channel Bottom

The channel bottom is generally flat. From the mouth of the entrance channel seaward to approximately the #1 Channel Marker Buoy, depths increase gradually from about 45 ft (14 m) to 60 ft (18 m) (Figure 2-11). Southwest of the #1 Channel Marker Buoy, depths increase from about 60 ft (18 m) to 115 ft (35 m) over a distance of approximately 330 ft (100 m). The seafloor is comprised of calcareous sand and rubble, even along the steep slope. Moving farther offshore, the seafloor becomes coarser with increasing amounts of rubble. No cliffs or ledges are present in the areas proposed for the cable route and buoy array.

Naturally occurring sedimentation influences the composition of the Pearl Harbor benthic community. Reef building corals occur on the channel bottom; however, they are extremely sparse and cover only 0.13 percent (less than 1/7th of one percent) of the seabed (Appendix D). Ongoing studies being performed as part of the DoD Coral Reef Protection Implementation Plan appear to show that similar, very sparse coral development and algal growth are present on the west side of the channel bottom.

The total number of fish and diversity of species is low along the channel bottom. Sea grass is the most prominent channel bottom feature, primarily *Halophilia decipiens.* Predominant invertebrates include the sea cucumber (*Ophiodesoma spectabilis*), sabellid or feather duster worms, serpulid worm tubes, and various benthic crabs and shrimp. Along the channel bottom, crab and shrimp burrows are present. Spotted eagle rays and schools of yellowfin goatfish (*Mulloidichthys vanicolensis*) have been observed feeding on the seafloor.

3.3.3.2 Channel Slope

The slope of the entrance channel varies throughout the length of the channel. Dead coral rubble and coarse calcareous sand dominate the slope. At the innermost portions of the channel's west slope, dead coral rubble and sand are overlain by substantial amounts of terrigenous material, such as leaf litter and mangrove propagules. Live coral cover in this area is extremely sparse. Sea urchins appear to be the dominant benthic invertebrate on most sections of the slope. The diversity of fish species is greater along the channel slope than on the bottom.

3.3.3.3 Channel Wall

The top of the channel wall begins at a depth of 6 ft (2 m) and runs to a depth of 20 ft (6 m). The wall occurs intermittently along the length of the entrance channel. The junction of the base of the wall and slope is generally less than 43 ft (13 m) in depth.

The wall is better developed on the west side of the channel than on the east, with many parts containing grottos and deep undercuts near its base. In some cases, these indentations extend back for over 6 ft (2 m). Large formations (up to 16 by 13 by 13 ft [5 by 4 by 4 m]) have broken off in some areas and settled less than 6 ft (2 m) from the wall, creating narrow passageways between the wall and the pieces of debris. Green sea turtles have been observed resting in recessions in the wall structure. Whitetip reef sharks (*Triaenodon obesus*) and reef blacktip sharks (*Carcharhinus melanopterus*) have also been observed in these grottos and undercuts along the channel wall.

Coral cover on the western channel wall increases dramatically in a seaward progression from the entrance channel. *M. patula* is the dominant coral growing in this zone (Navy 2002a). Additional coral species present include *P. lobata, Porites compressa, P. meandrina, Pavona varians, Montipora verrucosa, Montipora verrilli, Psammocora stellata, Fungia scutaria,* and *Leptastrea purpurea* (Navy March 2001, Appendix VII). The wall also provides substrate for a variety of sponges, alcyonarians, polychaete and sipunculid worms, and bivalve mollusks. The abundance and diversity of the flora and fauna increase in a seaward direction. The major families of Hawaiian reef fishes are represented in this zone.

3.3.3.4 Fossilized Reef Platform

The fossilized reef platform extends farther offshore on the west side of the entrance channel than on the east side. On the west side, the depth of the platform ranges from 6 to 20 ft (2 to 6 m), with modest spur and groove development on top of the platform at depths below 13 ft (5 m). On the east side, parts of the reef are exposed above the water at low tide, and introduced algae are dominant. Live coral cover is modest on most portions of the reef, although small areas on the west side support dense coral development. The dominant species are *P. meandrina, Montipora spp.* and *P. lobata*. Sessile and benthic invertebrate species are well represented. The major families of Hawaiian reef fishes are also represented in this zone; however, fish were not abundant in the area during previous surveys.

3.3.3.5 Sand-Rubble Zone

At depths below approximately 82 ft (25 m), the seafloor outside the entrance channel consists of loose sand deposits 10- to 30-ft (3- to 9-m) thick with occasional rubble outcrops. This sand-rubble zone is relatively devoid of living coral and algae. Fish observed in the sand-rubble zone include goatfish (*Mullidae*), wrasses (*Laborides phthirophagus, Pseudocheilinus octotaenia, Pseudojuloides cerasinus*), damselfish, and mackerel scad (*Decapterus macarellus*). Outer portions of this zone experience periodic scouring from the forces of storm waves acting on loose bottom rubble, with subsequent impacts on sessile organisms. The area considered for placement of the buoy array is within the sand-rubble zone and comprised almost entirely of coarse sand.

3.3.3.6 Threatened or Endangered Species

Species at the Pearl Harbor site listed as threatened or endangered under the ESA and State law include the threatened green sea turtle and endangered Hawaiian monk seal. Green sea turtles have been observed along the channel wall and fossilized reef platform. The Hawaiian monk seal has been recorded at Iroquois Point, located at the Pearl Harbor entrance channel. No observances of endangered hawksbill turtles have been reported.

An adult humpback whale and a calf were reported to have entered Pearl Harbor on March 21, 1998. However, this was a single and unusual event.

No HAPC are designated in the vicinity of the Pearl Harbor alternative location. Areas of rich biological diversity exist along the proposed cable route but these are localized and easily avoidable.

3.3.3.7 Commercial and Recreational Species

The native anchovy or nehu *(Encrasicholina purpurea)* is primary bait used in commercial aku fishing. The Navy issues permits for insured commercial aku boats to collect the nehu from certain regions of the harbor. Because the demand for nehu has decreased in recent years due to changes in the fishing industry, few fishermen or vessels use live bait for the capture of aku, and bait fishing in Pearl Harbor occurs on a reduced scale. The population status of nehu in Pearl Harbor is not known.

3.3.3.8 Marine Mammals

The MMPA protects any ocean dwelling mammal that primarily inhabits the marine environment. Within the proposed project area, Pearl Harbor entrance channel, mammals possibly present in the area and protected under the MMPA include the endangered Hawaiian monk seal, the endangered humpback whale, and various species of dolphin, as identified in Table 7-1 of Appendix F.

3.3.4 Terrestrial Biological Resources

3.3.4.1 Flora

The majority of terrestrial plant species that have been surveyed at the Pearl Harbor site are introduced or alien species. Several introduced plants have become common at Pearl Harbor, primarily low-growing species such as California grass (*Brachiaria mutica*) and pickleweed (*Batis maritima*). Original low-growing native vegetation, primarily sedges, herbs, and small shrubs, has been replaced by dense, woody stands of mangrove in the less developed areas of the estuary.

Native plant species observed along the shoreline at the Pearl Harbor site are milo (*Thespesia populnea*) and sea purslane (*Sesuvium portulascastrum*). Non-native vegetation includes sourbush (*Pluchea indica*), kiawe (*Prosopis pallida*), and mangrove (*Rhizophora mangle*).

3.3.4.2 Fauna

Two observed species of birds resident at the Pearl Harbor site are native, Pacific golden plover or kolea and the short-eared owl or pueo (*Asio flammeus sandwichensis*). Other observed resident species were introduced to the islands within the last century, including the red-vented bulbul (*Pycnonotus cafer*), chestnut mannikin (*Lonchura malacca*), spotted dove (*Streptopelia chinensis*), zebra dove (*Geopelia striata*), and Japanese white-eye (*Zosterops japonicus*).

The black-crowned night heron or ‘auku‘u is the only indigenous waterbird occurring at the Pearl Harbor West Loch area. Extensive mangrove and kiawe stands on the shorelines of West Loch provide potential nesting habitat for herons (Navy 1993). Migratory waterbirds and waterfowl considered indigenous to Hawai‘i and associated with the Pearl Harbor Honouliuli Refuge include the green-winged (American) teal (*Anas crecca*), northern pintail (*Anas acuta*), northern shoveler (*Anas clypeata*), and lesser scaup (*Aythya affinis*).

Migratory shorebirds that seasonally occur in the area are the Pacific golden plover, sanderling (*Calidris alba*), ruddy turnstone (*Arenaria interpres*), and wandering tattler (*Heteroscelus incanus*). At least 30 additional species of straggler and vagrant shorebirds may occasionally occur in the area. The majority of birds found in developed areas, grasslands, and disturbed secondary forests are exotic or introduced (non-native) species. Among the most common species are the common myna (*Acridotheres tristis*), red-vented bulbul, Japanese white-eye, house finch (*Carpodacus mexicanus*), zebra dove, and cattle egret (*Bubulcus ibis*).

Species of mammals that exist at the Pearl Harbor site include the mongoose, rat, house mouse, and feral dogs and cats.

3.3.4.3 Threatened or Endangered Species

No Federally listed threatened or endangered flora have been reported in the area of Building 562, where the land cable route is proposed. Four Federally listed endangered waterbirds, the

Hawaiian stilt (ae‘o), common moorhen (‘alae ‘ula), Hawaiian coot (‘alae ke‘o ke‘o), and the Hawaiian duck (koloa), are observed regularly at the Honouliuli Unit of the Pearl Harbor Wildlife Refuge, located on the northwest tip of West Loch Branch. No critical habitat has been designated for these species.

Two additional bird species listed as threatened or endangered by the State but not the Federal government are occasionally found in the Pearl Harbor vicinity: the threatened white tern (*Gygis alba rothschildi*) or manu-o-Ku, and the endangered short-eared owl or pueo.

3.3.5 Land and Marine Resource Use Compatibility

The State classifies land at the Pearl Harbor site in the Agricultural and Urban Districts. Surrounding land use districts are Agriculture, Urban, and Conservation. The offshore area of the project site is restricted and off-limits to the public.

3.3.6 Cultural Resources

The Pearl Harbor site is situated within the Pearl Harbor National Historic Landmark boundary. The land segment of the project is in an area designated in the Pearl Harbor Naval Complex Integrated Cultural Resources Management Plan (ICRMP) as having no or low potential for archaeological deposits (Commander Navy Region Hawaii 2001, Figure 2).

Building 562, proposed as the shore-based equipment shelter, was constructed in 1980 and is, therefore, not considered to be a historic facility.

3.3.7 Infrastructure

The equipment shelter would be located in Building 562 on the west shore of the entrance channel (Figure 2-11). Electrical power is provided by the HECO Iroquois Point Substation, located at the entrance to the Iroquois Point Housing along Iroquois Drive. The electrical distribution system is at its capacity. The 10-MVA Iroquois Point Substation steps the 46-kV transmission voltage to 11.5-kV distribution voltage. The capacity of the main feeders is not documented. The recloser breakers at the substation are rated at 560 amperes (A). It is standard practice to set breakers to a rating equal or less than the capacity of the feeder line for the breakers to be effective; thus, it is likely that the feeders also have the same 10 MVA capacity of the substation. Voltage is further stepped down by individual transformers in the Iroquois Point distribution system to provide 277/480 and 120/208 voltage AC for user consumption. Power is distributed via overhead lines on power/telephone poles.

3.3.8 Recreation

Recreational use of the land portion of the Pearl Harbor site is limited to casual bird watching and nature study. Ocean activities at this alternative site include netting, fishing, trapping, tropical fish collecting, surfing, scuba diving, paddling, kayaking, and shelling. In 1999, shoreline fishing at NAVMAG Pearl Harbor, West Loch Branch was banned and the permit system then in place was halted indefinitely. However, persistent subsistence fishing exists for several species of finfish and shellfish.

The Pearl Harbor entrance channel and the waters within the harbor are restricted to vessels owned and operated by military or DoD personnel under EO 8143, which prohibits civilian watercraft within Pearl Harbor unless authorized by the Navy. Authorized tour boats and military recreational boating are allowed in Pearl Harbor. The Pearl Harbor site is adjacent to the Iroquois Point Marina, which is for the exclusive use of Navy families residing at Iroquois Point housing.

3.3.9 Public Safety

Although a nearby refuge is periodically used for bird watching by Federal and State wildlife officials, as well as by members of the Hawaii Audubon Society, additional public access is discouraged for security and safety reasons. Shoreline fishing was banned at Pearl Harbor West Loch after the State Department of Health (DOH) issued: (1) an advisory warning against the consumption of fish and shellfish obtained from the Pearl Harbor Estuary, and (2) posted warning signs along the entire estuary shoreline alerting fishers of the advisory. Areas of Pearl Harbor have public use restrictions because of naval navigational concerns, explosive hazards, or security requirements.

3.3.10 Visual Resources

The Pearl Harbor site offers partial views of the Pearl Harbor Complex, Pearl City, ‘Aiea, Halawa Heights, and the Honolulu skyline. The view outside the entrance channel to the south is open ocean. To the east are views of Hickam Air Force Base (AFB) and Honolulu International Airport, with the skyline of Honolulu in the distance. Northern views include the Pearl Harbor Complex, urban areas of ‘Aiea, Halawa Heights, and Pearl City, with the Ko‘olau Mountains in the distance. To the west the views include the ‘Ewa Plain and the Wai‘anae Mountains in the distance.

3.4 DESCRIPTION OF RELEVANT AFFECTED RESOURCES – ALTERNATIVE C: NO ACTION

As the test would not be conducted in Hawai‘i, there would be no affected resources with this alternative.

3.5 DESCRIPTION OF RELEVANT NON-AFFECTED RESOURCES – ALTERNATIVE A: PROPOSED ACTION

3.5.1 Climate and Air Quality

The climate of Hawai‘i is influenced by its subtropical location, topography, and the surrounding Pacific Ocean. On O‘ahu, precipitation is primarily associated with the prevailing moisture-laden northeasterly trade winds that are intercepted and forced upwards at the Ko‘olau Range. Average annual rainfall at MCBH Kaneohe Bay is 40 in (1,016 mm), and the period of highest rainfall occurs between the months of October and April. Monthly average rainfall varies from 0.1 to 3.9 in (2.5 to 99.1 mm). Winds are predominantly northeast trade winds. During significant meteorological events such as tropical storms, winds of 25 knots (23.5 kilometers per hour [km/h]) or greater may occur (MCBH 2001).

Average temperatures on O‘ahu range from 72 degrees Fahrenheit (° F) (22 degrees Celsius [° C]) in January to 78.5°F (26° C) in August. Relative humidity ranges from a mean of 71.8 percent in December to a mean of 78.8 percent in March (MCBH 2001).

The U.S. Environmental Protection Agency (EPA) characterizes air quality by comparing concentrations of criteria pollutants to established National Ambient Air Quality Standards (NAAQS). The DOH has established ambient air quality standards similar to the NAAQS. Criteria pollutants at the national level include carbon monoxide, nitrogen dioxide, sulfur dioxide, particulate matter less than 10 microns in aerodynamic diameter, ozone, and lead. Based on ambient air monitoring data, EPA has classified the state as being in attainment of the Federal standards. In addition, pollutant concentrations within the state comply with State standards, which are more stringent than NAAQS.

Section 176(c) Conformity. This section of the Federal Clean Air Act (CAA) prohibits any Federal agency from engaging in, supporting, providing financial assistance for, licensing, permitting or approving any activity which does not conform to an applicable Federal Implementation Plan (FIP) or State Implementation Plan (SIP). Section 176(c) does not apply to the action being proposed in this EA because Section 176(c) does not apply to NAAQS attainment areas.

3.5.2 Currents and Tides

Tides in Hawai‘i are semi-diurnal with pronounced diurnal inequalities: two tidal cycles per day with unequal water level ranges. The mean tide range for Kane‘ohe Bay is 1.4 ft (0.43 m) with a diurnal range of 2.2 ft (0.67 m).

The semi-diurnal tide, the underlying large-scale oceanic current, and wind on the upper ocean layers all influence the currents around Hawai‘i; the tide is the dominant influence in most areas. The underlying oceanic flow approaches O‘ahu from the northeast and diverges between Mokapu Peninsula and Makapu‘u. Tidal currents parallel the ocean bottom contours and reverse with the stage of the tide. The reversing tidal currents are superimposed on the oceanic flow, with flood tide currents generally moving to the east and ebb tide currents to the west. The resultant net transport of water is to the northwest. Currents associated with the semi-diurnal tide are approximately 0.5 to 1.0 knot (0.9 to 1.8 km/h), with the maximum predicted flood tide current speed of 1.2 knots (2.2 km/h) and maximum ebb tide current speed of 1.0 knot (1.9 km/h). Wind typically influences the upper 15 ft (4.6 m) of the water column during trade wind conditions.

3.5.3 Tsunamis

Since 1819, 22 severe tsunamis have occurred in the Hawaiian Islands, with runup (maximum wave height on shore) elevations ranging from 4 to 60 ft (1.2 to 18.3 m). Tsunami runup in Hawai‘i during a given occurrence varies greatly with location. The elevation reached by the waves is affected by a number of factors including offshore bathymetry, coastal configuration and exposure to the generating area. The predicted 10-year wave height for the project area is 2.5 ft (0.76 m) above mean sea level, at a point 200 ft (61 m) inland of the coastline. The calculated 25-year height is 6.8 ft (2.1 m). There is no record of bore formation (tidal water that rises abruptly to form a wave as it moves inland) in this area of O‘ahu, so a tsunami wave can be expected to take a form of a rapidly rising and falling tide, with a wave period of approximately 10 to 15 minutes.

3.5.4 Hurricanes

Although hurricanes occur infrequently in the immediate vicinity of Hawai‘i, they do occasionally pass near the islands. Notable recent examples are Hurricane ‘Iwa, which passed within 30 mi (49 km) of Kaua‘i in 1982, and Hurricane ‘Iniki, which passed directly over Kaua‘i in 1992. Because hurricanes directly impact the Hawaiian Islands at such infrequent intervals, there is no realistic method to calculate a return period. Hurricane wave conditions at the project site are described in Section 3.2.2.

3.5.5 Geology and Soils

Mokapu Peninsula was created by volcanic activity building cones of molten rock, or lava, and steam-broken ash. Fluctuations in sea level caused by glacial activities alternately flooded and exposed the coastline, allowing thick limestone platforms and sediments to form from coral reefs that developed during lower sea levels. These platforms and sediments make up much of the relatively porous, calcareous land surface existing at Mokapu Peninsula today. The white sand of North Beach area is remnant of hard-shelled marine organisms and the erosion of coral reef structures. Heleloa sand dunes, created by the prevailing trade winds blowing beach sand inland, fringe the North Beach shore. The hillside along the onshore cable route is comprised of rock land, and a majority of the terrestrial soils in the project area consists of Molokai silty clay loam.

3.5.6 Water Quality

The waters off North Beach are classified as “A” by the DOH. Hawaii Administrative Rules (HAR) §11-54-03 state that the objective of Class A waters is to protect their use for recreational purposes and aesthetic enjoyment. Any other use shall be permitted as long as it is compatible with the protection and propagation of fish, shellfish, and wildlife, and with recreation in and on these waters.

3.5.7 Noise

Sources of ambient noise at North Beach include wind and wave noise (MCBH 2001). Wave noise is a strong contributor to ambient noise especially when large swells emanating from winter storms impinge on the beach. Intermittent passing motorboats also contribute to noise at North Beach.

Biological sounds from marine animals are another source of noise as sounds are widely used by marine mammals in their everyday survival including foraging, detecting predators, finding mates, and caring for young. Some sounds produced by humpback whales include songs, shrieks, grunts, and clicks. Dolphins emit whistles as well as barks and screams. Further information about marine mammal noises are provided in Appendix F.

Point sources of sound occur from military operations such as aircraft activities. Noise contours developed for the 1995 *Aircraft Noise Study for Marine Corps Air Facilities, Kaneohe Bay*, show that only a very narrow band of area immediately adjacent to the main runway experience noise levels above 65 decibels (dB) (MCBH 2001). Noise Zone 1 (less than 65 Ldn [day-night equivalent sound levels in units of the decibel or dB]) is an area of no impact. Noise Zone 2 (65-75 Ldn) is an area of moderate impact where some land use controls are needed. Noise Zone 3 (75 Ldn) is the most severely impacted area and requires the greatest degree of land controls. The Ldn is an average sound level generated by all aviation-related operations during an average busy-day 24-hour period, with nighttime noise levels (10:00 p.m. to 7:00 a.m.) increased by 10 dB prior to computing the 24-hour average to account for nighttime sensitivity.

3.5.8 Electromagnetic Radiation (EMR)

EMR zones are established around transmitting facilities when high-density electromagnetic power is a potential hazard to ordnance, personnel, and fuels or other volatile liquids. No EMR zones are located within the project area. Two major sources of EMR exist at MCBH Kaneohe Bay (MCBH 1999). The airport surveillance radar at the top of Pu‘u Hawai‘i Loa radiates 1.4 milliwatts (mW). The Precision Approach Radar (PAR), located in Building 5036 adjacent to the runway, radiates 80 kW at peak power. The base does not have unmitigated EMR hazards to ordnance (HERO), personnel (HERP), or fuel (HERF).

3.5.9 Ordnance Material

In the unlikely event that ordnance material is encountered that cannot be safely removed or avoided, the Navy will, as appropriate, confer with NMFS before proceeding with construction in the area of the discovered ordnance material.

The proposed project area falls outside existing Explosive Safety Quantity Distance (ESQD) arcs at MCBH Kaneohe Bay. The ESQD arcs represent hazard zones that are established by DoD for various quantities and types of explosives used by the military.

3.6 DESCRIPTION OF RELEVANT NON-AFFECTED RESOURCES – ALTERNATIVE B: PEARL HARBOR

3.6.1 Climate and Air Quality

Daytime average temperatures at Pearl Harbor range from lows of 76º F (24º C) during winter to highs of 87º F (30.5º C) in summer. Average annual humidity ranges from 58 to 80 percent. Average annual rainfall at Pearl Harbor is between 14.5 and 17.8 in (368.3 and 452.1 mm). Most of this rainfall occurs during Kona storms or rainstorms that cover the entire island.

As discussed in Section 3.4.1, areas within the state of Hawai‘i are in attainment of the NAAQS and comply with more stringent state standards.

3.6.2 Currents and Tides

The Pearl Harbor waters are influenced by a two-layer circulation system resulting from the large influx of fresh stream water to the harbor. The boundary between the two layers occurs at about the 5-ft (1.5-m) water depth in the entrance channel, but is seasonally variable. The bottom seawater layer reverses with the tide. Tides, winds, fresh water inflow, and ship-induced turbulence all affect water circulation in the harbor. Tidal currents are relatively mild, with the strongest occurring at the entrance to the harbor.

3.6.3 Tsunamis

As described in Section 3.5.3, tsunami runup in Hawai‘i during a given occurrence varies greatly with location. At the Pearl Harbor alternative site, a 100-year tsunami elevation would be 5 to 6 ft (1.5 to 1.8 m) at the harbor entrance.

3.6.4 Hurricanes

Hurricanes occur infrequently in the vicinity of the Hawaiian Islands. While the waters within Pearl Harbor are generally protected from large waves by the narrow entrance channel, the open coastal waters in the vicinity of Pearl Harbor are subject to hurricane-generated waves.

3.6.5 Geology and Soils

The ground surface of the area is the top of a fossil reef which has consolidated into limestone. This ancient reef grew when the sea level was up to 100 ft (30.5 m) higher than present. The fossil reef is highly permeable and serves as an aquifer and filter.

Below the reef, caprock consisting of a sequence of terrestrial and marine sediments extends to the top of the parent material, the Ko‘olau basalt. Overall permeability of the caprock is very low, preventing upward seepage of groundwater from the Ko‘olau basalt aquifer. The predominant soils of the West Loch area are the Mamala series or coral outcrop. Other general soil associations found in the Pearl Harbor area include the Lualualei-Fill Land-‘Ewa associations. This soil association is described as deep, nearly level to moderately sloping, well-drained soils that have a fine textured or moderately fine subsoil or underlying material, and areas of fill land on coastal plains.

3.6.6 Water Quality

Inland waters located within the Pearl Harbor entrance channel are known as the Pearl Harbor Estuary. DOH classifies these waters as Class 2, protected for recreational purposes, support and propagation of aquatic life, agricultural and industrial water supplies, shipping, and navigation. These uses are required to be compatible with the protection and propagation of fish, shellfish, and wildlife (HAR 11-54-03(b)(2)). Pearl Harbor waters and nearshore waters to 30 ft (9 m) from Keehi Lagoon (east of Honolulu International Airport) to Oneula Beach (west of NAVMAG West Loch) are listed on the State’s draft list of impaired waters under the Federal Clean Water Act Section 303(d) as “high priority” for Total Maximum Daily Load development for nutrients, turbidity, and suspended solids.[8]

DOH classifies marine waters outside the entrance channel to a depth of 600 ft (183 m) as Open Coastal Waters, designated Class A.

3.6.7 Noise

Sources of ambient noise at the Pearl Harbor site are shipping from military transit, wind and wave noise, and biological noise. The site is subject to aviation influences from the runways at both Hickam AFB and Honolulu International Airport.

3.6.8 Electromagnetic Radiation

At Pearl Harbor, potential EMR sources are individually evaluated for possible impact on personnel, fuel, ordnance, and interference. There are no major sources of EMR at the Pearl Harbor site alternative (Navy 1993).

8 http://www.hawaii.gov/doh/eh/epo/303dpcdraft.pdf

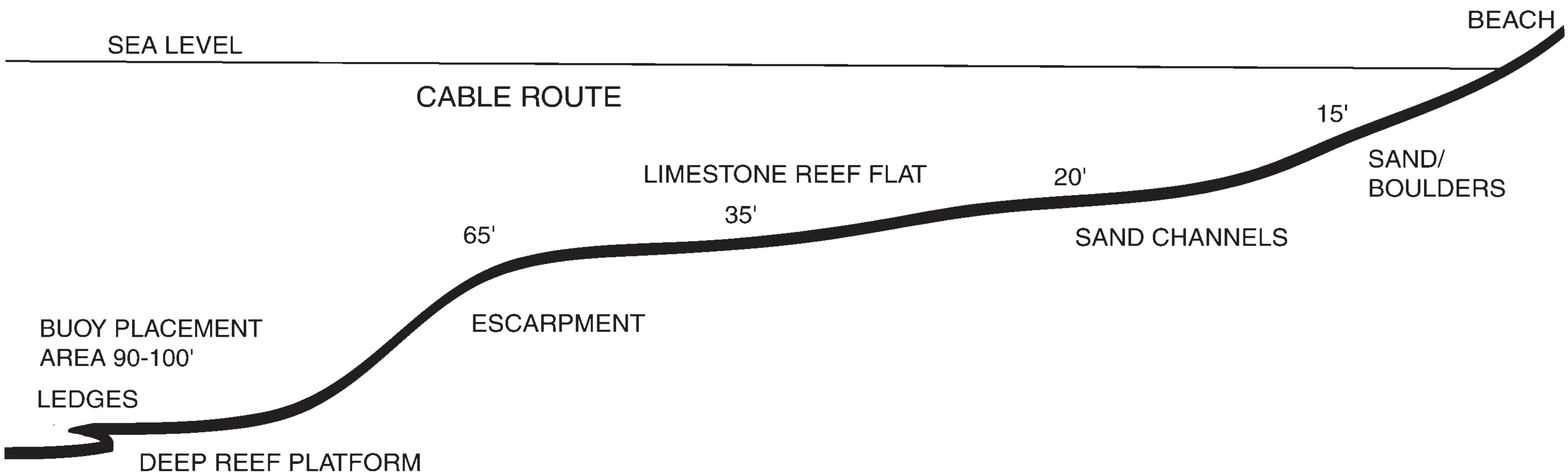
3.6.9 Ordnance Material

In the unlikely event that ordnance material is encountered that the Navy cannot safely remove or avoid, the Navy will, as appropriate, confer with NMFS before proceeding with construction in the area of the discovered ordnance material.

The project area falls just outside the ESQD arcs generated from ammunition handling wharves at NAVMAG Pearl Harbor, West Loch Branch. The risks associated with these ESQD arcs exist only when a loaded ammunition ship is at a wharf, or ammunition or explosives are staged on the wharves at NAVMAG Pearl Harbor, West Loch Branch.

3.7 RELEVANT NON-AFFECTED RESOURCES – ALTERNATIVE C: NO ACTION

With the No Action alternative, there would be no relevant non-affected resources because the WET test would not be implemented in Hawai‘i.

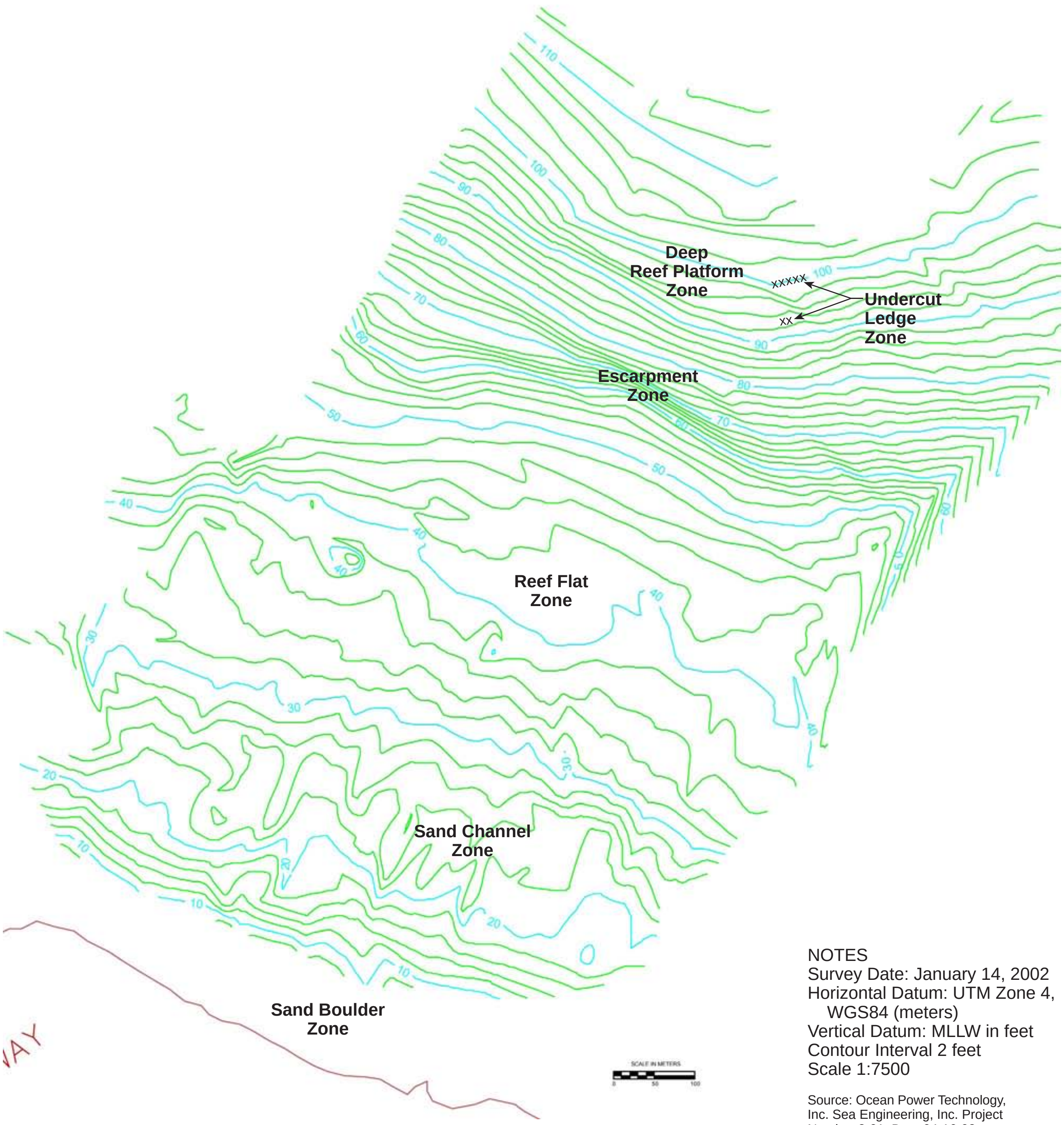


Note: Figure is not to scale horizontally or vertically.

Figure 3-1
WET BUOY/CABLE ROUTE BENTHIC ZONATION
North Beach, MCBH Kaneohe Bay

Environmental Assessment
Wave Energy Technology Project

1999.82.0624/001-7 k7.25.02 3



NOTES
Survey Date: January 14, 2002
Horizontal Datum: UTM Zone 4, WGS84 (meters)
Vertical Datum: MLLW in feet
Contour Interval 2 feet
Scale 1:7500

Source: Ocean Power Technology, Inc. Sea Engineering, Inc. Project Number 2-01. Date 04-16-02

NORTH

0 50 100 150 200
SCALE IN METERS

0 625
SCALE IN FEET

Note: Labeling of zones is approximate and not meant to depict full area of each zone.

Figure 3-2
BENTHIC ZONES
North Beach, MCBH Kaneohe Bay

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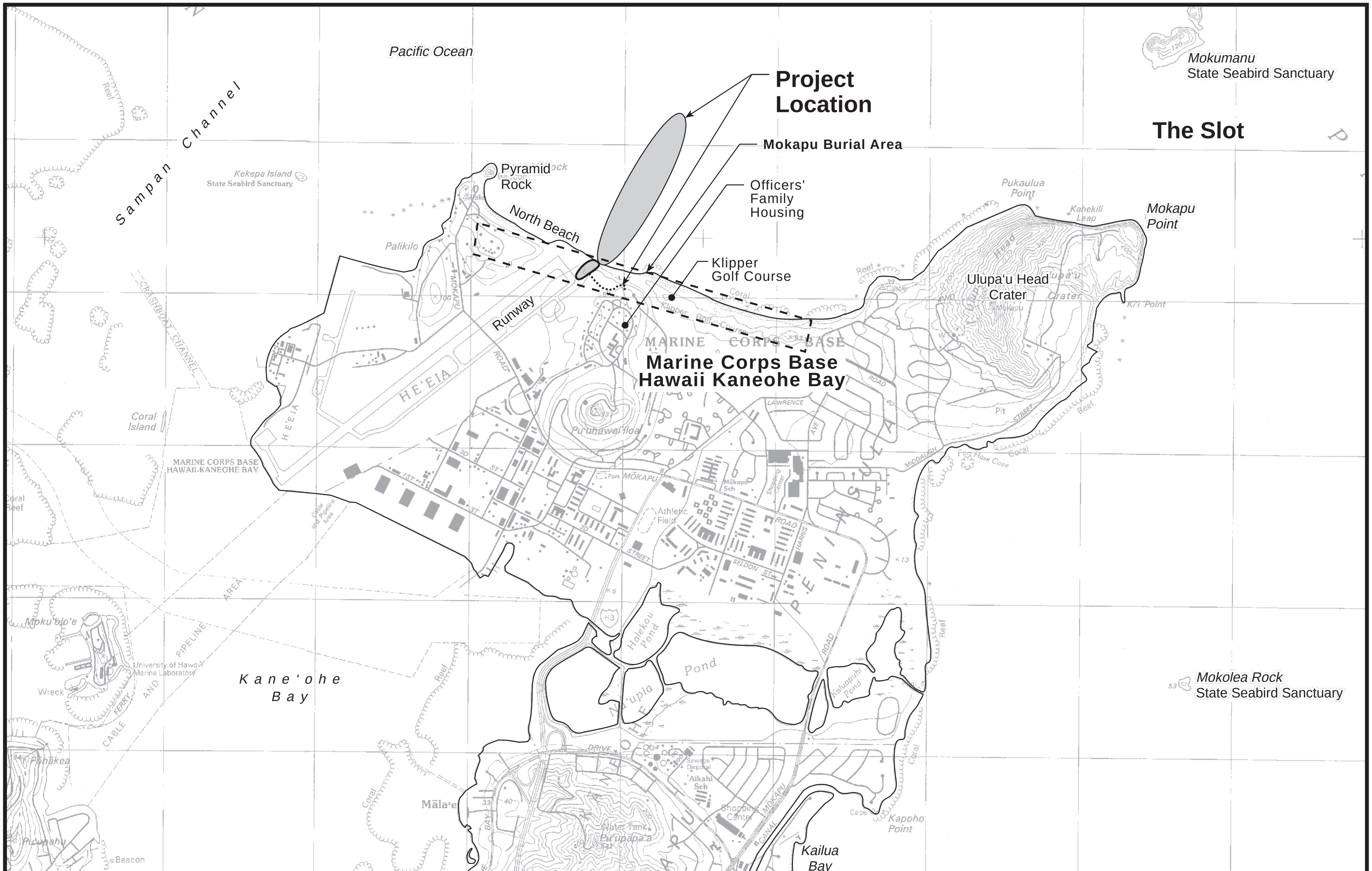
Unobstructed view of open ocean to the north and of coastal plants such as naupaka.

Figure 3-3
VIEW TO THE NORTH
North Beach, MCBH Kaneohe Bay

Environmental Assessment
Wave Energy Technology Project

1999.82.0624/006-1 k09.27.02 6



0 500 1000

SCALE IN METERS

0 1000 2000 3000

SCALE IN FEET

NORTH

Source: NAVFAC Dwg.No. 7,011,984

Legend

Mokapu Burial Area

Proposed Land Cable Route

Figure 3-4
LAND USE COMPATIBILITY AND RECREATION

1999.82.0624/001-5 k11.13.02 14

View of North Beach looking to the northwest and Pyramid Rock.

Figure 3-5
VIEW TO THE NORTHWEST
North Beach, MCBH Kaneohe Bay

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Wave Energy Technology Project

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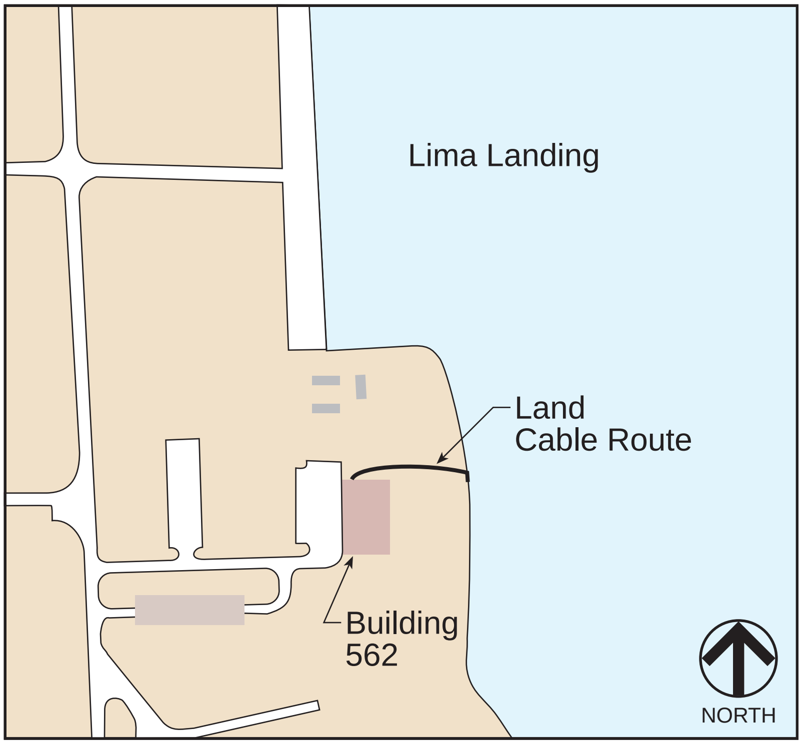

Land cable route, Pearl Harbor Alternative.

Building 562. Equipment shelter located inside double doors to the right of the group of people visible in the photograph.

Figure 3-6
PEARL HARBOR ALTERNATIVE
LAND CABLE ROUTE

Cable would come onshore to the left of the thick vegetation.

Cable would run along the concrete slab.

Figure 3-7
PEARL HARBOR ALTERNATIVE CABLE LANDING SITE

Chapter 4

Environmental Consequences

CHAPTER 4
ENVIRONMENTAL CONSEQUENCES

4.1 INTRODUCTION

Chapter 4 identifies the environmental consequences of implementing Alternative A: Proposed Action, Alternative B: Pearl Harbor, and Alternative C: No Action. It provides the scientific and analytic basis for comparing the alternatives, and presents direct, indirect, short-term, and long-term impacts on relevant resources. Direct impacts are a result of project implementation and may be short-term (temporary) or long-term. Indirect impacts are those caused by the action but occur later in time or are further removed from the action. Short-term impacts are interim changes in the local environment caused by project installation and would not extend beyond project associated activities, in this case a two- to five-year period. Long-term impacts may result in irreversible damage to resources. Cumulative impacts, discussed in Section 4.6 are those resulting from incremental impacts of the Proposed Action when added to other past, present, and future actions within an identified region of influence.

4.2 PREDICTED EFFECTS ON RELEVANT AFFECTED RESOURCES FROM ALTERNATIVE A: PROPOSED ACTION

Ten affected resources were identified in Chapter 3: shoreline physiography, oceanographic conditions, marine biological resources, terrestrial biological resources, land and marine resource use compatibility, cultural resources, infrastructure, recreation, public safety, and visual resources.

4.2.1 Predicted Effects on Shoreline Physiography

Potential impacts on shoreline conditions are dependent on the extent to which features such as vegetation or sand deposition patterns could be damaged or altered by the proposed project during installation and operation.

Impacts to the shoreline from the proposed installation would be minimal. A backhoe loader and hydraulic crane would be used to pull the undersea transmission cable ashore and assist with its placement on land. Heavy equipment activities would be specified to minimize disturbance to the shoreline and would be restricted to the end of the runway or the dirt roadway near the runway.

The prefabricated, concrete utility vault would be lifted into place with a crane and placed onto a gravel bed. Use of a gravel bed would promote drainage and ground water infiltration.

The presence of the WEC system would not alter currents or wave directions (Section 4.2.2), so shoreline physiography would not be affected. The WEC buoys would have only a very localized effect on currents and the affected area would not extend more than a few buoy diameters. There would be no effects on shoreline erosion or sand deposition patterns. Upon completion of the system test, the land based cable and equipment would be removed.

4.2.2 Predicted Effects on Oceanographic Conditions

Potential impacts on oceanographic conditions are dependent on the extent or degree to which the WEC buoys affect wave scattering or reflection and energy absorption.

The WEC buoys would not impact oceanographic conditions. This determination is based on analyses of (1) wave height reduction due to wave scattering and (2) wave height reduction due to energy absorption. Using a numerical solution to evaluate wave scattering caused by a wave passing through an infinite grating of circular cylinders, results indicate that the effects of six WEC buoys on wave transmission and reflection would be negligible. This is due to the relatively large design spacing between the buoy cylinders, 169 ft (51.5 m), as compared to the buoy diameter of 15 ft (4.5 m). Potential effects on wave heights due to energy absorption were analyzed by running a wave refraction-diffraction model. Results estimated that wave heights near the shoreline would be reduced by 0.5 percent for a wave period of 9 s, and less than 0.3 percent for a period of 15 s. The impact of six WEC buoys on a wave field would be minimal and would not be noticeable or quantifiable given the randomness of the wave action.

Appendix J provides details of the inputs, methodology, and findings of the analyses used to evaluate the predicted effects of the buoys on oceanographic conditions.

4.2.3 Predicted Effects on Marine Biological Resources

Potential impacts on marine biological resources are dependent on the extent or degree to which installation and operation of the WEC system would: (1) impact any marine mammal species or species listed as threatened or endangered under Federal or State law, (2) affect sensitive habitat or habitat critical to the continued existence of any threatened or endangered species, (3) affect HAPC, or (4) change the distribution or reduce the population of other marine species.

No significant impacts would occur to marine biological resources from installation and operation of the WEC system. The USFWS and NMFS concur with the Navy that the Proposed Action is not likely to adversely affect threatened or endangered species under their jurisdictions. The Proposed Action is not within an HAPC.

Protocols for avoiding impacts to listed protected species during installation of the buoys and undersea cable at the active site would be specified in the construction contractor’s Best Management Practices (BMPs). Such protocols would address the protection of mammals protected under the MMPA, including the endangered Hawaiian monk seal, the endangered humpback whale, and various species of dolphin, as identified in Table 7-1 of Appendix F.

Protection under the MMPA would be provided in accordance with Navy policy documented in the Chief of Naval Operations Instruction (OPNAVINST 5090.1B). Considering the proposed project activities, evaluation of potential impacts (presented herein), and the protections afforded by law and Navy policy, the taking of marine mammals under the MMPA is unlikely during the installation and operation of the WEC system.

Predicted effects on marine biological resources are discussed relative to undersea cable installation, buoy installation, operation, and removal of the WEC system in the following sections.

4.2.3.1 Installation of the Undersea Cable

Potential impacts on marine species from installation of the undersea cable include: (1) noise impacts due to the installation of rock bolts, (2) damage to corals within the narrow corridor of the undersea cable, and (3) entanglement of marine mammals with the cable.

The noise produced by drilling holes for the rock bolts would be localized, intermittent, and of short duration. Humpback whales, dolphins, and green sea turtles would be able to sense the sound produced by the drills but neither the amplitude nor the frequencies of noise produced would be sufficient to constitute an impact on these animals. It is unlikely that the noise would adversely impact marine species by disrupting feeding or other behaviors. Turtles and fish, in particular, may be attracted to the activity, possibly by the bottom biota stirred up by the drilling. Appendix F provides further discussion on this subject.

Installation of the cable would minimize interactions with biota by avoiding areas of rich biological diversity and high percentages of coral coverage. The selected cable route follows cracks and sand channels, most of which are filled with a layer of sand, precluding settlement of biota (Appendix E).

While unlikely, there is potential for entanglement of marine mammals and sea turtles with the undersea cable. Historically, problems with entanglement were due primarily to the lack of technology available to precisely place and secure a cable or control the amount of tension. This resulted in spanning or bridging of the cable, and loops developing over time. In contrast to the these early systems, the WEC undersea cable would have the following characteristics:

- Installation would occur in shallow water (i.e., depths to approximately 100 ft [30.5 m]).
- Installation would occur with adequate tension to allow the cable to contour to the seafloor without suspensions or forming loops. Divers would inspect the cable route once it is placed.
- The length of the cable is relatively short compared to trans-oceanic undersea cables, about 3,900 ft (1,190 m).

No significant impacts to marine species would occur with installation of the undersea cable. The noise produced from drilling is unlikely to adversely impact humpback whales, dolphins, or green sea turtles. The limited duration of the cable installation and placement of the cable flat on the seafloor would minimize the risk of listed species encountering or becoming entangled in the cable. There would be no risk of entanglement once the cable is rock-bolted to the seafloor. Mooring lines and anchor chains for the four mooring clumps would be pulled taut during installation, minimizing risks of entanglement.

4.2.3.2 Installation of the Buoy

No significant impacts to marine species would occur with installation of the buoys. In the area of the deep reef platform selected for the buoy array (the 95- to 104-ft [29.0- to 31.7-m] depth), the composition of the bottom is very homogeneous, consisting of limestone covered with a thin veneer of algal turf. The placement of the buoy anchors on the seafloor would impact the biota directly beneath each anchor, an area approximately 30 by 30 ft (9.1 by 9.1 m). The total area of the seafloor ultimately covered by six anchors would be 5,400 sq f. (497 sq m). Holes would be drilled to rock-bolt the anchors to the seafloor. Buoy installation and anchoring would cause only minor, localized turbidity as the seafloor at the site is relatively devoid of sand or sediment. The heavy ballast of the anchors and the installation of rock bolts on the flange frames would restrict movement of the anchors and scouring of the seafloor. Impacts on marine biota would be minimized by avoiding areas containing live corals.

The noise produced by drilling holes for the rock bolts would be localized, intermittent, and of short duration, as discussed in Section 4.2.3.1. Pelagic fish such as wahoo and skipjack tuna are highly mobile and, therefore, would not be affected during installation of the buoys and associated hardware. Bottom-dwelling fish such as goatfish are not abundant in the project site, and those that may be present would be displaced to nearby areas.

4.2.3.3 Operation of the WEC System

The potential for adverse impacts on marine biological resources during WEC system operations is minimal and not significant. However, as part of the Navy's BMPs, a biological monitoring plan for fish and bethnic organisms will be developed. Analyses conducted for the project indicate that there could be short-term direct impacts resulting from entrapment, exposure to EMR, and electrical leakage. No long-term direct or indirect effects are anticipated. Potential impacts due to heat and noise exposure were also analyzed and found to be negligible. Findings are summarized herein.

Entrapment. The potential for entrapment of marine species such as sea turtles within the WEC buoy structure is minimal (refer to Figure 2-5, Section 2.4.1.2, and Appendix F). The top of the buoy is closed, and the bottom is open, allowing ingress and egress through only one end. Although the possibility exists for an animal to enter and become disoriented, the size of the opening in the bottom of the WEC buoy provides a ready egress path. There are no entanglement or snagging obstructions within the interior of the structure to prevent egress. No horizontal flat surfaces exist within the buoy to provide resting habitat for marine species such as turtles.

EMR. In the natural environment, marine organisms are exposed to, and influenced by, electric and magnetic (EM) fields. Species with developed sensory receptors that can detect electric or magnetic fields can use this information for various behaviors. The sensing of electric fields by organisms is termed electroreception. The sensing of magnetic fields is magnetoreception. Exposure to EM fields has the potential to affect marine organisms in a variety of ways. The analysis conducted for the WET test considered only the potential for behavioral effects (Appendix F).

Power cables generate both electric and magnetic fields. The flow of seawater across the electric field of a power cable generates a weak magnetic field. Potential electric and magnetic fields surrounding the WEC undersea cable have been calculated for a range of electrical currents through the cable.

Based on the anticipated current passing through the WEC cable, the electric field strength at the surface of the cable would range from approximately 1.5 to a maximum of 10.5 millivolts per meter (mV/m) and would decrease exponentially with distance from the cable. The magnetic field strength at the surface of the cable would range from approximately 0.1 amperes (amps [A]) per meter (A/m) to a maximum of 0.8 A/m and would decrease exponentially with distance from the cable.

Organisms sensitive to magnetic fields may exhibit one of three behaviors: (1) detection and no effect, (2) detection and confusion or avoidance, or (3) attraction. These different behavioral patterns are discussed below.

- *Detection and no effect.* The first scenario is highly probable since the cable would be carrying alternating current rather than polarized direct current. The organism would detect the magnetic field but not exhibit any response.

- *Detection and confusion or avoidance.* In the second scenario, the organism may disrupt its current behavior while it “reanalyzes” the situation. The expected outcome is for the organism to assess the information from other sensory cues, ignore the anomalous magnetic perception, and continue its previous behavior. Avoidance would be the worst-case situation because it would mean that organisms were intimidated or uncomfortable within the magnetic field.

  The magnetic field resulting from the proposed WEC cable may affect the magnetoreception sensors of fish, including sharks, rays, and skates, in the vicinity of the cable and cause these animals to be temporarily confused. The impact on sharks would be minimal based on research studies with other undersea cables. Bottom-dwelling organisms would be the most likely to show avoidance behavior, while pelagic species (fish that spend most of their life swimming in the open area of the ocean) could readily swim over the magnetic field.

  Studies have demonstrated that sea turtles, whales, dolphins, porpoises, sharks, and rays are capable of following geomagnetic contours along the ocean floor, indicating a sensitivity to magnetic sources. Since the cable occupies a small area of the seafloor, the impact of avoidance behavior that could be potentially exhibited by marine organisms, in response to the presence of the WEC cable, would be minimal.

The cable does not cross any known critical migratory paths for threatened or endangered species.

- *Attraction.* Behavioral attraction of marine mammals to magnetic fields has not been recorded (Appendix F). The effects of attraction on marine mammals or other marine organisms are not possible to predict due to the lack of knowledge about factors such as the species attracted, number attracted, species behavior in the vicinity of the cable, reactions of other species in response to an aggregation, and numerous other factors.

Based on the available data as described in Chapter 4 and cited in Appendix F, impacts of electric and magnetic fields on marine organisms can be expected to range from no impact to avoidance of the vicinity of the WEC cable. Organisms sensitive to electric or magnetic fields may detect emissions near the WEC cable; however, the effects would be temporary. Since the cable occupies a small area of the seafloor, the impact of avoidance behavior would be minimal. The cable route would not occupy any unique feeding, breeding, birthing, or egg-laying areas. The analysis provided in Appendix F found no evidence in the literature of either short- or long-term effects of electric or magnetic fields from cables similar to the WEC cable on marine organisms, other than the possible behaviors described. Although there have been numerous inconclusive studies of the effects of electromagnetic fields on animals in air, no similar studies have been found of the effects of EMR on marine animals in seawater.

Electrical Leakage. During operation, the WEC system could possibly experience an electrical fault or short due to damage to the cable. In the event of an electrical fault, there is a short period of time during which the electrical current generated by the WEC system would leak to seawater. However, the computer-controlled electrical fault detection and circuit interruption system would shunt the electrical current to the load resistors within 6 to 20 milliseconds (ms), limiting the duration of the electrical field. If the fault persists, an electric field would develop in the vicinity of the fault. The voltage gradient would depend on the fault current and the distance from the fault.

A series of Navy studies on the effects of electrical fields found that fault durations of less the 20 ms and fault currents of less than 5 mV had only transient effects on marine life or divers (Appendix F). For divers, effects were generally described as a mild discomfort. The studies found no short or long-term effects from transient fields less than 20 ms and 5 mV; the only effects were transient. No other literature was found directly describing the effects of this type of highly transient electrical field on marine life. It is likely that electroreceptive species would simply detect the field and be diverted away from the vicinity of the fault during the brief period while the ground fault system actuates. With the WEC system, this period of exposure would be 20 ms or less. To prevent electrical faults or shorts from occurring, the WEC undersea cable would be armored with steel wires and an external jacket that make it highly resistant to damage. In addition, protection from leakage has been designed into the system. A computer-controlled fault detection and interruption system would divert the electric current from the cable and store it in load resistors in the event of a fault.

Heat. The effects of heating on marine organisms can be expected to reflect the Van't Hoff-Arrhenius relationship between temperature and metabolism, that a 50° F (10° C) increase in temperature would approximately double the metabolism of the organism, within the limits of ambient temperatures. Small temperature changes within ambient conditions have correspondingly small effects on metabolism. The average ambient temperature of the seawater surrounding the WEC undersea cable is 78.8° F (25.6° C), with a range of 75.9 to 80.4° F (24.4 to 26.9°C). The water in the relatively shallow depth at the site is in constant motion due to the wave action and currents.

The energy loss from resistance in an undersea cable results in the generation of heat and dissipation of this heat to the surrounding environment. The resistive losses in the WEC cable are calculated to range from 20 mW per foot (0.9 m) of cable for a single buoy generating 20 kW of power, to approximately 1.4 W per foot of cable (0.9 m) in the case of up to six buoys generating 250 kW. Based on the calculated resistive losses, the temperature rise in the cable is estimated to range from less than 0.018° F (0.01° C) for a single buoy to less than 0.025° F (0.023° C) for six buoys.

Heat losses from the WEC undersea transmission cable would have negligible impacts on seawater temperature in the vicinity of the cable, due to immediate dissipation by the natural flow of seawater. The large volume of seawater around the cable would keep temperature differences less than the natural differences due to solar heating, upwelling, and current-induced mixing. Although the WEC cable is in contact with the seafloor, the thermal resistance of the sediments or other seafloor material is substantially higher than that of the seawater. Hence, the heat transferred directly into the seabed materials would be negligible.

Heat released from the equipment canister, load resistors, and hydraulic fluid heat exchanger into the surrounding water is anticipated to be similar in nature to heat released from the undersea cable. The resulting temperature increase for a single buoy would be approximately 0.07º F (0.02º C). For six buoys, the resulting temperature rise would be 0.42º F (0.12º C), and in the constantly moving water at the project site, this change would be negligible.

Noise. There are no field data available on the acoustic output of the WEC system during operation. The WEC system is expected to produce a continuous acoustic output with an amplitude approximately similar to that of light to normal ship traffic, with a spectral content shifted to frequencies somewhat higher than shipping (Appendix F). Humpback whales, dolphins, and green sea turtles can sense acoustic energy of this amplitude and frequency content. However, no adverse impact on these species are anticipated because (1) there is no evidence in the literature that the amplitude and frequency of the noise expected to be produced by the WET system during operation will constitute an impact on these species, and (2) no other continuous sounds with a similar frequency, which could contribute to additive effects, were identified in the area. The taking of marine mammals, as defined under the MMPA, is unlikely. Refer to Appendix F for a more detailed discussion.

Potentially beneficial direct impacts on marine biological resources associated with the presence of the WEC system could occur. The WEC cable, anchor, and mooring block and chain could promote settlement of benthic organisms such as corals, which is validated by the observation of the high colonization rate of a discarded track from an amphibious vehicle in the reef flat zone.[1] As a result of coral growth on the cable and buoy anchor, a new fish habitat may be created. In addition, the buoys, anchors, and associated structures are anticipated to act as a Fish Aggregating Device (FAD).

There would be no indirect impacts to marine species such as the triggering of algal blooms or other negative shifts in biotic composition, particularly by the introduction of alien species. It is likely that alien species presently considered a nuisance within Kane‘ohe Bay are restricted to the particular oceanographic conditions and habitat that are unique to the Inner Bay. As the oceanographic climate at the wave-exposed project site varies greatly from the Inner Bay, the spread of alien algal species is unlikely (refer to Appendix H).

4.2.3.4 Removal of the WEC System

At the end of the test period, the Navy in conjunction with NMFS, USFWS, and the State DLNR, would determine whether equipment installed on the seafloor (i.e., the cable, buoy anchor system from the universal joint down, mooring clump base and anchoring system) should be removed or left in place. This material would not be considered “fill” under Section 10 of the Rivers and Harbors Act. Equipment such as the buoys and equipment canisters would be removed at the end of the test period.

4.2.4 Predicted Effects on Terrestrial Biological Resources

Potential impacts on terrestrial biological resources are dependent on the extent or degree to which the installation and operation of the WEC system would: (1) impact any species listed as threatened or endangered under Federal or State law, (2) affect sensitive habitat or habitat critical to the continued existence of any threatened or endangered species, or (3) change the distribution or reduce the population of other flora and fauna species.

Impacts on terrestrial biota would be minimal and not significant. There are no Federally or State-listed species found along the route proposed for the land cable. Wedge-tailed shearwater burrows exist in the vicinity of the proposed cable route; however, these sites will be avoided by placing the land cable, utility vault, and equipment shelter in previously disturbed areas and in existing facilities such as Battery French. The proposed project would not adversely affect native flora along the proposed land cable route.

4.2.5 Predicted Land and Marine Resource Use Compatibility Effects

Potential impacts on land and marine resource use are dependent on the extent or degree to which the proposed project would interfere with mission operations and/or compromise the integrity of land and marine resource uses in the area.

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[1] Furthermore, the presence of the metal tank track has not resulted in the growth of any biota on the surrounding reef that could be construed as a negative feature, such as blue-green algae (see Appendix H).

No significant impacts to land and marine resource use are expected with implementation of the WET test. Conflicts in marine resource use (e.g., conflicts with recreational activities such as fishing, boating, and diving) are anticipated from installation of the buoy array 1,200 yds (1,097 m) offshore, well outside the 500-yd (457-m) buffer zone. The proposed buoy array site is currently open to the public for fishing, boating, and diving. Although the area is subject to access limitations, at the present time public access is unrestricted. Therefore, no mitigation measures are proposed. To ensure public safety (refer to section 4.2.9) warning signs would be installed on each buoy to warn boaters and other recreational users of the area about the submerged obstruction and high voltage electric cable.

The WET test would not interfere with mission operations at MCBH Kaneohe Bay.

4.2.6 Predicted Effects on Cultural Resources

Potential impacts on cultural resources include the degree to which an alternative results in a change in the characteristics that qualify a historic property for listing in the NRHP The Proposed Action will occur partially within the boundaries of the Mokapu Burial Area and will involve the modification and use of a historic structure, Battery French. The Proposed Action is not expected to alter the characteristics qualifying these properties for inclusion in the NRHP.

Adverse impacts on the Mokapu Burial Site would be avoided. Previous studies have identified certain loci within the boundaries of the MBA that are known or likely to contain human remains or archaeological deposits. Activities associated with the Proposed Action would occur outside these loci.

If human remains or archaeological deposits were to be found in the project area, it is expected that they would be fairly deep below the ground surface. Investigations conducted for this project found that this area was covered with at least two feet of fill. Activities associated with the project would cause minimal ground disturbance and would be unlikely to encounter such deposits. Heavy equipment would access the project area using the taxiway and an existing dirt roadway in an area capped by fill. Movement of the equipment would be limited to placing the utility vault with a crane and staging the equipment near the ingress of the undersea cable to the shore for emergency support.

Should human remains or archaeological deposits be unexpectedly encountered, the appropriate provisions of NAGPRA and the NRHP will be followed.

Impacts on Battery French would be confined to the interior of the structure, which has been previously modified. The exterior of the structure, including the turret foundations, and its settings would not be altered.

In accordance with the regulations implementing Section 106 of the NHPA, 36 CFR Part 800, the Hawaii SHPO was consulted on the Proposed Action and the agency concurred with the Navy’s determination of “no historic properties affected” (see Appendix A-5). Notification of this finding was also provided to Native Hawaiian organizations and individuals that have previously expressed an interest in actions involving the Mokapu Burial Area. One organization, the Office of Hawaiian Affairs, and two of the consulted individuals provided comments on the Proposed Action. Their views are provided in Appendix A-5.

4.2.7 Predicted Effects on Infrastructure

Potential impacts on the electrical utility system include the extent or degree to which the proposed project would affect the quality of the electrical utility system.

No significant impacts are expected to occur on infrastructure. Modifications to Battery French would be minimal and limited to the interior (Section 2.4.1.2). Connection to the MCBH Kaneohe Bay power grid would supplement the existing base power. Moreover, the MCBH Kaneohe Bay electrical system would not be adversely affected by the WET project. Capacitors, the main inverter, and grid-side switchgear would protect the MCBH Kaneohe Bay electrical system. Power from the individual wave energy converters (up to six) feed a central DC bus and capacitor bank. The capacitors would absorb power surges from one or more of the wave energy converters. Power from the DC bus would then be transferred to the MCBH Kaneohe Bay power grid via a surge-protected DC/AC inverter.

4.2.8 Predicted Effects on Recreation

Potential impacts on recreation are dependent on the extent or degree to which the proposed project would interfere with the use and enjoyment of facilities and resources within the study area.

The undersea cable would cross the beach and connect to the utility vault within the 300-ft (91.4-m) restricted zone adjacent to the main runway. This zone is controlled by flight operations and is off limits to all recreational users. Information on regulations is made available to all residents, employees, and the general public; enforcement is provided by lifeguards, security personnel from Waterfront Operations, and base security personnel.

Recreation in the vicinity of the buoy array would be impacted for the two- to five-year project duration, however, the impact would not be significant. At present, there are no plans to restrict public access to the buoy array site. Warning signs would be installed on each buoy to warn boaters and recreational users of the area about the submerged obstruction and high voltage electric cable. Spear fishers, trollers, bottom-fishers, and boaters would have to detour around the buoys in transit to other sites. If public access to the WEC buoy array is not restricted, bottom-fishing, trolling, and SCUBA diving may increase, as the buoys would act as a FAD.

4.2.9 Predicted Effects on Public Safety

Potential impacts on public safety are determined by the extent or degree to which the project would interfere with enforcement of existing public safety regulations or cause harm to the public.

The buoy array would lie within a relatively heavily traveled corridor. Marine recreation user interviews (Appendix I) reveal that many local users of the area believe that potential adverse impacts would occur, regardless of safety precautions. Concerns on safety include recreational divers exploring the buoy system components and the possibility of a buoy breaking loose and creating a hazard to navigation. Another concern is the heightened danger of transiting watercraft colliding with the buoys, compounded by the possibility that the buoy would draw boaters and fishers to the area by its ability to attract and aggregate fish.

In response to the concerns identified above, potential hazards to public safety would need to be mitigated by installing appropriate markings on the buoy, implementing a response plan for reacting to system failures, and establishing communication procedures to promote public awareness of the WET system. Each buoy will be equipped with USCG-approved safety lights and standard USCG signage, such as ‘Government Property, Submerged Obstruction.’ An emergency response plan will be developed for mooring break and electrical fault alerts and for responding to other emergencies. In addition to filing a USCG Notice to Mariners to advise boaters on the location and dangers of venturing too close to the buoy array, press releases and community briefings are planned by the Navy to promote project awareness. Removal of the WET system at the end of the five-year test period would eliminate the aforementioned public safety concerns.

4.2.10 Predicted Effects on Visual Resources

Potential impacts on visual resources include the extent or degree to which the project would: (1) degrade the quality of an identified visual resource, including but not limited to a unique topographic feature, undisturbed native vegetation, or surface waters, or (2) obstruct public views of a scenic vista.

Impacts on scenic views would be minimal and temporary. Navigational aids on the buoys would extend approximately 30 ft (9 m) above sea level. At a distance of approximately 3,900 ft (1,220 m) from shore, the impact of the navigational aids would be minimal during both daytime and nighttime hours. At night, safety lights on the navigational aids would be visible in the distance.

4.3 PREDICTED EFFECTS ON RELEVANT AFFECTED RESOURCES FROM ALTERNATIVE B: PEARL HARBOR

4.3.1 Predicted Effects on Shoreline Physiography

Potential impacts on shoreline conditions are dependent on the extent or degree to which features such as vegetation or sand deposition patterns could be damaged or altered.

Installing the land cable, utility vault, and equipment shelter in previously disturbed areas (e.g., along the paved parking lot border) and in existing facilities (Building 562) would minimize impacts. The WEC system during operation would not alter currents or wave directions. Hence, there would be no effect on shoreline physiography during operation. Upon completion of the system tests, the land based cable and equipment would be removed.

4.3.2 Predicted Effects on Oceanographic Conditions

Potential impacts on oceanographic conditions are dependent on the extent or degree to which the WEC buoys affect wave scattering or reflection and energy absorption.

There would be no impacts on oceanographic conditions for the same reasons presented in Section 4.2.2.

4.3.3 Predicted Effects on Marine Biological Resources

Potential impacts on marine biological resources are dependent on the extent or degree to which installation and operation of the WEC system would: (1) impact any marine mammal species or species listed as threatened or endangered under Federal or State law, (2) affect sensitive habitat or habitat critical to the continued existence of any threatened or endangered, (3) affect HAPC, or (4) change the distribution or reduce the population of other marine species.

Predicted effects on marine biological resources are discussed relative to undersea cable installation, buoy installation, operation, and removal of the WEC system.

No significant impacts would occur to marine biological resources from installation and operation of the WEC system. The Pearl Harbor site is not within an HAPC. Based on recommendations for aquatic resources management in the Pearl Harbor INRMP, installation and operation of the WEC system at this alternative site would not impact aquatic resources management objectives. If the Pearl Harbor site is selected, the Navy would initiate an informal Section 7 ESA consultation for that site.

The Pearl Harbor entrance channel is designated as an aquatic resources management area. This designation directs the Navy to protect, conserve and manage aquatic resources as vital elements of the natural resources program. In addition, the Navy is to obtain and maintain baseline information on aquatic resources and fisheries at Pearl Harbor in order to facilitate effective resource management, monitor and track changes in the quality of the marine environment over time, and protect threatened and endangered marine species that may occasionally occur in the harbor waters.

Protocols for avoiding impacts to listed protected species during installation of the buoys and undersea cable at the active site would be specified in the construction contractor's BMPs. Such protocols would address the protection of mammals protected under the MMPA, including the endangered Hawaiian monk seal, the endangered humpback whale, and various species of dolphin, as identified in Table 7-1 of Appendix F. Protection under the MMPA would be provided in accordance with Navy policy documented in the Chief of Naval Operations Instruction (OPNAVINST 5090.1B). Considering the proposed project activities, evaluation of potential impacts (presented herein), and the protections afforded by law and Navy policy, the taking of marine mammals under the MMPA is unlikely during the installation and operation of the WEC system.

4.3.3.1 Installation of the Undersea Cable

Adverse impacts on marine species from installation of the undersea cable could include: (1) noise impacts due to the installation of rock bolts, (2) damage to corals within the narrow corridor of the undersea cable, and (3) entanglement of marine mammals with the cable. The potential effects of noise and entanglement on marine organisms are similar to those presented in Section 4.2.3.1.

Installation of the WEC system would minimize interactions with biota by avoiding areas of rich biological diversity and high percentages of coral coverage.

The limited duration of the cable installation and use of modern cable laying techniques would minimize the risk of Hawaiian monk seals and green sea turtles becoming entangled in the cable. There would be no risks of entanglement once the cable is secured to the junction of the channel slope and bottom.

4.3.3.2 Installation of the Buoy

Impacts on marine biological resources during installation of the buoy array would be minimal, similar to those described in Section 4.2.3.2. In the area of the sand-rubble zone selected for the buoy array, the composition of the bottom is very homogeneous, consisting of loose sand deposits with occasional rubble outcrops. As the seafloor in this area is relatively devoid of living coral or algae, initial placement of the buoy anchor on the seafloor would have minimal impact on biota. Fish may be temporarily disturbed but would likely swim away from the area. For these reasons no significant impacts would occur to marine biological resources from installation of the WEC system.

4.3.3.3 Operation of the WEC System

The potential for adverse impacts on marine biological resources during WEC system operations is minimal and not significant. Impacts due to entrapment within the buoy and exposure to EMR, electrical leakage, heat, and noise are summarized below. For a more in-depth analysis, refer to Section 4.2.3.3 and Appendix F.

Entrapment. There is minimal potential for entrapment of marine animals such as turtles within the WEC buoy structure. The interior of the buoy is free of obstructions, sharp edges, or corners, and the open bottom of the buoy provides a ready egress path. No horizontal flat surfaces exist within the structure to provide resting habitat for marine species such as turtles.

EMR. Based on the available data as described in Chapter 4 and cited in Appendix F, impacts of electric and magnetic fields on marine organisms can be expected to range from no impact to avoidance of the vicinity of the WEC cable. The analysis provided in Appendix F found no evidence in the literature of either short- or long-term effects of electric or magnetic fields from cables similar to the WEC cable on marine organisms other than the possible behaviors described in Section 4.2.3.3.

Electrical Leakage. There is potential for a very short-term electrical current leakage within the WEC system. It is likely that electroreceptive species would detect the field and be diverted away from the vicinity of the fault during the brief period while the ground fault system actuates. Studies have found that no short- or long-term effects in divers from transient fields less than 20 ms and 5 mV; the only effect observed were transient in nature (mild discomfort) (Appendix F).

Heat. Heat losses from the WEC undersea transmission cable would have negligible impacts on seawater temperature and seabed materials in the vicinity of the cable and hence, there would be no effects on marine biota. There would be no effects from heat on marine species.

Noise. There are no field data available on the acoustic output of the WEC system during operation. As explained in section 4.2.3.3, there is no evidence that the amplitude and frequency of the noise produced by the WEC system operation would impact humpback whales, dolphins, or green sea turtles (Appendix F).

Potentially beneficial direct impacts on marine biological resources would be associated with the presence of the WEC system, and creation of fish habitat given coral growth on the cable, anchor, mooring clump and anchor chain.

There would be no indirect impacts to marine species such as the triggering of algal blooms or other negative shifts in biotic composition, particularly by the introduction of alien species.

4.3.3.4 Removal of the WEC System

At the end of the test period, the Navy in conjunction with NMFS, USFWS, and DLNR would determine whether equipment installed on the seafloor (i.e., the cable, buoy anchor system from the universal joint down, mooring clump base and anchoring system) should be removed or left in place. This material would not be considered "fill" under Section 10 of the Rivers and Harbors Act. Other equipment such as the buoys and equipment canisters would be removed at the end of the test period.

4.3.4 Predicted Effects on Terrestrial Biological Resources

Potential impacts on terrestrial biological resources are dependent on the extent or degree to which the installation and operation of the WEC system would: (1) impact any species listed as threatened or endangered under Federal or State law, (2) affect sensitive habitat or habitat critical to the continued existence of any endangered or threatened species, or (3) change the distribution or reduce the population of other flora and fauna species.

No species listed under the ESA as threatened or endangered were found along the proposed land cable route. Two State-listed birds, the threatened white tern and endangered short-eared owl, are occasionally found in the Pearl Harbor vicinity; however, these species have not been identified in the area of the proposed land cable route. The land cable route and proposed site for the utility vault would be sited on previously disturbed areas along the paved parking lot border and the lawn of Building 562. Equipment would be sheltered in Building 562. Use of disturbed areas and existing facilities would minimize potential effects on terrestrial biota. The proposed project would not create changes in local populations of flora and fauna at the Pearl Harbor site.

4.3.5 Predicted Land and Marine Resource Use Compatibility Effects

Potential impacts on land and marine resource uses are dependent on the extent or degree to which the proposed project would interfere with mission operations and/or compromise the integrity of land and marine resource uses in the area.

No significant impacts to land and marine resource uses are anticipated from the WET project. The entire WEC system would be within a restricted area minimizing security risks, which would help to maintain system survivability over the two- to five-year test period. The proposed project would not interfere with mission operations at NAVMAG Pearl Harbor, West Loch Branch.

4.3.6 Predicted Effects on Cultural Resources

Potential impacts on cultural resources include the extent or degree to which an alternative results in a change in the characteristics that qualify an historic property for listing in the NRHP.

Although the Proposed Action at this alternative site would occur within the boundaries of the Pearl Harbor National Historic Landmark, no impacts on the Landmark are anticipated. The Proposed Action would not cause effects on any listed, contributing, or eligible historic properties within the landmark. The land segment of the project is in an area designated in the

Pearl Harbor Naval Complex Integrated Cultural Resources Management Plan as having no or low potential for archaeological deposits (Commander Navy Region Hawaii 2001).

4.3.7 Predicted Effects on Infrastructure

Potential impacts on the electrical utility system include the extent or degree to which the proposed project would affect the quality of the electrical utility system.

The wave energy converters would be connected to the electrical grid system. Power from the energy converters would be routed through a central DC bus and capacitor bank that could absorb power surges. The power from the DC bus would then be transferred to the Puuloa/Iroquois Housing area power grid via a surge-protected DC/AC inverter. The addition of isolation transformers may also be considered during the system design if necessary to provide additional protection to the power grid.

4.3.8 Predicted Effects on Recreation

Potential impacts on recreation are dependent on the extent or degree to which the proposed project would interfere with the use and enjoyment of facilities and resources within the study area.

Impacts to recreation within the Pearl Harbor entrance channel would be minimal since the area is largely restricted to boats owned and operated by military or DoD personnel. Direct impacts to recreation would occur at the location of the proposed buoy array, but public access is already limited in this area for fishing, boating, diving and other recreational activities. Impacts to recreation from the buoy array would be similar to those described in Section 4.2.8.

4.3.9 Predicted Effects on Public Safety

Potential impacts on public safety are dependent on the extent or degree to which the project would interfere with enforcement of existing public safety regulations or potentially cause harm to the public.

The buoy array would lie within a relatively heavily traveled corridor. Potential short-term impacts on public safety include increased use of the area by boaters and fishers if the buoys act as FADs, boat collisions with the buoys, concerns due to divers choosing to explore the buoys, and buoys breaking loose and becoming a hazard to navigation. Promoting public awareness of the project could mitigate some of these impacts, which could lessen over the test period as awareness increases. Removal of the system at the end of the test period would eliminate these potential impacts. Impacts to public safety from the system and proposed mitigation would be similar to that described in Section 4.2.9.

4.3.10 Predicted Effects on Visual Resources

Potential impacts on visual resources include the extent or degree to which the project would: (1) degrade the quality of an identified visual resource, including but not limited to, a unique topographic feature, undisturbed native vegetation, or surface waters, or (2) obstruct public views of a scenic vista.

Impacts on views would be minimal and temporary. Navigational aids from the buoys would extend 30 ft (9 m) above sea level. The impact would be minimal during both daytime and nighttime hours. At night, safety lights on the navigational aids would be visible in the distance.

4.4 PREDICTED EFFECTS ON RELEVANT AFFECTED RESOURCES FROM ALTERNATIVE C: NO ACTION

As the WET test would not be implemented in Hawaiʻi, there would be no impacts on affected resources.

4.5 ENERGY REQUIREMENTS AND CONSERVATION POTENTIAL

Energy requirements for Alternative A: Proposed Action and Alternative B: Pearl Harbor include fuel for installation and maintenance vehicles and equipment. The proposed WET test may contribute energy to the installation electric grid, providing a means of conserving or reducing use of fossil fuels.

4.6 CUMULATIVE IMPACTS

Cumulative impacts are effects on the environment that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what entity undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

4.6.1 Alternative A: Proposed Action

Cumulative impacts are not anticipated from implementation of the Proposed Action. No present or future projects are planned for the project area other than the Proposed Action. As presented in Section 4.2.3.3, no cumulative noise impacts are anticipated because of the lack of existing sounds with frequencies characteristic of the WEC system in the project area.

4.6.2 Alternative B: Pearl Harbor Alternative

Cumulative impacts are not anticipated for the alternative site at Pearl Harbor. No present or future projects are planned for the project area other than the proposed WET test. The Pearl Harbor site has restricted public access and is used primarily for ingress and egress of military ships. The entrance channel is dredged approximately every eight years for maintenance. A new effluent outfall in the open coastal waters offshore of Fort Kamehameha will be constructed; however, this would occur east of the Pearl Harbor alternative site. The effluent outfall would not contribute to cumulative impacts pertaining to implementation of the WET test at this site.

4.6.3 Alternative C: No Action

This alternative would not contribute to cumulative impacts.

4.7 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Irreversible commitments are those that cannot be reversed, except perhaps in the extreme long term. Irretrievable commitments are those that are lost for a period of time.

The Navy would commit the resources necessary to complete the installation and testing of up to six WEC buoys in waters with suitable wave energy conditions. There would be an incremental loss of resource materials used in construction of the buoys and transmission cable (e.g., steel and copper). The WET test would not result in an irretrievable loss of resources.

4.8 UNAVOIDABLE ADVERSE EFFECTS

No unavoidable adverse effects would be associated with implementation of the WET project.

4.9 CONCLUSION

Table 4-1 presents a summary of the predicted environmental effects for Alternative A: Proposed Action, Alternative B: Pearl Harbor, and Alternative C: No Action.

Table 4-1. Comparison of Predicted Environmental Effects

Potential Issue/ Impact	Alternatives		
	MCBH Kaneohe Bay Alternative A	Pearl Harbor Alternative B	No Action Alternative C
SHORELINE PHYSIOGRAPHY			
Impacts of installation and operation	No significant impacts are expected. The WEC system would not alter currents or wave directions and there would be no effects on shoreline erosion or sand deposition patterns. **Mitigation:** none proposed.	Same as Alternative A	No Impacts
Impacts of system removal	No significant impacts are expected. In consultation with the NMFS, USFWS, and DLNR, the Navy would determine at the end of the test period whether equipment installed on the seafloor should be removed or left in place. Land equipment would be removed. **Mitigation:** none proposed.	Same as Alternative A	No Impacts
OCEANOGRAPHIC CONDITIONS			
	No significant impacts are expected. Implementing the WET test would not affect wave scattering and energy absorption. **Mitigation:** none proposed.	Same as Alternative A	No Impacts
MARINE BIOLOGICAL RESOURCES			
Impacts to threatened and endangered species and marine mammals protected under the MMPA during installation and operation of the WEC system	No significant impacts are expected. The USFWS and NMFS concur that the Proposed Action is not likely to adversely affect threatened (green sea turtle) and endangered species (hawksbill turtle, humpback whale, and Hawaiian monk seal) under their jurisdictions. Protocols for avoiding impacts to listed protected species during installation activities would be specified in the construction contractor's BMPs. The taking of marine mammals protected under the MMPA is unlikely. **Mitigation:** none proposed.	If selected, the Navy would initiate informal Section 7 ESA consultation. The taking of marine mammals protected under the MMPA is unlikely. **Mitigation:** none proposed.	No Impacts

Table 4-1. Comparison of Predicted Environmental Effects *(continued)*

Potential Issue/ Impact	Alternatives		
	MCBH Kaneohe Bay Alternative A	**Pearl Harbor Alternative B**	**No Action Alternative C**
MARINE BIOLOGICAL RESOURCES *(continued)*			
Impacts of installation and anchoring on coral and benthic communities	No significant impacts are expected. Minor impacts would occur on coral and benthic communities along the proposed cable route and at the buoy array site. However, installation of the WEC system has been planned to avoid areas with high percentages of coral coverage. **Mitigation:** none proposed.	Minor impacts on coral and benthic communities would occur along the cable route. Installation would avoid areas with a high percentage of coral coverage. The buoy array site is essentially devoid of live coral. **Mitigation:** none proposed.	No Impacts
Impacts to HAPC	The site is not within an HAPC. **Mitigation:** none proposed.	Same as Alternative A	No Impacts
Impacts to marine mammals or turtles from the risk of entanglement with the cable and entrapment within the buoy	No significant impacts are expected. Entanglement would be a minimal concern as cable installation would occur in shallow water with adequate tension to allow the torque-balanced cable to resist forming loops and contour to the seafloor. Divers would inspect the cable route once it is placed. Entrapment of marine mammals or turtles within the buoy would be of minimal concern since the interior of the structure is free of obstructions, sharp edges or corners. As part of the systems monitoring plan to be developed by the Navy, the system will be examined for entrapment of marine species. **Mitigation:** none proposed.	Same as Alternative A	No Impacts
Impacts to marine life from exposure to EMR	No significant impacts are expected. The small scale and limited area of disturbance indicate that impacts from EMR on marine organisms would be minor. Impacts of EMR on marine organisms can be expected to range from no impact to avoidance (for bottom-dwelling organisms only) of the vicinity of the WEC cable. **Mitigation:** none proposed.	Same as Alternative A	No Impacts

Table 4-1. Comparison of Predicted Environmental Effects *(continued)*

Potential Issue/ Impact	Alternatives		
	MCBH Kaneohe Bay Alternative A	**Pearl Harbor Alternative B**	**No Action Alternative C**
MARINE BIOLOGICAL RESOURCES *(continued)*			
Impacts to marine life and divers from potential electrical current leakage	No significant impacts are expected. In the unlikely event that damage to the cable causes an electrical fault, transient effects to marine organisms and divers (mild discomfort) could occur. Electroreceptive species would likely detect the field and be diverted away from the vicinity of the fault during the short period while the ground fault system actuates. **Mitigation:** none proposed.	Same as Alternative A	No Impacts
Impacts to marine life from potential heat release	There would be no impacts to marine life from potential heat release. **Mitigation:** none proposed.	Same as Alternative A	No Impacts
Impacts to marine life from noise generated by the system	No significant impacts are expected. Installation noise produced by drilling holes for rock bolts would be localized, intermittent, and of short duration. Operation of the WEC system is expected to produce a continuous acoustic output similar to, but in a higher frequency of, ship traffic. It is unlikely that noise from system installation or operation would have adverse impacts on humpback whales, dolphins, and green sea turtles. The USFWS and NMFS concur with the Navy that the Proposed Action is not likely to adversely affect threatened or endangered species. The taking of marine mammals protected under the MMPA is unlikely during the installation and operation of the WEC system. **Mitigation:** none proposed.	Same as Alternative A	No Impacts
TERRESTRIAL BIOLOGICAL RESOURCES			
	No threatened or endangered species exist on the proposed project site. **Mitigation:** none proposed.	Same as Alternative A	No Impacts

Table 4-1. Comparison of Predicted Environmental Effects *(continued)*

Potential Issue/ Impact	Alternatives		
	MCBH Kaneohe Bay Alternative A	**Pearl Harbor Alternative B**	**No Action Alternative C**
LAND AND MARINE RESOURCE USE COMPATIBILITY			
	No significant impacts to land and marine resource use are anticipated. Marine resource use incompatibility at the offshore buoy array may result in system security risks. The area is currently open to public access for fishing, boating, and diving. Presently, there are no plans to restrict public access to the buoy array site. The project would not interfere with mission operations at MCBH Kaneohe Bay **Mitigation:** none proposed.	No significant impacts to land and marine resource use are anticipated. The proposed project would not interfere with mission operations at Pearl Harbor. **Mitigation:** none proposed.	No Impacts
CULTURAL RESOURCES			
	There would be no effect on historic properties and no impacts to areas within the Mokapu Burial Area (MBA), NRHP Site 50-80-11-1017, where Native Hawaiian human remains are likely to be found. The Hawaii SHPO was consulted on the Proposed Action and concurred with the Navy's finding of no historic properties affected. **Mitigation:** none proposed.	No impacts on the Pearl Harbor National Historic Landmark. No other cultural resources present. **Mitigation:** none proposed.	No Impacts
INFRASTRUCTURE			
	No impact **Mitigation:** none proposed.	Same as Alternative A	No Impacts
RECREATION			
	There would be impacts to recreation outside the 500-yd (457-m) buffer imposed by the presence of the buoy array during the two- to five-year project duration. These impacts would not be significant. **Mitigation:** none proposed.	No impacts to recreation because the area is used primarily for military ship ingress and egress and the area is off-limits to public access. **Mitigation:** none proposed.	No Impacts

Table 4-1. Comparison of Predicted Environmental Effects *(continued)*

Potential Issue/ Impact	Alternatives		
	MCBH Kaneohe Bay Alternative A	Pearl Harbor Alternative B	No Action Alternative C
PUBLIC SAFETY			
	There would be potential impacts to public safety outside the 500-yd (457-m) buffer imposed by the presence of the buoy array during the two- to five-year test period. **Mitigation**: Each buoy would have safety lights and standard USCG signage. The system would be monitored through a combination of automated system and visual observations. A response plan would be developed.	No impacts to public safety because the area is off-limits to public access. **Mitigation:** similar to Alternative A.	No Impacts
VISUAL RESOURCES			
	Impacts on scenic views would be minimal. Navigational aids from the buoys would extend approximately 30 ft (9 m) above sea level. At night, safety lights on the navigational aids would be visible in the distance. **Mitigation:** none proposed.	Same as Alternative A	No Impacts

Chapter 5

List of Preparers

CHAPTER 5
LIST OF PREPARERS

Listed below are the identities and backgrounds of the principal preparers who contributed to this EA.

U.S. NAVY

Gary Kasaoka. Planner-in-Charge. B.A. degree in zoology and M.S. degree in science and technology.

Jeannette Simons. Archaeologist. B.A. and M.A. degrees in anthropology.

Stephen Smith. Biologist. B.S. and M.S. degrees in biology.

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William Kramer. Biologist. B.S. degree in wildlife biology and M.S. degree in public policy.

BELT COLLINS HAWAII

Lesley Matsumoto, Principal-in-Charge. B.S., atmospheric science. Ms. Matsumoto has over 14 years of environmental consulting experience including environmental planning and feasibility studies. She was responsible for overall project organization and quality control.

Judith Charles, Project Manager. M.P.A., public administration and policy; M.S., soil science; B.S., botany. Ms. Charles' 19 years of multidisciplinary experience encompasses a technical background, environmental planning experience, and knowledge of natural resource policy**.** She was responsible for project organization and coordination and prepared all sections of the EA.

Sue Sakai, Quality Assurance and Quality Control. M.A. degree in political science. Reviewed document for accuracy, completeness, and consistency.

Maura Mastriani, Associate Environmental Scientist. B.S. degree in environmental science. Contributed to all sections of the EA.

SUBCONSULTANTS

John Clark, Ocean Water Recreation and Safety Consultant. B.A. in Hawaiian studies and Masters in public administration (M.P.A.); prepared ocean activities survey report.

Steve Dollar, Ph.D., Marine Research Consultants. Ph.D. and M.S. degrees in oceanography; conducted surveys and reported on marine biological resources.

Dallas Meggitt, Technical Director of Sound and Sea Technology. B.S. and M.S. degrees in aeronautical engineering, M.S. environmental engineering science; prepared technical report describing the potential impacts of entanglement, entrapment, electromagnetic radiation, heat release, electrical leakage, and noise.

Robert Rocheleau, Ocean Engineer, Sea Engineering Inc. M.S. in Ocean Engineering; prepared technical reports on the coastal and oceanographic setting, and wave energy conversion buoy impact on a wave field.

Chapter 6

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CHAPTER 6
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B-2. SeaFlow Project, Environmental Statement, Non-Technical Summary (Nov. 2001)

CASELLA STANGER

MARINE CURRENT TURBINES LTD.
THE SEAFLOW PROJECT, OFF FORELAND POINT, NORTH DEVON

ENVIRONMENTAL STATEMENT

NON-TECHNICAL SUMMARY

November 2001

Collated by	Stewart Lowther MIEEM Director of Ecology
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CONTENTS

INTRODUCTION

1 Marine Current Turbines Ltd have applied for permission to construct and operate a prototype tidal electricity generator at Ordnance Survey Grid Reference SS75000 52165, off Foreland Point, North Devon.

2 The DETR (now DTLR) and MAFF (now DEFRA) indicated to the company that, under the terms of the Harbour Works (Environmental Impact Assessment) Regulations 1999 (the Regulations), and Environmental Impact Assessment (EIA) would be required.

3 Marine Current Turbines Ltd commissioned Casella Science and Environment Ltd (now trading as Casella Stanger Ltd) to carry out the EIA, and to prepare an Environmental Statement (ES) in July 2001.

4 This document is a non-technical summary of the ES. The ES comprises two volumes. Volume 1 contains the central findings of the EIA. Volume 2 contains appendices that support those findings.

SCOPE OF THE ES

5 The Regulations require an Environmental Statement to contain: a description of the proposals; an outline of the alternatives considered by the developer; a description of the parts of the environment that may be affected by the proposals; a description of those possible effects and the measures taken by the developer to avoid or reduce their significance. Finally, the ES should highlight any data discrepancies, or assumptions that may have been made during the EIA, and which may have affected the outcome of the process. A non-technical summary is also required by the Regulations.

6 The DETR advised the developer on the aspects of the environment likely to be affected by the proposals. This advice determined the investigations that were carried out as part of the EIA.

DESCRIPTION OF THE PROPOSALS

7 The Seaflow project is best demonstrated by illustration (see Figure 1).

8 The structure will be supported by a single steel monopile drilled into the sea bed. The generator will be turned by an 11m rotor with three blades, turned by the water flowing past the turbine.

9 Installation of the turbine will be carried out from a jack-up barge, which will be towed to the site. The barge will drill a socket into the sea bed, place the support tower into it, and grout it into place using an inert grouting material. The cuttings from the hole will be pebble-sized and will have a volume of approximately 75 cubic metres. They will be pumped to the surface and then discharged onto the sea bed from a pipe 10m below the surface. The construction period is expected to be around two weeks.

10 The turbine will operate for up to five years. As the turbine is a prototype, it will not be connected to the shoreline via a cable, and the power it generates will be dissipated into the air. At the end of the trial period, the turbine would be removed. The supporting monopile would be cut off at sea bed level and the cut section removed.

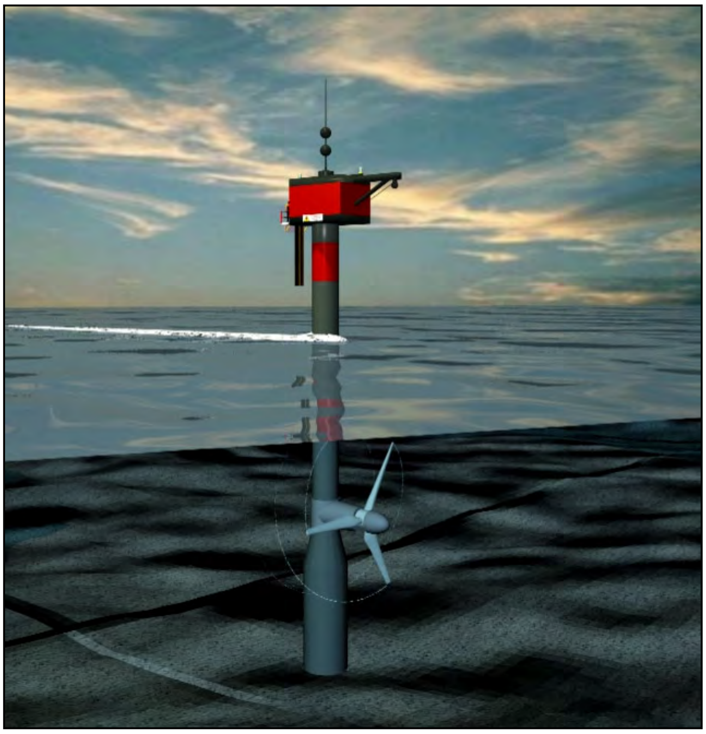

Figure 1: Artist's impression of the Seaflow Project

REASONS FOR SITE SELECTION

11 Several potential sites were examined before a final selection was made. The Foreland Point site was eventually selected because it meets the requirements for high current speeds, whilst at the same time was felt to present few problems to fisheries, navigation, or sensitive flora and fauna. In addition, the site is relatively close inshore and easily accessible, and thus suitable for the frequent monitoring of the prototype machine. Geophysical investigations carried out by the developer showed that the sea bed was suitable for supporting the turbine, and discussions with relevant third parties, including the Exmoor National Park Authority, and English Nature, raised no over-riding concerns.

CONSULTATIONS

12 A broad range of third parties were consulted both prior to and during the EIA process. The consultation exercise aimed to fulfil three purposes: to inform; to obtain information; and to hear any concerns, so that modifications to the design of the turbine could be made where possible.

13 Written views were received from the following:

- Lynton and Lynmouth Town Council
- North Devon District Council
- Trinity House Lighthouse Service
- The Crown Estate

- Maritime and Coastguard Agency
- North Devon Sea Fisheries Committee
- English Nature
- Devon Wildlife Trust
- Environment Agency

14 Meetings, attended by the developers and relevant Casella Stanger Ltd consultants, were held with:

- The Town Clark of Lynton and Lynmouth Town Council
- Representatives of the Exmoor National Park Planning Authority.

15 In addition, presentations were made by the developers and Casella Stanger to the Town Council of Lynton and Lynmouth, and to an open public meeting, attended by 27 interested parties including local residents.

16 Information provided by consultees was taken into account during the EIA process. Dialogue with third parties enabled the approach taken to specific aspects of the EIA (particularly the visual impacts) to be agreed at an early stage. Discussions during the process have enabled solutions to potential problems to be identified, where possible. The ES was therefore prepared in the light of the information and opinions of those consulted.

DESCRIPTION OF THE ENVIRONMENT

The Physical Environment

17 The marine current turbine is located on the seaward side of a depression that lies between Foreland Point and the underwater feature known as Foreland Ledge. The depression is approximately 700 metres long and has a floor around 100 metres wide. Water depths at the floor are between 20 –22 metres below chart datum (CD). The turbine is located on the northern slope of the depression, on the –15m CD contour.

18 The site is directly exposed to waves from west through north to east. The majority of waves are from the west and north west. The largest waves are from a WNW direction, although waves from further to the south, which are more subject to wind and swell, will also influence conditions at the site. Maximum wave heights can exceed 6 metres, although these are predicted to occur only extremely rarely (less than once every 100 years). By far the majority of waves at the turbine location (up to 92%) are less than one metre in height.

19 Tides within the Severn Estuary rise and fall twice a day. Data calculated for the Seaflow site show the mean high water spring tides to be 9.5m above chart datum, and mean low water spring tides to be 0.7m above CD, giving a spring tidal range of 8.8 metres. The neap tidal range is 4.4 metres.

20 Maximum tidal flows on both the ebb and flood tides are in an east to west direction. Maximum ebb currents are greater than maximum flood currents. Maximum current speeds are typically between 2.0 and 2.5 metres per second on spring tides. Current speeds of more than 1 metre per second persist for approximately 4.5 hours during the ebb tide flow, and for approximately 5 hours during the flood tide flow.

21 The seabed on the site is generally hard and featureless, with less than 1 metre of deposits overlying the bedrock. In some natural gullies, for example, 1000 metres from the turbine site, up to 2 metres of sand cover can occur, with evidence of sand waves on the surface. The turbine site, however, lacks fine sediments, which are presumed to have been removed by tidal currents.

The Biological Environment

22 Foreland Point is included within the Exmoor Heaths Coastal Site of Special Scientific Interest (SSSI), parts of which have been proposed as candidate Special Areas of Conservation (cSAC). The are included in the cSAC does not extend to the shoreline, and none of the habitats for which the SSSI was designated fall within the shoreline zone. No adverse impacts upon the integrity of the SSSI are predicted to arise from the Seaflow Project.

23 Sampling of the seabed, commissioned by Casella as part of the EIA process were analysed in conjunction with video footage of the site, also carried out as part of the EIA. The samples from the site and its vicinity showed the seabed community to be relatively homogenous, and dominated by mussels *Mytilus edulis* and barnacles *Balenus crenatus.* Encrusting bryozoan species and pea crabs *Pisidia longicornis* were also important components of the fauna. The remainder of the community was composed of moderate numbers of crustaceans, bivalves and polychaete worms. None of the sixty or so species found were unusual or rare.

24 The videolog confirmed the findings of the samples, and showed mussels occurring a few tens of metres away from the turbine location. Other species recorded on video, but not found in the grab samples included frequent large anemones (probably *Urticina* species), yellow sponges and the soft coral *Alyconium digitatum*. Dog whelks *Nucella lapillus* and occasional starfish and brittlestars were also found.

25 It was concluded that the community is not particularly risch or diverse, and contains elements typical of scoured cobbles. It is suggested that the tidal currents cause movement in the stones on the seabed, and prevent colonisation by many species. Additionally, the frequent cloudiness of the water would prevent the growth of plants and some encrusting animals.

26 There is no accurate means by which to evaluate the number and frequency of larger, roving marine species in the area. Bottlenose dolphins *Turciops truncatus*, certainly occur, and harbour porpoises *Phocoena phocoena,* other cetaceans and basking sharks *Cetorhinus maximus* are also likely. Sunfish have also been observed in the area. The marine habitats in the vicinity of the turbine site are not uncommon, however, and there is no evidence to suggest that any species is specifically attracted to the area.

27 A number of relatively common seabirds occur in the general area and several breed on the cliffs at Foreland Point. Anecdotal evidence suggests that the majority of acitivty on the water takes place in the relative shelter of the inshore waters, away from the main channel, where current speeds were greatest. Nevertheless, some diving birds may feed in the vicinity of the turbine structure.

Landscape and Seascape

28 Foreland Point is the northernmost point along a 55km stretch of coastline characterised by “hogs back” cliffs and steep wooded slopes. The dramatic nature of the coastline was one of the primary reasons for the designation of the Exmoor National Park in 1949, the main objective of which is to conserve and enhance the natural beauty of Exmoor. “Natural beauty” is taken to include flora, fauna, geological and physical features, and cultural aspects of the landscape.

29 The landscape character of the areas to each side of Foreland Point can be divided into four distinct types:

- Cliffs and foreshore
- Coastal moor and heathland
- Mature woodland on steep slopes
- Farmed landscape on gentle slopes

30 These are shown on Figure 2 in Appendix 2 of the Environmental Statement.

31 The largest community within the National Park is at Lynton and Lynmouth. Although two distinct settlements, they are regarded as a single community, sharing services and facilities. Lynmouth originally developed as a small port importing coal, culm and limestone, and exporting livestock and other produce. The herring fishing industry has also played a major role in the town’s economy. Lynton, although pre-dating Lynmouth, developed rapidly as a tourist destination during the Victorian period. A cliff railway links the two settlements, and in the present day, continues to be a major tourist attraction. Tourism currently comprises approximately 50% of the local economy.

32 All of Lynmouth, and central and eastern parts of Lynton, have been designated as Conservation Areas. Most of the open spaces in the settlements are protected for visual and recreational amenity.

33 There are no other towns or villages in the area. The only hamlet of note is Countisbury, which boasts a popular inn and an attractive church, both welcome signs to ramblers on the South West Coastal Path.

34 The character of the seascape is defined by the cliffs and shoreline, which create a dramatic backdrop for seafarers along this stretch of coastline. Lynmouth Bay has a particular sense of enclosure, framed by the cliffs of Foreland Point to the east and the wooded slopes of Lynmouth and Hollerday Hill to the west.

35 Views from land are of a tranquil and picturesque seascape. Because they face northwards, away from the sun, the sea appears deep blue and blue-green. On clear days, views are afforded across to South Wales and the Gower Peninsula.

36 The seascape is highly affected by weather conditions. Good visibility in the morning can haze over in the afternoon, and fog can shroud the coastline. During blustery and stormy periods visibility is also reduced and viewing can be challenging. The seascape becomes predominantly grey and waves vary in scale and force. These harsher conditions can be appealing to walkers on the cliffs and remote headlands.

37 There are a number of sensitive locations that will have potential views of the upper sections of the Seaflow Project. Key receptors identified in the Environmental Statement are (in no particular order):

- Fishing vessels and pleasure boats
- Holiday cottages at Foreland Point Lighthouse
- Ramblers on the South West Coastal Path
- Motorists on the A39
- Residents and tourists at Lynton and Lynmouth
- Tourists in the Valley of Rocks

ASSESSMENT OF IMPACTS

38 Possible impacts of the Seaflow Project were considered and assessed with regard to:

- Spatial effects (local, coast-wide, estuary-wide, national, international)
- Temporal effects (short, medium and long term)
- Reversibility
- Significance (major impacts are significant, minor impacts are not)

Physical Environment

39 The support column of the Seaflow turbine is designed to withstand both the short term high energy of storm waves and the longer term, lower energy stresses of normal conditions. The structure will cause a localised disturbance to passing waves, but will not significantly alter wave energy. This impact is of medium term, reversible and of minor significance.

40 Changes to water flows as they pass the underwater sections of the turbine, including the rotating blades, will be minor and localised. Some turbulence will occur downstream of the structure, but flows are predicted to recover quickly. The impact of the structure on flows is of medium term, reversible and of minor significance.

41 From a scouring and deposition point of view, there is a lack of potentially mobile sediments around the zone affected by current turbulence caused by the turbine. The speed and duration of existing flows have denuded the area of its fines, leaving a hard, compacted bed. Due to this lack of available material, there will be no impact on the overall sediment transport regime, either locally of in the wider marine environment.

42 Drilling of the seabed for the installation of the pile will potentially have an effect on water quality, both as a result of disturbance around the hole, and disposal of drill cuttings. This will primarily cause a localised clouding in the lower sections of the water column. The generally fast currents in the area will disperse this cloudiness quickly and there will be no residual impacts. There is a small possibility that some fines may settle out on the sea bed in areas of low flows e.g. in the lee of Foreland Point, or be transported onto beaches. The volume of material is, however, insignificant in relation to the volume of material arising from natural geomorphological processes, and the cuttings will be similar in composition to the existing materials in the marine environment.

Biological Environment

43 The seabed community identified during the studies undertaken by Casella Stanger on behalf of the developer is a robust one, able to tolerate a severe degree of scouring. During construction, some damage to the seabed community is inevitable. Such damage would be highly localised: in the vicinity of the foundations ($12m^2$); beneath the footprints of the jackup barge (a total area of $6m^2$) and at the cuttings discharge point (estimated to be around $50m^2$). Marine communities typically re-colonise impacted areas quickly, and the impacts are not expected to extend into the medium term. The lack of impacts on the physical environment of the site strongly indicates a similar lack of medium to long term impacts on the seabed community. The effects of the Seaflow turbine on these habitats are therefore predicted to be short terms and of minor significance.

44 Potential impacts on larger marine species comprise collision and the possible adverse effects of underwater noise. Collision risk is difficult to predict, owing to the non-randomness of animal behaviour and the probability that collision avoidance would normally occur. Dolphins and porpoises use echolocation and are likely to be aware of the structure. Seals have keen hearing and are also likely to be aware of the turbine. There is an uncertainty as to the means by which basking sharks detect their surroundings, particularly in the dark, but they are known to swim very slowly (around 3mph). The blades of the turbine rotate at a relatively slow rate of 23 revolutions per minute, and sweep a diameter of only 10 metres. Collision probability, even without avoidance, is therefore judged to be low, and serious injury and mortality are unlikely. Disturbance due to underwater noise is also difficult to predict, as the level of noise produced by the operating turbine is not known. It is likely to be considerably lower than noise produced by surface vessels, but would be of long, rather than short term duration. Taken in the round, the impacts of the Seaflow proposals are considered to be minor. However, it is recommended that measurements are made during the life-span of the Project to assess the frequency and level of underwater sound produced by the turbine. Should levels prove to be potentially problematic, appropriate design modifications can therefore be made to ensure that future installations are improved.

45 The possible impacts of the project on diving birds are considered to be insignificant, owing to the likely low intensity of use of the site.

Landscape and Seascape

46 Illustrations supporting this section of the ES are included within Volume 2, Appendix 3. The impact assessment considers the effects of the proposed structure on key locations, or “receptors”. These were identified either independently by a Casella Stanger Ltd specialist, or through discussions with the Town Clerk of Lynton and Lynmouth, and with representatives of the Exmoor National Park Planning Authority.

47 It is neither desirable nor practical to summarise the assessments of the visual impacts of the structure on these key receptors. Instead, the written descriptions for each receptor are reproduced in their entirety in the Appendix to this Non-Technical Summary.

48 In terms of the significance of the impact, at distances of over 3km, the visual impact of the turbine will be negligible. At between 2 and 3km, the structure will be visible from Wind Hill, Butter Hill and Kipscombe Hill. Although the

significance of the visual influence of the development cannot be described as negligible, it is reduced by the varied and dramatic nature of the coastline, which allow the seascape to absorb the Seaflow structure. Under 2km from the turbine, the structure will be easily visible from the stretches of the South West Coastal Path to each side of Foreland Point. On clear days, these views will be significantly altered by the presence of the structure, and it is suggested that a small, low level information board, which explains the project, may be suitable on these stretches.

49 At between 1 and 1.5km the minor footpath on the western side of Foreland Point is marked as dangerous and discourages most walkers from approaching from this direction. Access can be made from the east, but this is only by occasional walkers and those using the lighthouse cottages. Views from the holiday cottages are considered to be of high significance, although the temporary nature of the project will ameliorate this impact somewhat.

Effects on Fisheries

50 No commercial fishing takes place at the site of the development, although lobster pots are placed nearby in the inshore waters by two fishermen. There is a risk that these could be damaged by vessels during and after construction of the turbine. The resulting temporary loss of income could be of moderate significance to the fishermen concerned. It is recommended in the ES, therefore, that prior to the start of construction, discussions are held with the fishermen with a view to agreeing protected areas into which vessels associated with the Seaflow Project either do not venture, or enter only after consultation.

Effects on Navigation

51 The channel in the vicinity of the Seaflow project is used by a small number of vessels and the structure itself does not lie on a significant navigation route. The structure will be marked as an isolated navigation hazard in accordance with advice provided by Trinity House, and noctural lighting will be provided. The effects of the structure on navigation are therefore considered to be of minor significance, and will be of medium term duration.

Noise

52 A fog warning system, with a range of one nautical mile, will be fitted to the structure. The effects of the fog horn on Lynton and Lynmouth will be insignificant. The device would be audible from the South West Coast Path at Foreland Point, and from the holiday cottages at Foreland Point lighthouse. The extent to which this will be regarded as a negative impact will depend upon the perception of individuals affected. Some people are likely to find the sound evocative of the maritime environment they are visiting, whilst others may find it moderately intrusive.

DATA DEFICIENCIES

53 The following factors may affect the robustness of the conclusions reached in the Environmental Statement:

- The precise number and behaviour of roving marine species in the area is uncertain, and the level of underwater noise that the structure may produce is unknown. The assessment of likely effects on certain species, including dolphins, porpoises and seals was therefore made on the basis of discussions with the scheme designers, a review of some of the available literature on marine mammal sensitivity to noise, and reasonable professional judgement.
- Assumptions on levels of shipping in the immediate vicinity of the structure were based on anecdotal evidence, rather than on direct measurements.
- The effects of the foghorn are based on the assumption that the conditions that would trigger its use are comparatively uncommon in the area. No measured data was obtained to support this assumption.

SUMMARY OF IMPACTS

54 The following table provides a summary of the impacts assessment.

	Scale				Duration			Residuals		Significance		
	Local	Regional	National	International	Short term	Medium term	Long term	No residuals	Residuals	Major	Moderate	Minor
Physical environment												
Wave climate	✓					✓		✓				✓
Flow	✓					✓		✓				✓
Sea bed / sediments	✓					✓		✓				✓
Water quality	✓				✓			✓				✓
Biological environment												
Habitats/benthos	✓					✓		✓				✓
Marine species	✓					✓		✓				✓
Birds	✓					✓		✓				✓
Landscape												
>3km	✓					✓		✓				✓
2-3km	✓					✓		✓				✓
1.5-2km	✓					✓		✓			✓	
1-1.5km	✓					✓		✓		✓		
Fisheries	✓					✓		✓				✓
Navigation	✓					✓		✓				✓
Noise	✓					✓		✓				✓

APPENDIX TO NON-TECHNICAL SUMMARY:

VISUAL EFFECTS OF THE TURBINE STRUCTURE

Visual Effects of Turbine Structure

The visual impacts of the proposed marine current turbine and its superstructure above mean sea level have been assessed with regard to significant receptors of views of the installation after construction. These are scheduled below. Figure numbers refer to those in Appendix 3 of Volume 2 of the ES.

Visual effects on views from seafaring vessels

LOCATION	*DESCRIPTION OF VISUAL EFFECTS*
WITHIN 1 KILOMETRE *ELEVATION: 3METRES* *IMPACT: HIGH*	The tower and container housing the lifting gear for the turbine will be most prominent to any boats passing Foreland Point, but the black and red banding with 2 black spheres will identify it as a marine hazard (with fog horn) and it will be viewed in that context. The view from around 100 metres would be similar to that in illustration 2, fig 4.
Under 3 kilometres *Elevation: 3metres* *Impact: medium*	The installation will be less prominent but will still figure as a static identifiable item on clear days. The unit would still break the horizon line for small boats but in bright conditions, the supporting column and the edges of the container will begin to 'burn off', due to the limited acuity of the human eye
OVER 3 KILOMETRES *ELEVATION: 3METRES* *IMPACT: NEGLIGIBLE*	Although still just visible on clear days, the unit will begin to merge with the horizon and will have a negligible visual significance on the marine seascape

Visual effects on views from holiday cottages at Foreland Point

LOCATION	*DESCRIPTION OF VISUAL EFFECTS*
Montage A, fig 11 Foreland Point *Distance: 1.12km* *Elevation: 90m* *Impact: medium to high*	At just over 1km from the turbine structure and almost 100m above sea level, this is the closest land based view, with the cottages facing directly north toward the turbine structure. It would be noticeably apparent in most weathers and could be regarded as a point of interest, although to some extent the container and column will merge with the background seascape (ie structrure will not be silhouetted).

Visual effects on views from South West Coast Path

LOCATION	*DESCRIPTION OF VISUAL EFFECTS*
View 1A, fig 5 Lower slopes to north of Butter Hill *Distance: 1.63km Elevation: 225m Impact: medium*	This view marks the closest point from which the 'Datchet' can be seen from the South West Coast Path. The Datchet appears closer than 1.63km due to the view being projected over the clifftops directly towards the boat, but this view is lost further uphill due to more shallow slopes which shed views over the boat. For walkers who may have reached this point from Lynmouth, previous sections of path will, however, have afforded more distant views of the turbine structure - perhaps raising questions as to what it may be. This could be an appropriate location for an interpretive infor-mation board. 'The Foreland' ridgeline is also clearly seen to the right of the photograph, which casts a significant visual shadow over a large area.
View 1B, fig 5 Junction of coastal footpaths *Distance: 1.50km Elevation: 105m Impact: nil*	The western shoulder of The Foreland screens the Datchet from view just below viewpoint 1A and also displays a warning sign highlighting dangers of accessing Foreland Point Lighthouse from this side. Few walkers therefore venture further north from this point and on progressing eastwards for over a kilometre, views towards the Datchet are totally screened by The Foreland.
Viewpoint 2, fig 5 Coastal Path west of Butter Hill *Distance: 2.20km Elevation: 270m Impact: medium*	Long distance walkers using the South West Coast Path will have a focused view towards the proposed installation on walking north-east along the edge of Butter Hill towards Foreland Point. The Datchet is 2.2 km from view and similar to view 1A, it appears closer than its true distance due to being just above the landform horizon.
Views from Path below A39 and Wind Hill *Distance:2.50-3.25km Elevation: 100-250m* *Impact: low to medium*	This section of the South West Coast Path gently rises 150 metres over 1.5km between Blacklands Wood (leaving Lynmouth) and the ridgeline to the north-west of Countisbury, and passes through dense bracken for much of its length. The path can be seen below the viewpoint on **photomontage B**, which then continues through heather and gorse moorland below Butter Hill in the distance. Open running views would be obtained of the turbine structure for this whole length, but the dramatic nature of Foreland Point would act as a magnet for these coastal views, so increasing the capacity to accommodate the feature. Ninney Well is a scheduled ancient monument north-west of Wind Hill but no open views are obtained towards the turbine structure due to the configuration of the cliffs.
Views from Path between 1B and KipscombeComb	This section of the South West Coast Path runs east-west behind and to the south of The Foreland, and as such is totally screened from view of the Datchet.

e *Distance 1.5-2km Elevation: 118-190m Impact: nil*	This visual shadow continues up the valley south of the Warmersturt landform until one reaches Kipscombe Combe, and also along most of the smaller footpath running north to access Foreland Point.
Views from Kipscombe to Desolation Pt *Distance 2-3.5km Elevation: 160m Impact: low/ med*	For a few hundred metres to the north-west of Chubhill Wood, the footpath would have views toward the turbine structure, but being over 2km distant and with various elements of landform and woodland competing for visual attention, the potential impact of the structure would be reduced. For the next kilometre through Chubhill and Doctor's'Wood, the proposal would be totally obscured throughout the year by woodland. Over the next half a kilometre to Wingate Wood 2 short sections of path would have open views toward the structure, but the potential impact of these views would be minimised by the competing view along the cliffed coastline toward Foreland Point, similarly to views from north of Wind Hill.
Views beyond Desolation Pt *Distance: >3.5km Elevation: 160-200m Impact: negligible*	The visual shadows cast by the combination of Wingate Wood and the ridges of Desolate Red and Multieburff Hill means that potential views of the installation are not regained until almost 4km distant. From this distance, the unit would only just be visible on clear days and even then, would only appear as a small boat on the seascape.

Visual effects on views from other footpaths, farms and features

LOCATION	*DESCRIPTION OF VISUAL EFFECTS*
Viewpoint 3, fig 5 Access track to Foreland Point *Distance: 2.00km Elevation: 180m Impact: low/ med*	This view illustrates the narrow window of view between The Foreland (left) and the right hand landform (known as Warmersturt), from a point on the access track exactly 2km from the Datchet. This track yields access to Foreland Point lighthouse from the A39 near Kipscombe Farm, but is not on the main South West Coast Path and so seldom used by walkers.
Viewpoint 4, fig 6 from just above Kipscombe Farm *Distance: 2.75km Elevation: 300m Impact: low*	This view is taken from the public footpath just above Kipscombe Farm. 'The Datchet' is just visible above the coastal woodland, 2.75km from the viewpoint, but with the visual complexity of the landscape and seascape (farm buildings, wooded valley, large gentle landform and truncated coastal ridge), there is capacity to accommodate a relatively small marine feature without detriment to the seascape. The photograph clearly illustrates the significant influence of 'The Foreland' ridge closest to the boat in casting a large visual shadow further inland. It also shows how the intervening lower slopes of Barna Barrow and the mature woodland in Kipscombe Combe would effectively screen Kipscombe Farm from the installation.

Footpaths west of Kipscombe Farm *Distance: 2.3-2.75km Elevation: 290m Impact: low to nil*	Apart from a short stretch of path immediately west of Kipscombe Farm where the influence of the narrow window between 'The Foreland' and Warmersturt is still noticeable, the path remains totally shadowed from view by The Foreland. This influence extends up to Barna Barrow, which will also be totally screened from view.
Footpaths east of Kipscombe Farm *Distance: 2.3-3km Elevation: 280-300m Impact: low*	Figure 3 illustrates that this smaller path will have running views towards the turbine structure for about one kilometre until views are cut off by the north-eastern slopes of Kipscombe Hill. However, similar to viewpoint 4, the potential impact of views from these open vistas will be dissipated by the complexity of landscape features, which here includes Chubhill Wood below.
Viewpoint 5, fig 6 from Old Burrow Hill *Distance: 4.5km Elevation: 335m Impact: nil*	This small Roman Fortlet is accessed by a concessionary footpath off the A39. The photo-graph illustrates the influence of the well established pine plantation in totally screening Foreland Point and the Datchet from view.

Visual effects on views from the A39 on Countisbury Hill

LOCATION	*DESCRIPTION OF VISUAL EFFECTS*
Photomontage B fig 12 Countisbury Hill *Distance: 2.99km Elevation: 185m Impact: low to mediuml*	The photomontage shows the existing and proposed views from the coastal side of the single parking bay half way up Countisbury Hill. This gives the only opportunity for descending drivers to stop and view Foreland Point, although drivers and passengers on the A39 ascent have fairly continous views out over Lynmouth Bay.
	At 3 kilometres distance, the Datchet is visible on the clear sunny day that the photograph was taken. The scale of the turbine structure would be proportionately larger as illustrated on the photomontage but three factors would help to lessen its impact in the seascape: i) distance of view, where haze and atmospheric conditions will reduce the sharpness of image (not accounted for in the photomontage) ii) elevation of view, where the dark colours of the container (black and red) will often be set against a backdrop of darker marine colours iii) drama of view, where the articulation of Foreland Point with its coastline of rocky outcrops and sandy beaches draws the visual focus and increase the capacity of this section of seascape to accommodate change.
	This photomontage also illustrates views from the bridleway above and the long distance coast path below the parking bay, which although of different elevations, would be very similar to this view.

Visual effects on views from Lynmouth and Lynton

LOCATION	*DESCRIPTION OF VISUAL EFFECTS*
View 6, fig 6 Lynmouth Eastern Beach *Distance: 3.75km Elevation:8m Impact: negligible*	This illustrates the appeal of Lynmouth's Eastern Beach as a popular tourist spot. It is however some 3.8km from the Datchet, which appears as a small buoy on the horizon and which can be compared with the pleasure steamer nearer Foreland Point. Considering all the foreground activity and movement along this coastal strip, the presence of such a feature on the horizon will be hardly noticeable and its significance negligible.
Montage C, fig 13 Lynmouth Western Beach *Distance: 3.83km Elevation: 8m Impact: negligible*	This beach has a slightly different character from the Eastern Beach, mostly due to it being closer to the main visitor attractions and car park. The photograph was taken almost exactly opposite the base station of the cliff railway, and the popular promenade shows visitors enjoying landward views as well as out to sea. The photograph shows a fairly busy coastline, both in terms of visitor and in terms of physical elements, for instance promenade wall and fortification, river estuary and two rocky beaches, enclosing woodland and distant headland. The combined effect of all these elements is to diffuse any visual focus, and in terms of the turbine structure, to render it insignificant in this seascape context.
Views 7-9, fig 7 Cliff Railway *Distance: 3.8-4km Elevation: 8-135m Impact: negligible*	Photograph 7 illustrates one of the 2 cars on the Cliff Railway just after the start of descent, from which point views toward the turbine structure are totally screened by mature woodland on the northern side of the railway. This is illustrated by photograph 9, taken from the North Walk bridge which crosses the railway. The view from the railway itself is at a lower elevation and is even more channeled towards the Eastern Beach and Foreland Point (ie not to the turbine structure). The only place from where an open vista is gained towards the structure is from the top viewing station, as on photograph 8 – taken on the afternoon of the day after the Datchet was chartered. Viewing conditions were misty, as they were for all the previous day, highlighting the importance of the local climate in appraising marine features off the North Devon coast. Even on sunny days, however, the turbine structure would be a miniscule element in the seascape, to be observed closely only by telescope (possibly with an interpretative information point), would otherwise be visually insignificant 4km away.
View 10, fig 7 Northcliff Hotel Ground Floor *Distance: 3.83km Elevation: 8m*	This view – similar to photograph 9 but from the elevated ground floor of Northcliff Hotel (North Walk, just east from the cliff railway) shows a narrow view opened up over Lynmouth Bay. It was photographed on a clear sunny day, with the Datchet potentially visible

Impact: negligible	4km away, but illustrates the effect of atmospheric haze in rendering the boat, and most probably the structure, invisible. It also shows the presence of large beech and sycamore trees along on the cliff side which obstruct views to the structure from almost the entire length of North Walk at road level, and many ground and first floor views of the large hotels along the road.
Views 11-13 fig 8 Hollerday Hill Viewing Point *Distance: 4.15km Elevation: 200m Impact: nil*	Viewpoint 11 faces directly towards Butter Hill some 3km to the east (A39 can be seen rising up the hillside shoulder) The view is framed by canopies of mature Ash and Sycamore, which also obstruct views toward the Datchet when attempting to view from the right and in front of the stone display feature. Therefore, although a significant viewpoint over Lynmouth, this does not extend to the sea off Foreland Point. Views 12 and 13 detail the two display boards.
Views from Castle Hill and eastern edge of Lynton *Distance: 4.00km Elevation: 120-135m Impact: negligible*	Figure 3 illustrates the combined effects of the mature woodland screening views from many of the large hotels and properties along Castle Hill and Church Hill, and these and other buildings in turn screening potential views from the main developed area of Lynton. Upper floor windows from occasional buildings will have views out over Lynmouth Bay but in most cases these will be restricted with a competing foreground roofscape or townscape.
Views 14,15 fig 9 from Grattons Drive *Distance: 4.35km Elevation: 205m Impact: photo14 nil photo15 negligible*	Photograph 14 illustrates a significant intervening woodland belt which screens ground and almost all first floor views along Gratton Drive towards the proposed turbine structure. Even in winter this tree belt will still act as a good foil to the structure. Photograph 15 shows a view over Lynmouth Bay which is briefly glimpsed from the main access road just adjacent Grattons Drive. Although presenting an open vista over the bay, this is not judged to be significant due both to the distance of the object from view and the brevity with which it is viewed. It should be noted that views 14 and 15 were taken on a misty afternoon.

Visual effects on views from Hollerday Hill and the Valley of Rocks

LOCATION	*DESCRIPTION OF VISUAL EFFECTS*
View 16 fig 1 Valley of Rocks *Distance: 4.50km Elevation: 175m impact: nil*	Photograph 16 illustrates the rugged beauty that attracts tourists to this valley 1km west from Lynton and 5km from Foreland Point. Most visitors are content to stay within the vicinity of the café and car parks in the valley (one of which is seen in the middle distance), although some venture to one of the following viewpoints.
View 17 fig 11 Hollerday Hill *Distance: 4.25km*	Photograph 17 illustrates a view obtained by occasional walkers willing to tackle the steep zig-zag path from the valley floor. It is taken on the intermediate footpath half

Elevation: 200m *Impact: negligible*	way between the summit of Hollerday Hill and the lower footpath which extends from North Walk. The Datchet can just be seen 4.25km away, as can the lighthouse on Foreland Point, but these are dwarfed by the overall expanse of Lynmouth Bay and rendered practically invisible by the reflective light qualities across the bay. Dense Oak and Sycamore woodland can also be seen on the shoulder of Hollerday Hill, an enclosing feature of the seascape of Lynmouth Bay.
View 17 fig 11 Valley of Rocks *Distance: 4.60km* *Elevation: 135m* *Impact: negligible*	This most distant view of the Datchet is obtained from one of the gaps along the ridgeline enclosing the seaward side of the Valley of Rocks. This allows access from one of the main car parks to the South West Coast Path and vice-versa, and is accessible by less able-bodied members of the public. Although just visible to the naked eye when viewed from on site, the visual significance of the Datchet is 'burnt off' due to seascape reflections and the limit to the acuity of the human eye.

B-3. Siadar Wave Energy Project, Environmental Statement (2008)

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i Acronyms

AOD	Above Ordnance Datum
AoL	Ampullae of Lorenzini
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas
ASFB	Association of Salmon Fisheries Boards
BERR	Department of Business, Enterprise and Regulatory Reform
BW	Boussinesq Method
CAD	Computer Aided Design
CD	Compact Disk
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMACS	Centre for Marine and Coastal Studies
CoPA	Control of Pollution Act, 1974
CPA	Coastal Protection Act, 1949
CRTN	Calculation of Road Traffic Noise
CSO	Combined Sewage Overflow
dB	Decibels (measure of loudness of sound)
DoE AL 72	Department of Environment's Advisory Leaflet 72
DTI	Department of Trade and Industry
DWR	Deep Water Route
EIA	Environmental Impact Assessment
EMEC	European Marine Energy Centre
EMFs	Electro Magnetic Fields
EMS	Elliptical Mild Slope OR Environmental Management System
ENVID	Environmental Issues Identification
EPA	Environmental Protection Act, 1990
ES	Environmental Statement
FEH	Flood Estimation Handbook
FEPA	Food and Environmental Protection Act
FREDS	Forum for Renewable Energy Development in Scotland
GCR	Geological Conservation Review
GWh	Giga Watt Hour
HGV	Heavy Goods Vehicle
Hz	Hertz (measure of frequency)
ICES	International Council for the Exploration of the Sea

IEA	Institute of Environmental Assessment (now part of IEMA)
IEMA	Institute of Environmental Management and Assessment
IMO	International Maritime Organisation
IoA	Institute of Acoustics
ISO	International Standards Organisation
JNCC	Joint Nature Conservation Committee
LAT	Lowest Astronomical Tide (1.6.1)
LBAP	Local Biodiversity Action Plan
LCA	Landscape Character Assessment
LCT	Landscape Character Type
LIMPET	Land Installed Marine Powered Energy Transformer
MCA	Maritime and Coastguard Agency
MGN	Marine Guidance Note
MHWS	Mean High Water Spring
MLWS	Mean Low Water Spring
MMO	Marine Mammal Observer
MNR	Marine Nature Reserve
MRDF	Marine Renewables Deployment Fund
MSO	Marine Supply Obligation
MW	Mega Watt
MWh	Mega Watt Hour
NLB	Northern Lighthouse Board
NPPG	National Planning Policy Guidelines
NSA	National Scenic Area
NSR	Noise Sensitive Receptor
OREI	Offshore Renewable Energy Installations
OWC	Oscillating Water Column
PAN	Planning Advice Note
PE	Potential Evaporation
PTS	Permanent Threshold Shift
RIB	Rigid Inflatable Boat
RO	Renewables Obligation
ROC	Renewables Obligation Certificate
ROS	Renewables Obligation (Scotland) Order, 2007
ROV	Remotely Operated Vehicle
RSPB	Royal Society for the Protection of Birds

RYA	Royal Yachting Association
SAAR	Standard Average Annual Rainfall
SAC	Special Area of Conservation
SCT	Seascape Character Type
SEA	Strategic Environmental Assessment
SEPA	Scottish Environment Protection Agency
SMRU	Sea Mammal Research Unit
SNH	Scottish Natural Heritage
SOPEPs	Shipboard Oil Pollution Emergency Plans
SPA	Special Protection Area
SPP	Scottish Planning Policy
SSSI	Site of Special Scientific Interest
SWEP	Siadar Wave Energy Project
TMS	Traffic Management System
TTS	Temporary Threshold Shift
UK BAP	United Kingdom Biodiversity Action Plan
WIFT	Western Isles Fisheries Trust
WILBAP	Western Isles Local Biodiversity Action Plan
WRAP	Winter Rainfall Acceptance Potential
ZTV	Zone of Theoretical Visibility
ZVI	Zone of Visual Influence

1 Introduction

1.1 Background to the scheme

1.1.1 npower renewables Limited (npower renewables) is proposing to construct a new wave energy project generating up to 4 megawatts (MW) capacity on the north west coast of the Isle of Lewis at Siadar (see Figure 1-1). This demonstration project is known as the Siadar Wave Energy Project or SWEP.

1.1.2 npower renewables is one of the UK's leading renewable energy companies, dedicated to generating electricity using sustainable, environmentally friendly resources. It has a wide ranging portfolio that includes both onshore and offshore wind farms, hydro plant and co-firing biomass. Through the proposed SWEP, npower renewables is extending it's generation portfolio into marine renewables.

1.1.3 The development of the proposed scheme is being progressed by npower renewables in collaboration with the technology supplier Wavegen. npower renewables is also working with a local liaison group that includes the Siadar Pier Group, and the Urras Oighreachd Ghabhsainn (Galson Estate Trust) and also the Crown Estate.

1.1.4 With the European Marine Energy Centre (EMEC) in Orkney at the forefront of much of the technical and environmental work associated with wave energy devices in Europe, npower renewables and Wavegen are working with EMEC to identify areas where the Siadar scheme can adopt emerging standards and best practices and also to share information.

1.2 Overview of the project

1.2.1 The proposed project will be one of the first marine renewable energy projects in the UK, and will contribute directly to both Scottish and UK Government drives to establish marine renewables as a significant means of electricity production in the UK. The scheme will also contribute towards Scottish and UK targets for the production of electricity from renewable energy sources to deliver decreases in greenhouse gas emissions. With a capacity of up to 4 MW the scheme will generate on average more than 8 GWh each year, enough to supply the domestic needs of around 1,500 households.

1.2.2 The project is to be located in the coastal waters near Siadar, north west Lewis (see Figure 1-1). This area of Lewis is known, along with other parts of the Western Isles, to offer the greatest coastal wave resource in the UK (ABPMer *et al*, 2004; Marine Energy Group, 2004a). The coastal waters off the Atlantic coast have also been identified as an area for the development of wave energy projects in the recent Scottish Government Strategic Environmental Assessment (SEA) (Faber Maunsell & Metoc, 2007).

1.2.3 The project will use the active breakwater concept. An active breakwater consists of a breakwater type structure located in relatively shallow water a short distance offshore. The principle of energy conversion is the Oscillating Water Column (OWC). A series of air chambers are incorporated within the structure, and air turbines are used to capture energy from the wave driven flow of air in and out of the chambers.

1.2.4 For the proposed scheme it is envisaged that up to 40 turbines will be installed into a breakwater approximately 250 m long located 350 m offshore. The breakwater structure may be connected to the adjacent shore by a fixed link to facilitate access to the structure for operational and maintenance purposes. Alternatively a slipway and boat access may be used.

1.2.5 As well as the active breakwater harnessing of the local wave energy resource to generate electricity, it has the potential to provide benefits to the local community in terms of shelter for their boat slipway. The Siadar Pier Group are a local community group trying to redevelop the existing slipway at Siadar to improve boat access in the area. It was recognised that without some form of breakwater, improving the existing slipway would have limited benefit. With support from Highland and Island Enterprise, Innse Gall to Comhairle nan Eilean Siar and a local consultant, the Siadar Pier Group met with Wavegen, and the idea of an 'active breakwater' at Siadar was born and this has matured into the Siadar Wave Energy Project.

1.3 Policy background

The requirement for renewable energy generation

1.3.1 There is increasing demand for the supply of electricity using technologies that do not contribute to the emission of greenhouse gases (carbon dioxide in particular) because of three principal drivers:

- Increasing demand for electricity;
- Imperative to reduce emission of greenhouse gases, such as carbon dioxide; and
- Security of supply and the resulting drive to develop indigenous energy sources.

1.3.2 Renewable energy sources present a major opportunity to meet this demand. In addition to wind, the substantial wave and tidal stream resources around the UK and Scotland in particular (FREDS Marine Energy Group, 2004) are increasingly being considered for the provision of greenhouse gas free electricity from an inexhaustible and clean resource.

1.3.3 In doing so they would contribute to the Scottish target for the production of 50% of electricity demand in Scotland to come from renewable sources by 2020, with an interim target of 31% by 2011 (Scottish Government's Spending Review, 2007).

1.3.4 The proposed scheme will be one of the first significant projects to help make further progress toward the realisation of a substantial Scottish based marine renewables industry, which has the potential to deliver 7,000 jobs in Scotland directly concerned with marine renewable energy (FREDS Marine Energy Group, 2004).

Support mechanisms

1.3.5 The marine renewables sector is dominated by technologies that have yet to reach full commercial viability. Early projects therefore require Government support in order to secure funding for their construction. Renewable energy projects are primarily supported by the Renewables Obligation, with additional support provided through Research & Development (R&D) funding and capital grants. The two funding support mechanisms available to support this project are summarised below:

Renewables Obligation

1.3.6 The Renewables Obligation (RO) is the UK Government's main mechanism for supporting generation of renewable electricity. The obligation, enforced by legislation, requires licensed electricity suppliers to source a specific and annually increasing percentage of the electricity they supply from renewable sources which results in an economic benefit to the renewable generation scheme.

Marine Supply Obligation

1.3.7 Specifically to encourage Scottish marine developments, the Scottish Government has introduced its own obligation for wave and tidal projects, the Marine Supply Obligation (MSO). The MSO acknowledges that the marine energy industry is not at the point where it can compete with other more established renewable technologies and therefore requires additional support. This system provides an additional obligation for electricity to be supplied from marine renewables.

Marine renewables deployment fund (MRDF)

1.3.8 The £50m MRDF has been established by the Department for Business, Enterprise and Regulatory Reform (BERR, formerly the DTI) to offer capital grants to support technology development between prototype development and progression to commercial scale projects. The MRDF scheme is designed to support demonstration projects typically in the 3-5 MW scale to bring them closer to commercial reality. Under the qualifying criteria for MRDF funding the SWEP is well placed to be a recipient.

1.4 Consent requirements and development policy

1.4.1 Prior to commencement of any renewable energy development there are a number of statutory consents and approvals that have to be gained. Given that the proposed scheme will have a footprint in both the marine and terrestrial environments, it will require a number of different consent and licence approvals. Table 1.1 summarises all the key consenting legislation and environmental regulations relevant to the proposed project.

Table 1.1 Relevant environmental legislation and consents

Regulations	Details of requirement
Crown Estate Act 1971	A Crown Estate lease is required for the use of the foreshore and seabed owned by the Crown Estate. This consent is recognition of the Crown Estate's landowning interest and is separate to any permission which may be required from other Government departments. This application is supported by the EIA/ES.
Electricity Act 1989 (Section 36)	The Act provides the core legislation for planning consents for the construction and operation of generating stations. Electricity generation proposals over 1 MW offshore must be authorised under Section 36 of the Act enforced in Scotland through the Electricity (Applications for Consent) Regulations 1990 and the associated Electrical Works (Environmental Assessment) (Scotland) Regulations 2000.
Coastal Protection Act 1949 (Section 34) (CPA)	Section 34 of the CPA provides for the restriction and removal of works detrimental to shipping. Written consent is required if the works (while being carried out or subsequently) could cause an obstruction or danger to shipping.
Food and Environment Protection Act 1985 (Part II Deposits on the Sea) (FEPA)	Under FEPA a licence is required for depositing articles on or under the seabed. The primary objectives of the legislation are to protect both the marine environment and human health and to minimise nuisance and interference to other legitimate sea users. In deciding on whether or not a licence will be granted the licensing authority will pay particular attention to the environmental implications of the proposed project including: • The potential hydrological effects; • Interference with other marine activities; • Potential risk to fish and other marine life from contaminants, noise and vibrations; • The effects of increasing turbidity and potential for

Regulations	Details of requirement
	smothering/burial of benthic fauna and flora; and • Any adverse implications for designated marine conservations areas.
Electricity Works (Environmental Impact Assessment) (Scotland) Regulations f00	Stipulates the requirement to undertake an EIA for electricity developments in excess of 1 MW.
Town and Country Planning (Scotland) Act 1997	The Act provides the framework for the planning system in Scotland. The planning system regulates the development and use of land in the public interest, and is a method of reconciling the demand for development and the protection of the environment.
Environmental Impact Assessment (Scotland) Regulations 1999	The EIA Regulations set out the statutory procedures, list the types of project to which they apply, specify the information to be contained in an environmental statement (ES), list the consultation bodies and provide criteria for deciding whether projects are likely to have significant environmental effects.
Conservation (Natural Habitats &c.) Regulations 1994 Offshore Marine Conservation (Natural Habitats &c.) Regulations 2007	Competent authorities are required to ensure that steps are taken to avoid the disturbance of species and deterioration of habitat in respect of the terrestrial sites and species and that any significant effects are considered before authorisation of certain plans or projects. Provisions are also in place for issuing of licences (EPS licences) for certain activities and for undertaking monitoring and surveillance of offshore marine sites.
Energy Act 2004	Sections 105 to 114 of the Energy Act 2004 introduce a decommissioning scheme for offshore wind and marine energy installations. Under the terms of the Act, the Secretary of State may require a person who is responsible for one of these installations to submit (and eventually carry out) a decommissioning programme for the installation.

1.4.2 In addition to the above detailed legislative regime, there are also national planning policy guideline documents relevant to the proposed project. Relevant guidance has been considered as required e.g. Scottish Planning Policy (SPP) 6: Renewable Energy.

Local development policies

1.4.3 The Western Isles land use planning policy detailed in the Western Isles Structure Plan f03. The plan outlines key development and land use strategies set out under five broad headings that together aim to create sustainable communities within the western isles:

- Development management;
- Resource management;
- Economic development;
- Housing, community and leisure services;
- Transportation.

1.4.4 The separate Western Isles Local Plan is currently at the end of its statutory public consultation period and this will be integrated with the Western Isles Structure Plan 2003 in due course. The

Western Isles Local Plan, Map 01: North Lewis (2005), exhibits 3 areas subject to planning policies in the vicinity of the SWEP, these are:

- **RM8** Special Protection Area (Lewis Peatlands: Ramsar, SAC and SPA);
- **T1** Spinal Route (the A857);
- **RM3** Locally Important Agricultural Land (to the North West of Siadar).

1.4.5 Those policies listed above and other development policies relevant to the SWEP are outlined in Appendix A.

1.5 Purpose and scope of the environmental impact assessment

1.5.1 The Environmental Impact Assessment (EIA) process is the principal means by which the key requirements of the consent and licences listed above are addressed. The Electricity Works (EIA) Scotland Regulations 2000 enforce this requirement in Scotland. The EIA is a process that identifies the areas where significant environmental effects are likely to occur as a result of a development, and outlines any mitigation measures/management controls aimed at reducing or ideally offsetting these effects. The Environmental Statement (ES) reports the findings, which informs stakeholders and statutory consultees and provides recommendations for the establishment of environmental management and monitoring plans.

1.5.2 This ES reports the findings of the EIA process and explains how conclusions have been reached. The intention has been to present information in such a way as to demonstrate that the activities are being implemented in the correct manner with due consideration for the environment. This document is presented in the following sections:

PART ONE - BACKGROUND

- **Section 1** Background to the proposed project;
- **Section 2** Description of the main alternatives considered.
- **Section 3** Description of the proposed development programme;
- **Section 4** Description of the characteristics of potential environmental sensitivities to the proposed project;

PART 2 – ENVIRONMENTAL IMPACT ASSESSMENT

- **Section 5** EIA methodology, scoping and consultation
- **Sections 6 to 16** Detailed assessment of potential effects; and
- **Section 17** Description of the environmental management controls that will be in place to ensure implementation of commitments made during the EIA.

1.6 Data gaps and uncertainties

1.6.1 The Siadar site and area is presently an undeveloped area and as can be expected complete environmental and background information for such an area does not exist. As part of the EIA and as required by the EIA regulations, information gaps and uncertainties in scientific understanding were identified specific initiatives to address the issues commissioned. These included undertaking a number of surveys to generate baseline environmental data and the commissioning of a range of experts to undertake specific studies to assist in the assessment of effects.

1.6.2 Thorough execution of baseline research allows the production of a robust environmental description focussing on the elements of the environment that are considered to be most sensitive to the proposed project and expert studies assist in the assessment of potentially significant effects.

1.6.3 The following investigations/studies were commissioned as part of the EIA. Full copies of supporting reports are provided on a CD in the front of this report.

1.6.4 Environmental consultants Xodus AURORA, specialists in EIA for marine projects, were commissioned to undertake the full EIA and prepare the ES. Xodus AURORA worked closely with the npower renewables project team who provided input on the project alternatives, design, operation and decommissioning.

Table 1.2 Investigations and studies undertaken as part of the EIA process

Topic/issue	Organisation/individual	Study details	Provided on CD[1]
Phase 1 habitat survey (including otters)	West Coast Energy	Phase 1 habitat survey of terrestrial and intertidal, including consideration of otter populations	✓
Seabed survey	Aspect	Bathymetric, drop down video and side scan sonar surveys completed to inform report	✓
Terrestrial archaeology survey	Rachel Barrownman – Lewis based archaeologist	Survey of terrestrial archaeology and fieldwork for visual impact assessment on cultural heritage interests	✓
Marine cultural heritage - review of side scan sonar data	Headland Archaeology	Review of side scan sonar data to identify possible targets of cultural heritage interest	✓
Breeding bird survey	Alison Rothwell – Lewis based ecologist	Breeding bird survey, which also included observations of marine wildlife visible from shore	✓
Visual and landscape assessment	Xodus AURORA	Fieldwork to establish zone of visual influence, confirm locations for photomontages and assessment visual and landscape impact from key sensitivities	-
Design Statement for the onshore control building	Anderson Associates – Lewis based chartered architects	Details of the design process and preferred design option for the onshore control building	✓
Hydrology, geology and hydrogeology assessment	Mott MacDonald	Desk based study drawing on findings of survey work undertaken by West Coast Energy	-
Terrestrial habitats and ecology assessment	Xodus AURORA	Desk based study drawing on the findings of the survey work undertaken by West Coast Energy and breeding bird survey	-
Marine habitats and ecology assessment	Xodus AURORA	Desk based study drawing on the findings of the seabed survey, Phase 1 habitat survey and breeding bird survey	-
Cultural heritage assessment	Xodus AURORA	Desk based assessment drawing on the findings of the archaeological survey undertaken by Rachel Barrowman	-
Coastal processes	Mott MacDonald	Modelling of wave regime and	-

[1] Majority of impact assessment studies written up directly into the ES format, however where there are were separate studies/reports commissioned these are available for reference on the CD, provided within the front cover of the ES.

Topic/issue	Organisation/individual	Study details	Provided on CD[1]
assessment		shelter effects from the proposed breakwater and fixed link structure. Desk based study of potential effects on coastal process	
Onshore noise assessment	Mott MacDonald	Baseline noise measurements, modelling of received noise levels at sensitive onshore receptors and desk based impact assessment	-
Assessment of underwater noise and electromagnetic effects	Xodus AURORA	Desk based impact assessment study	-
Transport	Xodus AURORA	Desk based impact assessment study	-
Socio economic impact study	Brian Burns Associates	Local consultation and desk based impact assessment study	-

1.7 Extent of Design

1.7.1 The ES is based on the pre-consent designs which have established the broad design and construction methodology for the scheme. These designs are mature enough to be able to carry out a full and comprehensive EIA. However, at this stage in the design process there are some options within the scheme layout and construction methodology that remain viable alternatives until a detailed design is undertaken and construction contractor appointed, typically things which occur once consent has been granted. Based on the pre-consent designs all potential options associated with the proposed EIA have been assessed. Consent for all the options is being sought and is necessary to allow the successful progression of the scheme into construction.

2 Alternatives

2.1 Introduction

2.1.1 It is a requirement of the Electricity Works (Environmental Impact Assessment) Scotland Regulations 2000 that alternatives for achieving the objectives of the proposed development should be described and the basis for the selection of the preferred proposal should be outlined.

2.1.2 A consideration of alternatives has been undertaken at both the macro and micro level. At the macro level there are fundamental differences between the various methods of electricity generation. Having chosen to utilise wave energy, consideration of alternatives relating to the proposed wave energy scheme involved an initial review of potential locations having wave climates with potential for generating up to 4.0 MW of electricity.

2.1.3 At the micro scale, the iterative development process applied to the SWEP has also provided various design alternatives. Each of these has been considered or discounted on the basis of environmental, technical, financial or practical reasons. It must be noted that this project is one of the first of its kind and is a demonstration project from which a better understanding of the technology will be gained. At this stage of this development it is not possible to definitively state the project design which is why a number of the alternatives remain as options within this ES.

2.2 Alternative generation technologies

2.2.1 The Scottish electricity grid is connected to both the English and the Irish grids. These interconnections together with a significant overcapacity of generation plant, allow Scotland to be a net exporter of electricity, typically exporting about 20% of the electricity generated. In Scotland, a mix of technologies and fuels is used to generate electricity. The main sources of electricity are nuclear, coal, gas/oil and hydroelectric, although the composition is subject to variation over time because of changes in fuel prices, technological developments and the introduction of government policies and initiatives, such as those relating to renewable energy.

2.2.2 Thus in summary, 38 % of the electricity generated in Scotland comes from nuclear, with a further 48% coming from fossil fuels and the remaining 14 % coming from renewable sources (based on 2005 generation figures). However, as part of the Climate Change Programme, the Scottish Executive has set a target that 31 % of electricity demand in Scotland by 2011 should be from renewable sources, rising to 50 % by 2020. In response to this target and its associated regulatory and fiscal measures, many developers are now seeking consents for renewable technology, with wave and tidal schemes offering a large but as yet untapped opportunity.

2.2.3 In Scotland, the Renewables Obligation (RO) 2005 requires licensed electricity suppliers to source specified percentages of the electricity they supply from renewable sources. The percentage target is set to increase each year from a level of 4.9 % in 2004/05 to reach 10.4 % by 2010/11. In addition to this the Scottish Government has established the Marine Supply Obligation (MSO) which obliges suppliers to source some of their energy from marine energy projects thereby raising extra funds to support marine energy projects. SWEP would qualify for support under this scheme.

2.2.4 SWEP will therefore, contribute to the Government's renewable energy target and also that of npower renewables. However, it should also be a catalyst to further and more extensive projects of this type which can be rolled out not only in the UK but in locations around the world.

2.2.5 Other technologies have been considered but are not favoured for the following reasons:

2.2.6 **Nuclear** - at present, about 38 % of the electricity generated in Scotland is generated by nuclear technology at Torness (east of Edinburgh) and Hunterston (on the Clyde coast). Although this technology has low carbon dioxide emissions, this technology faces significant challenges in the long-term management of its waste streams and non-renewable fuel source. This technology is also unable to vary its output fast enough to satisfy the variability of electricity demand.

2.2.7 **Coal-fired Power Stations** – about 25 % of electricity is generated from coal in Scotland at for example the plant at Longannet in Fife. Such plant emits large quantities of atmospheric pollutants (including carbon dioxide) together with large quantities of warm cooling water (though cooling towers may reduce this need and the plant's efficiency). It also consumes a non-renewable fossil fuel, and produces a significant volume of ash and (depending on the precise technology used) flue gas desulphurisation by-products. This technology is also unable to vary its output fast enough to satisfy the variability of electricity demand.

2.2.8 **Gas-fired Power Stations** - such as the relatively modern plant at Peterhead, produce about 17% of the electricity generated in Scotland. Unlike nuclear and coal plant, the type of gas generation used at Peterhead is relatively flexible and can, within limits, follow the variations in electricity demand. However, it burns a premium grade, non-renewable fossil fuel at moderate efficiency, produces carbon dioxide and other atmospheric gases (albeit in smaller quantities than the older, less efficient, coal plant) and has a substantial cooling requirement.

2.2.9 **Hydroelectric Schemes** – hydroelectric schemes account for 10 % of the electricity generated in Scotland. npower renewables has an active program of building new run-of-river hydro schemes in the 1-5 MW output range. The proposed output of the SWEP compares well to the hydro schemes currently being consented and built in the UK and makes a valuable local contribution to electricity demands.

2.2.10 **Wind Power** – forms part of the other 4 % of Scotland's generation. Like hydro they do not emit pollutants and do not consume fossil fuels (other than during construction), however, there are periods when the wind speeds are not suitable for generation and hence other generation sources are required. npower renewables is actively developing such schemes both on and offshore in the UK.

2.3 Preliminary design alternatives for the Siadar Wave Energy Project

2.3.1 This section outlines the alternatives considered during the preliminary design and development of the SWEP and indicates the main reasons for selecting the proposal. The following section deals with the methods and options considered for:

- Site selection;
- Design process;
- Breakwater location;
- Access arrangements for the breakwater;
- Control building location; and
- Construction methodology.

2.3.2 There is always the option of simply not developing a project. However, given current central and local government policies supporting the development of renewable sources of energy, wave energy schemes should be developed where:

- Their environmental effects are acceptable;
- The scheme is accepted by the landowners and occupiers directly impacted; and
- The scheme is commercially viable.

2.3.3 As far as npower renewables is able to establish at this stage, the SWEP, in the form now proposed and allowing for final optimisation of the design, meets these criteria.

Site selection

2.3.4 npower renewables has a systematic method of assessing and prioritising schemes for development against each of the following general criteria:

- **Output** - the potential electrical energy generated;
- **Landownership** - the likelihood of concluding satisfactory agreements with all relevant landowners for the rights to develop the scheme;

- **Constructability** - how easy or difficult the scheme would be to construct from an engineering point of view, including the difficulty of the terrain, sea and subsea conditions, the need to excavate rock, ease of access for construction and any restoration after construction;
- **Environment and planning -** the likelihood of the necessary consents for the scheme being forthcoming, taking into account known environmental sensitivities, likelihood of encountering protected species, statutory and non-statutory environmental designations, planning policy and visual amenity issues;
- **Location -** the suitability of the project location in terms of ability to connect to the electricity grid system, ease of management and maintenance, and compatibility with npower renewables other interests;
- **Public interest -** the site specific public sensitivities surrounding the scheme, for whatever cause;
- **Competition -** the extent to which other parties are, or might be, competing to develop overlapping or incompatible schemes in the same locality; and
- **Stage of development** - taking into account the fact that the further the development process has progressed, the less is the potential for unforeseen risk to emerge.

2.3.5 The scheme proposed by npower renewables at Siadar ranked highly in all these criteria. Other potential wave energy schemes were considered by npower renewables and have also been considered at length by the technology provider Wavegen. On the above merits the Siadar site is viewed favourably, but as the technology is still to mature this scheme is viewed as being an opportunity to learn about which sites will be best to develop in the future. Further sites will be pursued subject to the above criteria and better knowledge available in the future.

Design process

2.3.6 The development of the design has been carried out over several stages of the project's life cycle. The first 3 stages up to and including the design study have been completed. These are as follows:

- **Preliminary design** – Various options were generated which provided the design necessary to solve the engineering challenge. The proposals at this stage did not involve much detail but were sufficiently well developed to be assessed from a general engineering and environmental prospective.
- **Feasibility** – The feasibility of various options was considered with respect to a number of criteria including environmental suitability, technical feasibility and economic viability. At this stage initial environmental, bathymetric and topographical surveys were commissioned to determine the environmental and technical constraints of the project.

- **Design study** – The preliminary design, which was developed further through the feasibility stage, was developed to a higher level of detail with additional engineering and environmental assessment. This was carried out for npower renewables by engineering consultants Jacobs Babtie. The design study examined in detail the various design solutions for the breakwater, access to the structure by boat, access to the structure by fixed link and the construction methodology. Wavegens' technology requirements have also to be incorporated into the design. The design process was run in parallel to the EIA, with the EIA process assessing and informing the design selection of various engineering solutions. A separate architectural design was also commissioned to develop an outline design for the onshore control building required to house the onshore aspects of the project.
- **Detailed design**– The detailed design will not be completed until the necessary consents and licences are in place. This will allow the final design to take account of any comments made by the statutory and non-statutory consultess in their responses to the consent and licence applications.

2.3.7 The scheme configuration presented in this ES has been the result of the first 3 stages of the design process described above.

Breakwater location

2.3.8 During the preliminary design stage, a wave resource study was undertaken. This identified the predominant incident direction of waves at this site. To maximise energy capture the structure should be oriented perpendicular to this direction. The location and depth of water at which the structure is located is a balance of the potential for a greater energy yield in deeper water versus the increased technical challenges required to build the scheme in deeper water. The other factor taken into account when locating the structure was the shelter benefit it would offer the existing slipway and the desire to maximise this whilst taking the other parameters into account.

Access arrangements to the breakwater

2.3.9 A permanent fixed link and boat access have both been assessed as options for accessing the structure for operational and maintenance activities. At this stage in the design process a decision on which option is best cannot be made so both options are still open. However, the following points will influence the access arrangements:

- The design work on the permanent fixed link has found that a full length rubble mound causeway is liable to be expensive and difficult to construct. However, a part causeway in the shallow waters inshore connecting to a steel truss bridge mounted on tripod dolphin piers in the deeper offshore sections is likely to be viable.

- Boat access is also still in contention as it eliminates a significant cost from the project, but is liable to lead to more restrictive operational access times that will be dependent on local sea and weather conditions.

2.3.10 The fixed permanent link will originate from either of two onshore locations to intersect the breakwater, either adjacent to the existing Scottish Water works or adjacent to the existing slipway. The landfall location for the link will largely depend upon how the scheme is constructed, but the preferred option is for it to originate adjacent to the existing slipway. Cabling will be required to transfer the electricity from the breakwater back to shore. If a fixed link is present then the cabling will be ducted through or over the structure, either bridge or rubble mound causeway. If there is no fixed link then the cabling will be laid on the seabed with suitable armour protection until the foreshore where they would then be buried.

2.3.11 The detailed design and procurement of the civil's works will determine which of these options is progressed. The favoured option is to have a permanent fixed link consisting of part rubble mound causeway and part steel truss bridge.

Construction methodology

2.3.12 The construction of the 10 breakwater caisson units, each weighing about 3,000 tonnes, and deploying them presents a considerable technical challenge. Minimising the amount of works to be carried out in the sea to reduce exposure to the potential for poor weather is a key concern which has ruled out a number of construction approaches. Two clear construction methodologies remain:

- Local fabrication of the caissons at a temporary construction facility onshore at the south end of the Siadar Bay. Raw materials would be delivered to site by road and a local borrow pit would also provide some of the aggregate required. Once completed, the caissons would be launched using a purpose built slipway and submerged trench and then secured in position.
- Remote construction of the caissons at an offsite fabrication facility. A specific location has not been identified. Once constructed the caissons would be floated, largely using their inherent buoyancy, and towed to site for installation.

2.3.13 There are existing roads and tracks connecting with the main A857 allowing good access to the site. Access during construction has been considered in detail and in consultation with the local authority transport department. A new temporary access track which ran to the south of Baile an Truiseil to reduce traffic through Baile an Truiseil was considered. However, it is favoured that the existing route is used during the construction period with the proviso that any road damage is made good at the end of the project. This also avoids disturbing the undeveloped habitats and archaeology which a new track has the potential to do.

Onshore control building

2.3.14 The location of the control building will be close to shore to minimise the cabling required from the breakwater. There are two candidate locations for it, either adjacent to the existing Scottish Water works or adjacent to the existing slipway. These locations were chosen for their operational convenience but also to avoid the various local ecological and archaeological interests. The favoured location will depend on which of the above options are progressed, in particular whether local construction is used and whether a fixed link is employed. It is sensible to have the building adjacent to the landfall of the fixed link or adjacent to the slipway if boat access is used.

2.3.15 A number of outline designs have been considered for the control building, taking into account the technical requirements and also the need for it to integrate well into the local landscape. The final floor plan and space requirements will depend on the need for a boat house, if boat access is required, and also the distribution of electrical equipment between onshore and offshore in the breakwater so it could vary considerably in size but for the purposes of the EIA the largest possible structure has been considered. Through an iterative process an indicative 'longhouse' style design has been produced by a local architect to satisfy the required criteria.

3 Description of the Proposed Development

3.1 Introduction

3.1.1 The SWEP is to be located in the coastal waters near Siadar, on the Isle of Lewis (see Figure 1-1). The scheme will consist of a breakwater-type structure up to 250 m in length located approximately 350 m offshore, due west of Siadar. This structure will house up to 40 wave energy conversion devices and will be one of the first wave energy power stations in the world. The total electricity generation capacity is to be up to 4 MW. The scheme could also enhance access to the sea by providing some shelter within the Siadar Bay to users of the local boat slipway facilities.

3.2 Design status

3.2.1 The design of the project is at a stage where the envelope of the location and dimensions of the structure are known, and possible construction methods have been established. A finalised design and construction method cannot be fully established until a construction contractor has been appointed after gaining consent. The options presented in the ES (see Table 3.1 and Figure 3-1) are not options for the consenting authority to choose between, but necessary options required to ensure there is a viable scheme which can be taken forward once consent is received. Therefore, consent for all the options presented here is being sought.

3.2.2 The design presented here has taken account of the environmental sensitivities identified in the scoping exercise and by further studies as part of the EIA. Where necessary the design has been modified to avoid any significant adverse effects. Once the planning consent is received there will be a further opportunity to refine the final design in response to any consent conditions.

3.2.3 The principal components of the active breakwater scheme, as shown in Figure 3-2, comprise of the following:

- a breakwater structure;
- wave energy converters located within the breakwater;
- a possible fixed permanent link to shore;
- an onshore control building and possible boat house;
- a possible new/refurbished slipway; and
- access tracks.

3.2.4 In addition, it is anticipated that there will be a need for an onshore site compound and possible construction base. This will be a temporary facility for use during the construction period only.

3.2.5 A borrow pit supplying aggregate materials to the site will also be located within 2 km of the development.

3.2.6 The following sections describe the scheme components.

Table 3.1 Scheme design options

<table>
<tr><td rowspan="10">Primary Options</td><th>Aspect</th><th>Options</th><td colspan="3" rowspan="2"></td></tr>
<tr><td rowspan="2">Caisson construction methodology</td><td>Local construction - construction compound established adjacent to the Scottish Water works at Siadar to fabricate caissons. A ramp would facilitate movement of the caissons from the foreshore into the sea. (1a)</td></tr>
<tr><td>Remote construction - the caissons are floated to site for installation. (1b)</td><th>Aspect</th><th>Options</th><td rowspan="6">Secondary Options</td></tr>
<tr><td rowspan="5">Operations and maintenance access to the breakwater.</td><td>Fixed permanent access to link the breakwater to shore by rubble mound causeway. (2a)</td><td rowspan="2">Cabling to Shore</td><td rowspan="2">Ducted cables embedded within fixed link (4a)</td></tr>
<tr><td>Fixed permanent access to link the breakwater to shore by part causeway part steel truss bridge. (2b)</td></tr>
<tr><td rowspan="3">Boat access from onsite slipway. (2c)</td><td>Cabling to Shore</td><td>Series of cables laid on seabed with protective armour sleeves and in buried duct under foreshore. (4b)</td></tr>
<tr><td rowspan="2">Slipway and boathouse</td><td>Refurbishment and upgrade of existing slipway with boathouse adjacent to it. (5a)</td></tr>
<tr><td>Retention of slipway used for local construction (Option1a) and boathouse part of adjacent control building. (5b)</td></tr>
<tr><td rowspan="2">Onshore control building</td><td>Located adjacent to existing slipway. (3a)</td><td colspan="4" rowspan="2"></td></tr>
<tr><td>Located adjacent to existing Scottish Water works. (3b)</td></tr>
</table>

3.3 Oscillating Water Column (OWC) wave energy converter

3.3.1 The scheme will use the Oscillating Water Column (OWC) wave energy principle to convert wave energy into electricity. This is relatively novel technology that has been employed experimentally in only a few locations world-wide. This project is a major progression for the technology and the scale of such projects and will be vital to proving and developing the wave power technology.

The project will serve as an important research and development mechanism to the advancement of the technology, and the roll-out of further such schemes worldwide. This demonstration project will not only progress the technical development of OWC technology, but also increase understanding of its interaction with and possible effects on the environment.

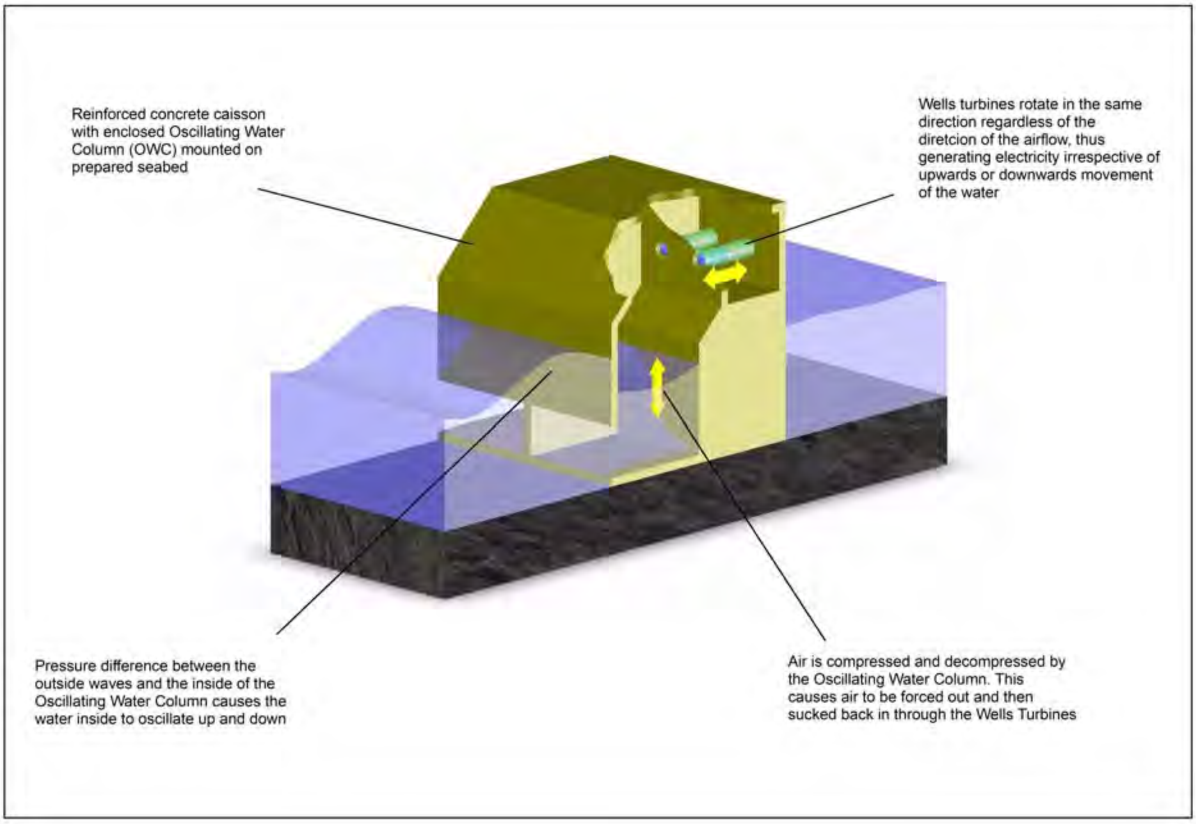
3.3.2 The main features of an OWC device include a collector chamber with submerged opening and a turbine and generator (see Figure 3-3).

3.3.3 The collector chamber consists of a chamber with a submerged opening to the sea and an air vent at the top. This allows waves to rise and fall within it, driving air in and out of the vent which is fitted with a Well's turbine. This converts the reciprocating flow of air into a constant rotational motion to drive a generator. The resulting energy is then transferred to shore by sub-sea or fixed link installed cables. The concept of OWC technology built into a breakwater structure in this way is known as an active breakwater.

3.3.4 A prototype device which adopts the OWC principle has previously been installed on the island of Islay. However, this LIMPET (Land Installed Marine Powered Energy Transformer) scheme is a shoreline energy converter which has been constructed in dry conditions on a rocky foreshore area. In an attempt to harness the higher levels of energy associated with the waves in the nearshore zone, npower renewables and Wavegen are developing OWC caisson units which will rest on the seabed in around 5 - 10 m of water.

3.3.5 A fresh water blade cleaning system will also be employed to maintain aerodynamic efficiency of the Wells turbines blades which otherwise can become encrusted in salt particles over time. The water would be piped to the structure as part of the bundle of electrical cables. Once discharged onto the blades the water would disperse into the atmosphere as a result of the high velocity of the blades.

Figure 3-3 Oscillating water column schematic



3.3.6 This scheme will be formed by an array of OWC's, in this case up to 20 distinct OWC's. Each OWC will drive a pair of 100 kW Wells turbine. So in total the scheme will have up to 40 turbines totalling up to 4.0 MW nominal capacity.

3.3.7 The final design and installation of the complete electrical system and wider works will take into account the requirements of the Electricity Safety, Quality and Continuity Regulations 2002.

Energy output predictions and carbon dioxide displacement

3.3.8 Output predictions for the SWEP take into account the variable nature of the wave resource, down time of the turbines due to maintenance and losses that are inherent in this type of scheme. The scheme will only generate electricity when the incident wave resource is sufficient to drive the turbines, although not always at maximum output. The capacity factor is a term used to describe the average energy output related to the maximum possible output of the SWEP if the generators were operating to their rated capacity over the same period.

3.3.9 It is estimated that the SWEP will produce approximately 8,000 MWh per year based on an assumed installed capacity of 4.0 MW. This is enough electricity to supply the average annual electricity needs of around 1,500 UK homes each year. This is based on the UK average annual domestic electricity consumption of approximately 4,700 kWh over the life of the SWEP this figure may change as average domestic electricity consumption changes.

3.3.10 Every kilowatt hour of electricity produced by the SWEP feeds in to the electricity network whenever it is produced. This reduces the demand for electricity generated by conventional power stations (often coal or gas) which vary their output to balance supply and demand on the network. Wave energy therefore saves the emission of carbon dioxide (CO_2) predominantly through reduced consumption of a combination of both coal and gas. It is difficult to predict exactly what volume of CO_2 emissions the SWEP will prevent as the amount of CO_2 generated by a varying mix of conventional sources changes from year to year. For the stated annual output, it is anticipated to be a saving of at least 2,960 tonnes of CO_2 with a theoretic maximum of 7,000 tonnes. In practice, the figure is likely to lie somewhere between the two[2].

3.3.11 Table 3.2 below presents carbon dioxide emission saving predictions for the SWEP. The offset will make an important contribution to the Scottish Government's targets of cutting carbon dioxide emissions. Over the life of the project, annual emission savings are expected to decrease in line with the increase in cleaner energy technologies contributing to the UK's generating plant mix.

Table 3.2 Carbon dioxide offset figures

SWEP installed capacity	Predicted annual generation	Number of homes equivalent supplied per annum	Carbon dioxide offset (tonnes per annum)[2]	
4.0 MW	8,000 MWh	1,500	2,960 tonnes of CO_2 Assuming gas produced electricity is always displaced (low case)	7,000 tonnes of CO_2 Assuming coal produced electricity is always displaced (high case)

3.4 The breakwater

3.4.1 The scheme will consist of a breakwater-type construction located in relatively shallow water a short distance offshore. Wavegen's OWC technology will be installed within the structure to capture energy from the incident waves.

[2] The figure for CO^2 savings depends on which source of electricity generation the SWEP generating capacity is displacing at any given time during the year. This range reflects the difference between CO^2 displacement factors of gas-fired and coal-fired generation. It should be noted that future changes in the power generating mix and fuel costs in the UK means this figure may change over time. Calculations assume emissions of 370 g CO^2 / kWh for gas generated electricity and 876 g CO^2 / kWh for coal generated electricity as stated in The Digest of UK Energy Statistics (2006).

3.4.2 To operate effectively as an active breakwater a number of important design criteria will have to be considered which will influence the layout, construction, installation and operation of the breakwater, including the following:

- Existing site access and layout;
- Nearshore wave climate;
- Suitable construction site for caisson construction and ability to transfer the caissons to offshore seabed site;
- Seabed topography and geology and ease of installation of the caissons;
- Incorporation of the optimum features for an OWC energy capture system; and
- Ease of access for operational and maintenance activities.

3.4.3 A technical assessment of these aspects has been used to determine the preferred location, design and construction methodology for the active breakwater.

Location

3.4.4 The preferred location is approximately 350 m offshore, due west of Siadar at grid ref NGR NB 3745 5507. Figure 3-4 shows the preferred breakwater position as well as the envelope within which it could be built as defined by the red line boundary. In relation to this diagram the corner apex locations are provided in the following table.

Table 3.3 Scheme design options

Apex	Coordinates: National Grid reference NB		Coordinates: degrees, decimal minutes	
	Easting	Northing	Latitude	Longitude
1	3755	5533	N58° 24.438"	W6° 29.692"
2	3768	5523	N58° 24.389"	W6° 29.552"
3	3735	5480	N58° 24.146"	W6° 29.860"
4	3722	5490	N58° 24.195"	W6° 30.000"

3.4.5 The final position will be determined by further design and site investigation work. The water depth at this location is approximately minus 5-6 mCD[3] at LAT[4]. Some flexibility is required such that the exact position of the breakwater could be moved north east or south west along the given depth contour by up to 150 m from a central position. This will allow for final refinements of the design immediately prior to construction.

[3]The mean tidal ranges experienced at Siadar are 3.6 m for spring tides and 1.6 m for neap tides. Chart Datum (CD) is 2.2 m below Ordnance Datum (OD) at Carloway, which lies approximately 24 km (15 miles) south east of Siadar

[4] Lowest astronomical tide (LAT) - the lowest water level that can be expected to occur under average meteorological conditions and under any combination of astronomical conditions.

3.4.6 For reference the significant tide levels at Siadar are given in the following table:

Table 3.4 Mean tide levels at Siadar

Mean Tide	Tidal Data (m CD)
MHWS	+4.2
MHWN	+3.2
MLWN	+1.6
MLWS	+0.6

3.4.7 To maximise the potential energy capture the structure will be oriented at 308 degrees. This orientates the long face of the structure into the predominant incident wave direction at this location which is from the north west.

3.4.8 The main structure may be connected to the adjacent coast by a rock armoured causeway and fixed steel trussed bridge to facilitate access to the turbines for operational and maintenance purposes. Alternatively a slipway and boat access may be used. Whichever approach is taken it will result in some significant differences in the way in which the construction and operational phases of the project will be carried out. This is described in detail in the relevant sections below.

Design

3.4.9 The most likely breakwater construction will be using concrete caissons (hollow boxes) arranged in a straight line on a prepared seabed. The design of the breakwater is a balance between creating the optimum shape for the purposes of energy capture whilst meeting the other design requirements for the given location (see Figure 3-4).

3.4.10 The breakwater will be up to 250 m in length and rise approximately 17 m from the seabed making about 9 m of structure visible above mean sea level.

3.4.11 The caisson design is under development and subject to change. Figure 3-5 shows the latest design. The currently proposed OWC units or caissons are 24 m long and of quadrant shaped cross section with radius 16.5 m, defining the width and will be 16.5 m tall. Although a quadrant shaped caisson is the current design, a rectangular shape caisson or straight angled face caisson may be an alternative option. All options will have very similar dimensions and characteristics. The caissons will be constructed in modules, each module containing a number of distinct collection chambers.

3.4.12 In this indicative design the complete breakwater would be made up of up to 10 caissons each containing 4 turbines paired up to an OWC giving a total of up to 40 turbines and 20 OWCs.

3.4.13 The caissons will be constructed from reinforced concrete. The design of the caissons has to take into account the potentially abrasive environment in which they would be located, in addition to the desired lifespan of the structure. Each caisson unit would weigh approximately 3,000 tonnes.

3.4.14 The caisson structure will be placed onto a prepared seabed platform, this process is described in Section 3.8.

3.4.15 To help support the structure, angled strut tubular steel piles could be anchored into the rock on the landward side and link into the top of the caissons. The indicative design allows for two piles of about 900 mm diameter per caisson. The piles will be socketted into the seabed and set at an angle of about 45 degrees. The socketting process is described in the description of the offshore installation in Section 3.8. Steel piles would be protectively painted with a coating which will be maintained and reapplied as necessary throughout the lifespan of the structure.

3.4.16 If boat access is used to access the breakwater, vessel landing points will be positioned on the landward face of the caissons and positioned to fit between the piles.

3.4.17 Further support is given to the caisson by two upstand points per caisson which will be installed on the seabed, adjacent to the propping piles, and at the back face of the structure. The upstand points are made from pre-cast concrete shells which would be grouted around stub piles socketted into the bedrock. These are located immediately adjacent to the back face of the caisson and will resist the sliding forces on the structure.

3.4.18 Alternative arrangements for holding the caissons in place may be used, such as rock anchors or ballast.

3.4.19 As well as the steel pile metalwork to support the caisson, there will be additional metal work on the structure itself. This will provide the necessary maintenance vessel landing points, stairs, walkways and handrails.

3.4.20 The chambers within the top of the structure will house the turbines, generators, actuators, controls and associated electrical and mechanical plant. Each caisson unit contains four OWCs with a turbine and associated equipment. A balance will be struck between how much of the electrical and control equipment is located in the caisson and how much is located onshore in the control building.

3.4.21 The turbines require ventilation to atmosphere to operate. The air flow will pass through a set of air intake/exit vents. Each caisson will require about 20 m^2 of vents, equivalent to 5 m^2 per turbine. Taking account of the supporting piles it will be necessary to arrange the vents in two 10 m^2 arrangements at the shore side of the structure. The vents will be ideally pointing down towards the sea to reduce their exposure to weather and also to discourage the propagation of any noise to sensitive receptors onshore.

Access to the breakwater by fixed permanent link

3.4.22 A number of possible fixed link solutions to access the breakwater have been assessed including, tunnel, bridge and causeway. The preferred means of providing a fixed link is by part causeway and part bridge. Assuming that the steel truss bridge is constructed over the final 250 m to the breakwater then the causeway would be about 250 m long extending from the shore to the MLWS depth. Exact lengths of each portion will be fixed during detailed design.

3.4.23 The proposed access causeway would be a rubble mound causeway formed from rock armour boulders capping a granular filled mound. Geotextile sheeting would be layered within the structure to improve strength and reduce permeability of the structure. The causeway would then be topped with a suitable road surface. Depending upon the final location of the breakwater the causeway could originate at either end of the Siadar Bay, either from the locale of the existing slipway or from adjacent to the Scottish Water works and the proposed onshore construction site.

3.4.24 A 3 m wide roadway would run along the causeway crest and be capable of carrying any vehicles required to access the structure. The side slopes of the structure can vary between a gradient of 1 in 2 to 1 in 4. The steeper the gradient there is obviously a smaller structure and less material is required but each armour unit of the causeway must be individually bigger. The core of the structure would be made from a granular material. The structure will have a wider foot print as the depth increases.

3.4.25 The crest level of the proposed causeway would be up to 6 m above Chart Datum, (+6 m CD). This would give a freeboard of 1.8 m at Mean High Water Springs (MHWS), which is +4.2 m CD. A 250 m long causeway extending to MLWS would be at most 5.4 m high off the seabed and approximately 24 m wide at the deepest point and this structure would be completely visible at certain tidal states. Up to about 5,000 m^3 of material would be required to construct this causeway. By comparison the full length rubble mound causeway would require up to 70,000 m^3 of material. The large rock armour pieces are liable to be sourced offsite but some of the granular fill material for the causeway could come from the onsite borrow pit.

3.4.26 Although the causeway will be in the lee of the breakwater structure waves will still diffract around the structure. Therefore, even though the causeway access road will not normally be inundated, it is possible that it will be overtopped by waves and wind blown spray.

3.4.27 Where the water depths increase and a causeway structure becomes increasingly unfeasible it would be more cost effective to utilise a bridge which spans over the last 150 m to 250 m to the breakwater to create the fixed permanent link. An indicative layout for the fixed link steel truss bridge section is given in Figure 3-6.

3.4.28 It is proposed that steel trusses would span between tripod dolphins spaced 30-40 m apart. Therefore for a 250 m length there would be 4 to 6 dolphins between the end of the causeway and the breakwater. The deck level of the bridge on the outer four spans would be at a level of about +8.6 m CD. This would give at clearance under the bridge of between 4.4 m and 8.0 m allowing sufficient clearance for small boats and vessels. The tripod dolphins would be formed from piles socketted into the seabed with a reinforced concrete cap onto which the steel trusses of the appropriate span would be fixed. The truss structures would be designed to support a light rail system or roadway capable of accommodating loads of up to a few tonnes. It is also possible that access over the fixed link is primarily by foot, with bogies on rails used for moving equipment.

3.4.29 Given the harsh environment in which it is to be located a truss bridge scheme would require to be well maintained in order for it to remain serviceable throughout the lifetime of the scheme.

3.4.30 The fixed permanent link will be accessible to authorised personnel working on the scheme and will not be accessible to the public due to health and safety reasons.

3.4.31 The arrangements for marking the fixed permanent link and ensuing that it is safe from a shipping and navigational point of view are described in Section 3.11.

3.4.32 Access to the breakwater by boat

3.4.33 The breakwater could be accessed via a fixed permanent link or by boat.

3.4.34 A 6 m Rigid Inflatable Boat (RIB) has been proposed as the type of craft which could be used for frequent man access. It is planned for a RIB to be tailored and launched from an upgraded existing slipway or a new slipway. The RIB could also be housed in the control building or a separate boat house.

3.4.35 For boat access, a slipway would be required from the shore. The existing slipway at NGR NB 1380 9549 would require upgrading as it is currently dilapidated and the rocky foreshore restricts usage to high tide conditions. Alternatively, the temporary slipway required to float the caissons from the local construction site could be retained long term. This latter temporary slipway is described in Section 3.8 and shown in Figure 3-1(6) and Figure 3-2.

3.4.36 Two options have been considered for the upgrade of the existing slipway to an all tide slipway for vessels of up to 1.5 m. These are as follows:

- A deep dredge with a long groyne wall up to about 200 m and relatively short slipway that can permit launch of boats close to shore. This option would require channel dredging and rock blasting to clear a suitable channel. Navigational marker posts would also be required to safely navigate the channel at high tide.
- A shallow dredge of about 60 m with a low height upstand wall and extended slipway constructed over the dredged area, which would permit boats to be towed by a land based vehicle some distance out into the bay for launch.

3.4.37 Whichever slipway is used, the intention is that it would be available for use by the community and wider public following completion of the construction and commissioning of the scheme.

3.4.38 Access onto the breakwater would be via landing platforms or ladders with or without floating pontoons attached to the landward side of the breakwater structure. Boats will approach the breakwater from Siadar and will moor along side in the lee of the breakwater structure. This will necessitate handrails on both sides of the walkways as they will be open as a result of the sloping back face of the structure.

3.5 Onshore control building and electrical infrastructure

3.5.1 An onshore control building of up to 250 m^2 or nominally 18 m x 12 m or 31 m x 8 m in size and up to 6 m high would be constructed near to the shore. It is proposed that this building be located at either the existing slipway at NGR NR 381 548 or adjacent to the existing Scottish Water works at NGR NB 378 545.

3.5.2 This building would house all necessary control systems, transformers, switch gear and metering. However, much of this equipment could also be located within the offshore breakwater. The space allocated for this equipment in the building described here considers the situation where the majority of the electrical equipment is located onshore, and hence this represents an upper bound for the building size. It would also contain a small office, welfare facilities, workshop and boat house in the case that a boat is used to access the structure. The boat house may also be a stand alone structure. Externally an open but covered public viewing area with interpretation boards would be incorporated into the seaward facing side of the building to facilitate public visits to the site.

3.5.3 The final design and installation of the complete electrical system and wider works onhore will take into account the requirements specified in the Electricity Safety, Quality and Continuity Regulations 2002.

3.5.4 Based on the functional requirements and dimensions of the control building a local architect has developed an indicative design for the control building at Siadar. The final design of the building will be determined once a design contractor has been appointed and will reflect the final options and detailed requirements for the building which will come to light at that stage.

3.5.5 The wave energy devices will be connected to the shore by a multi-core cable. The cables will be many fold:

- The principal purpose will be to export the power from the breakwater to shore;
- Provide communication channels to control the electrical and mechanical equipment;
- Provide auxiliary power to the equipment located offshore; and
- Provide fresh water to the blade wash system.

3.5.6 The cables will run from the breakwater to shore, either within or attached to the fixed permanent link (if constructed) or on the seabed. Any sub-sea cables laid on the seabed will either be buried or protected, as appropriate, to prevent exposure. This may include external flexible ductile iron sleeve units around the cable which may be fixed to the seabed by bolted saddles (a diver operation) or occasional concrete mattress laid over top of cable. In the foreshore the cable will be carried in a buried/ concrete covered conduit to the control building.

3.5.7 A south facing 90 cm diameter satellite dish would be required to link the scheme to npower renewables control centre. The dish would be located on an exterior wall of the control building.

3.5.8 The control building may have a small fenced off enclosure for the storage of materials and also the operation of any cooling or air conditioning equipment. Vehicle parking and turning areas would be situated around the building.

Building design

3.5.9 A local architect has been commissioned to develop a design for the onshore control building given the functional and technical requirements of the scheme. A thorough design process has been undertaken to establish an outline design as detailed in the Design Statement (see attached CD and Figure 3-7a). The Design Statement has been developed in accordance with the guidance set out in Planning Advice Note 68 *Design Statements.* Further to this specific response to the comments made by Architecture+Design Scotland in the Scoping Opinion, the Project Description has been written as clearly as possible making clear the design principles and rationale behind the layout plan. The preferred design is a longhouse concept reflecting the traditional form of the Western Isles (see Figure 3-7b & c), constructed from:

- Block timber frames or steel/timber structure;
- Pitched steel roof; and
- Stone and wooden cladding.

3.5.10 If the structure is located near the River Siadar then the existing footbridge over the river could be improved or renewed to improve the amenity of the area.

Figure 3-7b Control building – Indicative north east elevation. Structure to the right of the longhouse is the viewing platform from which to see the breakwater structure in situ

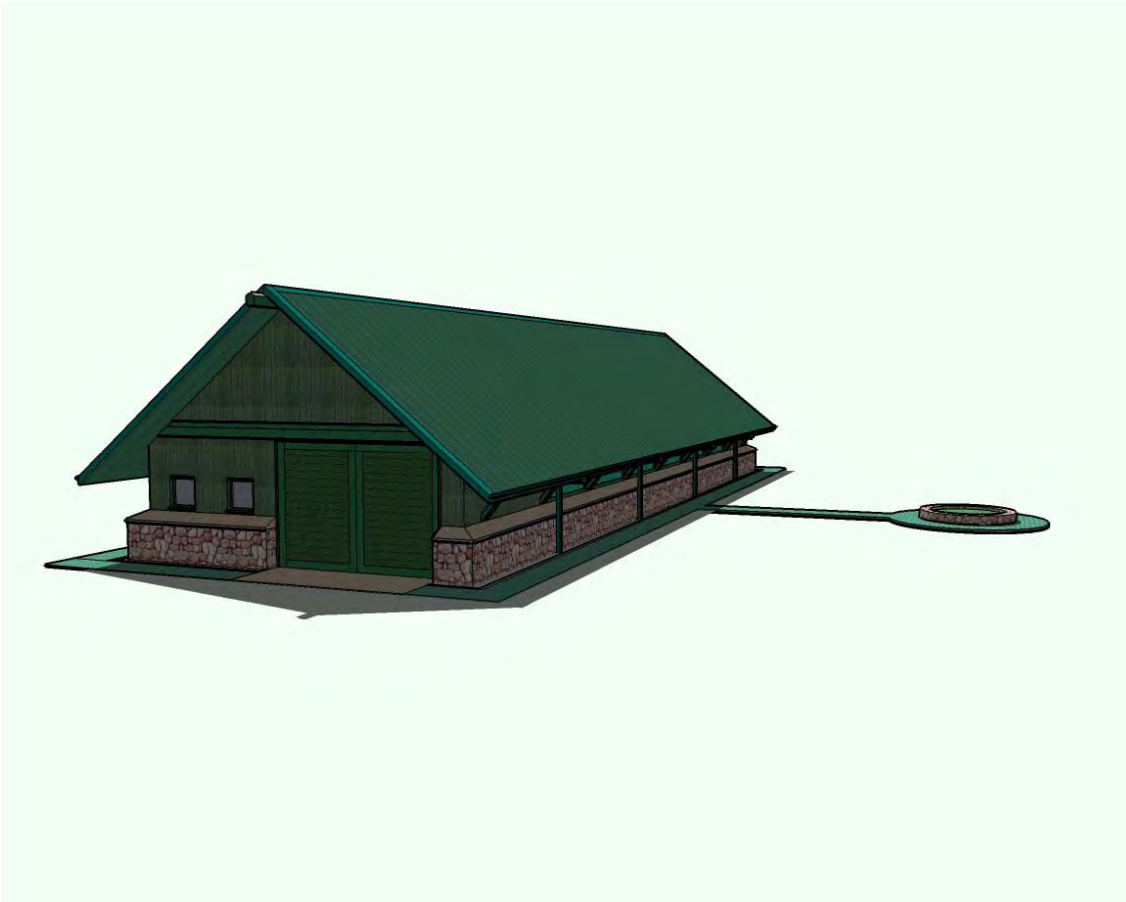
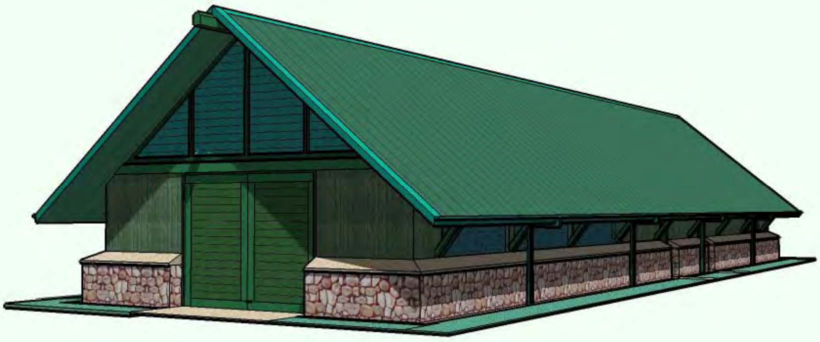


Figure 3-7c Control building – Indicative south west elevation of the proposed longhouse designed control building



3.6 Access tracks

Construction access

3.6.1 Vehicles would reach the site via the A857 which runs from Stornoway and along the north west coast of Lewis as a far the Port of Ness. There is already good access to the site off the A857 along single track unclassified roads and tracks. Access roads and tracks will be used during the construction and operation of the scheme and would involve the following:

- An unclassified road leads directly through Upper Siadar to the shoreline and existing slipway at the north west of the bay;
- The southern part of the bay can be accessed down an existing tarmac road through Baile an Truiseil and onwards past a gate on a sub-base road which leads to the shore and is used to service the Scottish Water works.

3.6.2 The use of heavy construction traffic associated with building the caissons at a local site compound would probably require the existing route by Baile an Truiseil to be maintained during construction and made good at the end of the works.

3.6.3 If the caissons are constructed offsite then the existing roads are deemed adequate to cope with the construction of the onshore aspect of the scheme, principally the construction of the onshore control building. To facilitate construction the sub base track to the shoreline may need to be widened and passing places added to facilitate the free flow of vehicles. Any existing tracks affected by the construction works would be resurfaced as necessary on completion of the construction period and would continue to be used during the operation of the scheme.

3.6.4 To facilitate the extraction of aggregate from a borrow pit site to the south west of the bay a new track to the borrow pit site will be required. This is regardless of where the caissons are constructed. The new track will link into the existing track and vary according to the preferred location of the borrow pit. The track could be constructed by stripping and storing any topsoil before establishing a hardcore base for the track. Alternatively a floating road could be established which would leave all but the surface level of soil undisturbed. Any topsoil stripped from the ground along the track route could be stored nearby to be used later for reinstatement. Figure 3-1 gives an indicative location for the proposed access track to the borrow pit.

3.6.5 In all potential construction scenarios, a temporary vehicle bridge over the Siadar River near the Scottish Water works and route along the top of the shingle bank at the beach head may be required. This would facilitate construction of the fixed link, onshore control building or slipway if used, and if positioned towards the north end of the bay at Siadar.

Operational access

3.6.6 Vehicle movements to the site post construction will be reduced in number and size. As a result access will be by the existing established access routes either through Upper Siadar or Baile an Truiseil.

3.7 Grid connection

3.7.1 The grid connection that will run from the control building to the existing electricity grid network would be provided by others and is therefore outwith the detailed assessment of this report. However, the connection is likely to consist of a buried cable running from the control building to connect to an existing 11 kV overhead line about 750 m to the south east near the A857 road. Alternatively a section of new 33 kV overhead pole-line connecting the scheme directly to the substation in Barvas some 7 km to the south of Siadar may be required.

3.8 Construction and site establishment

3.8.1 The construction of the scheme would fall into two categories: civils construction work and the electrical and mechanical work. The turbines, generators and other electrical and control equipment will be fabricated or procured by Wavegen and some of the equipment may be preinstalled in the caissons before their installation whilst other equipment will be installed once the caissons are in position.

3.8.2 The construction of the civil aspects of the scheme presents a serious logistical and technical challenge. To overcome this, a number of options have been assessed. These options remain viable methods of construction which will be decided by npower renewables and its build contractor, once appointed. The design and construction methodology discussed here has been developed in conjunction with engineering consultancy Jacobs Babtie and a number of civil engineering contractors. Final construction methods will be developed with the build contractors.

3.8.3 The main civil engineering aspect of the scheme is the construction of the concrete caissons. These cannot be practicably or safely constructed in situ in the sea. Pre-fabrication at an onshore location results in a safer and more controlled environment in which to operate. However, due to their weight, it is unlikely that the completed caissons could be readily lifted into position. Additional shore side infrastructure would be required to move the caissons into position in preparation for installation. The preferred solution is to launch the caisson from wherever it is fabricated, tow it into position and then sink it onto its foundations. This fundamental approach has been used to derive a number of construction and installation options.

3.8.4 The construction options which have been proposed for the construction of the caissons fall into two categories, although both adopt the same fundamental construction philosophy:

- Offsite construction at a remote location and shipping of the pre-fabricated caissons to the site.
- Local construction at a shoreline site in Siadar with the caissons floated directly into position from the shore.

3.8.5 The construction of the caissons can be carried out independently from the rest of the project. Other activities such as the dredging and preparation of the foundations and installation of the supporting piles can all be progressed while the caissons are being manufactured.

Remote construction of caissons

3.8.6 The caissons could be constructed at an offsite fabrication facility which would provide a safe and controlled environment in which to construct.

3.8.7 The disused dry dock at Kishorn in the Western Highlands approximately 140 nautical miles (nm) to the south east of Siadar and the Arnish yard at the entrance to Stornoway Harbour approximately 65 nm from the site are potential candidate sites for the fabrication of the caissons. However, other fabrication yards could also be considered, although proximity to site is a distinct advantage as this minimises the distances over which the caissons must be transported to site.

3.8.8 Once constructed the caissons would then need to be transported to site for installation. Similar to constructing onshore, once the caissons are built there will need to be a means by which the caissons are floated. This is most readily achieved in a dry dock which can be flooded. Alternatively a slipway and controlled winching system could be used to manoeuvre the caissons offshore.

3.8.9 Transit of the caissons from the fabrication site to Siadar presents an increased risk of the caissons becoming damaged or in extreme cases, sinking. Therefore, such activities would have to be carried out in the summer months to reduce the risk of exposure to inclement weather. Transportation options have been considered but a dry tow, where the caisson is carried on a large barge, is unlikely to be an option due to the high unit weights and exposed nature of the site. Wet tows relying partly on the caissons own buoyancy supplemented by external buoyancy is preferred.

3.8.10 Even if the caissons are constructed offsite there will still be a need for some infrastructure and activity onshore. This is principally to install the land based elements of the scheme and provide the landfall for the cable and possible fixed link structure. Where possible locally won aggregates will be used to provide the seabed foundation.

3.8.11 A small compound area would be required onshore where the onshore aspects of the scheme would be constructed from. About 1.5 hectares would be required for the housing of site offices, materials storage, plant and personnel accommodation. The compound area would be cleared and the topsoil stripped excavators and all wheel drive dump trucks. Initially sub-base would be imported from the borrow pit or other local quarry. Once the compound is prepared the site huts would be set up and the area fully fenced.

Local construction of caissons

3.8.12 The site for fabrication of the caissons needs to be large enough to accommodate construction of the caissons as well as space for site accommodation, storage of plant and materials and the storage of any topsoil etc. that will need to be removed to create the site. The relatively flat, low lying area of land to the south east of the River Siadar has been identified as a suitable site for the contractor's working area. Certain areas within an overall area of about 8.5 hectares (21 acres) would be required (see Figure 3-1) to be cleared.

3.8.13 The site could be prepared by removing any topsoil from the surface of the glacial till and levelling the ground with a layer of hardcore material thereby creating a suitable working area close to the shore. Alternatively a geo-textile could be used to float the compound on top of the existing ground. It is envisaged that any soil which was required to be removed when establishing the site could be stored nearby and used to reinstate the working area on completion of the project. The stripped topsoil would be stockpiled to provide weather protection to the camp. The topsoil could also be sited to provide some visual and noise screening from the local residences. If required, dust suppression could be from spray bars, water bowsers and hosing of stockpiles. Initially sub-base would be imported from the borrow pit or other local quarry. Once the compound is prepared the site huts and batching plant would be set up and the area fully fenced. Some reinforced concrete foundations would be required to support some of the plant and machinery to be employed in constructing the caissons.

3.8.14 The compound and construction facilities would comprise of the following:

- Power source from large super-silenced generators if uneconomic to bring in new cable.
- Oil and fuel storage in bunded tanks;
- Reinforcement assembly and storage;
- Two cranes used to transfer the assembled caisson onto bogies;
- Storage of top soil;
- Concrete formwork/shuttering and storage area;
- Material stores;
- Prefabricated site offices;
- Site stores;
- Winch equipment for lowering the caissons down the slipway; and
- Accommodation for 10 - 20 workers plus welfare facilities for up to 40 people - Accommodation units would be set up onsite, probably steel units due to exposed location or caravans tied down.

3.8.15 An estimate has been made of the workforce required to construct the caissons onsite of approximately 50 with a probable maximum of 38 at any one time depending upon the phase of the construction works.

3.8.16 The main materials for constructions of the caissons would be sourced as follows:

- Steel reinforcement would be brought to site via Stornoway;
- Shuttering and formwork would be brought to site via Stornoway;
- Concrete would either be batched onsite using:
    - Cement delivered to site via Stornoway;
    - Aggregate from the site borrow pit if suitable or delivered to site;
    - Water sourced from a connection to the local water supply or an abstraction could be made from the River Siadar (close to the mouth so there will be no implications downstream).
- Or ready mix concrete would be delivered from offsite.

3.8.17 The caissons will be constructed in stages working upwards from the floor slab to the main walls prior to the curved front face being formed. To aid their manoeuvrability, it is thought that the caissons could be constructed on simple wheeled bogies located on rails.

3.8.18 Once each unit is complete and gained strength it will be moved partially down the new slipway. It will be possible to partially fit out some of the steelwork and also install some of the generation equipment prior to installation offshore. It is likely that all or most of the caissons will be completed before the installation so that installation can be completed in one continuous operation.

3.8.19 When working near or in any watercourse, the activity would where relevant adhere to the relevant pollution prevention guidelines as published by SEPA and be controlled by the Controlled Activities Regulations (CAR) (e.g. water abstraction).

3.8.20 In order to transport the caissons into position a slipway and channel leading out into suitably deep water and to the breakwater location is proposed. A 20 m or so wide slipway with a roadway on top would lead from the construction site down into a deep water trench cut through the rocky foreshore. The slipway would have sloping sides and could employ rails on which bespoke bogies for carrying the caissons would travel. Winching gear would be required to enable the caissons to be lowered into the water in a controlled manner. At the outer end of the slipway a 20 m wide trench channel would be required to achieve an appropriate water depth.

3.8.21 One continuous gradient between the construction compound and deep enough water for the caissons to be manoeuvred into position is desirable for a smooth transition. In achieving this there will be a balance between building up the slipway and lowering the seabed for the trench. The slipway material would be acquired from the site borrow pit. The debris from the construction of the trench would be deposited on the seabed. Two potential options presently exist:

- Option 1 would require 12,060 m^3 of aggregate to build up the slip and 1,140 m^3 of material to be removed to form the trench.
- Alternatively, Option 2 would require 7,850 m^3 to build up the slipway and 4,860 m^3 to be removed to create the trench.

3.8.22 Onsite construction would be convenient as being close to site will also allow the construction to respond quickly and take advantage of short weather windows in which to move the caissons from the shore out to sea.

3.8.23 The compound area will be reinstated to its original state with the sub-base being re-used or sold to a local quarry, if it cannot be left in place or used to re-landscape the borrow pit area.

Offshore installation – seabed preparation

3.8.24 The seabed must be prepared to provide a suitable foundation for the caissons. This would involve the removal of any outcrops of rock from within the footprint of the structure that extend any higher than the proposed foundation level. Depending on the extent and hardness of any outcrops of rock which are encountered, it may be that they can be removed using a barge mounted backhoe excavator. Alternatively, it may be necessary for it to be drilled and blasted prior to excavation.

3.8.25 Once the protrusions are removed the foundation can be filled to the required level with rock dumped and spread on the seabed. The foundation is likely to consist of a coarse granular fill material with a geotextile membrane to protect against washout until the caissons have been placed. About 2,100 m^3 of granular bedding is the estimated requirement for this activity. The exposed edges and corners of the foundation may need to be protected with a concrete scour mattress. A concrete scour mattress is an array of thin concrete blocks or strips bound together by an integrated network of rope, typically polypropylene. The structure is flexible and can be readily laid over uneven surfaces to protect them. Once installed the mattresses present a binding surface for other materials such as sands stones and rocks. Approximately 1,200 m^2 of scour mattresses could be installed around the breakwater.

3.8.26 The proposed location of the structure straddles the 5 m contour and this is the desired foundation level, the amount of material to be added or removed will be minimised (see Figure 3-8).

3.8.27 To carry out this work a jack-up barge is proposed as it would provide a stable working platform from which this work could be carried out. The jack–up barge would also be the platform for the rock dredging, the preparation of the foundations and could also assist in the positioning of the caissons or the installation of the fixtures and fittings.

3.8.28 Depending upon the seabed conditions the jack-up barge may require spudcam stabilisation. This involves the pile legs of the jack-up barge being surrounded by a pile of rock which is installed once the legs have been placed. Until a detailed appraisal of the seabed condition is made quantities of material, if any, involved in this are uncertain.

3.8.29 The jack-up barge will also be used to install the caisson support and bridge piles. The Lewisian Gneiss underlying the seabed means that conventional pilling techniques used in softer materials cannot be used. To install the piles for the upstands and supporting piles they will need to be socketted into position. Socketting involves drilling a larger than pile diameter hole into the rock. The pile is then inserted onto the drilled hole and secured in place using a cement grout or concrete. The supporting piles socket attachment on the head of the pile would be attached prior to the caissons being installed. The supporting piles would be installed at an angle of around 45 degrees. For the caisson upstands, concrete sleeves could be grouted into place once the vertical stub piles are secured.

3.8.30 It is estimated that the drilling process for the piles would create about 150 m^3 of spoil material. This material could be reused offshore as in fill or bedding material for the caissons.

Offshore installation – caissons

3.8.31 With the seabed preparations complete the caissons can be moved into position. This will be carried out when there is a suitable weather window and is therefore most likely to be carried out in the summer. The availability of extended weather windows will be important so that the caissons can be secured in relatively short time frames, the failure to complete such tasks in a timely manner would put the caissons and operating vessels at increased risk.

3.8.32 From the local construction site the caissons would be moved by bogies down the slipway to the tidal zone where they will be manoeuvred into their final position. This would principally involve the winches which would lower the caissons is a controlled manner into the water.

3.8.33 Once the caissons are in the water, the installation operation is similar regardless of whether the caissons were fabricated onsite or transported from a remote site. It is expected that two heavy duty winch tugs would be required to manoeuvre the caissons in the water for installation. By sealing the submerged entrance the caissons could be floated into position. Additionally, in order to achieve adequate stability during towing and to achieve a uniform settlement when lowering the caissons onto the seabed, it may be necessary to attach additional buoyancy aids in the form of pneumatic fenders or polystyrene blocks. Previously installed caissons will also act as a guide and target to which the new caisson can be secured.

3.8.34 Once in position, the caissons would be held in place while they are lowered onto the prepared foundation in a controlled manner. The lowering would take place by a controlled reduction in the buoyancy of the caisson by removing external floatation aids or by flooding the sealed caisson chamber. The caissons would also be secured to the supporting steel piles. The prefabricated steel socket attached to the pile head will allow the pile and caisson to be easily secured to one another. A combination of the structures own mass, supporting steel struts and the upstand points will hold the structure securely in place.

Table 3.5 Summary table of vessel requirements

Vessel type	Principal function	No.	Duration
Jack Up Barge	Seabed preparation, piling	1	3 months
Tugs	Caisson installation	2	3 months
RIB	Safety boat	1	Duration of works

Offshore installation – permanent fixed link

3.8.35 The permanent fixed link could be a rubble mound causeway or a steel trussed bridge or a combination of the two. The causeway option would be constructed after some or all of the caissons have been installed. In this proposed scheduling, the causeway can be constructed in the relative safety in the lee of the breakwater making construction safer and easier.

3.8.36 Rock from the onshore borrow pit, remote quarry and possibly any spoil material from the underwater dredging and blasting would be used to form the causeway. Local materials would be used to construct from the shore outwards with the causeway being built progressively. Trucks would transport the rock and causeway fill materials to the end of the causeway. A combination of cranes or large diggers would then place the material as required. Materials from out with the site may be delivered by sea and would be used on the offshore extent of the causeway. Eventually the causeway structure would reach the breakwater and the permanent link is established.

3.8.37 The steel truss bridge would be largely constructed from a combination of a jack-up barge and onshore works. The jack-up barge would socket into position the tripod piles and reinforced concrete cap. Once at least two tripods are in place the spans could be lowered into position.

3.8.38 If a combination structure is used then the above construction methodologies would be adjusted as required and only applies to the relevant sections.

Offshore installation - fitting out and electrical and mechanical installation

3.8.39 Once installed and made accessible the caissons will be ready to be fitted out with walkways, landings, handrails and other furniture. The installation of the electrical and mechanical equipment can also commence once safe access has been established. Some of the electrical and mechanical equipment could be installed in the caisson as part of the fitting out onshore with the remainder installed once the caisson has been positioned offshore. Where there is no fixed link, a combination of lifting mechanisms mounted on the structure and boat mounted apparatus will be used to install the kit. However, given the modular nature of this technology, all the components are all relatively light and manoeuvrable.

3.8.40 The cable connection to shore would run in ducting attached to the fixed link structure. If the scheme is developed without a fixed permanent link then subsea cabling will be required. The cables and cable protection would be laid from a boat with diver support, or drawn through ducts with a winch mounted on the caisson and the cable drum onshore. The cable routes would aim to follow natural contours and gullies in the seabed/foreshore to run the cable in.

3.8.41 During construction of the offshore components the site may require lighting during working hours. In some instances due to the complexity associated with this work and the availability of suitable weather windows, 24 hour working may be required. However, this would be limited and Sunday working would be avoided as much as possible unless absolutely essential.

3.8.42 There is a combined sewage overflow (CSO) servicing discharges from the Siadar and Barvas settlements during storm conditions. This is operated by Scottish Water. This is located at the southern edge of Siadar Bay and approximately 50 m from the proposed development location. There is potential interaction if a causeway or new slipway is constructed in this area. The slipway and trench proposed for onshore construction as well as the seabed preparation for the breakwater foundation could all affect the outfall. As a result the outfall pipe will need to be protected or reconstructed and the outfall relocated if it will interact with the scheme or discharge inside the fixed link and breakwater.

3.8.43 In accordance with the navigational marking requirements for the scheme the lighting and cable marker, if required, will be installed on the structure and onshore. The details are described in Section 3.11.

Onshore works

3.8.44 The onshore control building would be constructed in parallel with the other works. The control building could be located adjacent to the existing slipway or close to the existing Scottish Water works and the local construction compound. In either location the building would be completed so that its readiness coincided with the installation of the electrical and mechanical equipment and commissioning of the scheme. If sited on the construction compound there may be some re-use of the infrastructure used for construction such as the foundations for the site offices or cranes.

3.8.45 In the event that the control building is to be located adjacent to the existing slipway then some land reclamation may be required to supplement the existing flat ground. The extra land would be formed by extending the existing flat land on the shoreward side making adjustments to the managed modified water courses close by.

Borrow pit

3.8.46 Aggregate for concrete would be sourced locally where possible and rock would be sourced either locally from the new borrow pit or from local quarries. However, due to the technical specification of the materials required for construction it may not be possible to readily win such materials from the borrow pit. Other sources of material include spoil from the dredged channel but this will probably be left in situ, redistributed to use in the caisson foundation and in fill material offshore. A preferred area for the borrow pit has been identified to the south west of the bay and local construction compound. An indicative borrow pit location is identified in Figure 3-1. The digging of trail pits and taking core samples will confirm the precise location to be used for the borrow pit.

3.8.47 The preferred approach to securing borrow pit material would be to strip off the peat topsoil. A shallow skim of rock extracted over large area would then be removed as demand dictates. This approach is designed to minimise the visual impact and facilitate re-instatement post construction. The borrow pit would be developed by excavating, ripping and blasting according to the ground conditions. Two mobile crushing units and a screening unit would be installed and used to provide sub-base for the compound area and possibly aggregate for concrete production.

3.8.48 Where aggregates are required to be sourced offsite these could be sourced from an existing quarry or a new quarry could be opened up. These arrangements would be the responsibility of the build contractor and any permissions or consents required to do so will be sought by the appointed contractor.

Table 3.6 Aggregate uses, sources and volumes

Usage	Volume	Potential sources	Most likely source at present time
Site establishment	1,500 m^3	Local Borrow Pit OR Offsite quarry	Local Borrow Pit
Caisson concrete aggregate	7,700 m^3	Local Borrow Pit OR Offsite quarry	Offsite quarry
Caisson bedding material	2,100 m^3	Redistributed seabed material OR Local Borrow Pit OR Offsite quarry	Offsite quarry
Boat access slipway	2,000 m^3	Local Borrow Pit OR Offsite quarry	Offsite quarry
Caisson launch slipway	12,060 m^3	Local Borrow Pit OR Offsite quarry	Offsite quarry
Partial causeway (250 m) from shore to structure	5,000 m^3	Local Borrow Pit OR Offsite quarry	Offsite quarry
Full length rubble mound causeway	70,000 m^3	Local Borrow Pit OR Offsite quarry	Offsite quarry

3.8.49 An access road to the borrow pit would be constructed during the establishment of the construction compound. With a borrow pit located as described vehicle movements associated with using the borrow pit will be contained within the construction access roads and not pass over any public roads.

3.8.50 Depending upon the final design of the scheme to be built, the volumes of material required will vary as will the final source of these materials. Should site investigations find suitable material in the onsite borrow pit then the possible total aggregate volumes to be extracted from the onsite borrow pit are as follows:

- Onsite construction of caissons and a fixed permanent link = 28,000 m^3
- Onsite construction of caissons and no fixed permanent link = 23,000 m^3
- Offsite construction of caissons and a fixed permanent link= 9,000 m^3
- Offsite construction of caissons and no fixed permanent link = 6,000 m^3

3.8.51 In the event that a full length rubble mound causeway is constructed then these figures could increase by up to about 60,000 m^3 but the likliehood of this material coming from an on site borrow pit is very low.

3.8.52 The borrow pit will be reinstated to the shape appropriate to best tie in with its surrounding landscape. Typically a layer of at least 1 m deep peat will be replaced on top of the rock.

Waste

3.8.53 Waste will be processed and disposed of in accordance with SEPA and local council guidelines.

3.8.54 General domestic waste will be collected in covered skips and disposed of by registered carriers.

3.8.55 Sewage waste will be either processed using an onsite klargester type unit or if the existing septic tank can be used, it will be.

3.8.56 Concrete wash out waste will be collected in lined bunds and disposed of through registered carriers as necessary.

3.9 Programme

3.9.1 The specific date for commencement is unknown, principally given the uncertainties associated with the planning and consenting process. Therefore, an indicative start date of Spring 2009 is given which would result in a completion date of December 2010, about 18 months. The main works onsite occur over a 12 month period. However, an early autumn commencement date is preferable as this leads to the main offshore works being carried out in the better weather the following summer. The overall timescale is similar regardless of whether the caissons are constructed locally or remotely. Given the potential for disruption due to weather there is the potential that these proposed timescales could be extended.

3.10 Amenity value

3.10.1 By its nature, a near-shore breakwater forms a barrier against incoming waves up to a certain size so it will serve the additional purpose of acting as a breakwater for fair weather inshore mooring grounds or harbour areas. At Siadar it is expected that it will also serve to calm the inshore waters on its landward side. This will offer some shelter for boat launching facilities used by the local community at Siadar. In large seas the structure would still be overtopped so it extends access in the marginal conditions when the current exposed situation would prevent sea access. This could facilitate future income generating sea related activity such as fishing and tourism.

3.10.2 The breakwater (and fixed permanent link if constructed) would not be accessible to the public due to the health and safety risk as waves would be expected to overtop the structures in some weather conditions.

3.10.3 If the access to the breakwater is by boat and the caissons have been constructed onsite then it is likely that the substantial slipway used to launch the caissons would become the main sea access point for the local community. In the case that offsite construction is used to build the caissons then an upgrade and refurbishment to the existing slipway would also be possible and made worthwhile by the shelter from the breakwater. In either scenario there will be an improved access to the sea than what is currently available.

3.10.4 If a fixed permanent link is installed then there will not be a routine need for boat access as part of the operation of the scheme. However, a refurbished existing slipway would benefit from the shelter and would become a more attractive investment for the local community than at the present situation.

3.10.5 As with any novel project it is expected that there will be a wide public interest in this project. Certainly, this has been found to be the case at Wavegen's LIMPET site in Islay which has become a tourist attraction in its own right. With this possible outcome in mind a small covered viewing gallery with interpretation boards will be a part of the onshore control building.

3.11 Operational activities

Access

3.11.1 If a fixed permanent link is constructed linking to the breakwater to shore then this will be the main means of access for vehicles and pedestrians to the breakwater and OWCs.

3.11.2 Without a fixed permanent link it is envisaged that a small RIB would be adequate to provide access for maintenance inspection purposes. Boat access and the onshore infrastructure and offshore facilities required to facilitate this are described in Section 3.4.

3.11.3 Occasional major maintenance of the wave energy devices would require their removal and this would be achieved either using a larger boat, such as a multicat vessel. Lifting gear could be mounted on the breakwater which would facilitate the removal and lowering of the electrical and mechanical equipment onto a craft. Other possible water borne methods for removing equipment include placing equipment in flotation pods which are towed to shore or using a barge with a lifting cradle.

3.11.4 Members of the public will be able to view the scheme from the shore. The control building which will have a public viewing gallery with scheme interpretation boards.

3.11.5 Once the heavy construction works have been completed vehicular access to the control building and slipway will be by the original local unclassified roads and tracks through Baille an Truiseil and Upper Siadar.

Electrical and mechanical maintenance

3.11.6 The primary function of the active breakwater scheme is to generate electricity and this will be achieved by the OWC units and the Well's turbines. It is envisaged that the primary maintenance consideration for the scheme would be the mechanical and electrical performance of the turbines and generators. The components here are high specification but under the expected operating regime they will require regular maintenance and replacement of parts as they become worn. Most maintenance will be carried out with the turbines in situ but there may be occasions when a unit needs to be removed for more extensive maintenance and repairs.

3.11.7 Regular maintenance requirements would principally involve routine monthly inspections of the turbines and greasing of the bearings.

3.11.8 The cables and cable protection will require periodic inspection by Remote Operated Vehicle (ROV), underwater submarine controlled from a boat. Alternatively a diver could perform this operation.

3.11.9 The equipment within the breakwater would employ some lubricants and fluids. A freshwater blade cleaning system will also be employed to maintain aerodynamic efficiency of the Wells turbine blades which otherwise can become encrusted in salt particles over time. The water would be piped to the structure as part of the bundle of electrical cables. Once discharged onto the blades the water would disperse into the atmosphere as a result of the high velocity of the blades. Additionally, hydraulic oil could be employed to operate control valves; any transformers located offshore may be oil filled and there would be a requirement to keep parts well greased as appropriate.

3.11.10 The transformers within the control building may contain oil and if so appropriate measures would be incorporated to prevent oil getting into the watercourse. All transformers of this type would be in a bunded enclosure. A 2-drum portable bund would be kept in the control building and/or on the breakwater and used for the storage of drums containing oils and greases. Appropriate containment measures would be implemented in accordance with the guidelines set out in Pollution Prevention Guidelines 2 Above Ground Oil Storage Tanks, updated to take into account the new Water Environment (Oil Storage) (Scotland) Regulations 2006 (SEPA Feb 2006).

Civils maintenance

3.11.11 The active breakwater structure is designed to have a minimum design life of 50 years. Due to the remoteness and environment in which the active breakwater is situated, it is vital that the design of the caissons is robust and durable such that they will remain serviceable throughout their intended lifespan with very low maintenance requirements. However, an inspection and maintenance regime will be adopted such that any minor damage to the caissons is repaired quickly.

3.11.12 It is anticipated that the structure will be inspected from a small service boat for any significant damage on a monthly basis, with a more thorough visual inspection being undertaken annually.

3.11.13 The protective paint coating on the steelwork items would normally be expected to last around 15 years to first maintenance, following which, it would required to be reapplied.

3.11.14 Due to the rocky nature of this area of the coast, it is anticipated that there will be limited requirement for maintenance dredging to be undertaken in the future. It may be necessary to remove specific pieces of debris that become lodged within the capture chambers but it is envisaged that the flow of water in and out of the capture chambers will act as a flushing mechanism to keep them relatively clear. This has been the experience at the LIMPET site where debris only temporarily resides in the capture chamber before being flushed out unaided.

3.11.15 It may be necessary to periodically repair or replace the concrete scour mattress along the seaward edge of the structure, beneath the entrance to the capture chambers. This location will be particularly susceptible to scour and abrasion due to turbulence created by the passage of water to and from the capture chambers.

3.11.16 The costs and effort associated with the operational phase of the civils are envisaged to be minimal. Once the structure has been installed and commissioned, it will only require occasional maintenance work.

3.11.17 If sacrificial anodes are fitted to the steel tubular piles, the anodes will need to be replaced approximately every 8 years. It is the intention that other significant maintenance will not be required until around 15 years into the life of the scheme.

3.11.18 If a fixed permanent access is used then this will also have maintenance requirements. Despite the need for large rock armour to protect the sides of a causeway, the structure will continue to move and settle through the natural wave regime. There will therefore be a need to frequently inspect the armour layers for displaced rock and to have it returned to a stable position where necessary. Depending upon what material is dislodged an appropriate digger or crane will drive onto the causeway and execute the repairs. In addition to this, the running surface along the crest of the causeway will also need annual maintenance.

3.11.19 If a steel truss bridge was constructed the structure and metalwork would require careful maintenance to remain serviceable in the harsh environment. An annual inspection and repair regime would be expected. The tripod piles will be similar to the supporting piles and therefore will be maintained under a similar regime.

Navigational markers

3.11.20 The Northern Lighthouse Board (NLB) has specified a set of navigational lighting and marking requirements for the scheme. The breakwater will be marked in line with the recommendations of the NLB. Depending on the final scheme options selected this could include:

- the seaward/most northerly point of the structure will be marked by a navigational light;
- the limits of any fixed permanent link construction works being marked by a lit buoy;
- both extremities of the breakwater are lit in the case that there is no fixed permanent link;
- If a fixed permanent link is constructed working out from the shore then the extremity of the works will be marked with a navigation buoy during construction;
- If subsea cables are installed and not routed through a fixed permanent link or buried or ducted on the seabed then they will be marked with a Cable Marker Board.

3.11.21 The offshore lights could be powered by an auxiliary supply to the breakwater or by solar power and batteries.

3.11.22 The Maritime and Coastguard Agency (MCA) will also be involved in agreeing the final arrangements for the safe marking of the structure and disseminating information about this new feature to mariners.

Lighting

3.11.23 Construction would be concentrated in the summer months during the best weather window so any lighting required around the compound or during installation would be minimal to provide a safe working/movement round the compound or at the installation site.

3.11.24 In the operations phase the onshore control building would feature external lighting. This lighting would only be used during maintenance visits or in the event of an emergency call out. Some lighting may also be required on the slipway, if boat access is used. The walkways and access areas on the breakwater structure may also have some safety lighting to facilitate safe working conditions.

Waste water and runoff

3.11.25 The control building would incorporate appropriate guttering and down pipes that would direct run-off from the building into the sea, drainage ditch or River Siadar. The car park adjacent to the control building would be surfaced with gravel and would be permeable, allowing surface run-off to drain through it. The discharges from the control building welfare facilities would be to a septic tank adjacent to the control building that would be emptied periodically to a licensed disposal facility. It may also be possible to utilise the local Scottish Water waste works to dispose of any waste water in the control building or at the construction compound. These arrangements would have to be agreed with the local council, Scottish Water and SEPA.

Emergencies

3.11.26 npower renewables contact details in case of emergency would be provided on a board attached to the exterior of the control building. Prior to operation of the scheme an emergency response plan will be developed and used in the event of an emergency.

Operating hours

3.11.27 The scheme would operate whenever the incident wave conditions are suitable to generate. Therefore, there are no defined operating hours for generation. However, on average the scheme would be running for approximately 75 % of the time with this concentrated around the winter period.

3.11.28 Regular maintenance and other activities would only occur during normal working hours Monday to Saturday. In the event of an emergency intervention could be required at any time.

3.12 Decommissioning

3.12.1 This project has a projected lifespan of 50 years. The breakwater structure and rubble mound causeway element of the fixed link (if constructed) will have a design life of 50 to 75 years, which could probably be extended through refurbishment. The bridge element of the fixed link (if constructed) will have a design life of 50 years. The control building will have a 50 year design life.

3.12.2 All efforts will be made to maximise the energy generation life of the breakwater. It is possible that the structure could be replanted with a new set of turbines at the end of the project and give the scheme a second life.

3.12.3 At the end of the energy generating phase of the scheme the breakwater would be left in situ, as would the rubble mound causeway element of the fixed permanent link (if constructed). Leaving these structures in place retains the shelter benefit and improved sea access in the longer term. This approach has been recommended in the Scottish Executives Scoping Opinion and is also in line with the DTI Guidance on decommissioning offshore projects of this type.

3.12.4 Electrical and mechanical components and any superficial fittings would be removed and any openings made safe. The electrical cables may be left in situ within the structure or seabed.

3.12.5 At the end of the bridge element of the fixed link's (if constructed) life it is envisaged that this element will be refurbished to extend life, replaced or removed, depending on the prevailing conditions. The same will apply to the onshore control building.

3.12.6 As required by the Energy Act 2004, a Decommissioning Programme will be prepared for the project.

4 Environmental Description

4.1 Introduction

4.1.1 This section is designed to give the reader an overview of the background environmental conditions which prevail at Siadar. If covers the physical, biological and human environment characteristics of the site. Having established this background the individual study topics in the subsequent ES sections explore the effects of the proposed development on these local characteristics.

Physical characteristics

Geographical and landscape aspect

4.1.2 The SWEP is to be located on the exposed north west coast of Lewis adjacent to the village of Siadar. It is approximately 27 km (17 miles) north west of Stornoway, the main town on Lewis. This area of Lewis, along with other parts of the Western Isles, offers the greatest coastal wave energy resource in the UK (DTI, 2004; Marine Energy Group, 2004).

4.1.3 The Isle of Lewis is relatively low-lying with the highest point in north Lewis being recorded on Beinn Mholach at 292 m (958 ft) above sea level. The interior is dominated by boggy moorland which forms extensive inland areas of North Lewis, crofting is also found in the area (Richards, 1998). Some of the land in the Siadar area is classified as locally important agricultural land (Western Isles Local Plan, 2005).

4.1.4 The coastal zone adjacent to Siadar consists of a small rocky bay, backed by a cobble beach, areas of exposed bedrock and small cliffs <2 m in height. The area consists of shallow peat and moraine till overlaying Lewisian Gneiss (BGS, 1991; BGS and Theadgould, 1997; Lewis Wind Power Limited, 2004). Some granite is also present at the southwest edge of Siadar Bay but no evidence of peat exists at the beach edge (Lewis Wind Power Limited, 2004).

Geomorphology and geology

4.1.5 The results of the seabed survey carried out by Aspect Land and Hydrographic Surveys Chartered Surveyors (Aspect, 2006) have informed this section. This included a bathymetry survey of the bay and seabed video footage.

Bathymetry

4.1.6 Chart depth readings decrease gradually from zero to a maximum depth of 28.4 m at N58°24.693’ W06°30.344’ which is about 1,400 m from the shore. The water depth at the breakwater location is approximately 8 m (5 m LAT) at mean sea level and the nearshore seabed is shallow and primarily a continuation of bedrock (Aspect, 2006).

Coastal and seabed geology and surface sediment

4.1.7 The seabed is composed mainly of exposed, jagged, kelp covered rocks interspersed with small areas of sand. The rock has long, linear features with many fissures that in places are up to 3.0 m wide and approximately 50 m in length. Many of the crevices and gullies between the rock outcrops are filled with both coarse and fine sand.

4.1.8 The seabed is gradually sloping from the MLWS mark at an appropriate gradient of 1.0° (1:35 to 1:50) in a seaward direction. Areas of broken rocks and boulders are evident in the infralittoral and towards the south east of the study site.

4.1.9 The shoreline adjacent to the breakwater location comprises a small rocky bay, backed by a cobble beach with areas of exposed bedrock and low cliffs. There are several bedrock outcrops, particularly at either side of the bay and along the adjacent coastline and these are interspersed by more cobble beaches and eroding cliffs.

Hydrodynamics

Tides

4.1.10 Carloway (15 miles south west of Siadar) has a spring tidal range of 3.6 m and a neap tidal range of 1.6 m (HR Wallingford, 2000). The area is also exposed to high energy waves and storm surges that can cause tidal levels to be higher (British Geological Survey, 1997). The flood tide runs south-west to north-east and the ebb tide runs in the opposite direction. The tidal currents are low velocity (HR Wallingford, 2000).

Waves

4.1.11 The western coasts of the Western Isles are exposed to winds and open offshore waters of the North Atlantic Ocean, and in turn produce high energy waves. Wave heights are known to exceed 3 m for over 10 % of the time and 1 m for 75 % of the time (Draper, 1991). The predicted 50 year wave height is approximately 35 m of the west coast of the Western Isles, which is significantly greater than other parts of the UK (Lee and Ramster, 1981).

Meteorology

Wind

4.1.12 Unsheltered areas of the west coast of the Isle of Lewis are frequently exposed to strong southerly and south westerly winds and gales. The Western Isles is noted as being one of the windiest places in the U.K. For 75 % of the time wind speeds can exceed 4 m/s and 0.1 % of the time wind speed can exceed 20 m/s at more exposed locations (British Geological Survey, 1997).

Visibility and daylight hours

4.1.13 Visibility conditions in the Isle of Lewis are generally good, although clear conditions can deteriorate quickly as a result of heavy showers of rain or snow, which can reduce visibility to less than 1 km. Persistent inland fog is not common, but sea fogs do occur. These sea fogs can occur at any time of the year and clear quickly if the wind changes direction.

4.1.14 The Isle of Lewis has extended periods of daylight during the summer months when the sun is above the horizon. In mid-summer, there are very few hours of darkness; as little as 2 hours. In contrast during mid-winter days are much shorter as the sun is very low in the sky and it can be dark from 4 pm until 9 am (Comhairle nan Eilean Siar, 2007a).

4.2 Biological characteristics

Onshore habitats and communities

4.2.1 West Coast Energy undertook an environmental baseline survey at Siadar using Phase 1 methodology (JNCC, 1993). The survey took place during September 2006 (West Coast Energy, 2006a).

4.2.2 Habitats in and adjacent to the proposed area of the development include coastal grassland, semi improved acid grassland, heath/mire, blanket bog and several wetlands. These habitats have been modified by grazing, cutting, drainage and agricultural practices.

4.2.3 The survey did not identify any priority species of plant listed by the EC Habitats Directive or the Wildlife and Countryside Act 1981, and there are no national or international designations in the area. However, there are several species known from the Siadar area, which are listed in the Western Isles Local Biodiversity Action Plan (WILBAP).

4.2.4 Crofting 1 is the dominant land type in the area surrounding Siadar (Richards, 1998); however boggy moorland is present nearby with an area of machair to the south.

Coastal habitats and communities

4.2.5 A habitat survey of the intertidal zone was commissioned using Phase 1 Methodology (Wynn *et al*, 2006) as part of the EIA and took place in October 2006 (West Coast Energy, 2006b).

4.2.6 Due to the area being exposed to regular and considerable wave action, marine communities tend to consist of large populations dominated by relatively few species (Irving, 1997). The shores around Siadar follow the typical pattern of an exposed to moderately exposed shore on the Scottish Atlantic coast, with no unusual species of particular conservation interest being recorded.

4.2.7 Fauna present include small mussels, limpets, edible periwinkle, acorn barnacle and the beadlet anemone. The rocky shores to the north of the bay are more exposed and subsequently support a more limited fauna and flora. Small mussel clumps are limited to crevices.

Sublittoral habitats and communities

4.2.8 A preliminary seabed survey of the area surrounding the proposed breakwater site was carried out during June 2006 (Aspect, 2006).

4.2.9 The substrates surveyed included fine sand, sand over rock and coarse sand, and the area dominated by kelps. Such kelp dominated areas are often associated with other algae and faunal communities. These can consist of sessile (those attached to the kelp and the seabed) and mobile (those that have the ability to move around the habitat) groups. Sessile groups most associated with kelp are tube worms, sea anemones, hydroids, bryozoans and other forms of algae. While the mobile forms are dominated by small snails, small crabs and sea stars.

Fish populations

4.2.10 There are 67 species of fish recorded in Western Isles waters, although data for the immediate area of Siadar Bay is lacking. Four British marine and estuarine species protected under national, European and international legislation has been found in the waters of the Western Isles (Potts and Swaby, 1997).

4.2.11 The distribution of fish species can vary greatly between juvenile and adult phases and with seasonal migrations. However, Barne *et al* (1997) and Coull *et al* (1998), interpreted information on the distribution and relative abundance of fish species obtained from recorded fish landings to infer the fish species likely to be present around the Western Isles.

4.2.12 Mackerel are widely distributed around Britain and are present in the seas around Lewis. Mackerel use the waters to the west of Lewis as a spawning and nursery ground between May and August. Migration of mackerel occurs twice a year; May - July and November - March. Herring, cod, haddock, saithe, lemon sole, Norway pout and sprat also use the area for spawning and/or nursery grounds (Barne *et al*, 1997; Coull *et al*, 1998).

4.2.13 In addition to the commercially important fish species, the coastal waters around Lewis are also likely to support populations of smaller fish species which provide a food source for birds and mammals in the area.

Migratory fish

4.2.14 Migratory salmonids, including both sea trout and Atlantic salmon, are afforded protection by the EC Habitats Directive, Bern Convention and Freshwater Fisheries (Consolidation) (Scotland) Act 2003. These fish are also of high resource value to anglers.

4.2.15 Sea trout are commonly found in the River Siadar. Historically salmon have also been found in the Siadar area, but have not been recorded recently. However, they are not known to frequent the River Siadar every year unlike rivers to the south (such as the River Barvas). It is known that rivers with larger populations of trout (e.g. the River Siadar) are less likely to also support salmon populations.

Crustaceans and shellfish

4.2.16 Rocky coastlines are a suitable habitat for crustaceans and shellfish. Lobster, edible crab, velvet crab, squat lobster and crawfish are present along the west coast of the Western Isles. Crawfish and edible crabs prefer softer substrates including sand and gravel.

4.2.17 Very few King scallops and Queen scallops are found on the west coast of Lewis. Important populations are present in many areas on the east coast of Lewis.

Birds

4.2.18 There are no specific conservation designations relating to birds in the immediate Siadar area, although there are internationally important breeding bird populations within approximately 3 km of the Siadar area. Specifically the Lewis Peatlands RAMSAR and SPA and the Barvas SPA.

4.2.19 A breeding bird survey of the shore areas of Siadar and Baile an Truiseil was carried out as part of the EIA (Rothwell, 2007). The survey area included the foreshore and some of the croftland

and common grazings of the townships of Siadar and Baile an Truiseil. The survey was undertaken between the 31st May 2007 and the 30th June 2007.

4.2.20 The survey identified breeding birds of various species including; curlew, lapwing, oystercatcher, redshank and snipe. Other species are known from the area, but were not identified from the survey; including red-throated divers, black-throated divers, corncrake and eider ducks among others. None of the breeding bird populations found on the site represented more that 0.1% of the UK breeding population.

4.2.21 Grasslands in the Western Isles are internationally important for the breeding corncrake, a globally threatened bird (Heredia *et al*, 1996). Previous studies of corncrake distribution have shown them to be close by to Siadar, but are more likely to be found inland than at the coast. This agrees with the observation of a calling corncrake heard approximately 500 m in land from the survey area during the bird survey (Rothwell, 2007).

Mammals

Otters

4.2.22 The Eurasian otter is protected by national and international legislation. It is an offence to disturb, kill, trap or harm the animal or damage or disturb its resting, feeding and breeding sites. The otter is listed on Appendix I of CITES, Appendix II of the Bern Convention and Annexes II and IV of the European Habitats Directive. It is protected under Schedule 5 of the Wildlife and Countryside Act 1981 and Schedule 2 of the Conservation (Natural Habitats &c.) Regulations 1994 (Regulation 38).

4.2.23 The Western Isles is an important location for otters and they are strongly classified as being marine in their distribution (Turtle and Meakin, 1997). Previous studies have shown that otters tend to concentrate their activities on rocky shores and at seaweed zones (Bryan, 1994).

4.2.24 The September 2006 survey by West Coast Energy (West Coast Energy, 2006b) found evidence of otter presence at various sites within the survey area.

Seals

4.2.25 Both grey and harbour seals are protected under European legislation and are listed in Annex II of the European Habitats Directive. They are also protected under the Conservation (Natural Habitats etc) Regulations 1994 and the Conservation of Seals Act 1970. Both species of seal are known to feed on a wide variety of fish. Sandeels comprise about 50 % (by weight) of the fish consumed, with the remainder being gadoids, flatfish and sculpins. Crustaceans are also taken as food (Hammond *et al*, 1994).

4.2.26 No seal haul out or breeding sites are known at Siadar, however during the May/June 2007 (Rothwell, 2007) the shore area of Siadar was observed for sightings of grey seals and any particular behaviour were identified and noted. Grey seals were observed to be present and foraging in the coastal waters of Siadar.

4.2.27 Harbour seals tend to favour more sheltered locations and there are no known harbour seal haul-out sites in the Siadar Bay area. No harbour seal presence was recorded during the survey.

4.2.28 As neither grey nor harbour seals haul out in the Siadar area, they are only expected to be occasionally present in transit or foraging.

<u>Cetaceans</u>

4.2.29 All species of dolphins, porpoises and whales (cetaceans) are listed in Annex II of CITES, Appendix II of the Bern Convention Annex, and in Appendix IV of the EC Habitats Directive as species of European Community interest and in need of strict protection. They are also protected under Schedule 5 of the Wildlife and Countryside Act, 1981. The harbour porpoise is covered by the terms of ASCOBANS (Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas), an international agreement with the aim of promoting the conservation of small cetaceans.

4.2.30 As part of the EIA, the Sea Mammal Research Unit (SMRU) at St. Andrews University provided data on the presence of cetaceans along the entire western stretches of the British Isles. Data for the area is not specific enough to give species or numbers utilising Siadar Bay. Therefore, the likelihood of species presence is inferred from various data sources including SNH, Hebridean Whale and Dolphin Trust, SMRU and anecdotal evidence. Species of cetacean present to the west of the Hebrides include:

<u>Inshore populations</u>

White-beaked dolphin; Risso’s dolphin; Harbour porpoise

<u>Inshore and offshore populations</u>

Long-finned pilot whale; Bottlenose dolphin; Killer whale

Offshore populations

Atlantic white-sided dolphin; Common dolphin; Sperm whale; Fin whale

Migratory species

Minke whale; Sei whale; Humpback whale; Blue whale; Sowerby's beaked whale; Northern bottlenose whale; Beaked whale spp.

Conservation, Designated and protected sites

4.2.31 There are no marine conservation designations in the immediate area of the proposed SWEP. There are however, internationally important conservation designations further inland. Specific details are provided in the Table below.

Table 4.1 Conservation and protected sites in the vicinity of the proposed SWEP

Site	Area (ha)	Distance from SWEP	Qualifying Interests
Lewis Peatlands RAMSAR site	58984.23	3 km	Blanket bog; Breeding bird assemblages; Dunlin (*Calidris alpina schinzii*) breeding assemblages
Lewis Peatlands SAC	27945.59	3 km	Blanket bogs; Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoëto-Nanojuncetea* Natural dystrophic lakes and ponds Otter (*Lutra lutra*)
Lewis Peatlands SPA	58984.23	3 km	Black-throated diver (*Gavia arctica*) Dunlin (*Calidris alpina schinzii*) Golden eagle (*Aquila chrysaetos*) Golden plover (*Pluvialis apricaria*) Greenshank (*Tringa nebularia*) Merlin (*Falco columbarius*) Red-throated diver (*Gavia stellata*)
Barvas SPA	649.2	3 km	Breeding site for corncrakes

4.3 Human environment

Population and development

4.3.1 The main area of population in the vicinity of the proposed SWEP site is the village of Siadar located immediately to the west, which consists of approximately 116 dwellings and 290 people. The settlement of Baile an Truiseil (approximately 26 dwellings and 65 people) is located to the south from Siadar is also close to the development site. Settlements comprise of a few small-scale linear and grid-type crofting villages.

Cultural heritage

4.3.2 An archaeological study (February - April, 2007) commissioned as part of the EIA comprised a desk-based assessment followed by a walkover survey. The aim of the archaeological survey was to identify and confirm the status and importance of all the archaeological interests onsite.

4.3.3 A range of cultural heritage sites were identified reflecting activity in the landscape around Siadar from the Neolithic and Iron Age, to the pre crofting and crofting era. A total of 66 cultural heritage sites have been identified in the immediate Siadar area.

Fishing activity

4.3.4 Information provided by the Western Isles Fishermans Association (WIFA) indicates that the west coast of Lewis supports a small lobster and velvet crab fishery, of approximately 10 vessels. However the north west coastline is very exposed and only suited to fishing in the summer months. Creel boats using this area fish out of Loch Roag, Loch Carloway and Ness, however will not generally work in water depths as shallow as those at the proposed breakwater site. The Siadar pier is only known to be used by one 27 ft creel boat during the summer and autumn months.

4.3.5 Winkle picking takes place along the shore in Siadar Bay.

4.3.6 Stornoway Sea Angling Association also uses the area for fishing, launching their vessels from Bragar, with these vessels at times plying the waters off Siadar. They are generally targeting herring, mackerel and dogfish.

Waste facilities

4.3.7 Scottish Water operates an outfall which discharges into the southern end of Siadar Bay. There is a solids treatment system onshore for this outfall which removes all solids that are then stored in a septic tank. This separation and storage occurs at a site to the south of the bay adjacent to the proposed onshore construction site and between this site and the mouth of the River Siadar. This tank is emptied by lorry which visits the site as demand dictates.

Shipping

4.3.8 Large commercial shipping passes the west coast of Lewis along designated deepwater channels that, at this point, are 10 km (6 miles) offshore (Stornoway Harbour Master, pers. comm.). Less than 1,000 vessels per annum pass the west coast of Lewis (DOVRE SAFETEC, 1999: Referenced in Eagle Lyon Pope Ltd. & Safety at Sea Ltd., 2005).

4.3.9 There are no harbours in the immediate vicinity of the proposed breakwater site, but a basic slipway is located at the north end of Siadar Bay.

4.3.10 The north west coast of Lewis has been categorised by the Royal Yachting Association (RYA) (2005) as a light usage area, with few recreational craft seen during summer months. The project site is out with any areas regarded as general sailing areas, and only as a place where day tripping and other boating activities occur. Shipping activity is therefore limited to small numbers local fisherman and recreational crafts.

4.3.11 There are no naval exercise areas immediately adjacent to the proposed SWEP area and no indications that the area is more than a transit route for surface vessels.

Tourism and recreation

4.3.12 The rugged coastline, sandy beaches and remoteness of the Western Isles are features that attract visitors to the area (Dunbar *et al.*, 1997).

4.3.13 Tourism in Lewis tends to be dominated by outdoor activities including cycling, hiking, mountaineering, angling, surfing and golf. Other activities include visiting ancient monuments, archaeological sites, heritage sites, Gaelic culture and wildlife watching (Dunbar *et al*, 1997). The north west coast of Lewis includes a number of Lewis's top tourist attractions, including the Butt of Lewis, Dun Carloway Broch, Arnol Blockhouse, Garenin Blackhouse village and the standing stones at Calanais.

4.3.14 Several surfing sites are located along the north coast of Lewis. The Stormrider Guide Europe – Atlantic Islands (2007) indicates three breaks along this coast, the closest of which is approximately 10 km from the proposed site. Surfing activity is also known to occur at Borve, which is approximately 3 – 4 km from the proposed site and local surfers are known to occasionally use breaks at the south of Siadar Bay.

4.3.15 At present there are no specific tourist facilities in Siadar, however the local population is keen to develop facilities in the village, and one of the main developments presently under discussion is the creation of a coastal path connecting those already in existence to the north and south of the Siadar area.

5 EIA Methodology, Scoping and Consultation

5.1 Legislative overview

5.1.1 The EC Directive on Environmental Assessment (85/337/EEC as amended by Directive 97/11/EC) seeks to ensure that where a development is likely to have a significant effect on the environment, the potential effects are systematically addressed in a formal ES. Offshore renewable energy schemes fall within the types of projects listed in Annex II of the Directive where an EIA is required.

5.1.2 In Scotland the requirements of the Directive have been enacted in relation to generation and transmission of electricity by way of various EIA Regulations, including The Electricity Works (EIA) Scotland Regulations 2000 (SSI 2000 No. 320).

5.1.3 Having completed the EIA, the developer is required to submit the ES to the competent authority. The EIA integrates into various consents which are related to the project. These are listed below:

- Section 36 Electricity Act 1989: The production of a statutory ES is governed by the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000.
- Section 5 Food and Environment Protection Act 1985: The production of a statutory ES in support of this licence application is not formally required. However, due to the nature of the project it is considered good practice to provide such information as standard.
- Section 34 Coast Protection Act 1949 (as amended by Section 36 of the Merchant Shipping Act): The production of an EIA in support of this consent is not formally required. However, due to the nature of the project it is considered good practice to provide such information as standard.

5.1.4 The ES considers the requirement for an onshore control building as part of the SWEP. A consent application will be made in relation to this under the following:

- Section 57 Town and Country Planning (Scotland) Act 1997: EIA is governed by the Environmental Impact Assessment (Scotland) Regulations 1999.

5.2 EIA methodology

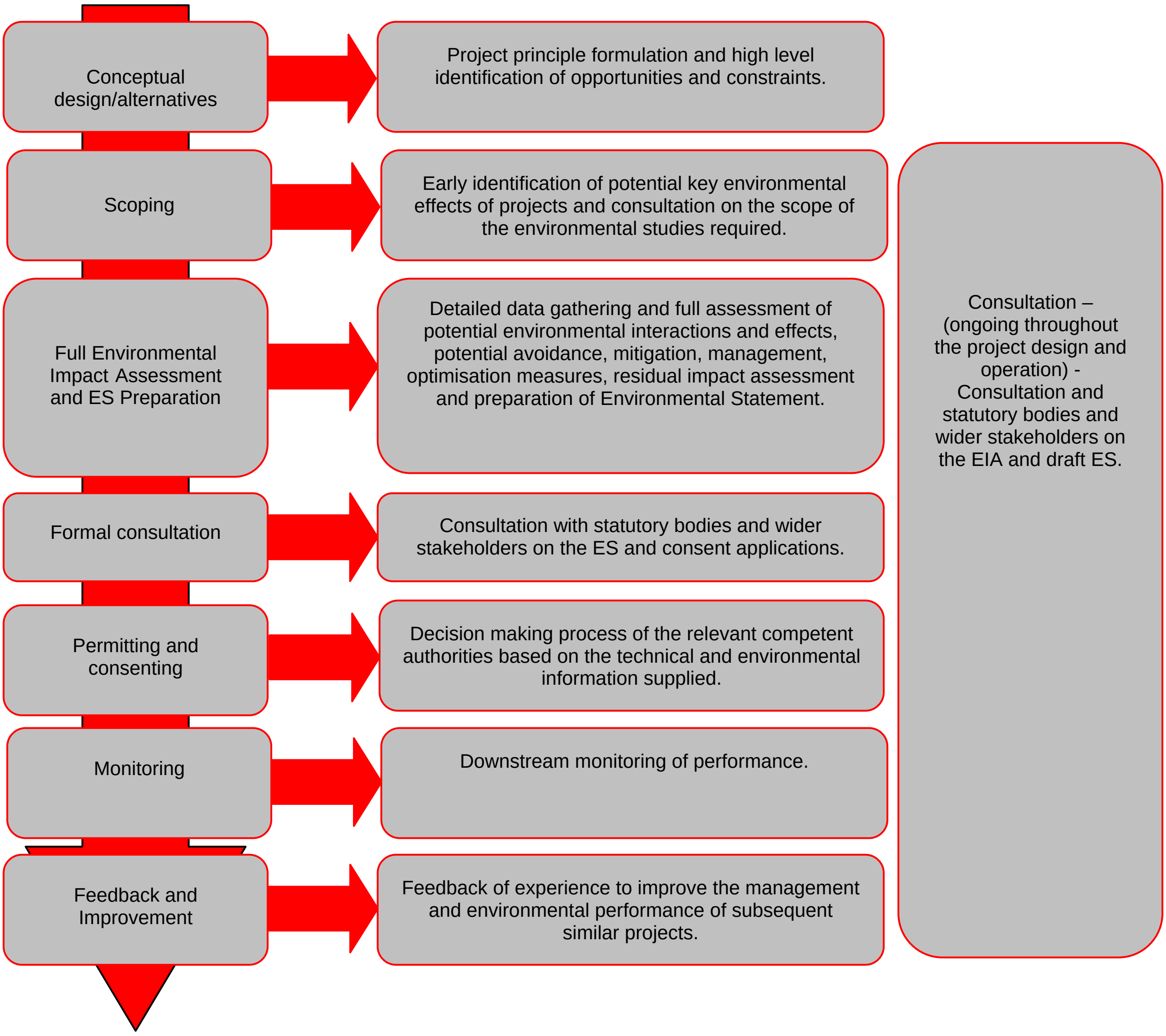
5.2.1 The EIA process requires an understanding of the proposed construction, operation and decommissioning of the SWEP and the environment upon which there may be an impact. Central to the EIA is the systematic identification of issues that could impact the environment, including other users of the environment. Once identified, these issues have to be assessed to define the level of potential impact they present to the environment, so that measures can be taken to remove or reduce such effects through design or operational measures (mitigation).

5.2.2 Cumulative effect and interrelation between each factor is considered in addition to the factors in isolation.

5.2.3 Key stages of the EIA are defined below and summarised in Figure 5-1.

- Defining the project;
- Why is the project required and what other alternatives are there;
- Scoping stage to identify the potential effects and how these should be assessed;
- Define the scope of the EIA based on the responses to the scoping stage;
- Describe the baseline environment and assess the sensitivity of the receptors / resources likely to be impacted;
- Carry out consultation throughout the EIA process;
- Assessment of effects:
    - Assess the magnitude of the possible environmental effects;
    - Evaluate the significance of these predicted effects, i.e. consideration of sensitivity of receptors;
    - Develop mitigation measures and establish how they are to be integrated into the project;
    - Evaluate the significance of the residual effects;
    - Assess potential cumulative effects;
- Production of an ES covering all findings and summarise in a non-technical summary; and
- Implement environmental monitoring as required.

Figure 5-1 The EIA process



5.2.4 The EIA covers all stages of the project from construction through to the decommissioning phase. All effects are taken into account throughout this period regardless of their duration (e.g. short-term drill piling activities to longer term operational noise effects). The environment is considered to include both ecological and socio-economic components.

5.2.5 Spatially the environment considered is within the vicinity of the site where the environment is likely to be impacted / altered. Therefore, the size of this considered environment will alter dependant on the identified impact (e.g. noise and visual will cover a larger spatial scale than terrestrial habitat loss).

The three primary development stages

5.2.6 The impact of environmental effects has been considered for all three primary stages of the development. These are:

- The Construction Phase. This covers the creation of the construction site, the borrow pit, any access tracks to be commissioned, the cabling process, offshore structures and onshore works.
- The Operational Phase. This phase begins after the construction phase has reached completion and the SWEP has been commissioned and is operational.
- The Decommissioning Phase. The decommissioning of the project after it has completed its operational life.

5.3 Significance of Effects

5.3.1 The regulations require that the EIA should consider the significance of the effects of the development on the environment. The decision process related to defining whether or not a project is likely to impact significantly on the environment is the core principal of the EIA process. However, the EIA regulations themselves do not provide specific definition relating to what significance actually is. However the methods used for identifying and assessing effects should be transparent and verifiable.

5.3.2 After reviewing various approaches to the evaluation of significance certain common points exist which have been taken into account for each of the effects related to the SWEP. These include:

- Environmental significance is a value judgement;
- The degree of environmental significance is related to the specific impact;
- The importance of an impact is related to its biophysical and socio-economic impact;
- Changes to the environment can be perceived as being acceptable.

5.3.3 As the determination of the significance of an impact is subjective, primarily based on professional judgement, this highlights the requirement for an extensive scoping and consultation process throughout the development of the project. This is something that has been particularly focussed on by npower renewables throughout the SWEP EIA process.

5.3.4 Once the key scope of studies has been established it is particularly important to standardise the description and assessment of all effects due to the development. Despite this being a subjective process a defined methodology, outlined below, is used to make the assessment as objective as possible. As the environmental factors under consideration can vary considerably depending on what is being assessed there is likely to be some variation in this process. This is evidently the case for the SWEP as effects will occur onshore and offshore, affecting the biological, physical and human environments.

5.3.5 Potential effects of the SWEP may be wide ranging in nature, for example they could be direct, indirect, short medium or long term, permanent or temporary and have positive or negative effects. The effects have been assessed through the following criteria based system which takes into account:

- Potential magnitude / frequency of the expected effect;
- The sensitivity of the receptors likely to be affected;
- Temporal effects – whether the changes is temporary or permanent;
- Relative importance of the environment;
- The degree of mitigation that can be achieved;
- Cumulative effects; and
- Positive or negative effects.

5.3.6 Typically, the magnitude of the impact and sensitivity of the receptor is subjectively given a rating scale throughout the ES to identify the overall effect. These are:

Magnitude of the Impact (positive or negative)	Sensitivity of the Receptor (positive or negative)
Very major	Very high
Major	High
Moderate	Medium
Minor	Low
Negligible	Negligible

5.3.7 The assessment of magnitude and sensitivity ratings of each potential impact are combined to define the significance of the effect (and example of which can be seen in Table 5.1). These have been assessed on a topic by topic basis throughout the ES. How these terms are defined in relation to each topic is set out in the specific sections.

5.3.8 Due to the extensive differences in the effects assessed there is no one definition that fits for all. Therefore, within each section there is an assessment giving a final significance effect. Any residual effect with a rating of “Moderate” or “Major” would represent a significant effect in terms of the EIA regulations. In the subsequent sections significant residual effects are in red text in the significance matrix, as in Table 5.1.

Table 5.1 Effect significance matrix

Magnitude	Sensitivity				
	Very High	High	Medium	Low	Negligible
Exceptional	**Major**	**Major**	**Major**	**Moderate**	Minor
Major	**Major**	**Major**	**Moderate**	Minor	Insignificant
Moderate	**Major**	**Moderate**	**Moderate**	Minor	Insignificant
Minor	**Moderate**	Minor	Minor	Insignificant	Insignificant
Negligible	Minor	Insignificant	Insignificant	Insignificant	Insignificant

5.4 Consideration of design options

5.4.1 The EIA has assessed all options as they relate to the specific study areas. In most cases it is expected that there is a worst case option for a particular impact topic and this has generally been assessed in greatest detail.

5.5 Mitigation and monitoring

5.5.1 Where significant effects related to the SWEP exist, it is important to consider mitigation measures. Such measures should remove, reduce or manage the effect to a point where the significance of that impact is reduced to an acceptable level.

5.5.2 Monitoring should also be considered an important post-development tool. This will allow the effects of any mitigation measures to be monitored and also the study of the accuracy of the predicted effects.

5.6 Scoping overview and consultation

Introduction

5.6.1 The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000 (Statutory Instrument 2000 No.320) (the Regulations), require that Environmental Statements should describe the likely significant effects of the proposed development on the environment. Scoping of potential issues associated with the physical and operational aspects of the development provides a basis for ensuring that the assessment is appropriately limited to issues of genuine potential significance.

5.6.2 This section of the ES describes the consultation process that was undertaken as part of the scoping exercise, sets out conclusions as to the issues that require addressing in detail in the ES.

5.6.3 In October 2006, npower renewables, requested a Scoping Opinion from the Scottish Ministers by submitting their scoping report. This report, which was prepared by West Coast Energy, identified the potential significant effects to be addressed in the EIA. npower renewables advised Scottish Ministers of their intention to submit a Section 36 Application to construct the proposed wave energy scheme. In February 2007, the Scottish Executive issued their Scoping Opinion, which identified the issues that should be addressed and included in the EIA. The Scoping Opinion from the Scottish Executive is included in Appendix B.

5.6.4 The consultation process has continued during the assessment process to:

- Ensure that statutory and other bodies with a particular interest in the environment are informed of the proposal and provided with an opportunity to comment;
- Obtain baseline information regarding existing environmental site conditions;
- Establish key environmental issues and identify potential effects to be considered in the EIA;
- Identify those issues which are likely to require more detailed study and those that can be justifiably excluded from further assessment; and
- Provide a means of identifying the most appropriate methods of impact assessment.

5.6.5 Consultees as part of the scoping process were contacted either by letter or by way of meetings. Where contact was made by letter the consultees were informed of the detail of the proposed development and were requested to provide any specific baseline information that they may hold or any comments that they may have concerning the scheme. Consultees included the following:

- Association of Salmon Fisheries Board;
- British Surfing Association;
- Civil Aviation Authority (CAA);
- The Chamber of Shipping;
- Comhairle nan Eilean Siar;
- The Crown Estate;
- Fisheries Research Service (FRS);
- Galson Estate Trust;

- Health and Safety Executive;
- Historic Scotland;
- National Air Traffic Services (NATS);
- Northern Lighthouse Board (NLB);
- Maritime and Coastguard Agency (MCA);
- Scottish Environment Protection Agency (SEPA);
- Scottish Natural Heritage (SNH);
- Scottish Water;
- Royal Society for the Protection of Birds (RSPB);
- Royal Yachting Associating (RYA);
- Western Isles Fisheries Trust (WIFT); and
- Western Isles Fishermen's Association (WIFA).

5.6.6 Following receipt of initial responses and subsequent meetings and correspondence with most of the above organisations, the assessment team reviewed potential significant issues and determined the scope (nature and extent) of individual assessments appropriate to the proposed development and its receiving environment. The following topics were identified for detailed assessment.

1. Terrestrial Geology, Hydrology and Hydrogeology;
2. Terrestrial Habitats and Ecology;
3. Marine Habitats and Ecology;
4. Cultural Heritage – Terrestrial and Marine;
5. Coastal Processes;
6. Onshore Noise;
7. Landscape and Visual;
8. Transport and Route Access;
9. Socio-economic; and
10. Underwater Noise and Electromagnetic Effects.

5.6.7 Consultation has been ongoing throughout the full EIA with consultees as required. Local based organisations including SNH, SEPA, WIFT and Comhairle nan Eilean Siar have been regularly updated on project progress during site visits and meetings held or discussions had with other consultees as necessary for specific topics. All issues raised during scoping and subsequent consultations as part of the EIA are detailed in each impact assessment section in the ES.

5.7 Community consultation

5.7.1 In addition to the formal consultees discussed above, an extensive Community Consultation program has been undertaken. This was undertaken in accordance with Planning Advice Note 81 (PAN81) 'Community Engagement – Planning with People'. PAN 81 is described as '*providing advice to planning authorities and developers on how communities should be properly engaged in the planning process' and 'shows how everyone can take part in shaping the future of their area, providing information and advice on how best to listen, engage and understand what people want for their area*.'

5.7.2 Formal public consultations about the proposed scheme started in July 2006, when sufficient information was available to present preliminary plans. These consultations included presentations to the Siadar Pier Group, Airidhantuim Community Council and a local public exhibition and public meeting. In addition to this, there has been local and national media coverage on Gaelic radio and BBC Gaelic TV programs. A website was also used to inform and consult with the community and other interested parties about the proposed development. A summary of all community consultations is provided in Table 5.2.

Table 5.2 Community consultation summary

Date	Activity	Location
31st July 2006	Public meeting at scoping stage	Barabhas village hall, Barvas
Various occasions 2006, 2007	Meetings with Siadar Pier Group	Siadar
28th August 2007	Meeting with Airidhantuim Community Council	Borve Hall, Borve
29th August 2007	Radio news Item	Gaelic FM
26th October 2007	Public meeting, Siadar	Airidhantuim Primary School, Siadar
26th/27th October 2007	Public exhibition, Airidhantuim Primary School, Siadar	Airidhantuim Primary School, Siadar
1st November 2007	Article in Stornoway Gazette	Local paper and online.
1st November 2007	Eòrpa TV report 'Project proposes using wave power to produce electricity'	BBC2
Ongoing	Project website	Online

Presentations to community council

5.7.3 Presentations were made to Airidhantuim Community Council. The purpose of meeting with the Community Council was to introduce the Community Council representatives to the proposed wave energy scheme and to answer any questions in relation to the proposal. Initial meetings were also used to establish the best means of engaging with people throughout the local community. As a result of this, the preferred methods of future consultation were:

- Public meetings;
- Public exhibition;
- Meetings with the Community Council;
- Local Notices;
- Information stands; and
- Website.

5.7.4 It is also noted that the Community Council Meetings are open to the public and there were usually 15 - 20 members of the public attending such events as well as the council members.

5.7.5 npower renewables will continue to keep the local community informed of any developments and consult them throughout the development process.

Public exhibition

5.7.6 A public exhibition was held at Siadar on 26th and 27th October 2007 at Airidhantuim Primary School, Siadar. Prior to the exhibitions and public meeting, invitation letters were sent out to about 250 households, within the local community council area. The public exhibitions were advertised in the local press (Fois Newsletter and Stornoway Gazette) which is distributed widely in the area and throughout the Western Isles. Posters advertising the event were also distributed around the local area and at local amenities. Approximately 150 people visited the exhibition over the two days.

5.7.7 The exhibition consisted of a series of mounted boards giving the background, rationale and benefits of the proposed scheme and then details of the design and layout of the scheme (at that point in time), its landscape and visual impact (illustrated with zones of visual influence, photomontages) and other potential environmental effects.

5.7.8 A video was also shown describing the other Wavegen sites in operation and under construction, namely the LIMPET site in Islay and the Mutrikku site in Portugal. Representatives from npower renewables, Wavegen and Xodus AURORA were on hand throughout the exhibition to take comments answer questions and provide additional information.

5.7.9 Visitors were invited to comment on, and discuss, the project and to contact the developer with any further comments or questions they had. Contact cards were available with email, telephone, address and website details.

Public meeting

5.7.10 A formal meeting with presentations and discussion from various speakers was held on 26th October 2008. Visitors were invited to comment on, and discuss, the project and to contact the developer with any further comments or questions they had. Contact cards were available with email, telephone, address and website details. About 35 people attended this event and many of them completed feedback forms giving a positive response to the development.

5.7.11 The historical background to the scheme and identification of the Siadar site came about through cooperation with the Siadar Pier Group and therefore has a strong community element.

Media coverage

5.7.12 Local radio have carried out a number of news items relating to the project, usually coinciding with the local public and community council meetings held about the project.

5.7.13 A broadcast by Gaelic TV about the project coincided with the public exhibition and there were interviews with staff and members of the public. The broadcast went out on BBC2 across Scotland on 1st November 2007.

Website

5.7.14 Pages with information about the proposal went live on www.npower-renewables.com/siadar in 2006 and have been updated throughout the consultation period and as the development has evolved. If visitors to the site are unable to find the answer to their question in the pages provided, an email and postal address were provided to contact the project manager directly.

Public consultation and feedback

5.7.15 The results from the comments forms completed at the public exhibitions have been collated and have been actively used to inform elements of the scheme, particularly the onshore arrangements where there are various local interests. A show of hands at the public meeting (attended by 35 people) found that there was unanimous support for the scheme and this was also reflected in the completed feedback forms which were available following the meeting and exhibitions. Any concerns registered in these forms are being actively addressed.

6 Terrestrial Geology, Hydrology and Hydrogeology

6.1 Introduction

6.1.1 This section assesses the potential effects of the SWEP on the surrounding terrestrial hydrology, hydrogeology and geology, it therefore relates to the onshore components; construction compound, fixed link/slipway landfall site, access tracks and control building only. A description of these components is provided in Section 3.

6.1.2 The assessment covers the construction, operation and decommissioning phases and identifies the potential effects and mitigation measures on the following receptors:

- Surface water: quality and flows;
- Groundwater: quality and flows; and
- Water users: abstractions and discharges.

6.2 Legislative framework and regulatory context

Legislative background

6.2.1 The following regulations set out the framework for legislative requirements for works affecting the water environment:

- Water Framework Directive (2000/60/EC);
- Water Environment and Water Services (Scotland) Act 2003; and the associated
- Water Environment (Controlled Activities) (Scotland) Regulations 2005 (CAR). The CAR regulations introduce controls over impoundments, abstractions and engineering affecting watercourses, including crossings.

6.2.2 Other relevant legislation includes:

- Water Quality (Water Supply) (Scotland) Regulations 2001;
- Groundwater Regulations 1998;
- Control of Pollution Act 1974;
- Environment Act 1995;
- EC Dangerous Substances Directive 1976 (76/464/EEC); and.
- Water Environment (oil storage) (Scotland) Regulations 2006.

Relevant planning policies and guidance documents include:

- Planning Advice Note 51 (PAN51), Planning, Environmental Protection and Regulation, Revised 2006;
- Planning Advice Note 61 (PAN61), Planning and Sustainable Urban Drainage Systems, 2001;
- Scottish Planning Policy 7 (SPP7), Planning and Flooding, 2004;
- SEPA Policies:
    - No.19 Groundwater Protection Policy for Scotland, 2003;
    - No.26 Policy on the Culverting of Watercourses, 1998;
- SEPA Pollution Prevention Guidelines:
    - PPG1 General guide to the prevention of water pollution, under review in 2007;
    - PPG2 Above ground oil storage tanks, 2004;
    - PPG5 Works in, near or liable to affect watercourses, (undated);
    - PPG6 Working at construction and demolition sites, (undated);
    - PPG18 Managing fire water and major spillages (undated); and
    - PPG21 Pollution incident response planning, 2004.
    - Other guidance and standards include:
    - SEPA Guidelines for Prevention of Pollution from Civil Engineering Contracts: Special Requirements (and Guidelines for the Special Requirements), 2006;
    - SEPA best practice guidance for crossing of watercourses (currently under development, due to be published in 2007);
    - Scottish Natural Heritage. Good Practice Guidance on Constructing Tracks in the Scottish Uplands, 2006;
    - Scottish Executive. River Crossings and Migratory Fish: Design Guidance. A Consultation Paper, 2000;
    - CIRIA. Control of Water Pollution from Construction Sites – Guide to Good Practice on Site, SP 156, 2002;
    - CIRIA. Control of Water Pollution from Construction Sites – Guidance for Consultants and Contractors, C532, 2001;
    - CIRIA. Environmental Good Practice on Site, C502, 1999; and
    - BS6031: 1981 Code of Practice for Earth Works.

6.3 Methodology

Scoping and consultation

6.3.1 Consultation in relation to hydrology and hydrogeology has been undertaken with the bodies listed in Table 6.1. The issues detailed in the table include those raised in the Scoping Opinion.

Table 6.1 Consultees and their key concerns

Name of organisation	Key concerns	Comment
Scottish Executive (Scoping)	Commented that the effects on water quality and the Water Framework Directive (WFD) should be considered.	Water quality effects covered in assessment. CAR regulations will have to be applied when considering watercourse crossings and possible water abstraction.
Association of Salmon Fisheries Board	Consider effects on migratory fish.	Effects on fish covered in the marine ecology section (Section 8). Indirect effects through spillages and sedimentation covered in this assessment. Design of watercourse crossings would take account of ecological need.
SEPA	Consider implications of CAR regulations.	CAR regulations discussed in assessment of watercourse crossings and possible water abstraction.
	Pollution risks should be identified. Preventative measures and mitigation should be identified.	Pollution of surface and groundwater covered in assessment. Mitigation measures specified including a pollution prevention plan. Principles of Pollution Prevention Guidelines will be included in the plan.
	SEPA has a policy against unnecessary culverting.	Design minimises watercourse crossings. Design of watercourse crossings will follow SEPA Best Practice Guidelines.
Western Isles Fisheries Trust	Proximity to watercourses in relation to fisheries interests.	Assessment of potential effects undertaken and suitable mitigation measures recommended.
	Water crossings should be minimised where possible.	Design minimises watercourse crossings. Design of watercourse crossings will follow SEPA Best Practice Guidelines.
	Recommend that land based construction is not carried out within 200 m of water courses.	Construction works are planned to be located as far as practicable from all water courses. Those activities located adjacent to watercourses will be appropriately managed to avoid effects.

Desk Study

6.3.2 A desk study has been undertaken to assess the existing hydrology, hydrogeology and geology of the area. Much of the information is based upon the Environmental Baseline Survey report for the SWEP, Isle of Lewis, November 2006 (West Coast Energy, 2006a), available on the attached CD. Table 6.2 lists the other sources of data utilised for this project:

Table 6.2 Sources of Data: Hydrology and Hydrogeology

Topic	Subject	Source
Climate	Rainfall	Flood Estimation Handbook (FEH) 1999
Topography	Elevation, relief	Ordnance survey map 1:25 000
Surface Water	Flooding	SEPA
	Catchment areas	Flood Estimation Handbook (FEH) 1999
Groundwater	Hydrogeology	BGS Hydrogeological Map of Scotland, 1:625 000, Aquifer Vulnerability map from SEPA website – SEPA, BGS, The MacCaulay Institute.
Geology	Geology	BGS Soil Survey of Scotland
Water users	Private water supplies	Comhairle nan Eilean Siar
	Abstractions	Scottish Water

6.3.3 Relevant information has been obtained to determine any concerns or effects to consider. This includes information on ecologically sensitive habitats relying on water, location and nature of public water supplies (from Scottish Water), the location of any private water supplies and notice of any special water features (SEPA and local authority (Comhairle nan Eileann Siar)).

Field survey

6.3.4 A field survey has not been undertaken as part of the assessment as a detailed environmental survey was carried out in September 2006 and reported upon in the 'Environmental Baseline Survey Report for the SWEP, Isle of Lewis', November 2006. However additional site information was made available from the Xodus AURORA general site visit in September 2006.

Significance criteria

6.3.5 The significance criteria employed for this section is based on the methodology defined in Section 5.3. The sensitivity and magnitude criteria are defined in Table 6.3 and Table 6.4 below.

Table 6.3 Definition of sensitivity of effect

Sensitivity (positive or negative)	Definition
High	Abstraction – public or private water supply Presence of Habitats Directive Annex 1 (water dependent) habitat Sites supporting populations of internationally important species which rely on water dependent habitats Internationally designated or proposed sites
Medium	Nationally designated sites Local ecological importance relating to water
Low	Watercourse of poor water quality with no ecological importance or water abstractors
Negligible	No surface or groundwater features

Table 6.4 Definition of magnitude / frequency of effect

Magnitude (positive or negative)	Definition
Major	Fundamental change to the hydrological/hydrogeological conditions resulting in temporary or permanent change
Moderate	Detectable change to the hydrological/hydrogeological conditions resulting in non-fundamental temporary or permanent change
Minor	Detectable but minor change to the hydrological/hydrogeological conditions
Negligible	No perceptible change to the hydrological/hydrogeological conditions

6.3.6 The magnitude and sensitivity of the potential effect are combined to define the significance of the effect, as shown in Table 6.5. Those criteria in red text are the residual effects considered significant under the EIA regulations.

Table 6.5 Effect Significance matrix

Magnitude	Sensitivity			
	High	Medium	Low	Negligible
Major	**Major**	**Moderate**	Minor	Insignificant
Moderate	**Moderate**	**Moderate**	Minor	Insignificant
Minor	Minor	Minor	Insignificant	Insignificant
Negligible	Insignificant	Insignificant	Insignificant	Insignificant

Pre-assessment of effects to identify worst case design options

6.3.7 A summary of the proposed project aspects which may result in an impact on terrestrial hydrology, hydrogeology or geology are presented in Table 6.6. Where more than one design or construction method is available all possible options are identified.

Table 6.6 Pre assessment of effects to identify worst case design options

Aspect	Options	Description	Discussion
Caisson construction	Local construction, construction compound established adjacent to the Scottish Water works at Siadar	Compound area approximately 8.5 hectares would be required. Temporary vehicle bridge over the River Siadar may be required. Water may be sourced from connection to the local water supply or from the River Siadar	Worst case because larger compound area is required and potential works to River Siadar
	Remote construction – caissons are floated to site for installation	Smaller compound area approximately 1.5 hectares would be required. The compound would be in the same location as the compound required for local construction.	Lower significance, smaller land take and works to River Siadar not expected to be required.
Operation and maintenance to the breakwater	Fixed permanent access to link the breakwater to shore by rubble mound fixed link	Would require construction of a new fixed permanent link.	Worst case because new structure required which has a larger physical impact than upgrading existing structure.

Aspect	Options	Description	Discussion
	Fixed permanent access to link the breakwater to shore by part rubble mound, part steel truss bridge		
	Boat access from onsite slipway.	Would require upgrades to existing slipway.	Lower significance because only modifications to existing structure which would have a smaller physical impact.
Control building	Located adjacent to existing slipway	Potential requirement to move the alignment of an existing drainage ditch.	The realigning of the drainage ditch should be considered as the worst case scenario.
	Located adjacent to existing Scottish Water works	The existing footbridge over the River Siadar could be improved or renewed to improve the amenity of the area	Lower significance, however, works to River Siadar may be undertaken.

6.3.8 This assessment has identified the worst case option for detailed assessment, with all other options assessed at the end of each subject.

6.4 Baseline description

Rainfall

6.4.1 The Flood Estimation Handbook (FEH) estimates the standard average annual rainfall (SAAR) to be 1,400 mm. However, the average annual rainfall is likely to be nearer 1,200 mm, as the Meterological Office gauge at Stornoway (NGR 1464 9332) gives a SAAR of 1,170 mm. Rainfall data collected on Lewis indicates that an average of between 1,000 mm and 1,400 mm of rain falls on low-lying ground, increasing with altitude to 2,000 mm. The Hydrogeological Map of Scotland (1998) indicates that the regional rainfall is between 800 and 1,200 mm per year.

Land use and topography

6.4.2 The northern plateaux of Lewis lie between 50 m and 150 m above sea level and are largely covered in an almost continuous expanse of blanket bog. This is occasionally broken by small hills, peaty lochs and deeply incised streams. Significant rock outcrops occur as cliffs along the coast.

6.4.3 The physical landscape of the site consists of rounded hills to the east with valleys running approximately from southeast to north west. The highest point on the site is north of Siadar at 34 m AOD (Above Ordnance Datum) with lowest being at sea level along the coast.

6.4.4 The majority of construction access is proposed to occur along two existing roads. Access to the shoreline and existing slipway at the north west of the bay will be via an unclassified road that leads directly through Upper Siadar. Access to the southern part of the bay will be via an existing tarmac road through Baile an Truiseil and onwards past a gate on a sub-base road.

6.4.5 To access the proposed potential borrow pit to the south west of the bay a new track to the site will be required. It will link in with the northern part of the existing tarmac road through Baile an Truiseil and may vary according to the preferred location of the potential borrow pit. This access track will cross bog/acid grassland mosaic and wet modified bog for approximately 400 m, as well as crossing the Feadai Siorravig Burn.

6.4.6 The proposed potential borrow pit location is currently used for rough grazing; the ground is peaty and damp.

6.4.7 The majority of the site is currently wet modified bog with some acid grassland in the southeast corner.

6.4.8 The proposed construction compound location is currently damp, mossy, rough grazing ground, with some scattered boulders and some boggy areas. This area is reasonably flat.

Hydrology

Local soil conditions

6.4.9 The Soil Survey of Scotland map shows that northern central Lewis is covered in blanket peat. However, the north-western coast and coastal areas have been stripped of peat for fuel. The remaining cover of soils is generally non-calcareous humic gleys. Isolated patches of forest soils and alluvium also exist in various locations near to the coast in northern Lewis.

Watercourses, surface water catchment areas and artificial drainage

6.4.10 The Siadar construction site lies close to three catchments (as shown on Figure 6-1):

- Loch Dubh na h-Airde catchment: this very minor catchment is located to the southwest of the survey area, lying on the lower slopes of the Tom a Mhinister. The outflow from Loch Dubh na h-Airde is the short stretch of Allt a Ghearraidh (about 1000 m) which flows east at first and then due north to the sea. There is also a well established man-made (constructed and regularly maintained) drainage channel, with a lower spill point than the Allt a Ghearraidh, which flows due north from the loch outfall down to the sea. The total effective catchment area to the loch is 1 km^2.

- Feadan Siorrabhaig catchment: This very small catchment is immediately adjacent to the south-western extremity of the site, lying on the north facing slopes at the head of Tom a Mhinister. The catchment is drained by the Feadan Siorrabhaig and a series of drainage ditches to the north of Baile an Truiseil area of Siadar. The catchment drains an area of approximately 1.5 km^2 and flows into the sea at grid reference NB 377 547, close to the south-western corner of the site.
- River Siadar catchment. The flows north west from its furthest headwater of Loc nana Leac. The channel runs in a wide mature valley, typical of many catchments flowing out along the north-western coast. The catchment drains an area of approximately 25.3 km^2 and the outflow to the sea occurs just to the north-east of the site. A very minor tributary joins the Siadar from the south (not shown on the OS 1:50,000 maps), just before it reaches the sea. Lambol Burn sub-catchment is part of the River Siadar catchment. This tributary of the Siadar joins from the north just before the Siadar drains into the sea. The sub-catchment is located to the north east of the site, the burn is the only outflow from Loch Bacabhat and has a total catchment area of less than 2 km^2. The burn flows in a south-westerly direction. At the existing road crossing (a concrete bridge) the burn is narrow and full of reeds. Upstream of the bridge the incline is steeper and the flow is faster and the burn is narrower. Downstream of this bridge the burn splits into two. The main burn is narrower and flows into the River Siadar further downstream and the other branch is wider and flows parallel to the road (a drainage ditch) discharging to the sea adjacent to the existing slipway by permeating through the shingle bank. The alignment of this ditch has been moved recently.

6.4.11 On the SEPA website, the River Siadar, was classified as A2 Good (biologically 2006) according to SEPA's classification scheme. Under the same scheme the coastal strip is classified as A Excellent according to SEPA's coastal classification scheme. SEPA have confirmed that there is currently no chemical water quality information available for the other streams in the survey area.

<u>Flooding</u>

6.4.12 The catchments are peaty and have characteristically flashy hydrological responses in which rainfall is converted to runoff quickly due to the generally impermeable nature of blanket peat. The baseflow (groundwater contribution) component is low.

6.4.13 Characteristically blanket peat catchments retain high soil moisture throughout the year, forcing runoff responses as almost as rapidly in summer as in winter. Storm rainfall can therefore be the primary cause of flooding in such catchments as high intensity rainfall is translated to runoff and stream flow almost as instantly.

6.4.14 The FEH provides guidance on the most up-to-date methods for assessing the hydrological properties of rivers and burns in the UK, providing details on the extent and characteristics of each water catchment. It should be noted that there is no site specific catchment data on the FEH CD ROM v1.0 or from SEPA gauging stations for the survey areas. Baseline stream discharge data on Lewis is very limited; it is restricted to the SEPA monitoring station on the River Creed.

6.4.15 Design flows for the River Siadar were presented in the Environmental Baseline Survey Report, November 2006 (West Coast Energy, 2006a). This information is summarised below.

6.4.16 The FEH rainfall-runoff method to calculate peak flows was used in the form of the revitalised FEH (ReFH 2005) rainfall-runoff spreadsheet V1.3. Design flow figures were obtained for the River Siadar because it is the major river in the study area and the river outfall is located close to the proposed development area.

6.4.17 Catchment descriptors were obtained from catchments deemed to be suitable analogues. This is a simplified methodology, but was considered suitable for the purposes of the baseline study in the absence of local data and the small catchments of the various rivers/streams.

6.4.18 The analogue catchments (NC2250 6535 and NC2315 6640) have similar characteristics (area, altitude, habitat, soils and aspect etc) and are located on the far north west of mainland Scotland at the same latitude as the River Siadar on Lewis.

6.4.19 Where actual catchment descriptors could be extrapolated for the River Siadar they were used to replace the analogue descriptors on the spreadsheet. These included:

- SAAR – Standard Average Annual Rainfall: assumed to be 1,400 mm for worst case purposes.
- Area: 25.3 km^2
- WRAP – Winter Rainfall Acceptance Potential – is classified as class 5, very low.
- PE - Potential Evaporation – taken as 520 mm/yr (from Meteorological Office)
- DPSBAR - index of catchment steepness. The catchment falls 120 m over approximately 9 km, which is 13.3 m/km.

6.4.20 The design flows calculated below in Table 6.7 provide indicative flows in the survey area that can be expected for a range of design events (return periods) and should be used to ensure that any new culverts or bridges over the River Siadar associated with the development are suitably sized to convey the expected range of flows.

6.4.21 Low flows (Q95) have been calculated using the methodology in the Institute of Hydrology report 108. The Q95 is also shown in Table 6.7.

Table 6.7 Design flows for River Siadar

Watercourse: **River Siadar**	
Area (km^2): **25.3**	
NGR location: **NB 377 547**	
Return period (Years)	**Discharge (m^3/s)**
2	15.8
5	20.4
10	24.1
25	28.9
50	33.4
100	38.8
200	45.5
Low Flows Q95	0.05

Note: It should be noted that the figures in Table 6.7 do not include an allowance for climate change.

Hydrogeology

<u>Geology</u>

6.4.22 The 1:100,000 BGS Solid Geology Map (Lewis and Harris (North)) indicates that the site is underlain by a relatively uniform bedrock of undifferentiated Lewisian Gneiss. The Lewisian Gneiss represents the oldest rocks in Britain (almost 3,000 million years old). An area to the south west of the survey area also contains granite of Archaean age.

6.4.23 In the north of Lewis the Gneiss is generally covered in a mantle of highly compressible peat typically between 1 m and 5 m thickness in the north of Lewis. However, the north-western and coastal areas were stripped of peat for fuel. The remaining cover of soils is generally non-calcareous humic gleys.

6.4.24 An intermediate zone of uncertain geotechnical characteristics lies beneath the peat and on top of the Gneiss throughout much of Lewis. This is generally a weathered profile of glacial till at the top of the Gneiss, which can form a substantial thickness in places. This horizon could have a much lower bearing capacity than unweathered rock, although in the past it has been used extensively on Lewis as foundation material for the construction of roads and tracks.

Groundwater in the bedrock

6.4.25 The Groundwater Vulnerability Map of Scotland (BGS, 1995) describes the bedrock in the area as weakly permeable, indicating that the bedrock underlying the site is low permeability rock and does not contain groundwater in exploitable quantities.

6.4.26 The 1:625,000 Hydrogeological Map of Scotland (BGS, 1988) shows that the region is underlain by impermeable Precambrian rocks (i.e. the Lewisian Gneiss), generally without groundwater except at shallow depths.

6.4.27 This is what will be expected as the Precambrian Gneiss offers little potential for groundwater storage and transport other than in cracks and joints.

Groundwater flow in the peat

6.4.28 The majority of the site is covered with a mosaic of blanket bogs and wet heaths which are predominantly fed by rainfall and surface water runoff. This coupled with the impermeable nature of the bedrock in the region indicates that any groundwater encountered is likely to be perched and localised.

6.4.29 The groundwater regime that operates in peat is complex and very variable over short distances. Water is frequently observed to discharge as seepages and small springs from peat deposits immediately adjacent to areas where peat faces are dry. Similarly pools of water are common on peat which indicates locally very low permeability zones close to areas of higher permeability where peat does not support pooling of water.

6.4.30 The presence of “peat pipes” within peat facilitates the rapid movement of water through peat similar to the presence of major fractures in hard rock formations. This movement can be vertical through to formations below the peat, or lateral within the peat.

Abstractions

6.4.31 The Comhairle nan Eilean Siar Environmental Health Officer identified no private water supplies within the survey area. There are no public water supplies within the survey area.

Ecologically sensitive sites relying on water

6.4.32 The Environmental baseline survey report for the SWEP, November 2006 states that the findings of the Phase 1 habitats survey were:

- No priority species of plant listed by the EC Habitats Directive or the Wildlife and Countryside Act 1981 were located in the study area;
- No UK BAP species of plant was recorded and no nationally rare or nationally scarce species of higher or lower plant was found; and
- The site has no national or international designations. The Local Plan and Local Biodiversity Action Plan (LBAP) do not have any information regarding proposed designations (Comhairle nan Eilean Siar, 2005).

6.4.33 An otter survey was carried out as part of the baseline survey. This was conducted along the coastal strip and inland moorland and lochans and found evidence of otter presence, but did not show high levels of activity. Otters are an Annex II species in the EU Habitats Directive.

6.4.34 The Breeding Bird Survey undertaken in 2007 found three red list species (corncrake, skylark and starling) and eight amber list species (greylag goose, oystercatcher, lapwing, snipe, curlew, redshank, common gull and the meadow pipit). None of the breeding bird populations found on the site represented more than 0.1 % of the UK breeding population.

6.5 Assessment of potential effects - construction

Potential effects

6.5.1 The construction phase is likely to be when there is the greatest risk of potential effect to the hydrology and hydrogeology of the site. This is when there is most activity onsite, and therefore, most risk of physical disturbance and pollution. This section describes the potential effects from the construction only, followed by the recommended mitigation measures. Residual effects (which include allowance for mitigation) are described below.

Effects on surface water flows and levels

<u>Potential effects</u>

6.5.2 A borrow pit is likely to be established to provide some of the aggregate requirements for the scheme, and therefore a new temporary access track between the site compound and the borrow pit would also be required. The proposed temporary access track between the site compound and the potential borrow pit crosses the Feadah Siorravig Burn and a very small tributary to the burn. The crossing point of the Feadah Siorravig is approximately 250 m upstream of the sea. At the crossing location the burn is approximately 1 m wide and normally only 5 cm deep. This crossing would not be permanent.

6.5.3 It is likely that a temporary vehicle bridge over the River Siadar near the Scottish Water works will be required. Watercourse crossings have the potential to have an effect on flows and sediment transport. If the crossing is not designed for a sufficient peak flow, scouring and overtopping could occur. Depending on the design of the crossing it could also be a migratory barrier to fish and other wildlife.

6.5.4 If the control building is located near the River Siadar then the existing footbridge over the river could be permanently improved or renewed to improve the amenity of the area. However, situating the control building adjacent to the existing slipway would potentially require the re-alignment of an existing drainage ditch.

6.5.5 The site compound and new control building will increase the area of hardstanding in the catchment. At most the area of the compound will be approximately 8.5 hectares. This will change the runoff characteristics but the existing land is very flat and is made up of generally saturated peat. Thus runoff from the site is not likely to be very different when the compound is placed on the site. Any minor increases in runoff due to a hard (but porous) surface would be difficult to quantify or measure. The proposed site compound and control building would be located adjacent to the beach and cover a relatively small area. Runoff from the compound hard surfaces will be discharge directly to the beach via pollution control measures (e.g. a settlement pond with a shut off valve to enable spillages to be intercepted and contained). There would be no discharges into watercourse. As a result of the mitigation (to stop discharge into a watercourse and the pollution control measures) there are no surface water or groundwater receptors downstream of the site compound and thus the potential effect is **insignificant**.

6.5.6 The potential borrow pit will change the runoff characteristics in the immediate footprint of the borrow pit. The precise location of the borrow pit has yet to be finalised but it would be somewhere on the catchment boundary between Allt a' Ghearraidh and Feadan Siorrabhaig. However, although both these catchments are small the total area of the borrow pit will be a small proportion of the total catchment area. Furthermore the borrow pit is located only 200 m from the sea, so any effect on surface water runoff will be very localised. These two streams have medium to low importance in terms of flow due to their limited size and extent, any impact on flows would be minor to negligible and the overall effect would be **insignificant**.

6.5.7 It is possible that the concrete could be batched onsite for caisson construction using an abstraction from the River Siadar. Any abstraction point would be approved by SEPA (under

CAR (2005) if required for a temporary abstraction) and would be located very close to the mouth of the river to the sea (but upstream of any saline influence from wave action). It is concluded there is no need to consider further mitigation with respect to abstraction as there are no sensitive receptors downstream. The sensitivity of the River Siadar is high due to good water quality, the presence of otters and salmonid potential, the magnitude of any impact on flows from the proposed abstraction would be negligible due to the location of the proposed abstraction and the overall effect would be **insignificant**.

6.5.8 The temporary crossings of the Feadah Siorravig Burn, minor tributary, and River Siadar could affect the ability of the water courses to transmit flood flows or to affect water quality. If culverts are put in place then the flow capacity of the streams could be affected when culverts become blocked, or if the culverts are undersized. If fords are installed then the crossings could affect water quality each time a vehicle passes through the watercourse. The Feadah Siorravig Burn and minor tributary are minor to low sensitivity, and the magnitude of any impact could be minor to moderate. Thus the effect would be **minor** in the worst case.

6.5.9 The River Siadar crossed well downstream of the main road inland – but land could be flooded if a culvert became blocked. The stream has medium sensitivity and the magnitude of the impact could be moderate temporary effects. The overall effect of a culverted crossing could therefore be **moderate**.

Mitigation

6.5.10 As the potential effects of temporary crossings are **minor to moderate** across the scheme (on the Feadah Siorravig Burn, minor tributary, and River Siadar) all crossings would be designed to take account of appropriate peak flows, and ecological needs. Therefore, the crossing structures are likely to span the stream and not cause any interference to the stream beds or the ability of the streams to transmit water under extreme weather conditions. The structures will be designed such that they have sufficient capacity to prevent flooding and erosion. The structures will allow the continuation of the riparian corridor underneath the bridge, and minimise the need for bank reinforcement. The design of the crossings will follow SEPA best practice guidance for crossing of watercourses and adhere to The Water Environment (Controlled Activities) (Scotland) Regulations 2005 (CAR, 2005).

6.5.11 Should the existing footbridge at River Siadar require permanent modification, the crossing will be designed to accommodate the appropriate peak flow, to prevent flooding and erosion issues.

6.5.12 If the drainage ditch is permanently re-aligned (worst case) for construction of the control building, the new alignment will be designed to accommodate the appropriate peak flow, to prevent flooding and erosion issues. It would be designed to ensure that no significant change to the hydrology of the stream resulted.

6.5.13 Depending on the detailed design of the crossings and re-alignment, authorisation may be required from SEPA. The CAR 2005 requires differing engineering levels of authorisation for river crossings.

6.5.14 Sensitive activities will be located as far from water courses as possible: 200 m where this is practicable. Where this is not practical, all activities near water courses will be appropriately managed to avoid any adverse effects.

Residual effect

6.5.15 If the suggested mitigation measures are enforced then the magnitude of any impact on flows would reduce to negligible. As a result the residual effect on surface water flows and levels during construction will be **insignificant**.

Non worst case

6.5.16 The non worst case set out in Table 6.6 would involve the fabrication of the caissons remotely and for these to be brought to the site by sea. This option would reduce the construction compound area significantly, and would probably not require significant concrete batching operations onsite either. There would not be any need to construct works that directly affected the River Siadar watercourse other than a possible bridge to allow vehicles to connect via a floating road to the site of the existing slipway to the north of the bay. Additionally improvements to the existing footbridge at the proposed control room location may be carried out.

6.5.17 Therefore, the impact on the River Siadar would be very much smaller and the risks of increased water flows as a result of increased runoff would be decreased accordingly. As the residual impact of the worst case is considered insignificant the non-worst case would also be **insignificant**.

Effects on surface water from spillages

Potential effects

6.5.18 Pollution of the watercourses may occur as a result of activities associated with the construction phase of the project such as silt contaminated runoff and spillage of oil and fuels from vehicles.

6.5.19 The surface watercourses at the greatest risk of pollution are those situated closest to the potential sources of pollution, for example if the construction works are within the stream channel (crossing of the Feadah Siorravig, River Siadar or any upgrades to the River Siadar footbridge), or within the catchments feeding the streams.

6.5.20 The effect of any unmitigated effect of a direct spill into a watercourse could be significant, depending on the location, volume of spillage and the nature of the substance spilled. An indirect spill, i.e. a spillage to ground with some runoff from contaminants reaching the river, could potentially have a lower significance effect, again depending on location, volume and nature of substance.

6.5.21 However, the risks present during construction are the normal risks associated with an engineering construction project, and are normally managed (as a minimum) by implementation of standard pollution prevention practices. Many of these practices are concerned with avoiding or containing incidents which would otherwise lead to the pollution of watercourses on the site.

6.5.22 Primary mitigation occurs in the form of embedded mitigation in that the site layout has been designed to avoid water crossings wherever possible.

6.5.23 SEPA's 'Guidelines for Water Pollution Prevention from Civil Engineering Contracts' (1999) and the following sources of Pollution Prevention Guidance (PPG) notes will be followed:

- PPG1: General guide to the prevention of pollution;
- PPG2: Above ground oil storage tanks;
- PPG3: Use and design of oil separators in surface water drainage systems;
- PPG5: Works in, near or liable to affect watercourses;
- PPG6: Working at construction and demolition sites;
- PPG8: Safe storage and disposal of used oils;
- PPG13: High pressure water and steam cleaners; and
- PPG21: Pollution incident response planning.

6.5.24 Recommendations given in CIRIA SP156 ('Control of water pollution from construction sites - guide to good practice') will also be followed.

6.5.25 Prior to works commencing, the contractor will be responsible for developing (i) a pollution prevention plan as part of the detailed method statements, and (ii) emergency procedures should a pollution incident occur. A pollution prevention plan will apply to all phases (construction, operation and decommissioning). These plans will be produced following consultation and agreement with SEPA and all appropriate personnel working on the site will be trained in their use. As a minimum, the pollution prevention plan will comply with SEPA's Pollution Prevention Guidelines, best practice as advocated by CIRIA and in addition include site specific measures. Emergency procedures will include contact details (including SEPA,) details of spill kits onsite and brief instructions on actions in case of spillage/emergency.

6.5.26 Particular care will be undertaken at the crossing points of the Feadah Siorravig Burn and any work to the River Siadar crossing. Refuelling will be undertaken well away from watercourses and where practicable on an impermeable surface in a designated area. Spillage kits will be permanently placed at these locations to enable the quick containment and clear up of spillages.

6.5.27 Any fuels, oils and lubricants stored onsite during construction will be contained within a properly designed and maintained bunded facility to minimise the risk of spillage and stored away from watercourses. This facility will be drained through oil interceptors (or rainfall from the storage areas will be contained and pumped into tanker to be removed from site for safe treatment and disposal).

6.5.28 The magnitude of effects on surface water from spillages, taking account of the good pollution prevention practices, is expected to be minor and temporary. The sensitivity of all the watercourses in relation to water quality is regarded as high due to the good quality of the River Siadar (and assumed good quality of the other streams) and the presence of otters.

6.5.29 As a result the overall effect of a pollution incident would be **minor** effect during construction assuming the worst case scenario given that appropriate pollution prevention guidelines will be followed to minimise the risk of a spill of a harmful substance into a watercourse.

<u>Mitigation</u>

6.5.30 As no significant effects are predicted there are no additional mitigation measures required to be enacted to protect water quality.

<u>Residual effect</u>

6.5.31 The significance of any major effect is expected to remain **minor** and temporary.

<u>Non worst case</u>

6.5.32 By removing the concrete batching plant for caisson construction from the area the risks of pollution effects is substantially reduced. However, this operation would have been carried out in a controlled environment as set out above. Many of the other sources of potential pollution remain as set out above.

6.5.33 The effect is therefore the same as the residual effect for the worst case set out above.

Sedimentation and erosion effects

Potential effects

6.5.34 Runoff from disturbed or eroded soils could cause increased sedimentation of watercourses. Increased sediment load and settlement could have a direct or indirect effect on the ecology of the watercourses, for example, by either killing macro-invertebrates by smothering, or by changing the oxygenation state of stream beds used by breeding fish.

6.5.35 The activities most likely to cause a potential effect due to sedimentation and erosion are (worst case scenario): construction of the tracks, site compound, establishment of the potential borrow pit and construction of a permanent fixed link to the fixed link. Runoff from eroded or disturbed soils could cause increased sediment loads in watercourses.

6.5.36 Depending on the final methodology the track could be constructed by stripping and storing any topsoil before establishing a hardcore base for the track. The construction compound would be prepared by removing any topsoil from the surface of the bedrock and levelling the ground with a layer of hardcore material. Any topsoil stripped from the ground could be stored nearby to be used later for reinstatement.

6.5.37 The borrow pit area would be striped of peat topsoil. Material requirements from the borrow pit could potentially involve up to 70,000 m^3 of fill material and rock armour arising from the construction of a permanent fixed link comprising of a full length rubble mound causeway to the breakwater.

6.5.38 Soil erosion can occur wherever flows are artificially concentrated, especially where soil is disturbed. Erosion may occur within drainage ditches, due to water flowing at high velocities and scouring exposed soil within the drains.

6.5.39 The magnitude has been assessed as moderate as the effects could be detectable and result in localised changes in water quality or changes to the nature of the stream beds. The sensitivity of watercourse in relation to water quality is regarded as high, as stated above.

6.5.40 There could be a **moderate** effect during construction without mitigation.

Mitigation

6.5.41 As a significant potential adverse effect could arise in relation to sediment and erosion additional mitigation is appropriate. Thus, careful consideration will be given to ensure construction will be managed in a manner to minimise erosion and sediment generation.

6.5.42 Sediment generated during construction will not be allowed to enter watercourses. Silt traps, settlement lagoons and attenuation areas to remove or filter out sediment from access tracks or construction site drainage before it discharges to a watercourse will be provided. This will include the compound. The most appropriate methods will be determined during construction, but may include such easily installed equipment such as straw bales as a filter medium, permeable check dams made from roughly graded rock fill, and silt fencing which will prevent the transport of most fine material.

6.5.43 Careful planning for the control of sediment in discharged water will be undertaken at the construction areas prior to the start of work. Control measures will be located as close to each construction area as possible. This minimises the amount of water that has to be contained for sediment removal by settlement. Straw bales and check dams will be installed at frequent intervals in the drainage system to slow the flow, create storage and allow settlement.

Residual effect

6.5.44 The proposed mitigation measures reduce the magnitude of the impact from **moderate** to **minor**. The overall significance of the effect thus drops from **moderate** to **minor** and the effects would be temporary during construction.

Non worst case

6.5.45 The non-worst case would be unlikely to require a borrow pit as the access to the breakwater would be by boat and less aggregate will be needed throughout the construction process. However, the requirement for a borrow pit to service other parts of the construction process may well remain and cannot be discounted. This would result in much less opportunity for sediment to be generated in the vicinity of the two minor burns near the borrow pit, and would also result in fewer watercourse crossings and movement of vehicles (all of which might create minor sediment risks in watercourses).

6.5.46 The substantially smaller construction compound would also generate much less runoff with less risk of suspended materials being mobilised to enter the watercourses.

6.5.47 With the proposed mitigation discussed above the magnitude of any effects is thus likely to be negligible. The overall effect would then become **insignificant** for this case.

Effects on groundwater flows and levels

Potential effects

6.5.48 Any excavations within, or constructions on the peat (e.g. the access track to the potential borrow pit), will influence the existing hydrology by altering permeability and / or redefining drainage paths. Drainage paths may be affected, potentially leading to changes in groundwater levels, either through drainage or saturation (pooling / damming). Where groundwater was present in the peat, any foundations could create localised barriers to flow.

6.5.49 Excavation of the borrow pit could change shallow groundwater flows, particularly if groundwater dewatering had to take place to enable the pit to be worked in the dry. However, due to the low permeability of surrounding formations this is only likely to occur in a very minor way with discharges from a small sump only required at low volumes – abstracted water would be discharged to the peat downstream of the borrow pit and any impact would be extremely localised.

6.5.50 There are no potable sources relying on groundwater that will be affected by the proposed works.

6.5.51 The magnitude of effects to shallow peat groundwater flow or level is considered to be minor but very localised. The magnitude of the effect on groundwater in the bedrock is negligible.

6.5.52 Groundwater flow in the peat is considered to have low sensitivity to changes in groundwater levels as the peat is not a major aquifer and the permeability is very low generally, so the area potentially affected is small. Groundwater sensitivity in bedrock is negligible as the bedrock is largely impermeable and there are no water supplies derived from this formation in the area.

6.5.53 There will be insignificant effects during construction on shallow groundwater, and **insignificant** effects on deeper groundwater.

Mitigation

6.5.54 As the potential effect is insignificant there are no additional mitigation measures required in relation to effects on groundwater flows or levels.

Residual effect

6.5.55 The residual effect remains **insignificant**.

Non worst case

6.5.56 The removal of the borrow pit from the scheme removes the primary source of any impact on groundwater flows and levels from the scheme. As the overall effect was insignificant the impact remains **insignificant**.

Effects on groundwater quality

Potential effects

6.5.57 Pollution of groundwater may occur as a result of potentially polluting activities such as accidental spillage of oil and fuels from vehicles, disposal of waste water, waste collection and disposal procedures, site compound installation and construction activities. The pollution that could arise will generally be relatively confined in extent as the volumes available to pollute groundwater will be relatively small and the permeability of the formations are very low – thereby limiting the areas that could be affected. Furthermore there are no widespread contiguous aquifers in the area. Some pollution could enter streams if the pollution to groundwater occurred close to the streams. It is noted that the peat will provide a very good environment for attenuation of many organics that could be released to the environment and so the movement in shallow groundwater will be partially mitigated naturally. However, the presence of peat pipes will permit pollution to move through peat relatively quickly and with less attenuation (other than dilution) than if it moved through the porous body of the peat.

6.5.58 The best practice measures described in the section on surface water spillages also apply for the control of effects on groundwater quality. The procedures for dealing with a spill that infiltrated the ground will be set out in the site pollution prevention plan.

6.5.59 The magnitude of impact to groundwater quality is thus considered to be **minor**.

6.5.60 The sensitivity of the shallow groundwater is regarded as low as there are no users of the groundwater in the area other than baseflow to streams. Pollution could result in negative changes to the ecology in streams but is likely to involve relatively limited volumes of contaminants. Any pollution effects will be localised so the magnitude is considered minor in relation to groundwater (shallow or deep).

6.5.61 There is a potential **insignificant** effect on groundwater quality during construction.

Mitigation

6.5.62 As the potential effect is insignificant there are no additional mitigation measures required in relation to effects on groundwater flows or levels.

Residual effect

6.5.63 There is a potential **insignificant** effect on groundwater quality during construction.

Non worst case

6.5.64 The removal of the borrow pit from the scheme reduces the main source of risks to groundwater quality for this case. Other sources of risks remain largely unchanged, and as such the residual effect remains **insignificant**.

Residual effect - summary

6.5.65 Table 6.8 summarises the residual construction effects taking account of mitigation measures discussed in previous sections:

Table 6.8 Construction effects post mitigation

Effect	Mitigation	Assessment of residual effect post mitigation		
		Magnitude	Sensitivity	Significance
Effects on surface water flows and levels	Appropriate design measures Minimise hardstanding areas	Negligible	High	**Insignificant**
Effects on surface water from spillages	Pollution control measures including: - pollution response measures - training - storage facilities - refuelling measures - waste storage and disposal	Minor	High	**Temporary Minor**
Sedimentation and erosion effects	Measures to minimise sedimentation and erosion Appropriate design of river crossings	Minor	High	**Temporary Minor**
Effects on groundwater flows and levels	Discharge of dewatering back to ground in local area	Minor in peat Negligible in bedrock	Low	**Insignificant**
Effects on groundwater quality	Pollution control measures including - pollution response measures - training - storage facilities	Minor	Low	**Insignificant**

Effect	Mitigation	Assessment of residual effect post mitigation		
		Magnitude	Sensitivity	Significance
	- refuelling control measures - waste storage and disposal			

6.6 Assessment of effects – operational phase

Potential effects

6.6.1 The potential effects during the operational phase will be less significant than those during the construction phase. The risks of a pollution incident will be substantially lower. Once construction works are complete, if a fixed permanent link is constructed linking the breakwater to the shore this will be the main means of access to the breakwater for vehicles and pedestrians. The control building is proposed to be located at either the existing slipway or adjacent to the existing Scottish Water works. This section describes the potential effects from the operations only, followed by the recommended mitigation measures and residual effects.

Effects on surface water flows and levels

Potential effects

6.6.2 There will be a permanent increase in lower permeability or impermeable areas at the site due to the control building, however the site compound area will have been reinstated after construction. The control building will incorporate appropriate guttering and down pipes that will direct runoff from the building into the sea, drainage ditch or River Siadar, depending on the final option. The car park adjacent to the control building will be surfaced with gravel and will be permeable, allowing surface runoff to drain through it. These measures have been built into the design to minimise effects in surface water levels and flows.

6.6.3 Appropriate design methods should be implemented during detailed design to ensure proper drainage during operation. Any maintenance works during the operational phase, potentially affecting surface water flows and levels, should be designed to avoid any increases in runoff or changes to flows in the watercourses. This is particularly important for any alterations to drainage, however this is not considered to be a likely event. Drains should be inspected periodically, to ensure that they are kept clear.

6.6.4 The magnitude of effects on the surface water flow regime is considered to be negligible due to the close proximity of the site to the sea and the small increase in hard standing compared to the overall catchment area.

6.6.5 The sensitivity of surface water in relation to flows is regarded as high due to the good quality of the River Siadar and the presence of otters.

6.6.6 There will be an **insignificant** effect on surface water flows and levels during operation.

Mitigation

6.6.7 No specific mitigation measures are required as the potential effect is **insignificant**.

Residual effect

6.6.8 The residual effect on surface water flows and levels during operation will be **insignificant**.

Non worst case

6.6.9 The non-worst case removes the need for any impact on the Adhiann Siadar as the river will not be directly affected. Otherwise the effect remains the same as for the worst case and the overall effect is **insignificant**.

Effects on surface water from spillages

Potential effects

6.6.10 The transformers within the control building may contain oil, and if so, appropriate measures would be incorporated to prevent oil entering any watercourse. Small items of plant and light vehicles all carrying or using fuels will also regularly be on site. Due to the planned small volumes of liquids stored onsite there is little likelihood of significant spillages.

6.6.11 Good pollution prevention practices will be implemented as described in the section on construction effects to prevent pollution of controlled water. npower renewables will also develop an operational pollution prevention plan.

6.6.12 The risks will be managed by implementation of good pollution prevention practices. Many of these practices are concerned with avoiding or containing incidents which would otherwise lead to the pollution of watercourses on the site and would follow the appropriate pollution prevention guidance documents produced by SEPA.

6.6.13 The magnitude of effects on surface water from spillages, taking account of the pollution prevention practices to ensure compliance with the law, is expected to be negligible.

6.6.14 The sensitivity of the surface watercourses in relation to water quality is regarded as high due to the good quality of the River Siadar and the presence of otters.

6.6.15 There will be an **insignificant** effect during operation.

Mitigation

6.6.16 Despite the potential effect being assessed as insignificant during any routine or emergency maintenance additional specific pollution management practices will be introduced depending on the nature of the works.

Residual effect

6.6.17 The proposed mitigation measures maintain the magnitude to **insignificant**.

Non worst case

6.6.18 The non-worst case during operations with regard to spillages to surface water remains as for the worst case and the overall effect is still **insignificant**.

Sedimentation and erosion effects

Potential effects

6.6.19 Sedimentation and erosion effects are not envisaged as being significant during operation, except potentially where maintenance is being undertaken. Routine maintenance will take place on controlled areas and will not result in soil erosion or the release of sediment into watercourses. Thus the impact is deemed to be negligible in magnitude for planned maintenance and operation.

6.6.20 Unplanned maintenance might occur in less controlled conditions and could result in soil erosion where flows are artificially concentrated, especially in areas where soil is disturbed.

6.6.21 Under such conditions the magnitude has been assessed as moderate as the effects could be detectable and result in localised changes in water quality or changes to the nature of the stream beds. Such changes would be temporary as they would be rectified as soon as they were detected.

6.6.22 The sensitivity of surface waters in relation to water quality is regarded as high, as stated previously in the section on construction effects.

6.6.23 There would be an **insignificant** effect during planned operation and maintenance works.

6.6.24 There could be a **moderate** but temporary during unplanned maintenance works.

Mitigation

6.6.25 Drainage will be inspected on a regular basis, and maintenance will be targeted at areas where erosion or silt accumulation was observed. With a proper management plan, covering working procedures to be adopted even in cases of unplanned maintenance, the impact of any unplanned maintenance should be reduced to **minor**.

Residual effect

6.6.26 During routine operation and maintenance the potential effects remain **insignificant**.

6.6.27 During unplanned maintenance the mitigation measures should reduce the effect to **minor**, but of a temporary nature. The proposed mitigation measures would reduce the magnitude of the effect to **minor** and temporary.

Non worst case

6.6.28 Under this case the same issues remain as for the worst case. The overall effect is therefore determined to be **minor** and temporary for unplanned maintenance. For routine operation and maintenance the effects remain **insignificant**.

Effects on groundwater flows and levels

Potential effects

6.6.29 The permanent control building may potentially influence the existing hydrology by altering permeability and / or redefining drainage paths. Drainage paths may be affected, potentially leading to changes in groundwater levels, either through drainage (dewatering) or saturation (pooling / damming). Where groundwater was present in the peat, any foundations could create localised barriers to flow. However the scale of the changes would be extremely localised (limited to within 10 m of the building).

6.6.30 There are no potable sources relying on groundwater that will be affected by the proposed works.

6.6.31 Groundwater flow in the peat is considered to have low sensitivity to changes in groundwater levels as the peat is not a major aquifer, and the area potentially affected is small. Groundwater sensitivity in bedrock is negligible as the bedrock is impermeable and there are no water supplies derived from this formation in the area.

6.6.32 The magnitude of effects to shallow peat groundwater flow or level is considered to be negligible. The magnitude of the effect on groundwater in the bedrock is negligible.

6.6.33 There will be **insignificant** effects during operation on shallow or deep groundwater.

Mitigation

6.6.34 As the effect is **insignificant** there is not requirement to provide additional mitigation.

Residual effect

6.6.35 There will be **insignificant** effects during operation on shallow or deep groundwater.

Non worst case

6.6.36 The non-worst case presents the same risks to groundwater levels and flows as the worst case – although the location of the control room would be different. However, there would be less impact on groundwater levels in the vicinity of the proposed borrow pit during operation as the borrow pit would not be created during construction.

6.6.37 As the effect was **insignificant** for the worst case, it remains **insignificant** for the non-worst case.

Effect on groundwater quality

Potential effects

6.6.38 The risks of a pollution incident will be substantially lower during operation compared to the construction phase as described in the effects on surface water spillages section above. Due to the general absence of hazardous substances on the site during operations the potential for release of such substances to groundwater is considered extremely low.

6.6.39 During operation the pollution prevention plan and emergency procedures from the construction phase will be updated to reflect the operational and maintenance needs. This should be implemented, relating to specific activities being undertaken onsite.

6.6.40 Any pollution would be very localised due to the low permeability of the peat and bedrock and the small volumes of substances involved, so the magnitude of any impact is considered negligible in relation to groundwater.

6.6.41 The sensitivity of the shallow groundwater is regarded as low as there are no users of the groundwater in the area other than baseflow to streams. Pollution could result in negative changes to the ecology in streams but is likely to involve relatively limited volumes of contaminants.

6.6.42 There will be an **insignificant** effect during operation.

Mitigation

6.6.43 As the effect is **insignificant** there is not requirement to provide additional mitigation.

Residual effect

6.6.44 The residual effect remains **insignificant**.

Non worst case

6.6.45 The non-worst case presents the same risks as the worst case to groundwater quality. As such the effect remains the same and is **insignificant**.

Residual effect - summary

6.6.46 Table 6.9 summarises the operational effects.

Table 6.9 Operational effects post mitigation

Effect	Mitigation	Assessment of residual effect		
		Magnitude	Sensitivity	Significance
Effects on surface water flows and levels	Appropriate design measures Minimise hardstanding areas	Negligible	High	**Insignificant**
Effects on surface water from spillages	Pollution control measures including - pollution response measures - training - storage facilities - refuelling measures - waste storage and disposal	Negligible	High	**Insignificant**
Sedimentation and erosion effects	Measures to minimise sedimentation and erosion	Minor	High	**Minor**
Effects on groundwater flows and levels	Design of drainage measures	Negligible	Low	**Insignificant**
Effects on groundwater quality	Pollution control measures including - pollution response measures - training - storage facilities - refuelling measures - waste storage and disposal	Negligible	Low	**Insignificant**

6.7 Assessment of effects – decommissioning

Potential effects

Details about the decommissioning are given in Section 3.12. The effects during decommissioning will be similar to those in the construction phase, but lesser in scale and magnitude, as it is expected the offshore breakwater would not be removed. There may be however be effects associated with the dismantling and control building and therefore effects similar to the non-worst case construction effects.

Effects on surface water flows and levels

6.7.1 Any changes to existing access tracks, watercourse crossings and the control building will potentially change the runoff characteristics resulting in a change to the speed of response to rainfall events and a change in the rate of runoff. However, the site is located adjacent to the coast, and any increased runoff will discharge directly to the sea, rather than to a particular watercourse. There are no sensitive receptors downstream of the development site.

6.7.2 The magnitude of effects on the surface water flow regime is considered to be negligible due to the close proximity of the site to the sea.

6.7.3 The sensitivity of surface water in relation to flows is regarded as high due to the good quality of the River Siadar and the presence of otters.

6.7.4 There will be an **insignificant** effect on surface water flows and levels during decommissioning.

Effects on surface water from spillages

6.7.5 Potential effects on surface water from spillages are similar to those described in the section on construction effects above.

Sedimentation and erosion effects

6.7.6 Potential effects on sedimentation and erosion are similar to those described in the section on construction effects above.

Effects on groundwater flows and levels

6.7.7 Any changes to excavations within, or permanent structures on the peat, will influence the existing hydrology by altering permeability and / or redefining drainage paths. Drainage paths may be affected, potentially leading to changes in groundwater levels, either through drainage (dewatering) or saturation (pooling / damming).

6.7.8 There are no potable sources relying on groundwater that will be affected by the proposed works.

6.7.9 Groundwater flow in the peat is considered to have low sensitivity to changes in groundwater levels as the peat is not a major aquifer, and the area potentially affected is small. Groundwater sensitivity in bedrock is negligible as the bedrock is impermeable and there are no water supplies derived from this formation in the area.

6.7.10 The magnitude of effects to shallow peat groundwater flow or level is considered to be minor. The magnitude of the effect on groundwater in the bedrock is negligible.

6.7.11 There will be **insignificant** effects during decommissioning on shallow groundwater, and **insignificant** effects on deeper groundwater.

Effects on groundwater quality

6.7.12 Potential effects on groundwater quality are similar to those described in the section on construction effects above.

6.7.13 The sensitivity of the shallow groundwater is regarded as low as there are no users of the groundwater in the area other than baseflow to streams. Pollution could result in negative changes to the ecology in streams but is likely to involve relatively limited volumes of contaminants. Any pollution effects will be localised so the magnitude is considered minor in relation to groundwater (shallow or deep).

6.7.14 There will be a **minor** effect during decommissioning.

Mitigation

6.7.15 The proposed mitigation measures for the construction phase are considered appropriate for the decommissioning phase but should be adapted according to the final scope of decommissioning works. For example, the mitigation measures appropriate to the design of watercourse crossings are not required.

Residual effect - summary

6.7.16 Decommissioning effects depend on the final scope of the decommissioning. Therefore, Table 6.10 which summarises the residual decommissioning effects should be used as a guide to the potential effect only:

Table 6.10 Decommissioning effects post mitigation

Effect	Mitigation	Assessment of residual effect post mitigation		
		Magnitude	Sensitivity	Significance
Effects on surface water flows and levels	Appropriate design measures Minimise hardstanding areas	Negligible	High	**Insignificant**
Effects on surface water from spillages	Pollution control measures including: - pollution response measures - training - storage facilities - refuelling measures - waste storage and disposal	Minor	High	**Temporary Minor**
Sedimentation and erosion effects	Measures to minimise sedimentation and erosion Appropriate design of river crossings	Minor	High	**Temporary Minor**
Effects on groundwater flows and levels	Discharge of dewatering back to ground in local area	Negligible	Low	**Insignificant**
Effects on groundwater quality	Pollution control measures including - pollution response measures - training - storage facilities - refuelling control measures - waste storage and disposal	Minor	Low	**Insignificant**

6.8 Cumulative effects

6.8.1 There are no other developments that could result in a cumulative effect when combined with the proposed project.

6.9 Proposed monitoring

6.9.1 If appropriate, monitoring of the watercourses, particularly in terms of total suspended solids and turbidity, will be undertaken to determine the effectiveness of the mitigation measures and identify if further action needs to be taken.

6.10 Summary and conclusions

6.10.1 Within the SWEP site the baseline hydrological and hydrogeological conditions have been identified. Any changes to flows, increases in sedimentation or pollutant release have the potential to have an adverse effect on the receiving environment.

6.10.2 Construction of the SWEP involves many activities which may potentially affect the receiving environments. These activities have been identified and an assessment of their significance made. Mitigation measures to be adopted during the construction, operation and decommissioning phases have been outlined. In order to ensure that these measures are carried out, project pollution prevention plan and emergency procedures will be developed as part of the Environmental Management Plan and adhered to by all site contractors, see Section 17.

6.10.3 Continued consultation with SEPA will be carried out in order to ensure on-going agreement regarding the proposed mitigation measures.

6.10.4 The residual effects are predicted as ranging from **temporary minor** to **insignificant** assuming the implementation of the mitigation measures described.

6.10.5 This conclusion has been reached through a thorough assessment of the design options likely to have the biggest effect, the so called worst case conditions. The other options have been considered and are expected to have similar or reduced effect and therefore the residual effects presented above present the worst case.

7 Terrestrial Habitats and Ecology

7.1 Introduction

7.1.1 This section will study the effects that the SWEP will have on local terrestrial habitats and species in the area above mean high water springs (MHWS). The focus is on the onshore facilities, i.e. construction compound, control building, borrow pit and access tracks, as these are most likely to impact directly upon the terrestrial surroundings. All aspects of the project are covered, from construction through to operation and eventual decommissioning.

7.2 Legislative framework and regulatory context

7.2.1 A full study of all the necessary regulatory frameworks relevant to terrestrial habitats and ecology was carried out prior to this assessment. Legislation, policies and associated guidance which have been taken into consideration include:

- EC Directive 79/409/EEC on the Conservation of Wild Birds (the ‘Birds Directive’);
- EC Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Flora and Fauna (the ‘Habitats Directive’);
- Nature Conservation: Implementation in Scotland of EC Directives on the Conservation of Natural Habitats and of Wild Flora and Fauna and the Conservation of Wild Birds (the ‘Habitats and Birds Directive’). Revised Guidance updating Scottish Office Circular No. 6/1995;
- Conservation (Natural Habitats &c) Regulations 1994 (the ‘Habitats Regulations’);
- Wildlife and Countryside Act 1981;
- Biodiversity: the UK Action Plan, CM 2428, HMSO, January 1994;
- Western Isles Local Biodiversity Action Plan (LBAP) Audit Report June 2002;
- Assessing the Natural Heritage Resource, A Guidance Note for Local Authorities from Scottish Natural Heritage, SNH, 1996;
- Scottish Government Planning for Natural Heritage: Planning Advice Note 60 (2000);
- SNH Policy Statement No. 01/02: Renewable Energy;
- SNH Service Level Statement: Renewable Energy Consultations;
- National Planning Policy Guidelines of relevance to this assessment:
    - NPPG 14 Natural Heritage;
- Scottish Government Planning Policy Guidelines of relevance to this assessment:
    - SPP 6 Renewable Energy;

- Local planning policies of relevance to this assessment:
  - DM1 Location of Development;
  - DM5 Availability of supporting infrastructure;
  - DM7 Assessment of Development Proposals;
  - RM11 Habitats and Species;
  - ED2 Development of Alternative and Renewable Energy Resources; and
  - T4 Road Safety, Highway Improvements and Traffic Management.

7.3 Methodology

Scoping and consultation

7.3.1 Consultation in relation to terrestrial ecology has been undertaken with the bodies listed in Table 7.1 below. The issues detailed in the table include those raised in the Scoping Opinion.

Table 7.1 Consultees and their key concerns

Name of organisation	Key concerns	Comment
The Fisheries Committee (Scottish Government)	Sufficiently consider fisheries issues including access to/egress from the River Siadar for migratory fish.	Effects on fish migration covered in Section 8.
Scottish Natural Heritage (SNH)	Both direct and indirect ecological issues should be addressed in detail, including effects on designated sites, protected species and habitats.	Consideration of direct and indirect issues covered in this assessment and Section 8.
	An appraisal of bird populations at the site should be made.	A breeding bird survey has been conducted.
	Although the Lewis Peatlands SPA is inland of the scheme, the impact on the red throated diver which inhabit this area should be considered as these feed in coastal areas (though no significant impact is anticipated).	Effects on red throated diver which may use the offshore area around the breakwater are considered in Section 8.
	All construction should be carried out as far from water courses as possible.	Construction works are planned to be located as far as practicable from all water courses. Those activities located adjacent to watercourses will be appropriately managed to avoid effects.
	Assess effects of noise on salmonids and review salmonid data for the area.	The effects of noise on fish, including migratory salmonids, are covered in Section 15. Existing salmonid data for the area have been reviewed.
	If assessment indicates a potential	Assessment does not indicate a potential

Name of organisation	Key concerns	Comment
	significant impact on salmonids, consider setting up monitoring programmes.	significant impact on salmonids.
	Requested report covering local otter population including location of holts.	Local otter population assessed as part of Phase 1 habitat survey.
Royal Society for the Protection of Birds (RSPB)	Effects on existing biodiversity should be considered (though few issues are anticipated) and careful monitoring should take place.	Biodiversity effects are covered in this assessment. Where appropriate, monitoring programmes will be implemented.
Association of Salmon Fisheries Board (ASFB)	Consider effects on migratory fish.	Effects on migrating salmonids are covered in Section 8 and 15.
	Proper regard should be given to the potential effects on fish species and their habitat, including both direct and indirect effects on fish and their habitat.	Direct effects on in-stream fish are covered in this section. Indirect effects through spillages and sedimentation are covered in Section 6.
	Development should be conducted in full consultation with Western Isles Salmon Fisheries Board and WIFT	Consultation with WIFT has informed this assessment and will continue post ES submission as required.
Western Isles Fisheries Trust (WIFT)	Timing of works should avoid fish spawning season.	Where possible, no in-stream works will be carried out between the months of October and June.
	Consider the possibility of quantitative habitat and fish surveys and post development/construction phase surveys.	Phase 1 habitat survey carried out and report produced. Assessment indicates no significant impact on fish therefore no post development/construction surveys are deemed necessary.
	Concern expressed over direct and indirect disturbance to migrating fish.	Disturbance to fish migrations covered in Section 8.
	Consideration should be given to sea trout known to occur in the River Siadar and a precautionary approach taken regarding salmon which have historically been present in this river.	Effects on salmonids in the River Siadar considered in this assessment.
	Recommend that land based construction is not carried out within 200 m of water courses.	Construction works are planned to be located as far as practicable from all water courses. Those activities located adjacent to watercourses will be appropriately managed to avoid effects.
	Where works close to water courses cannot be avoided careful mitigation measures are required to prevent any sediment from entering watercourse. These should be described in detail.	Mitigation measures against sedimentation are covered in the hydrology assessment (Section 6).
	Water crossings should be avoided where possible. If necessary they should be bridges and not culverts to allow for free passage of fish and riverbed ecology.	Design minimises watercourse crossings. Design of any required watercourse crossings will follow SEPA Best Practice Guidelines.
	In-stream and riparian works including crossing the river with vehicles should also be avoided, or minimised and only carried out at certain times of year as	Where possible, no in-stream work will be carried out between the months of October and June.

Name of organisation	Key concerns	Comment
	described above.	
	If juvenile fish habitat is to be disturbed, juvenile fish should be removed first.	If juvenile fish habitat disturbance is unavoidable, further consultation with WIFT will ascertain suitable mitigation.
SEPA	Impact on protected sites, habitats and designated areas should be addressed, together with mitigation measures.	Effects on these areas and their mitigation are covered in this assessment.
	Consider if the development will assist or impede delivery of LBAP elements.	This assessment considers LBAP species.
	Ideally, the salt marsh area should be avoided during construction and a survey of similar receptors should be carried out.	Phase 1 terrestrial habitat survey has been carried out. One option for the onshore control building involves encroaching onto the salt marsh area. Potential effects are considered in this section.
	The wider environmental issues associated with the borrow pit should be assessed, including the potential for pollution, noise, dust, blasting and impact on water.	Pollution of surface and ground water is covered in the hydrological assessment (Section 6). Other issues are covered in this assessment.
	Surveys must be conducted at appropriate times of year and by qualified, experienced personnel.	Baseline surveys have been scoped and undertaken by qualified, experienced personnel.
	Consultation with SNH recommended.	SNH has been consulted.
Comhairle nan Eilean Siar	Ecological effects should be included in the EIA.	Terrestrial ecological effects are covered in this assessment.

Desk study

7.3.2 A desk study has been undertaken to assess the terrestrial ecology of the area. Much of the information is based upon the Environmental Baseline Survey report for the Siadar Wave Energy Project, Isle of Lewis, November 2006 (West Coast Energy, 2006a). Table 7.2 lists the other sources of data utilised for this assessment.

Table 7.2 Sources of Data: Terrestrial habitats and ecology

Topic	Subject	Source
Species present	Locally important species	Western Isles Local Biodiversity Action Plan Audit Report (2002)
Species present	UK BAP species	Biodiversity: the UK Action Plan, CM 2428, HMSO, January (1994)
Habitat resource	Locally important habitats	• Western Isles Local Biodiversity Action Plan Audit Report (2002) • Environmental baseline survey report for the Siadar Wave Energy Project, Isle of Lewis (2006)
Ornithology	Breeding birds	Siadar Wave Energy Project Breeding Bird Survey (2007)
Otters	Otter activity in the proposed development area	Environmental baseline survey report for the Siadar Wave Energy Project, Isle of Lewis (2006)
Salmonids	Lewis wind farm ES (2004 and 2006 addendum)	

Field surveys

7.3.3 An environmental baseline survey, including a Phase 1 habitat survey and otter survey, was undertaken at Siadar on the 13th and 14th of September 2006 (West Coast Energy, 2006a). The weather was warm and dry with clear skies and burn levels were low.

7.3.4 The survey area covered two distinct habitats:

- Coastal strip; and
- Inland moorland and lochans.

7.3.5 The survey extended 500 m outside the site boundary both up and down the coast, and along any inland watercourses.

7.3.6 In addition, a breeding bird survey was carried out, the Siadar site being visited on four occasions: 31st May 2007 and 9th, 18th and 30th June 2007. All visits in this case were carried out on days of dry weather. The breeding birds were surveyed by walking the croftland and shore areas, ensuring that all areas were checked to within 100 m.

Significance criteria

7.3.7 The significance criteria employed for this section is based on the methodology defined in Section 5.3. The sensitivity and magnitude are defined in Table 7.3 and Table 7.4 below.

Table 7.3 Definition of species and habitat sensitivity

Sensitivity (positive or negative)	Definition
Very high	Internationally designated sites including SACs and SPAs or species/assemblages which form qualifying interest of SACs, SPAs or SSSIs. IUCN globally threatened species.
High	Nationally important sites (SSSIs) or species which contribute to the integrity of an SPA or SSSI but which are not listed as qualifying species/assemblages. Ecologically sensitive species such as rare birds (<300 breeding pairs in the UK). Species present in nationally important numbers (>1 % UK population).
Medium	Sites of local value. Species on Annex 1 of the EC Birds Directive. Species on Annex 1 / 2 of the EC Habitats Directive. Species listed in Schedule 1 of the Wildlife and Countryside Act 1981. Species present in regionally important numbers (>1 % regional population). Species occurring within SPAs and SSSIs but not crucial to integrity of the site. Species listed as priority species in UK BAP.
Low	Sites not containing features that would meet the criteria for sites of local value, but nevertheless having some biodiversity value. Any other species of conservation interest, e.g. LBAP species.
Negligible	Sites/species not of conservation concern.

Table 7.4 Definition of magnitude (based on IEEM guidelines, 2006)

Magnitude (positive or negative)	Definition
Exceptional	Total loss or very major alteration to key elements / features of the baseline conditions such that the post development character / composition / attributes will be fundamentally changed and may be lost from the site altogether.
Major	Major loss or major alteration to key elements / features of the baseline (pre-development) conditions such that post development character / composition / attributes will be fundamentally changed.
Moderate	Loss or alteration to one or more key elements / features of the baseline conditions such that post deployment character / composition / attributes of baseline will be partially changed.
Minor	Minor shift away from baseline conditions. Change arising from the loss / alteration will be discernible but underlying character / composition / attributes of baseline condition will be similar to pre-development circumstances / patterns.
Negligible	Very slight change from baseline condition. Change barely distinguishable, approximating to the “no change” situation.

7.3.8 The magnitude and sensitivity of the potential effect are combined to define the significance of the effect, as shown in Table 7.5. Those criteria in red text are the residual effects considered significant under the EIA Regulations.

Table 7.5 Effect significance matrix

Magnitude	Sensitivity				
	Very High	High	Medium	Low	Negligible
Exceptional	**Major**	**Major**	**Major**	**Moderate**	Minor
Major	**Major**	**Major**	**Moderate**	Minor	Insignificant
Moderate	**Major**	**Moderate**	**Moderate**	Minor	Insignificant
Minor	**Moderate**	Minor	Minor	Insignificant	Insignificant
Negligible	Minor	Insignificant	Insignificant	Insignificant	Insignificant

Pre assessment to identify worst case design options

7.3.9 A summary of the proposed options in relation to the assessment of effects on terrestrial habitats is shown in Table 7.6.

Table 7.6 Scheme design options

Aspect	Options	Description	Discussion
Caisson construction	Local construction; construction compound established adjacent to the Scottish Water works at Siadar	Compound area approximately 8.5 hectares would be required. Temporary vehicle bridge over the River Siadar may be required. Requirement for local borrow pit including access track.	Worst case because larger compound area is required impacting on greater terrestrial area.
	Remote construction – caissons are floated to site for installation	Smaller compound area approximately 1.5 hectares would be required. The compound would be in the same location as the compound required for local construction. Temporary vehicle bridge over the River Siadar may be required. Requirement for borrow pit including access track.	Lower significance due to smaller area being impacted on.
Operation and maintenance of the breakwater	Fixed permanent access to link the breakwater to shore by rubble mound fixed link	Would require construction of a new fixed permanent link.	Worst case because new structure required which has a larger physical impact than upgrading the existing slipway.
	Fixed permanent access to link the breakwater to shore by part rubble mound, part steel truss bridge		
	Boat access from onsite slipway.	Would require upgrades to existing slipway.	Lower significance because only modifications to existing structure which would have a smaller physical impact.

Aspect	Options	Description	Discussion
Control building	Located adjacent to existing slipway	Potential requirement to move the alignment of an existing drainage ditch and impact on a marshland through land reclamation.	Worst case, realigning the drainage ditch and impacting any marshland areas should be considered as the worst case scenario.
	Located adjacent to existing Scottish Water works	The existing footbridge over the River Siadar could be improved or renewed to improve the amenity of the area	Lower significance, however, works to River Siadar may be undertaken.

7.3.10 This assessment has identified the worst case option for detailed assessment, with all other options assessed at the end of each subject.

7.4 Baseline description

Designated sites

7.4.1 The designated sites which are closest to the proposed development are shown in Section 12 (Figure 7-1) and described below.

Barvas SPA

7.4.2 The Barvas SPA is part of the twin Ness and Barvas SPA. It consists mainly of traditionally managed, semi-intensified grassland and marshy areas within crofting land and is a site of European importance as a breeding area for corncrake (*Crex crex*).

Lewis Peatlands

7.4.3 The Lewis Peatlands comprise an extensive area of deep blanket bog, interspersed with bog pool complexes and freshwater lochs, covering the main part of Lewis. Grazed, poor-quality grassland also occurs, with heather (*Calluna vulgaris*) dominant on the coast. Overall, the continuous and largely unfragmented extent of the peatland is a striking feature of the area.

SPA designation

7.4.4 The peatlands are designated SPA for a range of characteristic peatland breeding birds, especially waders, divers (including red throated divers, *Gavia stellata*) and raptors.

SAC designation

7.4.5 The peatlands are designated SAC for their waterbodies and blanket bog.

RAMSAR designation

7.4.6 The peatlands are designated RAMSAR for their blanket bog and associated wetland fowl.

7.4.7 The site of the proposed works is outwith any international or national designations, neither is it known to be proposed for any regional or local designations. The Phase 1 habitat survey determined that there are no protected or highly sensitive habitats that could be affected by the development. The area consists of habitats modified by grazing, drainages, cutting or agriculture activities and there are no areas of unimproved vegetation. There is, however, an area of marshland behind Siadar Bay which is considered locally important, and SEPA have expressed a wish that ideally no construction take place in this area.

7.4.8 The nearest designated area of relevance to the proposed development is the Lewis Peatlands SPA, located approximately 3 km away toward the interior of the island. The SPA itself is inland of the scheme; however the red throated divers which nest here may feed in the coastal waters by the proposed SWEP development. This potential impact is considered in the marine ecology section (Section 8).

Habitats and flora

7.4.9 The results of the Phase 1 habitat survey are shown in Figure 7-2 and described below.

7.4.10 Approximately 37.5 % (65 hectares) of the survey area is comprised of grassland and has been subdivided into two groups; semi-improved acid grassland and marshy grassland. Semi-improved acid grassland (34.0 %) is dominated by *Deschampsia flexuosa*, *Nardus stricta* and *Juncus squarrosus*, with *Galium saxatile* and *Potentilla erecta*. Also witnessed: *Dactulis glomerata*, *Cynosurus crisatus*, *Ranunculus acris*, *Lolium perenne*, *Trifolium repens*, *Potentilla anserine* and *Rumex acetosa*. Marshy grassland is found at the wetland at An Fideach and is dominated by *Carex* spp., *Eleocharis* spp., *Potentilla palustris* and *Juncus effusus*.

7.4.11 Dry heath/acid grassland mosaic covers approximately 3.5 % (6 hectares) and is dominated by *Calluna vulgaris*, *Juncus squarrosus*, *Festuca ovina*, *Nardus stricta*, *Potentilla erecta* and *Galium saxatile*.

7.4.12 Bog covers approximately 47.3 % (82 hectares) and consists of blanket bog, wet and dry modified bog. An area of blanket bog is located between Loch Sminig to the south and Lac Nic Dhomhnuill to the north and is characterised by small bog pools and hummocks. Species recorded include: *Eriphorum* spp., *Cladonia* spp., *Molinia caerulea*, *Calluna vulgaris*, *Erica tetralix*, *Sphagnum papillosum* and *Sphagnum palustre*. Wet modified bogs characterised by

Calluna vulgaris, *Trichophorum cespitosum* and *Molinia caerulea* and dry modified bogs are dominated by *Calluna vulgaris*, *Eriophorum vaginatum*. Both areas are heavily grazed.

7.4.13 Coastal grassland covers approximately 10.9 % (10 hectares) of the survey area and is dominated by *Armeria maritima*, *Festuca rubra*, *Thymus praecox*, *Plantago maritima*, *Lotus corniculatus*, *Bellis perennis*, *Carex* spp., *Ceratium* spp., *Ranunculus* spp. and *Silene uniflora*.

7.4.14 No priority species of plant listed by the EC Habitats Directive or the Wildlife and Countryside Act were identified in the survey area, neither were any plants listed as UK BAP species or nationally scarce species.

Birds

7.4.15 Bird species of conservation importance identified during the breeding bird survey are listed in the Table 7.7 and the distribution of these birds in the survey area shown in Figure 7-3.

Table 7.7 Bird species of importance in the vicinity of Siadar, Isle of Lewis

Species	Siadar survey area population	Conservation status*
Common gull (*Larus canus*)	25 pairs	Amber. Resident breeding colony
Oystercatcher (*Haematopus ostralegus*)	3 breeding pairs	Amber. Resident breeding colony
Mallard (*Anas platyrhynchos*)	1 breeding pair	Green. Resident breeding colony
Lapwing (*Vanellus vanellus*)	2 breeding pairs	Amber. Resident breeding colony
Snipe (*Gallinago gallinago*)	3 breeding pairs	Amber. Summer population
Curlew (*Numenius arquata*)	1 breeding pair	Amber. Wintering population
Redshank (*Tringa tetanus*)	5 breeding pairs	Amber. Resident breeding colony
Skylark (*Alauda arvensis*)	6 territories	Red. Resident breeding colony
Meadow pipit (*Anthus pratensis*)	17 territories	Amber. Resident breeding colony
Wren (*Troglodytes troglodytes*)	1 territory	Green. Resident breeding colony
Wheatear (*Oenanthe oenanthe*)	1 territory	Green. Summer population
Starling (*Sturnus vulgaris*)	5 breeding pairs	Red. Resident breeding colony
Greylag goose (*Anser anser*)	1 nest	Amber. Visitor
Corncrake (*Crex crex*)	1 calling bird	Red. Summer population

*Colour code taken from RSPB Population Status of Birds in the UK (RSPB, 2006). Red species (rapid decline in breeding population or range) have the highest conservation priority, followed by amber (moderate decline in breeding population or range) and green (no identified threat to the population status).

7.4.16 Consultation with the RSPB revealed that one pair of reed bunting was observed to use the area of marsh behind Siadar Bay in 2006, however none were observed in the 2007 survey. This species has RSPB red status and is a UKBAP priority species due to nationally declining populations. The exact cause of this decline is unclear, however deterioration of wetland habitats may have had a serious effect on populations.

Otters

7.4.17 Otters (*Lutra lutra*) are largely solitary, nocturnal animals. From detailed studies on coastal otters elsewhere in Scotland, females are known to range over relatively long sections of coast, on average about 5 km, while males average about 8 km. Litter size varies between 1 and 4 (usually 2 - 3) cubs. Cubs are born in natal holts which are usually some distance from major watercourses. The young then move to holts nearer the shore, where they are suckled for up to 6 months and remain with their mothers for 10 - 12 months before dispersing (Kruuk *et al*., 1987).

7.4.18 Otters are opportunistic carnivores and although their primary source of food comes from freshwater habitats they also make extensive use of the seas and coastal areas. In general, the otter's diet is dictated by what is abundant and most easily caught. The diet is dominated by demersal fish, which account for around 80 % of the prey taken. These include eelpout, rocklings, butterfish, eel, blenny and flatfish. Free-swimming fish and shore crabs are also eaten, but in much smaller numbers.

7.4.19 Although otters utilise coastal areas, they also require access to freshwater for bathing and terrestrial/riparian areas for resting and breeding.

7.4.20 The otter survey conducted along the coastal strip and inland moorland and lochans of the survey area found evidence of otter presence but did not show high levels of activity. No holts or couches were located along the coast itself, but signs of otter presence included spraints and feeding remains. The two larger lochans both had evidence of otter activity including couch sites, tracks, spraints, feeding remains and two confirmed holts (see Figure 7-3). A mother and cub were also seen feeding and playing on several occasions along the coast, at one stage being observed feeding off the coast in Siadar Bay, then moving north along the coast (West Coast Energy, 2006a).

Salmonids

7.4.21 Consultation with WIFT established that sea trout (*Salmo trutta*) are known to occur in the River Siadar. An electrofishing survey of the river carried out by WIFT on behalf of AMEC in 2004 confirmed the presence of sea trout but did not find any Atlantic salmon (*Salmo salar*); however, these have also historically been known to occur in the River Siadar (indicated from consultation with WIFT). Figure 7-4 illustrates the location of electrofishing surveys in the area surrounding Siadar.

Other species of conservation importance

7.4.22 Red deer (*Cervus elaphus*) were also found during the baseline site survey (West Coast Energy, 2006a). These are listed as a Species of Conservation Concern in the Western Isles LBAP.

7.5 Assessment of effects – construction phase

7.5.1 The potential impact of the proposed works on terrestrial species and habitats within the proposed development area is considered below.

7.5.2 All construction effects would be short term (approximately 18 months), however it is this phase which poses the greatest potential risk to terrestrial ecology, mainly through physical disturbance and possible pollution arising from both construction works themselves and reinstatement works following construction. Potential effects on important natural heritage aspects are considered in the sections below.

Designated sites

7.5.3 The proposed development area does not lie within any statutory or non-statutory nature conservation sites, therefore no impact is predicted and no mitigation measures are necessary.

Habitats and flora

Potential effects

7.5.4 The proposed construction site is located in an area of dry heath/acid grassland with patches of wet modified bog. To accommodate the site, an area will need to be cleared, resulting in a temporary loss of approximately 8.5 ha of vegetation. The proposed borrow pit site is located in an area of semi-improved acid grassland with patches of marsh/marshy grassland. The exact dimensions of the borrow pit will be dependent on the amount of aggregate required from the area. Although the magnitude of impact as a result of the construction site and borrow pit is likely to be major, the habitats which will be disturbed are of low sensitivity and therefore effects on habitats and flora would be of **minor** significance.

7.5.5 The access track to the borrow pit would penetrate an area of semi-improved acid grassland with patches of marsh/marshy grassland and a small area of dry heath/acid grassland with patches of wet modified bog. In this case, the magnitude of impact is seen as moderate on an area of low sensitivity, so again the impact on habitats and flora would be of **minor** significance.

7.5.6 Construction of the control building and car park will encroach by up to about 0.07 ha upon an area of marsh/marshy grassland which SEPA would like to see avoided. This area of marsh has some local biodiversity value and is therefore of medium sensitivity. In a local context, the magnitude of change will be major, therefore resulting in a **moderate** impact on this habitat.

7.5.7 Direct construction effects on freshwater habitats will be limited to the possible vehicle crossing of the River Siadar which has the potential to impact upon the nature of the river bed, and possible abstraction close to the mouth of the River Siadar if caissons are constructed locally. These are discussed in Section 6.

Mitigation

7.5.8 All areas of retained vegetation will be protected by fencing off work areas (i.e. the main construction site and buffer zones around access tracks and the control building construction area), for example using Euromesh®. Since no plant species of international, national or local importance have been found in the area, no transplanting is required. Following construction, however, the construction site, access road and borrow pit areas will be reinstated with local vegetation, in accordance with the appropriate Method Statements.

Residual impact

7.5.9 With the provision of the mitigation described above, it is considered that the impact of the construction site, borrow pit and access track on habitats and flora will be **minor**. The impact of control building construction on the area of marshland, however, remains **moderate**.

Non worst case

7.5.10 If construction of the caissons was to occur remotely and the breakwater maintained via boat access rather than a fixed link connection, there would be no requirement for a large construction compound, and if the control building were to be located adjacent to the Scottish Water works, the area of marshland behind Siadar Bay would not be disturbed. The residual impact in this instance would therefore be **insignificant**.

Birds

Potential effects

7.5.11 The proposed construction operations will result in the temporary loss of areas of grassland which have the potential to provide nesting and foraging habitat for a number of terrestrial bird species, some of which are of European, national and local conservation importance. There would also be the potential for disturbance to these and other birds using the surrounding areas due to noise and vibration generated by construction activity. In addition, direct mortality may arise due to vehicles using the access roads.

7.5.12 None of the breeding bird populations found at the proposed development site represents more than 0.1 % of the UK breeding population. Effects on most bird species using terrestrial areas where construction is to take place will be of minor magnitude. As the sensitivity of these species ranges from low to medium, the significance of any impact will range from **insignificant** to **minor**.

7.5.13 During the breeding bird survey, the most sensitive bird species found close to the area of the proposed construction works was an individual corncrake (*Crex crex*), classified as near-threatened according to the IUCN Red List of Threatened Species, and the qualifying species for the nearby Barvas SPA.

7.5.14 The corncrake Species Action Plan outlined as part of the Western Isles LBAP (2005) notes that suitable corncrake habitat comprises tall grasses and herbaceous vegetation of at least 20 cm in height so that they can be concealed at all times. As the proposed construction site is located in an area of dry heath/acid grassland with patches of wet modified bog, it does not provide suitable habitat for this species. Any long vegetation present, such as *Juncus* spp., is too dense to allow the birds to move through it or reach the ground surface to forage for food.

7.5.15 As the individual corncrake was recorded 0.5 km from the survey area and 1 km from the actual construction site itself, in more suitable habitat, the magnitude of change in this case is rated as negligible, therefore the significance of any impact will be **minor**.

<u>Mitigation</u>

7.5.16 Mitigation is necessary in order to prevent contravention of the Wildlife and Countryside Act (1981) through the disturbance and destruction of nests and nest building birds. Therefore:

- All vegetation clearance will be undertaken outside of the bird nesting season or following a breeding bird survey, in consultation with SNH and the RSPB, to protect nesting habitat;
- Nesting or nest building birds at any construction location will be immediately assessed with the project ecologist in consultation with SNH and the RSPB; and
- Construction areas will be fenced off to reduce disturbance to birds in areas of retained habitat.

Residual impact

7.5.17 There will be an **insignificant** temporary or long-term impact on birds in the Siadar area due to construction works.

Non-worst case

7.5.18 Remote construction of caissons would mean that there would be no large construction compound, and therefore a much smaller area of bird habitat would be potentially impacted. In addition, there would be much less noise and vibration disturbance and a reduced risk of road mortality as local construction activity including the number of construction vehicles required would be greatly reduced. The residual impact in this case would therefore also be **insignificant**.

Otters

Potential effects

7.5.19 There will be no direct disturbance to otter breeding or rest areas caused by construction operations, as the nearest holts and couches are some distance away (1 km and 1.5 km) beside the lochans shown in Figure 7-3. Since some level of otter activity has been observed by the coast, however, it can be expected that construction will cause some degree of disturbance. Effects on otters in the marine environment are considered in the marine ecology assessment (Section 8).

7.5.20 Possible effects on otters as a result of construction operations include:

- Direct mortality caused by construction traffic;
- Disruption of access routes between inland holt sites and coastal feeding areas (e.g. along watercourses);
- Siltation from ground disturbance could smother habitats for fish and flora, with knock-on effects on otters;
- Reduced flows caused by river crossings could impact prey species ability to migrate upstream;
- Pollution through fuel/oil spillage could harm otters and their prey; and
- Disturbance/displacement due to construction noise, construction site lighting and human activity.

7.5.21 Otters are active at night, and have been observed to avoid illuminated areas; however this may be due to site activities rather than the lights themselves. They are very mobile animals with extensive ranges (e.g. the female and her cub observed in the West Coast Energy 2006a Phase 1 habitat survey were seen to range over 3 km in 1.5 h). Therefore, should an area of habitat be impacted locally, otters will simply move to other areas. Observations have also shown that otters are extremely tolerant of disturbance and are not unduly affected by noise, for example they have been observed breeding under the jetty of Sullom Voe oil terminal in Shetland during routine work operations and living under shore installations at fish farms.

7.5.22 As otter activity is low in the proposed construction areas and no holts or couches are present in the immediate vicinity, it is considered that the magnitude of change for the species would be minor. As the otter on Lewis is judged to be a species of medium sensitivity, the significance of effects on otter populations is therefore rated as **minor**.

Mitigation

7.5.23 Water quality, flow, access and sedimentation effects relate directly to the impact of the development on the hydrology of the area. Mitigation against such effects is therefore discussed in the hydrology section (Section 6) and not considered further here. Mitigation against the remainder of the effects listed above will include the following:

- A pre-construction survey will be undertaken shortly before construction works commence, to determine levels of otter activity at that time and if any new holts/couches have been established within the survey area;
- A European Protected Species (EPS) licence will be obtained if required; and
- Construction and excavations will not occur where there are known otter breeding or resting sites. Where this cannot be avoided relocation under EPS licence may be an option.

Residual impact

7.5.24 Any impact on otters in the Siadar area due to construction works will be **insignificant**.

Non worst case

7.5.25 Remote caisson construction would mean reduced construction activity and traffic, therefore reducing the risk of disturbance and direct mortality to otters. River crossings would still be required, therefore siltation and disruption of access routes would remain an issue; however with mitigation measures in place impact on otters remains **insignificant**.

Migratory salmonids

Potential effects

7.5.26 From a terrestrial perspective, the most important impact to consider in terms of the effect of construction works on migratory salmonids is the release of sediments into the River Siadar, which is considered to have a high fisheries sensitivity status. Sediment could smother eggs in spawning gravels or suffocate the fish themselves. The latter is perceived to be the greater risk in this case, as the impact would be concentrated in the lower reaches of the river in areas which lack suitable spawning habitat.

7.5.27 This has the potential to reduce river flows, thus affecting the ability of salmonids to reach spawning grounds. Construction of a river crossing over the River Siadar may necessitate the in-stream presence of construction vehicles. This could lead to direct behavioural disturbance due to vehicles presenting an obstacle to fish movement, the disruptive effects of noise, and direct mortality of fish. Pollution from fuel/chemical spills could also directly impact salmonids.

7.5.28 In terms of Atlantic salmon, a precautionary approach will be taken, as although these fish have not been observed recently in the River Siadar, they have historically been present. Sea trout are present in the River Siadar. Salmon and sea trout are considered species of medium sensitivity, and the magnitude of change which could result from the construction works is rated as major. Construction activities could therefore result in a **moderate** impact to migratory salmonid species.

Mitigation

7.5.29 Water quality, flow, barrier and sedimentation effects relate directly to the impact of the development on the hydrology of the area. Mitigation against such effects is therefore discussed in the hydrology section (Section 6) and is not considered further here. Mitigation against the effects which relate specifically to salmonids will include the following:

7.5.30 Where possible, no in-stream works will be carried out between October and June to avoid disruption to spawning and activity in the water course will be kept to a minimum. If disturbance to juvenile fish habitat cannot be avoided, further consultation with WIFT will ascertain appropriate mitigation.

7.5.31 The river mouth will be monitored to ensure it is kept clear of obstructions that may have the potential to affect access to the river mouth by migrating salmonids.

Residual impact

7.5.32 With mitigation measures in place, the magnitude of possible effects becomes minor, which would result in a **minor** impact to migratory salmonid species. No extensive monitoring programmes will be set up, as this assessment does not indicate a significant impact on salmonid populations.

Non worst case

7.5.33 Remote construction of caissons would mean a decreased risk of fuel/chemical spills in the area and therefore a decreased risk of in-stream pollution. A river crossing may, however, still be required in this scenario, therefore the risk of siltation still exists and the residual impact remains **minor**.

Other species

7.5.34 Red deer may be affected by construction operations, mainly through noise and visual disturbance, and there would also be an increased risk of mortalities caused by construction traffic. However, since red deer activity was found to be low in the survey area, and as they are considered a species of low conservation concern, the impact on construction activities in this case is rated **insignificant**.

7.6 Assessment of effects - operational phase

7.6.1 Ongoing effects on terrestrial ecology will arise as a consequence of the presence of the scheme and ongoing site maintenance. The potential effects during the operational phase will be less significant than those during the construction phase, as land used for construction will have been reinstated and levels of activity in the area will be greatly reduced. There may be ongoing minor disturbance to terrestrial communities due to the need for routine maintenance works involving noise and human presence. Other than this, effects will arise from the continued physical presence of the control building and car park including localised habitat loss and day to day activity. Potential effects of the operational phase on important natural heritage aspects are detailed in the sections below.

Designated sites

7.6.2 As with the construction phase, the proposed development area does not lie within any statutory or non-statutory nature conservation sites, therefore **no impact** is predicted and no mitigation measures are necessary.

Habitats and flora

7.6.3 **No impact** upon habitats and flora is expected in addition to what is detailed in the construction section.

Birds

Potential effects

7.6.4 Operational activities have the potential to cause minor disturbance to nesting and foraging birds in the area, mainly due to occasional human presence. There is also a continued risk of direct mortality due to vehicles visiting the site.

Mitigation

7.6.5 Vehicle activity will be much lighter than during the construction phase and will not greatly add to existing traffic in the area. No specific mitigation measures are therefore required.

Residual impact

7.6.6 Operational activities will result in an **insignificant impact** on birds in the Siadar area.

Non-worst case

7.6.7 With the control building in place, terrestrial aspects of the proposed development will not be affected by different operational scenarios, therefore effects will remain **insignificant**.

Otters

Potential effects

7.6.8 Operational activities have the potential to cause minor disturbance to otters ranging in the area, mainly due to occasional human presence, road mortality and control building lights.

Mitigation

7.6.9 Vehicle activity will be light during the operational phase and will not greatly add to existing traffic in the area and building lights will only be used when natural light levels are insufficient for safe working practices. No specific mitigation measures are therefore required.

Residual impact

7.6.10 No holt or resting sites were noted close to the control building and car park, therefore operational activities will result in an **insignificant impact**.

Non worst case

7.6.11 With the control building in place, terrestrial aspects of the proposed development will not be affected by different operational scenarios, therefore effects will remain **insignificant**.

Migratory salmonids

Potential effects

7.6.12 Operational activities will not impact upon watercourses in the Siadar area. The potential effects of the operational phase on salmonids in the marine environment are covered in the marine ecology section (Section 8).

Mitigation

7.6.13 None are required as the activities during the operational phase will not impact on the watercourses in the area.

Residual impact

7.6.14 **No impact** on migratory salmonids within these watercourses is expected.

Other species

7.6.15 Effects of the operational phase on red deer in the Siadar area will be limited to occasional disturbance due to human presence and traffic. Operational activities will result in **no impact** on red deer.

7.6.16 Overall, there will be **no impact** on any species in the terrestrial environment as a result of the operational phase of the project.

7.7 Assessment of effects - decommissioning phase

7.7.1 The effects during the decommissioning phase are likely to be limited to disturbance caused by human presence including noise and vibration. Since decommissioning is likely only to involve minor works such as the removal of electrical and mechanical components and the main structures are to stay in place, the effects at this stage would be minimal. There should be no direct disturbance to any terrestrial habitat areas as a result of decommissioning.

7.7.2 It is possible that the species affected by decommissioning will have become habituated to the occasional service vehicle, noise and physical presence of infrastructure during its operational phase, therefore decommissioning effects are not expected to be as disturbing as construction works and are overall considered **insignificant**.

7.8 Cumulative effects

7.8.1 There are no other existing developments in the area that could result in a cumulative effect on terrestrial ecology in the Siadar area when combined with the proposed development.

7.8.2 In terms of proposed developments, possible construction of the AMEC wind farm on Lewis (a portion of which would be located close to the Siadar area) may occur, if consented, at the same time as construction of the SWEP development. Terrestrial species may therefore be displaced from both construction areas at the same time. It should be noted, however, that a distance of >3 km separates the two proposed developments and both construction phases will be temporary. Given the large areas of remaining undisturbed habitat, any cumulative impact as a result of the two developments combined is likely to be **minor**.

7.8.3 In the main, any cumulative effects will arise as a result of the combined terrestrial aspects of the development itself, i.e. the borrow pit, access road, river crossing, construction site and control building. Cumulative effects on terrestrial habitats and ecology will therefore be greatest during the construction phase when each of these aspects is active. Given that the construction phase is temporary in nature; cumulative effects as a result of the development itself are rated as **minor**.

7.9 Summary and Conclusions

7.9.1 This section has addressed potential effects of the proposed SWEP development on terrestrial habitats and ecology, i.e. designated sites, habitats and flora, birds, otters, migratory salmonids and red deer. In addition to a desk study, an environmental baseline survey and breeding bird survey were used to inform the assessment.

7.9.2 Potential effects which were identified include temporary and permanent habitat loss; disruption of access routes; direct mortality caused by increased vehicle traffic; direct and indirect effects of pollution, and noise and light disturbance.

7.9.3 The proposed development area does not lie within any statutory or non-statutory nature conservation site, and no protected plant species were found. During construction, there will be a minor impact on habitats of low sensitivity. A small area of wetland of local biodiversity value will be lost during the construction phase, resulting in a moderate impact. Following mitigation, however, the overall residual impact on habitats and flora is judged to be **minor**.

7.9.4 With the adoption of the mitigation measures outlined in this section, there will be no construction impact upon birds, otters, migratory salmonids or red deer which exceeds minor significance. Operational and decommissioning activities will result in **insignificant** effects on terrestrial habitats and ecology, and cumulative effects both as a result of different elements of the development itself and in combination with other proposed developments are likely to be **minor**.

8 Marine Habitats and Ecology

8.1 Introduction

8.1.1 This section studies the effects that the SWEP will have on the marine environment, below mean high water springs (MHWS). This includes both the habitats that are likely to be affected and the species whose environment may be impacted. The focus is on the offshore structures; namely the breakwater, the fixed link and any slipway facilities. It covers all aspects of the project from construction through operation and into the decommissioning phase. Therefore, the effects studied will not only include physical disturbance, but also less obvious effects from the operational phase of the project.

8.1.2 One key concern in the marine environment are the effects upon any protected species in the vicinity of the structures / works, which comprise primarily of cetaceans (these are mainly transient in nature). As these are of particular concern the primary impact relating to them, namely underwater noise, is addressed specifically in Section 15.

8.2 Legislative framework and regulatory context

8.2.1 A full assessment of all the necessary regulatory frameworks was carried out prior to the marine habitats and ecology study. Legislation, policies and associated guidance that have been taken into consideration include:

- EC Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Flora and Fauna (the ‘Habitats Directive’);
- EC Directive 79/409/EEC on the Conservation of Wild Birds (the ‘Birds Directive’);
- Nature Conservation: Implementation in Scotland of EC Directives on the Conservation of Natural Habitats and of Wild Flora and Fauna and the Conservation of Wild Birds (the ‘Habitats and Birds Directive’). Revised Guidance updating Scottish Office Circular No. 6/1995;
- Offshore Marine Conservation (Natural Habitats &c) Regulations 2007;
- Conservation (Natural Habitats &c) Regulations 1994 (the ‘Habitats Regulations’);
- Conservation of Seals Act 1970;
- Wildlife and Countryside Act 1981;
- Food and Environment Protection Act 1985;
- Water Environment (Controlled Activities) (Scotland) Regulations 2005 (CAR);
- Biodiversity: the UK Action Plan, CM 2428, HMSO, January 1994;

- Western Isles Local Biodiversity Action Plan (LBAP) Audit Report 2004;
- Assessing the Natural Heritage Resource: A Guidance Note for Local Authorities from Scottish Natural Heritage, SNH, 1996;
- National Planning Policy Guidelines of relevance to this assessment:
    - NPPG 13 Coastal Planning (August 1997);
    - NPPG 14 Natural Heritage (January 1999);
- Scottish Government Planning Policy Guidelines of relevance to this assessment:
    - SPP 6 Renewable Energy
- Scottish Government Planning for Renewable Technologies: Planning Advice Note (PAN) 45;
- Pollution Prevention Guidelines of relevance to this assessment:
    - o PPG 5: Works in, near or liable to affect watercourses.
- Western Isles Structure Plan:
    - o RM2 Land Management, Crofting and Biodiversity;
    - o RM11 Habitats and Species;
    - o RM12 Conservation Areas;
- Western Isles Local Plan.

8.3 Methodology

8.3.1 Appropriate consultees were approached regarding the marine habitats and ecology of the area and how these may be affected by the project. The data from an initial Phase 1 habitat survey (West Coast Energy, 2006b) of the intertidal zone, an underwater video assessment of the subtidal zone (Aspect, 2006) and an in depth desk based review of other studies and effects related to the area, were used to assess the potential effects.

Scoping and consultation

8.3.2 Consultation in relation to habitats and ecological effects in the marine environment has been undertaken with the bodies listed below (Table 8.1). The issues detailed in the table include those raised in the scoping opinion.

Table 8.1 Consultees and their key concerns

Name of organisation	Key concerns	Comment
The Association of Salmon Fishery Boards & Institute of Fisheries Management	The effects on fish interests related to increased noise and vibration at sea during construction and operation.	Desk based study to assess the effects of noise and vibration (see Section 15).
	Construction may affect the level of sediment suspended in the water column.	Consultation with SEPA and SNH identified the minimal impact due to a lack of sediment in the vicinity of the proposed site.
	The project may affect the levels of food available to fish interests.	Effects on local species and habitats addressed as part of this assessment.
	Effects due to increased electromagnetic effects due to the presence of power cables.	Desk based study assessed the likely effects (see Section 15). Mitigation measures of burying and / or cable shielding will be implemented.
	Effects due to the permanent change in the habitat of the area.	Qualitative assessment of habitat alteration issues as part of this assessment.
Comhairle nan Eilean Siar	Effects on the ecology of the area.	A full ecological assessment will be made of the site as part of the EIA.
SNH	Effects of the project on the presence of cetaceans through its presence and increases in noise to the area.	Further consultation with SNH concluded that a baseline cetacean survey was not necessary. Desk based study to assess the effects of underwater noise on cetaceans as part of the EIA (see Section 15). Appropriate mitigation and monitoring measures will be in place during construction and operation.
	Effects on the otters of the area.	An initial survey of otter presence has been made and considered as part of the terrestrial and marine assessments. A further survey will be carried out prior to construction.
	Effects due to the use of antifoulants required for the structure.	Specific antifoulant system not yet defined.
	Increases in sedimentation due to loss of energy in the area.	Covered in the coastal processes assessment (Section 10).
	Potential alteration in the composition of the local algal communities.	The shoreline of the bay is already slightly sheltered in relation to the more exposed shoreline outwith the bay, particularly in the vicinity of the existing slipway, therefore no major alteration in the algal communities is expected.

Name of organisation	Key concerns	Comment
	Effects of the project, in a cumulative way with the Lewis Wind Farm, on the Red-throated divers in the area.	AMEC data related to the flight paths of the Red-throated diver has been obtained and is considered in the terrestrial habitats section (Section 7).
WIFT	The potential effects to the local watercourses with particular reference to spawning areas and sedimentation.	Mitigation in place to avoid where possible the fish spawning season (Oct – June). Any work near (within 200 m of) watercourses will be well managed.
	Potential for the blocking of access to the River Siadar.	There will be no permanent blocking of the river from the proposed structures. Blocking is highly unlikely to occur during construction, but a watching brief will be maintained and clearance operations will take place as and when required.
RSPB	No known concerns regarding this type of structure – potentially a positive for the birdlife in the area. Divers tend to use Barabhas Bay and Siadar is not a prime site.	An assessment of any likely effects on birds considered in the terrestrial and marine assessments.
Scottish Government	Effects on marine mammals need to be taken into account.	Primary effects are related to noise and have been assessed as part of the EIA (Section 15).
	Effects on red throated diver need to be taken into account.	Consultation with RSPB, the carrying out of a breeding bird survey and after obtaining data from AMEC has identified this issue as being insignificant.
	Effects on migratory salmonids and other fish stocks in the area should be assessed.	Consultation with FRS has identified that the presence of the structures is unlikely to impact on migratory salmonids as they utilise their sense of smell for navigation when adjacent to the shoreline. The area is too shallow to be important breeding grounds for other species of fish (e.g. herring).
	Effects of noise and vibration on the marine mammals and fish in the vicinity of the site.	See Section 15.
SEPA	Effects of sedimentation and pollution to the local watercourses.	Sediment accumulation unlikely due to the lack of sediment in the marine system (agreed by SEPA and SNH). Sediment effects in freshwater areas are covered in Section 6.
	Foreshore flora	SEPA noted the presence of knotted wrack and brown seaweed and advised consultation with SNH on mitigation measures.

Desk study

8.3.3 A desk study was undertaken to identify and assess the habitats of the area and the main species within these habitats that are likely to be affected by the project. These extensive desk based studies and the additional consultation process, has allowed an assessment to be made of effects on marine habitats and species.

Field surveys

8.3.4 A Phase 1 habitat survey of the intertidal zone was carried out by West Coast Energy (2006b). Although a specific habitat survey of the subtidal environment was not carried out, a bathymetric survey was completed, which included drop-down video footage providing information on the habitats present (Aspect, 2006 – copy of report on enclosed CD).

8.3.5 Additionally a survey undertaken in May and June 2007 by a local ecologist (Rothwell, 2007), identified the presence of foraging grey seals within Siadar Bay.

Significance criteria

8.3.6 The significance criteria employed for this section is based on the methodology defined in Section 5.3. The sensitivity and magnitude are defined in Table 8.2 and Table 8.3 below.

Table 8.2 Definition of sensitivity of effect

Sensitivity	Definition
Very high	Very sensitive such as resident rare and / or protected species / habitat and / or contains the entire population and / or breeding population of a species.
High	Rare / protected species frequently known to be present in the area. Significant areas of protected habitat present and / or a significant proportion of a species population or its breeding sites.
Medium	Rare / protected species occasionally known in the area. Protected habitat areas present and / or a large proportion of a species population or its breeding sites.
Low	Rare / protected species rarely known in the area. Protected habitat areas not known and / or a small proportion of a species population or its breeding sites.
Negligible	Rare / protected species not known from the area. Protected habitat areas not present and / or a negligible proportion of a species population or its breeding sites.

Table 8.3 Definition of magnitude / frequency of effect

Magnitude	Definition
Very major	Very major alteration / removal of the baseline population / habitat conditions of the area. Guide: Removal / alteration of >50% of a habitat OR >50% population loss of a species OR a significant impact to a rare / endangered species.
Major	Major alteration / removal of the baseline population / habitat conditions of the area. Guide: Removal / alteration of 30-50% of a habitat OR 30-50% population loss of a species OR a major impact to a rare / endangered species.
Moderate	Moderate alteration / removal of the baseline population / habitat conditions of the area.

	Guide: Removal / alteration of 10-30% of a habitat OR 10-30% population loss of a species OR a moderate impact to rare / endangered species.
Minor	Minor alteration / removal of the baseline population / habitat conditions of the area. Guide: Removal / alteration of 5-10% of a habitat OR 5-10% population loss of a species OR a minor impact to rare / endangered species.
Negligible	Very slight alteration / removal of the baseline population / habitat conditions of the area. Guide: Removal / alteration of <5% of a habitat OR <5% population loss of a species OR a negligible impact to rare / endangered species.

8.3.7 The magnitude and sensitivity of the potential effect are combined to define the significance of the effect, as shown in Table 8.4. Those criteria in red text are the residual effects considered significant under EIA regulations.

Table 8.4 Effect significance matrix

Magnitude	Sensitivity				
	Very High	High	Medium	Low	Negligible
Very Major	**Major**	**Major**	**Major**	**Moderate**	Minor
Major	**Major**	**Major**	**Moderate**	Minor	Insignificant
Moderate	**Major**	**Moderate**	**Moderate**	Minor	Insignificant
Minor	**Moderate**	Minor	Minor	Insignificant	Insignificant
Negligible	Minor	Insignificant	Insignificant	Insignificant	Insignificant

Pre assessment to identify worst case design options

8.3.8 A summary of the proposed options in relation to the assessment of effects on marine habitats and ecology Table 8.5.

Table 8.5 Scheme design options (marine aspects)

Aspect	Options	Description	Discussion
Caisson construction	Local construction; construction compound established adjacent to the Scottish Water works at Siadar	Slipway from which caissons are to be launched and trench dredged to give area of deep water in which to float them. Seabed preparation for the breakwater. Drilled pile installation.	Worst case because larger compound area is required with greater levels of work being carried out, which could potentially impact on the River Siadar and affect migrating salmonid stocks utilising the coastal waters. Additionally trenching operations and the construction of a slipway will impact on both the intertidal and subtidal zones.
	Remote construction – caissons are floated to site for installation	No trenching or slipway required. Seabed preparation for breakwater. Drilled pile installation.	Lower significance due to lack of trenching and slipway. Smaller compound area with

Aspect	Options	Description	Discussion
			lower levels of work and resultant reduced potential for impact on the River Siadar and adjacent coastal waters.
Operation and maintenance to the breakwater	Fixed permanent access to link the breakwater to shore by rubble mound fixed link	Would require construction of a new fixed permanent link.	Worst case because new structure required which has a larger physical impact on marine habitats and ecology of the area in addition to additional in-water works (e.g. drill piling). Potential to alter hydrodynamics of the bay.
	Fixed permanent access to link the breakwater to shore by part rubble mound, part steel truss bridge		
	Boat access from onsite slipway.	Would require upgrades to existing slipway.	Lower significance because only modifications to existing slipway.

8.3.9 This assessment has identified the worst case option for detailed assessment, with all other options assessed at the end of each subject.

8.4 Baseline description

Intertidal

8.4.1 In October 2006 West Coast Energy carried out a Phase 1 habitat survey of the intertidal zone of Siadar Bay including an assessment of the local biotopes and species (West Coast Energy, 2006b). This was an optimal time to undertake this survey due to spring tides and high amounts of growth on the shore. A walkover of the shoreline was used to identify and map the location of intertidal biotopes. The survey showed the exposed intertidal zone to be characterised by fucoids, as well as knotted wrack, kelp, green seaweed, breadcrumb sponge and pink encrusting coralline algae. Twelve main biotopes and three subsidiary biotopes (rockpool biotopes in the upper and mid shore areas) were identified. Some biotopes were patchy in nature and there was difficulty in differentiating between them. Where this was the case the biotopes were combined, which is standard practice. The main factors determining the differing biotopes can be related to certain factors including substrate type, exposure to wave action, emersion / immersion and salinity (most notably near the mouth of the River Siadar where the shoreline is devoid of macroalgal seaweed growth).

8.4.2 The biotopes on the shore within the bay – the area most likely to be affected by the additional shelter provided by the proposed breakwater – are dominated by moderately exposed to sheltered biotopes. These include areas dominated by the seaweeds *Fucus spiralis* and *Ascophyllum nodosum*. Areas immediately to the north of the site are dominated by the exposed *Fucus serratus* biotope – this is, however, positioned primarily to the north of the proposed fixed link. The subtidal fringe was primarily kelp dominated and the biotopes (e.g. IR.HIR.kFar.Ala) included the species *Alaria esculenta, Himanthalia elongata,* and *Laminaria digitata*. The more exposed biotopes containing *A. esculenta* was situated south of the bay. The only non-algal dominated biotope is classified LR.HLR.MusB.Cht.Lpyg (Connor *et al.*, 2004), which is dominated by barnacles (*Semibalanus balanoides* and *Chthamalus stellatus*), mussels (*Mytilus edulis*), dogwhelks (*Nucella lapillus*) and limpets (*Patella* sp.). These biotopes are very patchy in nature and located on lower shore outcrops to the south and north of the bay, considered to be the most exposed areas of the shore.

8.4.3 No species or biotopes of conservation importance were observed at the site during the Phase 1 habitat survey. All biotopes present are known from much of the intertidal habitats present along the Isle of Lewis Atlantic coastline. This distribution of habitats is illustrated in Figure 8-1.

8.4.4 Previous studies have identified Siadar Bay and its surrounds as an area where otters forage; therefore use the intertidal zone as an access area to the sea.

8.4.5 Grey seals (*Halichoerus grypus*) are very common along the west coast of Lewis. The west coast of the Western Isles is an internationally important breeding site which produces approximately 40 % of the grey seal pups born in the UK (Barne *et al.*, 1997). Grey seals are known to haul out at the Butt of Lewis (a site of international importance) 17 km north east of Siadar and in Loch Roag, 25 km to the south west of the Siadar site. Grey seals appear to be more faithful to particular haulout sites (Thompson & Miller, 1990). There are no known haul out sites in Siadar Bay; however, a total of five grey seals were recorded foraging close inshore in Siadar Bay during the breeding bird and marine mammal (Rothwell, 2007).

8.4.6 Harbour seals (*Phoca vitulina*) also require to haul out to mate and pup. They are less common on the western coasts of Lewis as they prefer more sheltered locations. There are no known harbour seal haul outs in Siadar Bay.

<u>Associated fauna</u>

8.4.7 Each biotope identified during the Phase 1 habitat survey has specific flora and fauna permanently associated with it, none of which are of conservation concern, however, protected species (i.e. otters) use the area. Additional species not mentioned above are typical of the coastline type and / or have been identified from other sources or data from consultees, include:

- **Vascular plants** Grass and thrift
- **Lichens** *Verrucaria maura*, *Verrucaria mucosa*, *Lecanora* sp.

- **Algae** *Corallina officinalis*, *Palmaria palmata*, *Porphyra* sp., *Mastocarpus stellatus*, *Enteromorpha* sp., *Halichondria panacea*, *Cladophora* sp.
- **Invertebrate fauna** *Littorina littorea*, *Actinia equina*, Spirorbidae, *Gibbula cineraria*, *Littorina saxatilis*.
- **Birds** *Anas penelope* (Wigeon), *Calidris alpina* (Dunlin), *Calidris canuta* (Knot), *Calidris maritima* (Purple sandpipers), *Larus argentatus* (Herring gull), *Larus marinus* (Black-backed gull), *Larus canus* (Common gull), *Haematopus ostralegus* (Oystercatcher), *Numenius arquata* (Curlew), *Gallinago gallinago* (Snipe), *Tringa tetanus* (Redshank).
- **Mammals** *Lutra lutra* (Eurasian otter)[5], *Phoca vitulina* (Harbour seal)[6], *Halichoerus grypus* (Grey seal)[7].

Subtidal

8.4.8 Although a full subtidal survey has not been carried out, the typical biotope for such exposed shores is IR.HIR.kFar.LhypR (*Laminaria hyperborea* with dense foliose red seaweeds on exposed infralittoral rock) as categorised in Connor *et al.* (2004). Bedrock and small areas of sandy gravel intersperse this dominant bed form and were shown from some drop-down video work (Kongsberg CCD Underwater Video Camera) and through the deployment of a Shipek grab, which was used for sample collecting. The seabed samples and video footage were analysed at a later date. These surveys were carried out in support of the bathymetric survey in 2006 by Aspect Land and Hydrographic Surveys: Chartered Surveyors (Copy of report is included on CD).

8.4.9 The survey covered the various types of substrate found in Siadar Bay and obtained a general picture of the seabed habitats in the area. The areas chosen as seabed survey stations were videoed and are considered to be representative of the wider habitats of the project area. The infralittoral zone in the proposed area is typical of such zones on the Atlantic coast of Scotland and, as such, is unlikely to support species of conservation importance. However, there are several species known from the area of Siadar Bay (and further offshore) that are listed in the Western Isles Local Biodiversity Action Plan (WILBAP). These include several mammal species (e.g. otter, harbour porpoise, baleen whales, small dolphins, toothed whales, and harbour & grey seals) and marine turtles. Although certain fishes (e.g. basking sharks and common skate) are mentioned in the WILBAP they have not been observed in the area of the proposed SWEP. Commercial fish are also given priority status; however the area of Siadar Bay is not exploited commercially and is too shallow for commercial species such as herring to spawn in.

[5] There are no known otter holts on the coastal fringe, but otters have been observed utilising the coastal shallows to feed.
[6] There are no known harbour seal haul-out sites in the area likely to be affected by the SWEP.
[7] There are no known grey seal haul-out sites in the area likely to be affected by the SWEP.

8.4.10 Grey seal pups begin their offshore life independently and are notoriously inquisitive; it is possible they are attracted by objects moving in the water column.

8.4.11 Any effects upon cetaceans are particularly important due to their protected status and as such the effects upon them are fully considered within this ES. As the primary concern affecting cetaceans potentially utilising the area is that of noise so these effects are not treated here but in a separate section dedicated to these issues (see Section 15).

Associated fauna

8.4.12 As previously stated there has not been a full subtidal habitat study carried out for the area and, therefore no specifically identified subtidal fauna associated with the zone can be mentioned. However, various studies and anecdotal evidence do allow for the identification of certain species likely to be present in the area. Certain species (e.g. the dogfish) are likely to be found permanently in the area. However, others (e.g. the Red-throated diver) are irregular visitors from other areas of ocean or land. Red-throated divers nest in the nearby Lewis SPA (see Table 4.4 in Section 4) and travel to the coast to feed, occasionally seen in Siadar Bay. Salmon and sea trout are also known from Siadar Bay and the River Siadar. Salmon spend approximately a year at sea before returning to spawn in the river where they hatched. Spawning periods occur between November and January but fish can be found several months prior to spawning. Following spawning most fish die but a few survive and spawn again. Young fish spend approximately 2-4 years in the river system and once developed into smolts swim downstream and migrate to the sea between April and June. The sea trout life cycle is almost identical to that of salmon, apart from the majority of sea trout survive after spawning and return back to their natal spawning river on several occasions.

8.5 Assessment of effects – construction phase

Intertidal

Potential effects

8.5.1 Marine effects within the intertidal zone during the short 18-month construction phase of the project relate to the potential construction of the slipway connecting the construction site with deeper water; the trenching of the foreshore for the placement of the cabling connecting the SWEP with the onshore control building (were the fixed link, linking the SWEP to the foreshore not built); and / or the construction of the fixed link between the breakwater and the foreshore.

8.5.2 The primary effects that the construction of all / any of the above will likely have are:

- Physical removal / displacement of habitat;
- Sedimentation and sediment accumulation during construction (Note: all sedimentation issues have been covered in Section 10); and
- Potential pollution from spillages.

8.5.3 The physical displacement of the habitat due to the construction of the slipway for the floating of the caissons from the construction site is considered to be minor as it will only impact on a very small proportion of the foreshore as a whole. As already mentioned, construction will not impact on any species of conservation importance; therefore the sensitivity of the area is considered low. Additionally, such a small scale habitat effect is unlikely to impact on species which utilise this habitat, including those protected species in the area (e.g. the otter). The overall significance is therefore considered to be **insignificant**.

8.5.4 Such an impact will also be indicative of the construction of the potential fixed link structure as the habitats impacted are similar in nature. Therefore, the impact of the fixed link is also considered to be **insignificant** for the same reasons.

8.5.5 The area for the proposed SWEP is sediment deficient. This was shown during a drop-down video survey and confirmed through consultation with SNH and SEPA. Although any activities during the seabed preparation and drill-piling will produce some sediment, this is expected to be minimal. Heavy sedimentation and sediment accumulation can impact on algae by increasing the turbidity of the water column and on benthic communities through the sediment settling out of the water column, thereby potentially smothering such communities. Fish (in particular the salmonids in the River Siadar) in the area will also be affected through the potential impact on their gill structures by this increased sediment loading in the water column.

8.5.6 Trenching of the foreshore to allow for the burial of the cable connecting the breakwater to the onshore control building will create some disturbance to the benthic community in the area and potentially create some additional sedimentation, depending on what the nature of the sediment is beneath the large boulder substrate. Any impact will be temporary in nature and the large boulder substrate will be reinstated once the cable has been laid. Any sediment that does build up during this phase of the operation is likely to be swiftly dispersed at higher tidal states and during periods of rough weather.

8.5.7 Sedimentation linked with the construction of the fixed link will occur as the structure is built (the methodology likely to be utilised will be end-tipping) and effects are likely to be similar in nature to the trenching of the foreshore for the cable laying.

8.5.8 The effects of oil/fuel/lubricant/fluids leaks/spills from construction vessels and vehicles are likely to affect the intertidal zone of the bay. The level of impact caused will be dependant on the amount spilled and the conditions at the time of the spill.

8.5.9 The overall area of the bay in which these operations will occur gives a moderate magnitude effect and the sensitivity of the area is low. Therefore, the overall impact from the construction activities will be **minor**.

Mitigation

8.5.10 Works will be timed to incur the minimum level of disturbance to the local flora and fauna wherever possible, particularly in relation to the effects on wild salmonids. Between the months October - June these fish migrate up to spawn and then leave freshwater as smolts and return into the marine environment. Although it would be impractical to avoid works during this entire period, they will be well managed to have as little disturbance as is practicable. All major heavy construction activities will occur at appropriate times, and with the appropriate management measures in place, in order that any noise, dust and sediment loading of the intertidal zones are minimised to prevent effects on breeding populations, migrating populations and others utilising this zone at certain times of the year.

8.5.11 Procedures will be established to firstly avoid spills but also to control and manage them should they occur. The receptor sensitivity is low and the likely impact is minor so the potential effects of any spills on the intertidal zone are considered to be **insignificant**.

Residual effect

8.5.12 With mitigation measures in place the residual rating given to potential effects on the intertidal zone is rated as **insignificant**.

Non worst case

8.5.13 If the caissons were to be constructed offsite then the effects on the intertidal zone will be less severe, and therefore again the residual effect would be **insignificant**.

Subtidal

Potential effects

8.5.14 The primary issue with regards to the construction phase of the project relates to the noise generated by such works, covered in detail in Section 15. Other issues relate to the construction phase are similar to those for the intertidal and include the physical removal of habitat (through the preparation of the seabed and the installation of the breakwater structure); the alteration of local hydrodynamics; and the potential for increased sedimentation to the area.

8.5.15 These effects will have the potential to increase the water turbidity in the area and alter the transportation of sediment and species composition at locations affected by hydrodynamic alterations. Any increase in turbidity will affect algae within the area and the gill structures of local fishes e.g. salmonids present in the River Siadar. Additionally, higher trophic species hunting abilities may be impaired if they rely on sight. Sediment accumulation will also affect the faunal component of the benthic community through smothering. The overall area of the bay in which these operations are to occur gives a moderate magnitude effect; however, the sensitivity of the area is low. Therefore, the overall impact from the above activities will be **minor**.

8.5.16 Wild salmonids migrating to Siadar Bay to reach the River Siadar may be blocked by any structures and / or affected by any increases in sedimentation to the area. They are unlikely to be affected by the presence of the structures due to the open nature of the steel truss bridge and the fact that once close to shore they utilise their sense of smell in order to locate the river mouth. Therefore the magnitude of the effect is rated as minor and the sensitivity of the fish to sediment increases to medium as sedimentation has the potential to affect their gills. However, the possibility of significant increases in sediment loading of the water column is minimal due to the sediment deficient nature of the site. Therefore the overall significance is rated as **minor**.

Mitigation

8.5.17 It should be noted that the area is sediment deficient in nature and production of sediment through the implementation of appropriate construction processes and techniques will be minimal. No specific mitigation measures are therefore required.

Residual effect

8.5.18 With the appropriate monitoring protocols in place and the fact that the construction period is short in duration and the area is sediment poor then the effect rating is considered to be **insignificant**.

Non worst case

8.5.19 The primary effect of the non-worst case scenario is the lack of need for a causeway to be constructed. Therefore, drill piling in the area will reduce significantly and would only be associated with the breakwater structure. This would reduce the potential for sedimentation occurring in the area. However, as the area is already sediment deficient this effect is still considered to be **insignificant**.

8.6 Assessment of effects – operational phase

Intertidal

Potential effects

8.6.1 The operational phase will impact on the intertidal zone through the physical presence of certain structures. The structures likely to impact on this zone are the new slipway to the south of the bay, the fixed link connecting the breakwater with the shore, which will be constructed to the north of the bay and the breakwater itself (through alterations in the hydrodynamics of the bay).

8.6.2 These structures (which, if built, will be permanent) will have the potential to alter the water currents within the intertidal zone at certain stages of the tide. This will have the potential to allow for sediment build-up in areas where the water flow is weaker and the sediment loading in the water may settle out onto the shore. Any such build-up is likely to be minimal due to the lack of sediment in the area (see Section 10) and frequent storms will remove any such build-up. The only possible exception to this is the build up of sediment in areas protected by the breakwater. However, as the area is in general sediment deficient, this is unlikely to become an issue. Therefore, the magnitude of effect from any such build-up is seen as being negligible, with the sensitivity of the area being low due to the rare presence of any protected species. Therefore, the overall impact significance is **insignificant**.

8.6.3 A potential significant impact to the habitats and species is the alteration to the flow dynamics of the area, which is likely to impact on the species composition. Species in the bay at Siadar are adapted to moderately exposed areas of rocky coastline and the alteration of this to become more sheltered in nature will have the effect of allowing species unable to survive on moderately exposed shores the opportunity to colonise the area. However, this will occur across a very small portion of the coastline (modelling suggests that it will only occur within the confines of the bay itself: see Section 10) it has the potential to alter the species composition of the area. This impact will affect the whole bay. However, despite the entire bay being affected, there is considerable natural variation on exposed rocky shores and there are coastal zones similar in nature to the north and the south the magnitude is considered to be major. Additionally, there are no species of conservation importance in the area the sensitivity of the bay is low. In a local context, the overall impact is considered to be **minor**.

8.6.4 Although the new structures will remove a small portion of the intertidal habitat they will also provide new surfaces which will be easily and readily colonised. This virgin surface will be open to colonisation from all species represented by larvae present in the water column; it is likely that the species dominating this colonisation will be common to the area. The structure will cover only a small portion of the bay and is classed as being minor, with the sensitivity of the area being low. Therefore, the introduction of such a structure will be **insignificant** to the area's biodiversity as a whole.

8.6.5 The use of lubricants and fluids to maintain the working efficiency of the offshore and onshore components of the facility may potentially impact on the intertidal zone if leaked / spilled. The impact on the shoreline would be dependant on the amount leaked / spilled and the sea state at the time (for any offshore leaks / spills). The quantities likely to be involved (from either the offshore or onshore components of the scheme) are considered to be negligible.

Mitigation

8.6.6 Access / egress to the river will be monitored for any blockages that may occur through the alteration of the hydrodynamics of the bay resulting in the build-up of any material or sediment.

8.6.7 Appropriate storage of any lubricants and / or fluids will be in accordance with SEPA's PPG 2. Emergency procedures will be in place in the event of a pollution incident. A spill kit will also be maintained on site and staff trained in its use for a speedy response to any incidents.

Residual effect

8.6.8 Taking into account the nature of Siadar Bay and its marine communities and the mitigation in place the residual effect on the intertidal zone is considered to be **insignificant**.

Non worst case

8.6.9 Once the causeway or slipway is in place (dependent on how the structure is to be serviced) the operational effects on the intertidal zone will be very similar and the residual effect will remain **insignificant**.

Subtidal

Potential effects

8.6.10 The primary impact to the subtidal environment and the species therein during the operational phase of the project is noise. This is likely to affect sensitive and protected cetacean and pinniped species and is covered in detail in Section 15.

8.6.11 The structure is approximately 350 m offshore and, as such, is unlikely to be a hazard to otters foraging in the area as otters tend to remain within 100 m of the shore whilst foraging (Kruuk and Moorhouse, 1990; Kruuk *et al.*, 1990). However, if the fixed link is to be built, this will give the otters land access to the breakwater, by allowing them to move along or swim along the side of the causeway, thus becoming a potential hazard.

8.6.12 During the proposed 25-year operational phase of the project there are potential effects related to the localised build-up of sediment. The permanent structures (namely the slipway and the breakwater) within the subtidal zone are likely to affect the hydrodynamics of the bay. This has implications for the transport of sediment as well as the species composition at particular locations within the bay. The magnitude of effect from any such build-up is seen as being negligible, with the sensitivity of the area being low due to the lack of any protected species. Therefore, the overall impact significance is given as **insignificant**.

8.6.13 The foreshore in the vicinity of the existing slipway is already somewhat sheltered in nature due to the configuration of the surrounding coastline of the bay itself. There will be additional shelter from wave action from the presence of the breakwater which may affect the species composition of the area. Any detrimental effects to species adapted to more exposed conditions will likely be counterbalanced by the addition of new virgin surfaces (e.g. the breakwater structure itself) appropriate for species colonisation. Due to this impact affecting the whole bay the magnitude is considered to be major; however, there is considerable natural variation on exposed rocky shores and there are similar areas of coastal zone to the north and south of the proposed site. Additionally, as there are no species of conservation importance in the area the sensitivity of the bay is low. Therefore, the overall impact is considered to be **minor**.

8.6.14 The area of Siadar Bay is not important for the inshore fishery fleet, in part due to its shallow nature. Therefore, effects to the local fisheries are expected to be **insignificant**. Additionally the structures cover a limited area. Migrating salmon and sea trout in the area attempting to reach the River Siadar are unlikely to be affected by the presence of such structures as they will not impair access to the river mouth at high tide (the only period of the tide when there is access to the river). When so close to a freshwater source salmonids use their sense of smell for navigation and this will allow them to find the river with relative ease. The magnitude of the effects on local fish and shellfish is negligible, as is their sensitivity. Herring spawning is known to occur off of the west coast of Lewis, but in considerably deeper water (15 – 40 m) and will not be affected by the project. Therefore, the overall impact is considered to be **insignificant**.

8.6.15 Birds in the area are not thought to be threatened by the presence of any of the proposed structures and the RSPB has indicated there may potentially be a positive impact for bird life in the area. The magnitude of effect due to the presence of the permanent structures is negligible as is the sensitivity of the species present. The additional shelter provided to the bay by the structures is expected to attract other species (e.g. eider ducks) (identified through RSPB consultation) to the bay. Additionally the bay is small and the proportion of local populations using this area is minimal. The overall impact is, therefore, considered to be **insignificant**.

8.6.16 Seals have been observed in the offshore waters of Siadar Bay, but there are no identified haul-out sites.

8.6.17 As the structures that are to be positioned in the bay (breakwater, slipway, fixed link) will create new virgin benthic habitat for colonisation and successional processes to occur, there is not thought there will be an overall loss of habitat to the area – indeed there is likely to be a gain of habitable space. This potential increase in benthic fauna will likely have a knock-on effect with according increases in local fish populations (the breakwater structure for instance acting like a Fish Aggregating Device [FAD]), which, as identified above, may in turn may potentially lead to increases in the level of birds utilising the area.

8.6.18 The equipment housed within the breakwater structure will require some lubricants and fluids to maintain their general good order and working efficiency. The storage and use of these fluids should not affect the marine environment during general operation; however, accidental spills may occur. Therefore, the possible impact of such fluids on the marine environment is considered to be **minor**.

<u>Mitigation</u>

8.6.19 The positioning of the breakwater structure considerably offshore (350 m), but still in shallow waters (approximately 5 m CD), avoids impacting upon any local otter populations as well as offshore fish species which spawn in deeper waters off of the west coast of Lewis.

8.6.20 A similar wave power site on Islay has not prevented seals from foraging within only a few meters of it whilst operating. Therefore, it is not expected that they will be displaced from the bay.

8.6.21 In order to prevent any fluid spillages bunding and oil interceptors will be employed. Emergency procedures will be in place in the event of a pollution incident. Additionally, where practicable, environmentally friendly greases will be employed.

Residual effect

8.6.22 With all mitigation measures in place the residual effect of the operational phase of the project on the subtidal environment is considered to be **insignificant**.

Non worst case

8.6.23 The primary difference between the worst case and the non worst case scenario is the type of causeway which is to be constructed. If it is fully rubble mound then this blocks passage of migrating fishes and allows otter's easy access to the breakwater structure. If, however, the fixed link is part rubble mound causeway and part steel trussed bridge then this will create a more 'open' structure. This will allow migrating fish easy passage and potentially prevent the movement of otters out to the breakwater as they may not wish to swim across the areas of open water created by this type of structure. Therefore, the residual effect in this instance is considered to be **insignificant** or less.

8.7 Assessment of effects – decommissioning phase

Intertidal

Potential effects

8.7.1 No additional effects will be incurred during this phase of the project as the two structures (the slipway to the south of the bay and/or the fixed link to the north of the bay) likely to impact on the intertidal zone are permanent in nature and their presence will assist the local community with regards access to the sea and with the provision of shelter to the foreshore. At the decommissioning stage it is expected that only the electrical and generation equipment will be removed.

8.7.2 The impact from such operations to the intertidal zone is expected to be **insignificant**.

Mitigation

8.7.3 The proposed mitigation measures for the construction phase are considered appropriate for the decommissioning phase, but should be adapted according to the final scope of the decommissioning works.

Subtidal

Potential effects

8.7.4 The permanent structures (namely the rubble mound portion of the causeway and the breakwater structure) are likely to remain in place post the operational phase of the project. Benthic and other (fish, bird, etc.) communities will have become adapted to and dependant on their presence and their removal may well be damaging to these new local populations.

8.7.5 Therefore, if these structures are to remain, any effects during this phase of the project are likely to be similar to those for the operational phase. Any works to remove such structures will create similar quantities of sediment as during the construction phase, although this will likely be quickly dispersed due to the exposed nature of the western coast of Lewis.

8.7.6 However, it is likely that if the fixed link were to be part constructed of a steel trussed bridge then this would likely be removed at the end of the operational life of the project. This would have similar effects to the construction phase and would require additional onsite equipment to carry out this task.

Mitigation

8.7.7 The proposed mitigation measures for the operational phase are considered appropriate for the decommissioning phase, but should be adapted according to the final scope of the decommissioning works.

8.7.8 If the steel trussed bridge were present and to be removed then mitigation measures in line with the construction phase would be implemented.

Residual effect

8.7.9 The residual effect of the decommissioning phase of the project is considered to be **insignificant**.

Non worst case

8.7.10 If only the electrical and generating equipment are to be removed during the decommissioning phase and all other structures are to remain in situ then the impact on the marine habitats of the area is considered to be again **insignificant**.

8.8 Cumulative effects

Construction phase

8.8.1 There are no other works planned in the inshore waters or the foreshore of the area. Therefore, the construction phase of the project is will have no major cumulative effects on the area.

Operational phase

8.8.2 There is very little sediment in the local area of the site (see Section 10), which was shown by the bathymetric survey of the area.

8.8.3 The operational phase of the project is likely to have the most potential for impacting habitats and wildlife through its physical presence and the potential for underwater noise (which is covered in detail in Section 15).

Decommissioning phase

8.8.4 The decommissioning phase of the project is limited in duration and will have no major cumulative effects on the wildlife. Any wildlife which has become associated with the structure will likely be common to the area.

8.9 Summary and Conclusions

8.9.1 The primary sources for concern with regards the marine habitats and species in the area of Siadar Bay are the mammals (both terrestrial mammals that utilise the bay and the true marine mammals) as well as the migratory salmonids that return to the bay in order that they may migrate up the River Siadar to spawn. Some of the effects on these species and the habitats were **moderate** (for cetaceans – see Section 15) and **minor**. However, there are no habitats / biotopes of conservation importance in the area and there are no species of conservation importance utilising Siadar Bay and its surrounds. Therefore, so long as the appropriate mitigation measures are put in place then the residual effects are primarily **insignificant**, rising to **minor** in one instance. Therefore, the overall effect of the project on the marine ecology of the area is seen as being **insignificant** in nature.

9 Cultural Heritage – Terrestrial and Marine

9.1 Introduction

9.1.1 The following section provides an assessment of the potential effects of the onshore and offshore components of the SWEP on archaeology and cultural heritage. All of the onshore and offshore components of the SWEP project have the potential to disturb archaeological and cultural heritage resources.

9.1.2 Vehicle and other machinery movements, especially those associated with onshore construction and production and launching of the breakwater caissons (if undertaken onshore) may indirectly affect archaeology from vibration.

9.1.3 The consideration of the effects from the construction, operation and decommissioning of the development on the historic setting have also been considered. The findings of this assessment are summarised in Section 12.

9.2 Legislative framework and regulatory context

9.2.1 Legislation, policies and general guidance that have been taken into consideration during this assessment include:

- NPPG 5 Planning and Archaeology
- NPPG 18 Planning and the Historic Environment
- PAN 42 Archaeology – The Planning Process and Scheduled Monument Procedures

9.3 Methodology

Scoping and Consultation

9.3.1 Consultation in relation to cultural heritage has been undertaken with the bodies listed in Table 9.1. The issues detailed in the table include those raised in the Scoping Opinion.

Table 9.1 Consultees and their key concerns

Name of organisation	Key concerns	comment
Historic Scotland	The location of the SWEP adjacent to Scheduled Ancient Monuments, cause for concern.	Visual impact assessment undertaken by Rachel Barrowman on all cultural heritage sites in the area (see Section 12).
	Any predicted effects from each SWEP option should be addressed in detail in the ES and mitigation measures given where appropriate.	Effects and mitigation measures addressed in this section.

Name of organisation	Key concerns	comment
	Significant effects on Teampull Pheadair, Chapel & Siadar should be assessed and documented in the ES.	Archaeological assessment both terrestrial and marine has been conducted. Photomontages undertaken depicting views of the development both to and from cultural heritage sites in the area (see Section 12).
	Effects of borrow pit on all scheduled sites in the area including Steinacleit and Clach Stei Lin should be considered.	Consideration of effects covered in the terrestrial archaeological assessment and in the visual impact assessment (see Section 12).
Airidhantuim Community Council	Concern expressed over the visual impact of the SWEP.	Visual impact assessment and archaeological assessment undertaken by independent archaeologist Rachel Barrowman.
Scottish Natural Heritage (SNH)	Request that a visual impact assessment be undertaken from fixed locations.	Terrestrial archaeological survey included a visual impact assessment on cultural heritage interests (see Section 12).
Comhairle nan Eilean Siar	Dr Macleod had one reservation regarding underwater archaeology in that inundated sediments in the area are bedrock.	Review of underwater sonar data to assess potential marine cultural heritage interests provided to Dr Macleod and used to inform assessment on marine cultural heritage.
	Historic Scotland to be consulted regarding Scheduled Monuments in the area.	Historic Scotland have been consulted.
	Mitigation measures to be included in the ES	Environmental effects upon the cultural heritage sites have been assessed and mitigation measures included in this section.

Desk study

<u>Terrestrial environment</u>

9.3.2 Lewis based independent archaeologist, Rachel Barrowman undertook a desk-based assessment to assess both the direct and indirect effects of the SWEP for each cultural heritage site within the Siadar survey area. The survey also examined the visual effects of the SWEP on nationally important Scheduled Ancient Monuments within the Zone of Visual Influence (see Section 12). Dr Mary MacLeod, Western Isles Archaeology Service (Local Sites and Monuments Record) and the National Monuments Record for Scotland (NMRS) were consulted during this desk study.

9.3.3 The Environmental Assessment Scoping Report (West Coast Energy, 2006c) identified 114 known cultural heritage sites in the Siadar survey area that may be affected by the SWEP. These included Scheduled Ancient Monuments, a Monument in Care, and sites and monuments recorded in the National Monuments Record of Scotland and the Sites and Monuments Record for the Western Isles. It was concluded of those sites only 29 sites were found to be within the area over which the project will be developed and 5 Scheduled Ancient Monuments were found to be within the Zone of Visual Influence that may be affected by the proposed development.

9.3.4 The Scheduled Ancient Monuments found within the Zone of Visual Influence include:

- Clach Stei Lin;
- Steinacleit (Monument in Care);
- Loch an Duin;
- Clach an Truiseil; and
- Teampall Pheadair.

9.3.5 Teampall Pheadair is the only Scheduled Ancient Monument located within the area that may be directly impacted by the project. Potential effects on the visual and landscape setting for these monuments has been considered as part of the visual and landscape impact assessment (see Section 12).

9.3.6 During this desk study it was recognised that there may also be unidentified sites within the area of the SWEP; these were identified and assessed during the walkover survey (see below).

Marine environment

9.3.7 Headland Archaeology Ltd reviewed side-scan sonar data (produced by Aspect Land and Hydrographic Surveys) in order to identify any possible cultural heritage sites that may be impacted upon by the proposed development (Headland Archaeology, 2006).

9.3.8 The side-scan sonar data was reviewed and analysed using Sonar Pro Klein viewing software. Using plans of the proposed SWEP locations, the data was cross-referenced and the cable connecting the breakwater with the land-based sub-station identified.

9.3.9 The Receiver of Wrecks, Historic Scotland (marine team) and The Royal Commission on the Ancient and Historical Monuments of Scotland (RCAHMS) were also consulted to enquire if there are any marine archaeological sites in the area.

Field survey

Terrestrial environment

9.3.10 As part of the assessment of the physical and visual impact on archaeological and historic sites, a walkover survey of the proposed onshore development areas was undertaken. The survey took place over the following dates; 21st – 22nd February, 6th – 8th March, 12th March, 27th March and 16th April 2007. Weather conditions during the survey period varied from overcast and cloudy on some days to sunny and dry conditions.

9.3.11 The survey area was split up into four different areas, A to D which covers the full length of Siadar Bay. Each survey area reflects the current land use, terrain, cultural heritage and density of cultural remains. Both new and known cultural sites were identified during the walkover survey and every site identified by the desk-based assessment was checked. Each site identified was given a unique SABS reference number and the results from the desktop study were taken into the field to allow known sites to be linked to remains indentified on the ground. The grid references for known sites were checked and new sites recorded on the ground using a hand held global positioning system (GPS). The information and observations gathered during the walkover survey was used to form recommendations for mitigation for each site as incurred by the SWEP, its use and construction.

9.3.12 Each Scheduled Ancient Monument in the Zone of Influence area was visited during the walkover survey and the view from each site was recorded and noted in relation to the SWEP. The potential impact of the SWEP and its associated construction works on the setting of each Scheduled Ancient Monument was also assessed and has been fully reported in the visual and landscape impact assessment (see Section 12).

9.3.13 Sites initially identified by the desk based assessment were visited to evaluate the potential impact of the proposed works. The survey area was also examined to identify any further sites of archaeological significance not previously recorded. Both new and known sites were identified during the walkover survey and every site identified by the desk based assessment was identified and checked.

9.3.14 Each site identified was assigned an individual site number, plotted on a map (see Figure 9-1) and described. The full survey report is provided on the enclosed CD.

Marine environment

9.3.15 As detailed above, side-scan sonar data obtained by Aspect Land and Hydrographic Surveys (Aspect, 2006) was used to assist the assessment of potential effects on marine archaeological heritage.

Significance criteria

9.3.16 The significance criteria employed for this section is based on the general methodology defined in Section 5.3. The importance attributed to each onshore archaeological site has been determined using the criteria outlines in Table 9.2 below. The criteria incorporate general guidelines as described in NPPG 5 – Archaeology and Planning and it's companion PAN 42 Archaeology – the Planning Process and Scheduled Monument Procedures.

Table 9.2 Definitions of importance of archaeological sites

Level of importance	Criteria
High	Archaeological sites of national importance, Category A Listed Buildings, World Heritage Sites, Scheduled Ancient Monuments.
Medium	Sites of regional importance, Category B Listed Buildings.
Low	Locally important sites, other sites (e.g. findspots), Category C Listed Buildings

9.3.17 The magnitude of any adverse impact on an archaeological site caused by the development proposals, prior to final mitigation, was determined using the criteria below in Table 9.3.

Table 9.3 Definitions of magnitude of impact

Level of impact	Criteria
High	Groundbreaking works would result in the loss of an area, features or evidence fundamental to the historic character and integrity of the site. Severance would result in the complete loss of physical integrity.
Medium	Groundbreaking works would result in the loss of an important part of the site or some important features and evidence, but not areas or features fundamental to its historic character and integrity. Severance would affect the integrity of the site, but key physical relationships would not be lost.
Low	Groundbreaking works or the severance of the site would not affect the main features of the site. The historic integrity of the site would not be significantly affected.
Negligible	Groundbreaking works or the severance of the site would be confined to a relatively small, peripheral and/or unimportant part of the site. The integrity of the site, or the quality of the surviving evidence would not be affected.

9.3.18 The sensitivity and magnitude of the potential effect are combined to determine the significant effect, as shown in Table 9.4. Those criteria in red text are considered significant under the EIA regulations.

Table 9.4 Effect significance matrix

Magnitude of physical impact	Archaeological importance		
	High	**Medium**	**Low**
High	**Major**	**Major**	**Major**
Medium	**Major**	**Major**	Minor
Low	**Major**	Minor	Minor
Negligible	Minor	None	None

Pre assessment to identify worst case design options

9.3.19 It was not deemed necessary to define the worst case scenario for the cultural heritage assessment, but more appropriate to assess the entire physical footprint of the development.

9.4 Baseline description

Introduction

9.4.1 The Western Isles are one of the oldest islands in the world and have several excellent examples of structures dating from 3000BC. It is well known that the Western Isles are famous for their rich and varied history and contain many archaeological and historical sites that appeal to both the specialist and to the general tourist. Among the archaeological remains and historic attractions include prehistoric forts, wheel houses, chambered cairns, monoliths, stone circles, churches and ecclesiastical ruins (The Outer Hebrides Handbook and Guidebook, 1995). The Isle of Lewis is renowned for having a number of prime examples of stone circles, the most famous being the Callanish Stones located 15 miles west from Stornoway overlooking Loch Roag. Located within a few miles of Callanish is a first class example of a well preserved Iron Age Broch, Dun Carloway; its purpose believed to have been a defence/lookout tower estimated to be over 2000 years old.

9.4.2 Located on the outskirts of Siadar near to the village of Baile an Truiseil is the impressive monolith Clach an Truseil dating back to the late Bronze Age. Clach an Truseil is Scotland's tallest standing stone towering some 5.7 m. Its true function is not known, but it is thought that it may have served as an astronomical or religious function. Four historical sites are located within Siadar village; Steinacleit, Teampall Pheadair, Tobar Anndrais and Clach Stein (The Outer Hebrides Handbook and Guidebook, 1995). Steinacleit is an ancient chambered cairn dating back approximately to 3000-1500BC located at the south end of Loch an Duin. An array of boulders is all that marks the site. Slightly north of Steinacleit is Clach Stein, a fragmented tomb that is made up of 10 vertical slabs surrounding a burial chamber. Teampall Pheadair is located onshore at Mol Eire, Siadar and was scheduled in 1992. All that remains is a grass covered rectangular mound where once a 12th century chapel and small medieval settlement is thought to have stood. This site is identified on the 1st edition map (1853), where it is described as an old burying place with the site of a place of worship. It is upwards of a hundred years since anyone was buried here. Tobar Anndrais is located east of Teampall Pheadair and has been described as one of the most important wells in the Western Isles due to its healing waters. The well is no longer in use and is presently filled with stones.

Terrestrial environment

9.4.3 The proposed development area has been considered as three separate areas (A-D) (see Figure 9-1).

9.4.4 Area A is comprised of dry heath/acid grassland head cliffs and marsh/marshy grassland along the coast with semi-improved grassland further inland. Land use in Area A is dominated by fenced croft land used for grazing and coastal erosion is particularly evident at the cliffs near the Scheduled Ancient Monument of Teampall Pheadair and at Rubha Bhlanisgaidh. Area A begins near to Cladach Lag na Greine at the coast and extends out continuing south to Upper Siadar Road and continues west to the north end of Mol Eire, where the shingle beach meets the track along the cliff top. The only proposed SWEP activity likely to occur in this area is the potential construction of the onshore control building located on the boundary between Areas A and D.

9.4.5 The majority of Area B is comprised of unimproved boggy heath. There is evidence of relict peat cutting, possible field walls, stony subsoil and several slabs recorded during the walkover, having the potential to be a part of a prehistoric landscape below the peat. The number of archaeological remains in the area is less dense compared with Areas A, D and C. Area B begins at Loch Dubh na h-Airde and continues south near to Loch Sminig and south easterly to the A857 Stornoway-Ness main road. From here the Area B boundary continues north westerly before meeting up with Area C. The proposed SWEP activities likely to occur is the installation of a borrow pit located approximately 1.5 km west from Teampall Pheadair and between 0.45 and 1 km from Clach an Truiseil and the access track. The access track is proposed to start just off the main A857 Stornoway to Ness road continuing North west towards the borrow pit and continuing into Area C to the Clach an Truiseil road.

9.4.6 Rocky cliffs in Area C are subject to strong south-westerly gales and high wave action during the winter months and coastal erosion is clearly evident between Geodha Ruadh and Siorrabhig. Area C comprises of a mixture of land uses, including fenced croft land, improved grassland and flooded land currently used for grazing. North of the fenced croft land Area C starts where Area D ends and continues south westerly passing Clach an Truiseil located approximately 50 m outside the survey perimeter. The Area C boundary heads north westerly, back towards the coast before extending westerly past Loch Dubh na h-Airde en route for the coast. The only proposed SWEP activity likely to occur is a new track running from the proposed borrow pit (Area B) through Area C avoiding any cultural heritage sites in close proximity meeting the Clach an Truiseil road and the new access track will combine with an existing track in Area D leading down to the proposed construction site.

9.4.7 Area D encompasses the bays and shingle banks of Siorrabhaig and Mol Eire. South east of Mol Eire is Loch Fideach, west of the loch has undergone considerable disturbance during the installation of pipes, drains and a treatment tank. North east of the River Siadar (runs through the middle of Area D) and south east of Loch Fideach the land is classified as croft land and is unsuitable for development. North west of the River Siadar the land comprises of unimproved boggy land. Area D begins where Area A ends (Upper Siadar Road) extends further out and round. Area D ends west of the River Siadar and runs down to the coast (roughly the centre of Siadar Bay). Proposed SWEP activities likely to occur in Area D is the construction site which is estimated to be located approximately 0.5-0.8 km away from Teampall Pheadair, situated behind the shingle bank at Mol Eire in an area already housing pipes and access tracks and a new slipway. The land here has already undergone low-key intrusive works during sewage pipe installation.

Site descriptions

9.4.8 A range of cultural heritage sites have been identified by both the desk-based assessment and the walkover survey, reflecting activity in the landscape around Siadar from the Neolithic and Iron Age, to the pre-crofting and crofting era. A total of 66 cultural heritage sites have been identified throughout four areas described above (Areas A – D).

9.4.9 Area A is densely populated with cultural heritage sites with the majority associated with the medieval and post-medieval settlements in the Siadar area. These include at Cuibhatotar, Siadar Iorach, Teampall Pheadair and Lambol burn. Iron Age activity has also found to be within this area near to Teampall Pheadair. Land use in the area is generally croft land and grazing. Coastal erosion is clearly evident at Area A and is threatening the cliff line below Teampall Pheadair and Rubha Bhlanisgaidh. All cultural sites recorded in Area A are presented in Table 9.5.

9.4.10 Area A contains both locally and nationally important sites. All national importance sites are located primarily along the coast with local importance sites located more inland. Teampall Pheadair is the only Scheduled Ancient Monument located in Area A.

Table 9.5 Summary list of sites in Area A and their importance

Site number	Coordinates	Description	Importance	SMR	NMRS
SABS 1	NB 38055 55351	Possible enclosure	Local	6531	NB35NE
SABS 2	NB38068 55360-38034 55312	Accreting erosion	-	-	-
SABS 3	NB 38013 55329	Accreting erosion	-	-	-
SABS 4	NB38007 55320	Accreting erosion	-	-	-
SABS 5	NB 37996 55286	Enclosure wall	Local	-	-
SABS 6	NB 37951 55258 NB 37968 55265	Cuibhatotair possible robbed structures/walls	Local	6530	NB35NE

Site number	Coordinates	Description	Importance	SMR	NMRS
SABS 7	NB 37951 55258	Possible structure	Local	6530	NB35NE
SABS 8	NB 37935 55257 / 37924 55330	Accreting erosion	Local	-	-
SABS 9	NB 37944 55193	Eroded structure	Local	6529	NB35NE
SABS 10	NB 37893 55152 (SABS)	Eroded/cleared structure	Local	6528	NB35NE
SABS 11	NB 37893 55152 NB 37931 55133 (SABS)	Stone and turf wall	Local	6528	NB35NE
SABS 12	NB 37927 55097	Enclosure	Local	6527	NB35NE
SABS 13	NB 3793 5497 NB 37978 54858 – NB 37953 54955 (SABS)	Rubha Bhlanisgaidh, structure, midden, settlement	National – within Scheduled Area	308	NB35SE 11
SABS 14	NB 37980 54958 (SABS)	Teampall Pheadair stone and turf field wall	National – within Scheduled Area	307	NB35SE 10
SABS 15	Centred on NB 38052 54959	Ruins on 1st edition map	National – within Scheduled Area	-	-
SABS 16	S end NB 37974 54956 – N end NB 37978 54977	Teampall Pheadair stone and turf field wall	National – within Scheduled Area	307	NB35SE 10
SABS 17	S end NB 37974 54956 – N end NB 37978 54977	Teampall Pheadair, Rubha Bhlanisgaidh enclosure/structure	National – within Scheduled Area	307, 308	NB35SE 10 NB35SE 11
SABS 18	W end NB 37957 54957	Teampall Pheadair edge of wall or terrace	National – within Scheduled Area	307	NB35SE 10
SABS 19	NB 37957 54957	Teampall Pheadair possible curvilinear structure	National – within Scheduled Area	307, 308	NB35SE 10, NB35SE 11
SABS 20	NB 3792 5499 NB 37943 54989 (SABS)	Teampall Pheadair, church & enclosure, Scheduled Ancient Monument no. 5341	National – within Scheduled Area	307	NB35SE 10
SABS 21	S end NB 37948 54969 to N end NB 37940 54981	Enclosure wall south of Teampall Pheadair	National – within Scheduled Area	307	NB35SE 10
SABS 22	S end NB 37937 54985 to N end NB 37930 55023	Enclosure wall north of Teampall Pheadair	National – within Scheduled Area	307	NB35SE 10
SABS 23	W end at NB 37951 54983	Enclosure wall east of Teampall Pheadair	National – within Scheduled Area	307	NB35SE 10
SABS 24	NB 37958 55008	Ruined building north east of Teampall Pheadair	National – within Scheduled Area	307	NB35SE 10
SABS 48	NB 38120 54900	Ruins	Local	3152	NB35SE 31
SABS 49	NB 38118 54854	Ruin & enclosure	Local	3152	NB35SE 31

Site number	Coordinates	Description	Importance	SMR	NMRS
SABS 50	NB 38113 54842	Field wall	Local	3152	NB35SE 31
SABS 51	NB 38146 54842	Field wall	Local	3152	NB35SE 31
SABS 57	NB 38120 55220	Tobar Aindreas, Holy well	Local	304	NB35NE 1
SABS 58	NB 38100 55200	Na h-Annaidhean, Ecclesiastical place name	Local	306	NB35NE 3
SABS 59	NB 38230 55140	Midden	Local	305	NB35NE 2
SABS 60	From NB 391 554 to 3790 550	Siadar pre-crofting settlements	Local	3986	NB35NE 4
SABS 61	NB 3823 5491	Possible mill	Local	3153	NB35SE 32
SABS 62	NB 38266 54923	Enclosure	Local	-	-
SABS 63	NB 3831 5492	Possible mill	Local	3167	NB35SE 47
SABS 64	NB 3837 5493	Possible mill	Local	3166	NB35SE 46
SABS 65	NB 38474 54960 (SABS)	Site of possible structure	Local	-	-
SABS 66	NB 3841 5494	Building	Local	3165	NB35SE 45

9.4.11 Area B is less densely covered in archaeological remains, with only nine cultural heritage sites identified. However, the potential for nationally important prehistoric sites below the peat is high. All the cultural heritage sites identified in this area are situated along the east and west sides of the proposed access track route, and to the south of Buaile Bhonnachaidh and listed in Table 9.6.

9.4.12 Area B contains only locally important sites and the majority of the sites are located in the south and are in close proximity of the A857 Stornoway to Ness road.

Table 9.6 Summary list of sites in Area B and their importance

Site number	Coordinates	Description	Importance	SMR	NMRS
SABS 25	NB 37618 53236	Possible field wall	Local	-	-
SABS 26	NB 37587 53229	Turf & stone building	Local	-	-
SABS 27	NB 37572 53205	Possible stone alignment	Local	-	-
SABS 28	NB 37572 53248	Possible stone alignment	Local	-	-
SABS 29	NB 37390 53404	Mound or possible structure	Local	-	-
SABS 30	NB 37348 53575	Modern quarry & dump	-	-	-
SABS 31	NB 37220 53470	Shielings on 1st ed (1853)	Local	3145	NB35SE 24
SABS 32	NB 37137 53495	Old peat track	Local	-	-
SABS 33	NB 36661 53445	Area of possible settlement	Local	-	-
SABS 67	NB 3717 5335	Stone setting; platform	Local	-	NB35SE 65

9.4.13 In Area C, the majority of the cultural heritage sites identified are associated with the remains of old pre-crofting settlement and enclosures along the coast and inland, south to Allt a' Ghearraidh and Feadan Siorrabhig. Coastal erosion is clearly evident between Geodha Ruadh and Siorrabhig and is accreting at a considerable rate. The Scheduled Ancient Monument of Clach an Truiseil is located just outside the Area C boundary (50 m) at Baile an Truiseil.

9.4.14 Area C contains locally important sites only (see Table 9.7).

Table 9.7 Summary list of sites in Area C and their importance

Site number	Coordinates	Description	Importance	SMR	NMRS
SABS 34	NB 36567 54089	Possible eroded structure	Local	-	-
SABS 35	NB 36866 54202 to NB 36840 54275 (SABS)	Field wall shown on 1st edition map (1853)	Local	6524	NB35SE
SABS 36	NB 3700 5415	Farmstead shown on 1st edition map (1853)	Local	3157	NB35SE 36
SABS 36a	NB 36891 54069	Eroded structure	Local	3157	NB35SE 36
SABS 36b	NB 36878 54082	Possible eroded structure	Local	3157	NB35SE 36
SABS 36c	NB 36990 54090	Eroded structure/house site	Local	3157	NB35SE 36
SABS 36d	NB 37025 54081	Enclosure walls	Local	3157	NB35SE 36
SABS 36e	Centred on NB 36966 54170	Relict field wall shown on 1st edition map (1853)	Local	3157	NB35SE 36
SABS 36f	NB 36966 54170	House site or mound	Local	3157	NB35SE 36
SABS 36g	NB 36966 54170	Relict field wall	Local	3157	NB35SE 36
SABS 36h	NB 36998 54235	Enclosure wall	Local	3157	NB35SE 36
SABS 36i	NB 37113 54163	Field enclosure wall	Local	3157	NB35SE 36
SABS 36j	NB 37113 54163	Site of black house	Local	3157	NB35SE 36
SABS 37	NB 36896 54294	Bog iron slag? Eroding from section	Local	-	-
SABS 38	NB 36908 54286	Mill	Local	-	-
SABS 39	NB 37113 54153	Eroded structure	Local	-	-
SABS 40	NB 37129 54083	Mound-possible structure	Local	-	-
SABS 41	From NB 37297 53828	Baile an Truiseil township	Local	-	-
SABS 42	NB 37379 53713	Baile an Truseil pile of stones	Local	-	-
SABS 43	NB 37464 53756	Baile an Truiseil township: ruined black house and enclosure	Local	-	-
SABS 44-45	NB 37453 54109 (SABS)	Baile an Truiseil township	Local	-	-

Site number	Coordinates	Description	Importance	SMR	NMRS
SABS 46	NB 37473 54424	Field wall	Local	-	-
SABS 47	NB 37507 54252	Possible eroded prehistoric features	Local	-	-

9.4.15 Six cultural heritage sites were identified in Area D, located either on the coast east of Siorrabhaig or on the banks of the River Siadar. A stone circle is also located further inland from the river. No cultural heritage sites have been identified to the north west of the river where the land is classified as unimproved boggy moorland. There is however potential for sites in this area due to the prehistoric features and pre-crofting settlement remains located nearby.

9.4.16 Area D contains locally important sites only (see Table 9.8).

Table 9.8 Summary list of sites in Area D and their importance

Site number	Coordinates	Description	Importance	SMR	NMRS
SABS 52	NB 37520 54510	Enclosures	Local	3155	NB35SE 24
SABS 53	NB 37474 54445	Possible eroded structure	Local	-	-
SABS 54	NB 38030 54400	Mill	Local	3154	NB35SE 33
SABS 55	NB 37904 54391	Possible eroded structure	Local	-	-
SABS 56	NB 38007 54437	Structure or pond, mill	Local	3154	NB35SE 33
SABS 68	NB 3803 5433	Stone circle (possible	Local	-	NB35SE 63

Marine environment

9.4.17 The interpretation of the sidescan sonar data by Headland Archaeology concludes that there are no significant wreck remains or associated debris, prehistoric features or deposits of cultural heritage interest that are likely to be impacted upon from the SWEP. However, due to the nature of the area and the dense kelp coverage across the survey area has affected the quality of the results recorded (Campbell, 2006). Smaller structures or features may not have been picked up and therefore gone unnoticed. Due to the harsh, exposed conditions of the Atlantic Ocean experienced at the west coast of Lewis has meant long-term survival of wrecks and remains in the area is minimal. Despite this, fragments of ship remains, structures, artefacts and prehistoric deposits may have migrated into natural crevices in the seabed.

9.4.18 From the RCAHMS database a number of wrecks are located along the west coast of Lewis but none are present in the Siadar area.

9.5 Assessment of effects and mitigation

9.5.1 As the design and location of the onshore components of the SWEP project are yet to be finalised, the approach to the assessment of the potential effects upon cultural heritage has been based on a sensitivity audit, encompassing all known and potential cultural heritage receptors which could be conceivably affected by the project as currently defined. The assessment has considered the potential effects upon the cultural heritage in and surrounding the proposed project development area. The assessment has considered both direct e.g. physical disturbance and/or removal, and indirect e.g. effects on landscape and visual setting.

Terrestrial environment

9.5.2 The potential effects and their significance have been determined according to the methodology previously defined. Effects have been considered on an area by area basis, as described above.

<u>Area A</u>

9.5.3 This area is densely populated with cultural heritage sites, the majority of which are associated with the medieval and post-medieval settlements in the Siadar area, at Cuibhatotar, Siadar Iorach, Teampall Pheadair and Lambol Burn. There are also indications of earlier, Iron Age occupation in the area, as evidenced from the eroding middens in the cliff line below Teampall Pheadair. Most of Area A is now under fenced croft land and is still in use for grazing. The coastline is accreting at a considerable rate, and the cliff line below the SAM of Teampall Pheadair, at Rubha Bhlanisgaidh, is under particular threat.

9.5.4 The only potential aspects of the project located in area A are the onshore control building, the shore connection, a fixed link and upgrade of the existing slip. The locations of these aspects of the project do not directly impact any of the identified cultural heritage sites.

9.5.5 Should the location of any of the above change direct effects on cultural heritage interests will be avoided wherever possible and the site specific mitigations detailed in Table 9.9 implemented.

9.5.6 There is the potential for the proposed breakwater development to protect this part of the coastline from further erosion, and to therefore have a positive impact on the cultural heritage in Area A.

Table 9.9 Area A impact assessment and mitigation summary

Site number	Coordinates	Description	Importance	Potential impact	Significance of impact	Mitigation
SABS 1	NB 38055	Possible enclosure	Low	High	Major	Avoidance

Site number	Coordinates	Description	Importance	Potential impact	Significance of impact	Mitigation
	55351					
SABS 2	NB38068 55360- 38034 55312	Accreting erosion	-	-	-	Potential positive impact
SABS 3	NB 38013 55329	Accreting erosion	-	-	-	Potential positive impact
SABS 4	NB38007 55320	Accreting erosion	-	-	-	Potential positive impact
SABS 5	NB 37996 55286	Enclosure wall	Low	High	Major	Avoidance
SABS 6	NB 37951 55258 NB 37968 55265	Cuibhatotair possible robbed structures/walls	Low	High	Major	Avoidance
SABS 7	NB 37951 55258	Possible structure	Low	High	Major	Avoidance
SABS 8	NB 37935 55257 / 37924 55330	Accreting erosion	Low	High	Major	Potential positive impact
SABS 9	NB 37944 55193	Eroded structure	Low	High	Major	Avoidance
SABS 10	NB 37893 55152 (SABS)	Eroded/cleared structure	Low	High	Major	Avoidance
SABS 11	NB 37893 55152 NB 37931 55133 (SABS)	Stone and turf wall	Low	High	Major	Avoidance
SABS 12	NB 37927 55097	Enclosure	Low	High	Major	Avoidance
SABS 13	NB 3793 5497 NB 37978 54858 –NB 37953 54955 (SABS)	Rubha Bhlanisgaidh, structure, midden, settlement	High	High	Major	Avoidance
SABS 14	NB 37980 54958 (SABS)	Teampall Pheadair stone and turf field wall	High	High	Major	Avoidance
SABS 15	Centred on NB 38052 54959	Ruins on 1st edition map	High	High	Major	Avoidance
SABS 16	S end NB 37974 54956 – N end NB 37978 54977	Teampall Pheadair stone and turf field wall	High	High	Major	Avoidance
SABS 17	S end NB 37974 54956	Teampall Pheadair, Rubha Bhlanisgaidh	High	High	Major	Avoidance

Site number	Coordinates	Description	Importance	Potential impact	Significance of impact	Mitigation
	– N end NB 37978 54977	enclosure/structure				
SABS 18	W end NB 37957 54957	Teampall Pheadair edge of wall or terrace	High	High	Major	Avoidance
SABS 19	NB 37957 54957	Teampall Pheadair possible curvilinear structure	High	High	Major	Avoidance
SABS 20	NB 3792 5499 NB 37943 54989 (SABS)	Teampall Pheadair, church & enclosure, Scheduled Ancient Monument no. 5341	High	High	Major	Avoidance
SABS 21	S end NB 37948 54969 to N end NB 37940 54981	Enclosure wall south of Teampall Pheadair	High	High	Major	Avoidance
SABS 22	S end NB 37937 54985 to N end NB 37930 55023	Enclosure wall north of Teampall Pheadair	High	High	Major	Avoidance
SABS 23	W end at NB 37951 54983	Enclosure wall east of Teampall Pheadair	High	High	Major	Avoidance
SABS 24	NB 37958 55008	Ruined building north east of Teampall Pheadair	High	High	Major	Avoidance
SABS 48	NB 38120 54900	Ruins	Low	High	Major	Avoidance
SABS 49	NB 38118 54854	Ruin & enclosure	Low	High	Major	Avoidance
SABS 50	NB 38113 54842	Field wall	Low	High	Major	Avoidance
SABS 51	NB 38146 54842	Field wall	Low	High	Major	Avoidance
SABS 57	NB 38120 55220	Tobar Aindreas, Holy well	Low	High	Major	Avoidance
SABS 58	NB 38100 55200	Na h-Annaidhean, Ecclesiastical place name	Low	High	Major	Avoidance
SABS 59	NB 38230 55140	Midden	Low	High	Major	Avoidance
SABS 60	From NB 391 554 to 3790 550	Siadar pre-crofting settlements	Low	High	Major	Avoidance
SABS 61	NB 3823 5491	Possible mill	Low	High	Major	Avoidance
SABS 62	NB 38266 54923	Enclosure	Low	High	Major	Avoidance
SABS 63	NB 3831 5492	Possible mill	Low	High	Major	Avoidance
SABS 64	NB 3837 5493	Possible mill	Low	High	Major	Avoidance

Site number	Coordinates	Description	Importance	Potential impact	Significance of impact	Mitigation
SABS 65	NB 38474 54960 (SABS)	Site of possible structure	Low	High	Major	Avoidance
SABS 66	NB 3841 5494	Building	Low	High	Major	Avoidance

Area B

9.5.7 Area B is less densely covered in archaeological remains, with only nine cultural heritage sites identified, sites 25-33. However, the potential for nationally important prehistoric sites below the peat is high. The majority of this area is unimproved boggy heath, with evidence of relict peat cutting, possible field walls and old shieling sites. Where the peat has been cut and then the surface of the subsoil has been eroded, recumbent slabs were noted during the walkover, and have also been recorded in the NMRS, demonstrating a high potential for prehistoric features below the peat.

9.5.8 None of the cultural heritage sites located in area B will be directly impacted by the present proposed borrow pit location or borrow pit access track.

9.5.9 However, due to the high potential for prehistoric sites below the peat in this area, it is recommended that if any stripping of the peat in this area is to be undertaken, including that of the proposed access track, the area should be subject to an archaeological evaluation of a percentage of the overall area, so as to assess the likelihood of archaeological remains in the area to be affected by the development.

9.5.10 It is also recommended that those areas where sites have already been recorded should the location of the borrow pit and access track change all area where sites have already been recorded be avoided, except the old peat track site 32 and possible field wall, site 25 which could only be partially affected due to their extensive nature and for which watching briefs are recommended (see Table 9.10).

9.5.11 The exception to this is the modern quarry (site 30) on the edge of survey area, for which no mitigation is necessary. This site has already been excavated and disturbed by quarrying and the building of a track.

Table 9.10 Area B impact assessment and mitigation summary

Site number	Coordinates	Description	Importance	Potential impact	Significance of impact	Mitigation
SABS 25	NB 37618 53236	Possible field wall	Low	High	Major	Watching brief
SABS 26	NB 37587 53229	Turf & stone building	Low	High	Major	Avoidance
SABS 27	NB 37572 53205	Possible stone alignment	Low	High	Major	Avoidance
SABS 28	NB 37572 53248	Possible stone alignment	Low	High	Major	Avoidance
SABS 29	NB 37390 53404	Mound or possible structure	Low	High	Major	Avoidance
SABS 30	NB 37348 53575	Modern quarry & dump	Low	Negligible	None	None
SABS 31	NB 37220 53470	Shielings on 1st ed (1853)	Low	High	Major	Avoidance
SABS 32	NB 37137 53495	Old peat track	Low	High	Major	Watching brief
SABS 33	NB 36661 53445	Area of possible settlement	Low	High	Major	Avoidance
SABS 67	NB 3717 5335	Stone setting; platform	Low	High	Major	Avoidance

Area C

9.5.12 This area comprises improved grassland, and the majority of the cultural heritage sites identified – sites 34-47, are associated with the remains of old pre-crofting settlement and enclosures along the coast and inland, south to Allt a'Ghearraidh and Feadan Siorrabhig. Some of the remains are recorded on the 1st edition map (1853), although they are not as well preserved as those in Area A. The tops of the rocky cliffs along the coastline are denuded and between Geodha Ruadh and Siorrabhig the coastal erosion is accreting at a considerable rate. The south east part of the area is under fenced croft land, and the cleared or eroded remains of pre-crofting and crofting settlement can be seen in the crofts south of Siorrabhig at Baile an Truiseil. The SAM of Clach an Truiseil is just over 50 m outside the edge of the survey area at Baile an Truiseil.

9.5.13 The present proposed project layout, borrow pit access track and the south west section of the onshore construction compound do not directly impact any of the identified cultural heritage sites in area C.

9.5.14 The construction compound will potentially impact site 46, a field wall and site 47 a potential prehistoric stone setting. However the eastern end of area C has already been disturbed due to the digging of drains and improvement of the access track to the Scottish Water treatment works in recent years. Therefore, establishment of the construction compound does not need to avoid impact on these two sites, however the area should be subject to more detailed archaeological evaluation so as to further assess the likelihood of archaeological remains in the area to be affected by the development.

Table 9.11 Area C impact assessment and mitigation summary

Site number	Coordinates	Description	Importance	Potential impact	Significance of impact	Mitigation
SABS 34	NB 36567 54089	Possible eroded structure	Low	High	Major	Avoidance
SABS 35	NB 36866 54202 to NB 36840 54275 (SABS)	Field wall shown on 1st edition map (1853)	Low	High	Major	Avoidance
SABS 36	NB 3700 5415	Farmstead shown on 1st edition map (1853)	Low	High	Major	Avoidance
SABS 36a	NB 36891 54069	Eroded structure	Low	High	Major	Avoidance
SABS 36b	NB 36878 54082	Possible eroded structure	Low	High	Major	Avoidance
SABS 36c	NB 36990 54090	Eroded structure/house site	Low	High	Major	Avoidance
SABS 36d	NB 37025 54081	Enclosure walls	Low	High	Major	Avoidance
SABS 36e	Centred on NB 36966 54170	Relict field wall shown on 1st edition map (1853)	Low	High	Major	Avoidance
SABS 36f	NB 36966 54170	House site or mound	Low	High	Major	Avoidance
SABS 36g	NB 36966 54170	Relict field wall	Low	High	Major	Avoidance
SABS 36h	NB 36998 54235	Enclosure wall	Low	High	Major	Avoidance
SABS 36i	NB 37113 54163	Field enclosure wall	Low	High	Major	Avoidance
SABS 36j	NB 37113 54163	Site of black house	Low	High	Major	Avoidance
SABS 37	NB 36896 54294	Bog iron slag? Eroding from section	Low	High	Major	Avoidance
SABS 38	NB 36908 54286	Mill	Low	High	Major	Avoidance
SABS 39	NB 37113 54153	Eroded structure	Low	High	Major	Avoidance
SABS 40	NB 37129 54083	Mound-possible structure	Low	High	Major	Avoidance

Site number	Coordinates	Description	Importance	Potential impact	Significance of impact	Mitigation
SABS 41	From NB 37297 53828	Baile an Truiseil township	Low	High	Major	Avoidance
SABS 42	NB 37379 53713	Baile an Truseil pile of stones	Low	High	Major	Avoidance
SABS 43	NB 37464 53756	Baile an Truiseil township: ruined black house and enclosure	Low	High	Major	Avoidance
SABS 44-45	NB 37453 54109 (SABS)	Baile an Truiseil township	Low	High	Major	Avoidance
SABS 46	NB 37473 54424	Field wall	Low	High	Major	Evaluation
SABS 47	NB 37507 54252	Possible eroded prehistoric features	Low	High	Major	Evaluation

<u>Area D</u>

9.5.15 This area encompasses the shingle banks at Siorrabhaig and Mol Eire, the low eroding coastline between, and the low-lying land behind Mol Eire and Loch Fideach. On this west side of this area there has been considerable disturbance in the past from the insertion of drains and sewerage pipes, and more recently, a new water treatment tank and track.

9.5.16 Two sites of cultural heritage importance are located within the proposed onshore construction compound, the enclosures at site 52 and possible eroded structure at site 53. Direct impact on these sites will be avoided by fencing them off within the proposed construction compound.

9.5.17 However, the area to the north west of the river comprises unimproved, boggy land, and no cultural heritage sites were identified in this part of the area. The presence of possible prehistoric features and pre-crofting settlement remains nearby (sites 46 and 47 in Area C, sites 52, 53 and 68 in Area D) and a second possible stone circle outside the survey area (NB35SE 62) demonstrate a potential for sites in this area. The area should be subject to an archaeological evaluation, so as to assess the likelihood of archaeological remains in the area to be affected by any development in this area (see Table 9.12).

Table 9.12 Area D impact assessment and mitigation summary

Site number	Coordinates	Description	Importance	Potential impact	Significance of impact	Mitigation
SABS 52	NB 37520 54510	Enclosures	Low	High	Major	Evaluation
SABS 53	NB 37474 54445	Possible eroded structure	Low	High	Major	Evaluation
SABS 54	NB 38030 54400	Mill	Low	High	Major	Avoidance
SABS 55	NB 37904 54391	Possible eroded structure	Low	High	Major	Avoidance
SABS 56	NB 38007 54437	Structure or pond, mill	Low	High	Major	Avoidance
SABS 68	NB 3803 5433	Stone circle (possible	Low	High	Major	Evaluation

9.6 Mitigation strategy

Terrestrial environment

9.6.1 The overall mitigation strategy will be based on the assumption that all internationally and nationally important archaeology remains will be preserved in situ and that all potential direct effects on such remains are avoided by sensitive design and implementation of the construction, operation, maintenance and decommissioning elements of the project. For all other remains a programme of detailed evaluation and survey will be carried out, in the instances where detailed design indicates a direct impact. This will allow the quantification of the exact scope of the overall mitigation response and also provide additional data on the archaeological resource of Lewis.

9.6.2 Ultimately the mitigation methods outlined above will form a staged approach in response to the level of importance a receptor and the impact of the proposed works on that receptor. The ultimate mitigation for the onshore areas may take the form of a combination of preservation in situ (by means of mitigation/avoidance by design) and archaeological excavation and/or watching brief (which achieves 'preservation by record').

9.6.3 The final mitigation and monitoring approach will be agreed through discussion with and the Western Isles county archaeologist.

9.6.4 Activities associated with the construction phase of the project and the long term presence of a new breakwater and onshore control building could also have an impact on the historic environment, such as the settings of historic buildings. This has been fully assessed as part of the landscape and visual impact assessment (see Section 12).

Marine environment

9.6.5 It is proposed that during ROV surveys of the seabed area any observations of potential cultural heritage effects will be recorded and communicated to the Western Isles archaeologist to ascertain their significance and establish any mitigation that might be required.

9.7 Cumulative effects

9.7.1 There are no other existing or known future developments in the area that could result in a cumulative direct effects on terrestrial or marine cultural heritage in the Siadar area.

9.7.2 In terms of the potential cumulative effects from the possible construction of the AMEC wind farms there could be cumulative effects on the historic setting of the area. This has been addressed in Section 12.

9.8 Summary and Conclusions

9.8.1 In summary it is concluded that the installation or construction of the onshore components of the SWEP project (included potential effects from vibration) has the potential to have a major effect were they to impact on these known and potential unknown features of cultural heritage significance. However it is considered that the mitigation programmes set out above for each of the distinct survey areas will reduce the effects on the onshore cultural heritage to a **minor** significance.

9.8.2 It should also be noted that there is a potential positive impact from the construction of the breakwater in that it will reduce the energy of the waves presently impacting the headland at the north end of the bay and provide protection to the presently eroding coastline.

9.8.3 Based on the baseline environmental information available, the review of side scan sonar data available for Siadar Bay and the consultation undertaken as part of the EIA, it is concluded that on the information available to date, there are no sizeable (> 5 m) structures / features likely to be of cultural heritage interest in the subtidal marine environment of Siadar Bay that will be impacted by the proposed project.

9.8.4 However due to the nature of the survey area and dense kelp coverage across the subtidal area, smaller structures and artefacts or features may well have been obscured. In addition the nature of the coastline and the seabed represent a dynamic natural environment where the long term survival of wreck remains is negligible. Furthermore, the survival of remains – such as deposits – of the now inundated relict prehistoric landscape is also negligible (Smith, 1997). Despite this, fragments of ship remains, structures, artefacts and prehistoric deposits may have migrated into the natural crevices and gullies in the bedrock seabed.

9.8.5 Observations of any potential marine cultural heritage interests will be recorded and communicated to the Western Isles county archaeologist to ascertain their significance and establish any mitigation that might be required.

10 Coastal Processes

10.1 Introduction

10.1.1 The following section investigates the effects that the proposed SWEP will have on the coastal processes in the Siadar Bay. The assessment includes the effects on offshore hydrodynamic processes and the prevailing coastal processes at the shoreline. This section shall address all aspects of the project offshore and along the shoreline and consider these from construction through to the operation and into the decommissioning phase.

10.1.2 The coastal environment in the vicinity of the proposed breakwater must be assessed in order to ascertain the potential effects on wave climate, erodability of the coastline and other factors by the construction and operation of the breakwater.

10.2 Methodology

Scoping and consultation

10.2.1 The work carried out for the EIA involved understanding the bay and geomorphological features and how they might respond to changes by empirical observation as well as research into works already carried out on the study area. To assess the potential changes in the prevailing features, numeric modelling of the wave climate was carried out. After much review and consultation it was decided that numerical sediment modelling was not appropriate.

10.2.2 Consultation in relation to coastal processes has been undertaken with the bodies listed below (Table 10.1). The issues detailed in the table include those raised in the Scoping Opinion.

Table 10.1 Consultees and their key concerns

Name of organisation	Key concerns	Comment
Scottish Environment Protection Agency (SEPA)	The need (or otherwise) to model sediment transport in the area.	SEPA agreed with Mott MacDonald that sediment transport modelling was not necessary due to the sediment poor nature of the area.
	Effect of the causeway - The development with no causeway or with a piled structure would be preferable as it would reduce the development footprint and minimise the effects on the wave climate.	No final design decision made on the presence or absence of a causeway and all potential options require consent.
	Presence of the outfall.	Should a slipway be constructed at the southern end of Siadar Bay the outfall may need to be extended from its present position.
Scottish Natural Heritage (SNH)	Presence of geological GCR sites to the north of the site.	Attention was drawn to the presence of the site and the assessment has considered the potential

Name of organisation	Key concerns	Comment
		effects on the GCR sites.
	Effect on adjacent surfing breaks.	There is a possible affect of edge waves affecting the adjacent surf breaks. Was considered a "theoretical possibility as opposed to a medium to high risk".
Scottish Water	The water from the storm water outfall into Siadar Bay may become impounded due to the presence of a causeway constructed at the southern end of Siadar Bay.	The tidal wash of the bay aids effluent dispersion and sand deposition.
		It is likely that the outfall pipe will be directly impacted but can be protected in terms of likely traffic, while at the same time a suitable access point may be left for Scottish water
Local Surfing Interest. Represented by Derek MacLeod of Hebsurf	The presence of the breakwater could lose breaks in the Siadar Bay or adjacent areas	The break in Siadar Bay only 'works' in with a south-westerly swell and the surf is not of particularly high quality compared to the other local breaks which also work under those conditions.

Desk study

10.2.3 Coastal changes to date; the existing coastline; and the prevailing forcing factors on the shoreline were assessed using the following sources of information:

- Geological maps and memoirs;
- Aerial photographs;
- Siadar Wave Resource Assessment (RPS 2006)

Sortie	Frames	Scale	Date
CPE/Scot/UK 186	1220, 1221, 1222, 1223	1:10000	09.10.1946
OS/67/118	303, 304, 305	1:10000	30.05.1967
OS/69/397	009, 010	1:15000	01.08.1969
OS/85/049	100, 101	1:13000	11.05.1985
ASS 60589	034, 035	1:24000	04.04.1989
OS/99/262B	032, 033, 034	1:7800	28.07.1999
OS/01/070	151, 152, 153	1:12600	09.05.2001

- Historic maps (Ordnance Survey); and

Map number	Scale	Survey year	Publication year
NB 37 55	1:2500	1971	1972
NB 37 55	1:2500	1971	1972
NB 35 SE	1:10000	1971	1974
NB 35 SE	1:10000	1971	1974
NB 38 55	1:2500	1990	1990
NB 38 54	1:2500	1990	1990

- Published studies such as 'The Beaches of Scotland' (Ritchie and Mather, 1984) and 'The Coastal Cells of Scotland' (HR Wallingford, 2000).

10.2.4 The research shows that the bay is generally dynamically stable with minimal sediment transport within the pocket bay. The research has aided the assessment of the environmental impact of the proposed breakwater.

Sediment modelling

10.2.5 Sediment modelling has not been carried out as part of this EIA because there are believed to be few likely effects on sediment motions in the area.

10.2.6 The hydrographic survey carried out on behalf of npower renewables by Aspect (surveyed 23rd June 2006) also showed little sediment present at the time of the surveying. Walkover surveys by Mott MacDonald coastal geologists and geomorphologists also confirmed that there appeared to be little mobile sediment in the bay system. The bay is dominated by the outcropping rock which forms the wave cut platform and north cliff frontage. The sediments present in the bay system are mainly cobble to boulder size (with some gravel) and thus of low mobility and are only likely to be moved during a storm event.

10.2.7 Following research into the dynamics of the coast it became apparent that there was little sediment involved in littoral processes along the shore. Mott MacDonald discussed their approach with the Scottish Environmental Protection Agency (SEPA) and Scottish Natural Heritage (SNH) and their representatives; Alistair Rennie and Mark MacDonald respectively, agreed that sediment modelling would be unnecessary in this sediment-poor coastal environment.

Wave modelling

10.2.8 To ascertain the potential effects of the breakwater structure on the Siadar Bay and adjacent area computational wave modelling was undertaken. Three main scenarios were modelled, which included: the base case (i.e. natural conditions); with the breakwater only; and with the breakwater and fixed link.

10.2.9 The incident waves were modelled at angles of 300˚, 315˚ and 330˚ and at heights of 1 m and 3 m. The wave heights chosen for the modelling (1 m and 3 m) reflect wave conditions that are experienced frequently and a 3 m wave height that occurs about 10% of the time (Draper, 1991). Modelling of more extreme events leads to increased uncertainties as to how the system may respond.

10.2.10 Bathymetry was obtained from the Aspect survey completed in June 2006. The bathymetry of the bay gently shelves to 15 m depth. The seabed gradient appears to steepen slightly below 15 m depth. The proposed breakwater shall be built at about 5 m depth.

10.2.11 Mike 21 modelling software was used to for the wave modelling. The majority of the modelling was carried out with Elliptical Mild Slope (EMS) and a small number of models were conducted using the Boussinesq Method (BW). The methods are very similar, both take account of depth limitation, refraction, reflection etc. The main difference between the methods is that the BW method has a random directional wave while the EMS is a regular uni-directional wave. Thus the incoming EMS waves always originate from the same direction while the BW waves have a random spread 15˚ each side of the main wave generation direction. The BW modelled waves are closer to the natural case as incoming waves will have some directional spread.

10.2.12 Three orientations for the incidence of incoming waves have been modelled (300˚, 315˚ and 330°). The three orientations reflect the most frequent and naturally occurring inshore waves at the breakwater location (see baseline description).

10.2.13 The models were run with a water level to represent mean high water springs (MHWS) as this is the most severe tidal condition which will commonly be experienced. The wave models were run up to water depths of -1 m model datum (i.e. -1 m from MHWS). Wave heights inshore of this point were extended by a linear translation. No surge effects were modelled.

10.2.14 The modelling carried out considered the impact of a straight breakwater.

10.2.15 The scenarios modelled allowed the comparison between the current, natural condition and when the breakwater may be present. The effect of a fixed link was also assessed. The wave modelling supported understanding changes to wave climate in the area owing to the breakwater, including assessing any shelter benefit which may be provided by the breakwater to the slipway structure (locally called 'the pier') which is used periodically to launch small craft for leisure.

10.2.16 Figure 3-4 (Section 3) illustrates the breakwater position for which modelling was undertaken. The red box illustrates the range of positions over which the breakwater could be located. It should also be noted that the inclusion of a fixed link between the shore and breakwater is also still optional.

10.2.17 Additionally, 3 dimensional computer animated models of the project in situ under certain incident wave conditions were produced. These show the effect of the breakwater and fixed link structure on 1m waves from a direction of 315 degrees. The animations are contained on the enclosed CD.

Field survey

10.2.18 A field visit was conducted on the 17th and 18th of July 2007 relating to the coastal geology of the area. During this visit the geomorphology of the area was appraised.

Significance criteria

10.2.19 The significance criteria employed for this section is based on the general methodology defined in Section 5.3.

10.2.20 The sensitivity and magnitude are defined in Table 10.2 and Table 10.3 below.

Table 10.2 Definition of sensitivity of effect

Sensitivity	Definition
Very high	A very sensitive area with active long-shore sediment transport and an erosion-prone coastal edge subject to non-recoverable change. Has the potential to be adversely affected in the long-term.
High	A sensitive area with little long-shore sediment transport. The coastline is erosion-prone and could be subject to non-recoverable change.
Medium	Areas of medium sensitivity are less likely to suffer from non-recoverable change than sensitive areas, however non-recoverable change is possible.
Low	Areas of low sensitivity are robust and will not be prone no non-recoverable change and degradation even in the event of a change to the wave climate. A slowly eroding coastline formed of hard rock or coast with little mobile or predominantly coarse material.
Negligible	A very slowly eroding or insensitive shoreline such as a hard rock cliff with few structural weaknesses which slowly erodes. A sediment poor littoral zone.

Table 10.3 Definition of magnitude / frequency of effect

Magnitude	Definition
Very major	An effect which is manifest by a very large change in the coastal system such as the prevention of littoral drift, alteration of the wave climate in a certain area or the long-term

	change of a large section of shoreline leading to large scale erosion or accretion.
Major	A major alteration of the baseline coastal system such as coastal inundation, the long term modification of the prevailing wave climate or littoral drift patterns or other large changes in the erosion or accretion of the coast.
Moderate	Change to local sediment drift patterns and coastal cliff recession resulting in a slight increase in localised erosion.
Minor	Small, localised change to the wave climate, littoral drift patterns, and coastal cliff recession.
Negligible	Very localised effects which do not change the rate of recession of the coastal edge or lead to disturbances in the prevailing littoral drift and wave climate.

10.2.21 The sensitivity and magnitude of the potential effect are combined to define the significance of the effect, as shown in Table 10.4. Those criteria in red text are the residual effects considered significant under the EIA regulations

Table 10.4 Effect significance matrix

Magnitude	Sensitivity				
	Very high	High	Medium	Low	Negligible
Very major	**Major**	**Major**	**Major**	**Moderate**	Minor
Major	**Major**	**Major**	**Moderate**	Minor	Insignificant
Moderate	**Major**	**Moderate**	**Moderate**	Minor	Insignificant
Minor	**Moderate**	Minor	Minor	Insignificant	Insignificant
Negligible	Minor	Insignificant	Insignificant	Insignificant	Insignificant

Pre assessment to identify worst case design options

10.2.22 Given the large range of potential effects, all design options have been considered, rather than identifying a specific worst case option.

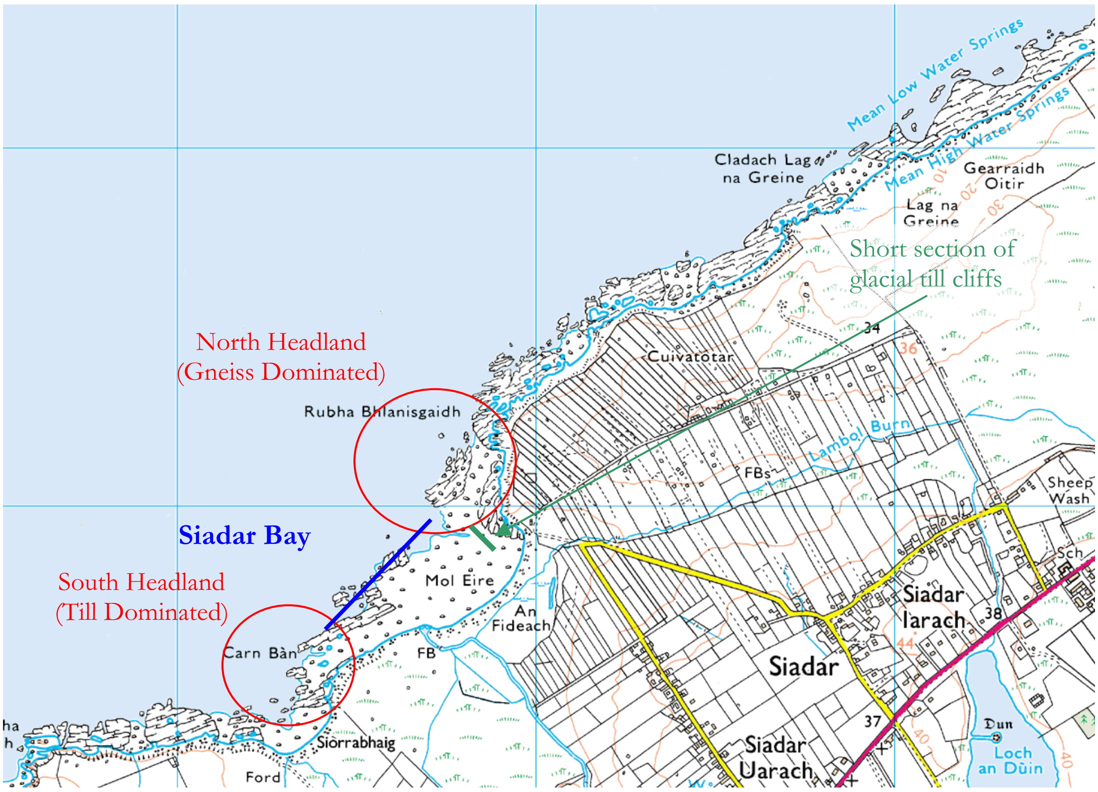
10.3 Baseline description

Coastal baseline

10.3.1 The north west coast of the Isle of Lewis is characterised by a number of small embayment's in the northeast-southwest trending coastline.

10.3.2 The area of interest for this study is shown in Figure 10-1. The main area of our investigation is Siadar Bay, bounded by two headlands. The bay is dominated by hard rock cliffs to the north which supplies large boulders and cobbles to the foreshore and a gneissic wave cut platform. The southern portion of the bay and south headland are formed of glacial till material. The main bay is characterised by a low shingle bank which divides the cobble beach from the low marshy hinterland. The shingle bank locally has patchy vegetation on its crest and seaward side which assists in part to stabilise the bank.

Figure 10-1 Area under investigation for coastal issues (Ordnance Survey Mapping, Crown Copyright Reserved. Licence No AL 549428)



Coastal geology

10.3.3 The majority of the coastline of the Outer Hebrides is dominated by Precambrian rocks, which are over 540 million years old. The Isle of Lewis itself is largely formed of Lewisian Gneiss, which in some areas is overlain by younger deposits (British Geological Survey, 1992).

10.3.4 Glacial till dominates some of the low cliffs to the south of the bay (see Figure 10-1) and the low cliffs immediately north of the slipway. The height of the till cliffs is variable, but they are generally lower than 2 m high. The till is a poorly sorted, matrix supported glacial deposit with angular to sub-rounded clasts of gneiss material.

10.3.5 Headlands formed of Lewisian Gneiss show persistent jointing which acts as a control mechanism for the formation of the headlands. Weathered blocks dominate the shoreline close to the north headland (see Figure 10-1). The beach material is predominantly boulder, cobble and gravel material with occasional sand grade material.

Geomorphology

10.3.6 The bay has a pronounced cobble ridge which has been named the 'shingle bank' elsewhere in the ES but is predominantly formed of cobble grade material. The 'shingle bank' feature runs along the top of the beach above the extent of high tide. On the leeward side the cobbles and shingle are vegetated. The shingle bank provides a high point between the sea and the hinterland. A stream runs along the back of the beach behind the shingle bank until it reaches the sea, part of the stream has penetrated the mid point of the shingle bank.

10.3.7 A geomorphological map of the Siadar Bay was produced following survey work on the 17th and 18th July 2007 and is presented in Figure 10-2.

10.3.8 The majority of beach material is cobbles and gravels of Lewisian gneiss. The beaches close to the cliffed frontage to the north are dominated by sub-angular boulders from the cliffed frontage. A number of deeply incised geos dominate the cliffs, where the gneiss protrudes onto the beach in the form of fingers of inclined rock which run perpendicular to the cliff edge in many places. Further south towards the main bay the grade of beach sediment becomes finer, with cobbles being dominant in the shingle bank.

Bathymetry

10.3.9 The bathymetry of the bay gently shelves to a 15 m depth. The seabed gradient appears to steepen slightly below the 15 m water depth. 2 D and 3D bathymetric views of the bay are presented in Figures 10-3 and 10-4.

Figure 10-3 Bathymetry 2D view (Mott MacDonald, 2007)

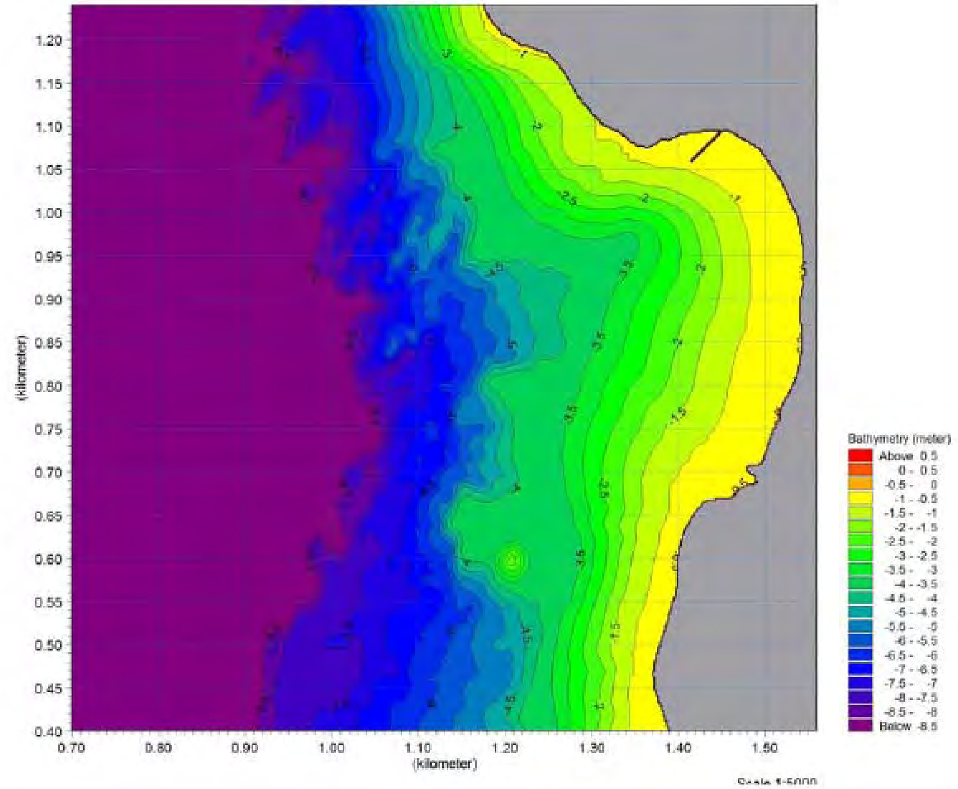
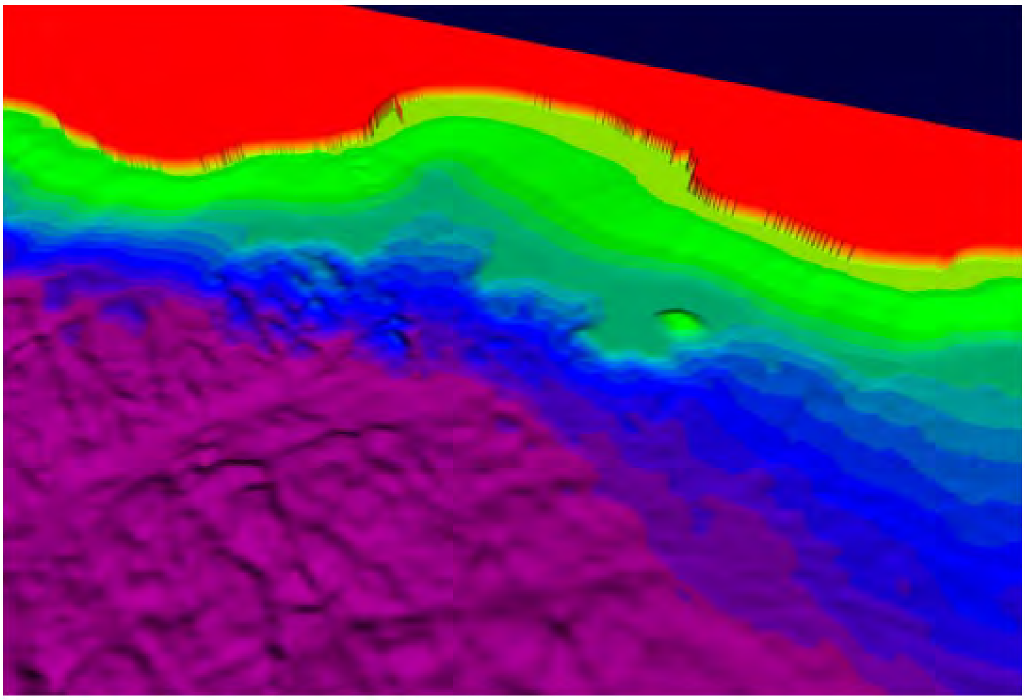


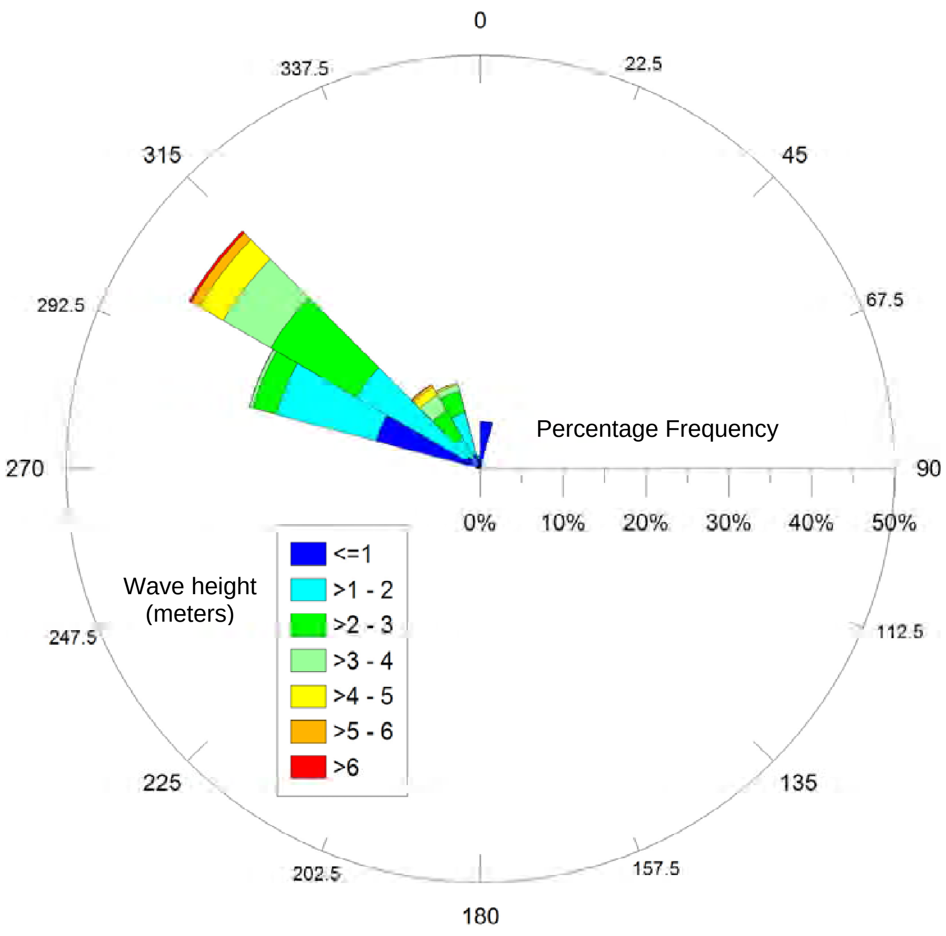
Figure 10-4 Bathymetry 3D view (Mott MacDonald, 2007)



Wave climate and tidal regime

10.3.10 The wave climate of this area is severe due to the exposed position, and is prone to the full force of Atlantic storms. The energy coming inshore via waves is also high, leading to the bay's favourable conditions for the development of the active breakwater. For 10 % of the year the wave heights offshore of Siadar exceed 3 m (Draper, 1991). The wave rose illustrated in Figure 10-5 Shows the direction and height of incident waves at a point 60 m north east of Siadar Bay (close to the location of the proposed breakwater) (RPS, 2006).

Figure 10-5 Wave rose showing direction and height of incident waves at point 600 m north east of Siadar Bay (RPS, 2006)



10.3.11 Refraction and diffraction processes control offshore waves from the south west and west in their original orientations, but are forced round to more north westerly orientations by the topography and bathymetry of the area.

10.3.12 Waves in the bay are depth limited as there is effectively unlimited fetch for swell formation across the Atlantic in many incident wave directions.

10.3.13 Carloway (15 miles south west of Siadar) has a neap tidal range of 1.6 m and a spring tidal range of 3.6 m (HR Wallingford, 2000). The flood tide runs south-west to north-east and the ebb tide runs in the opposite direction. The tidal currents are low velocity (HR Wallingford, 2000).

Sediment transport

10.3.14 The offshore seabed sediments to the west of Lewis are thin and dominated by gravels (JNCC, 1997) which are only moved under storm wave conditions when the environment is energetic enough to transport large grade material.

10.3.15 The bay is considered to have its own sediment system and be bypassed by any drift that may occur offshore. It is also considered that the waters to the west of the Outer Hebrides are supplied by little sediment from onshore or tidal currents (JNCC, 1997). The west coast of the Outer Hebrides is generally sediment poor.

10.3.16 The sources of 'fresh' sediment are limited to eroded and re-worked glacial deposits (HR Wallingford, 2000). In the case of Siadar Bay the sediment supply would be likely to originate from the erosion of local glacial deposits such as the headland to the south of the main bay and from the till plateaux mantling the Lewisian Gniess headlands to the north (see Figure 10-1).

Geological conservation designations

10.3.17 There are no Special Sites of Scientific Interest (SSSIs) or Joint Nature Conservation Committee (JNCC) sites in Siadar Bay. There is a JNCC Geological Conservation Review site for the 'Quaternary of Scotland' on the north west coast of Lewis (Gordon and Sutherland, 1993) but this does not extend to Siadar Bay and it is anticipated that the breakwater will have negligible impact on the JNCC site. The issue of enhancing or maintaining the conservation of a geological resource has no relevance to the coastal setting within the study area.

10.4 Assessment of effects and mitigation – construction phase

Potential effects and mitigation

10.4.1 The design is sufficiently developed so that the general location of the structure and its dimensions are known. The construction method has been considered and a number of options exist: the main option, which will have a marked difference on the environmental effects, is the presence or absence of a fixed link and the composition/make-up of this link i.e. rubble causeway and/or steel truss bridge.

10.4.2 The potential construction phase effects are shown in Table 10.6 below.

Table 10.6 Potential coastal effects of the construction phase

Event	Predicted impact	Significance	Mitigation measures	Residual significance
Local construction of caissons and other onshore works				
Establishment of caisson construction site on south side of the bay	The coastal edge/cliff may become degraded by people and or plant moving over the cliffed edge.	Moderate	Construct a 10 m landward buffer zone from the coastal edge to preserve safety and minimise the impact on the cliff. Construct appropriate walkways for personnel and plant to use when getting to the beach.	**Minor**
Launch of caissons from slipway	A crane is proposed for caisson transit.	Moderate	The crane should be positioned outside of the 10 m buffer zone landward of the cliff or employ appropriate foundations.	**Minor**
Increased run off from the site	An increase of water in the stream and potentially erosion of the till cliff.	Moderate	Ensure that appropriate drainage is installed during site construction.	**Insignificant**
Cabling to shore	Armour sleeving may cause a slight change in hydrodynamics and navigability.	Minor	Embedded the cabling in the fixed link or bridged structure where appropriate. If a fixed link is not used the cabling shall be placed on the seabed with protective armour sleeves.	**Insignificant**
Cabling from the shoreline to the control building	Cabling across the shore could result in trenching in the till cliffs resulting in instability and disturbance of the beach deposits.	Moderate	The cabling should aim to minimise the disturbance of the till cliffs and have minimal impact on the cliff face.	**Minor**
Construction of the breakwater structure				
Excavation or preparation of seabed	The structure will need to be placed on a level seabed which may require the blasting of rock or the removal of superficial deposits, or placement of fill.	Minor	Where appropriate will be used for infill Beneficial if blasted rock remains in the bay area as a source of sediment for the future as through time it will become cobble grade and may nourish the shingle ridge	**Insignificant**
Construction of fixed link				
Construction of rock armour fixed link or trussed bridge on the south headland, with a glacial till base.				
Transport of	Transit over the coastal	Moderate	Set up a 10 m buffer zone	**Minor**

Event	Predicted impact	Significance	Mitigation measures	Residual significance
construction materials	edge will lead to erosion of the cliff edge		landward of the cliffs. An access slope to the beach could be constructed to minimise the impact on the cliffs.	
Construction of rock armour fixed link or trussed bridge on the north headland, with a Lewisian Gneiss base.				
Landward construction	Disturbance of the Lewisian Gneiss is unlikely to cause erosion, however care should be taken of the till cliffs to the north of the existing jetty	Minor	The till cliffs should be protected during construction.	**Insignificant**
Transit of construction materials	The transit of materials to a north fixed link is likely to affect the low lying marshy land on the shoreline (at the base of the existing slipway), resulting in increased erosion potential and sediment run off.	Moderate	A hardstanding should be created at the base of the current pier to ensure that the area is not eroded. Appropriate drainage should also be installed.	**Minor**
Culverting access to be provided along the shingle bank at the top of the beach. This access is required as an option, as it would facilitate construction of the fixed link if positioned towards the north end of Siadar Bay	The installation of culverting may destabilise the cobble bank reducing the protection to the hinterland	Moderate	Minimise the effect of the culverting works by ensuring that the shingle bank is protected by putting an agreed working methodology in place which would include limits of work, the maximum plant allowed on the shingle bank, and details on the reconstruction of the shingle bank to its previous position and profile. It shall be vital to protect the shingle bank material and shingle bank vegetation.	**Minor**
	Plant moving along the shingle bank with materials for the breakwater and fixed link may cause de-vegetation and destabilisation	Major	Construct trackways for the plant that can be removed from the shingle bank following construction. This will establish the route for plant carrying material. Safe guard the vegetation. Ensure that the	**Minor**

Event	Predicted impact	Significance	Mitigation measures	Residual significance
			shingle bank is re-profiled where appropriate.	
Construction of slipway on south side of the bay				
Construction of a new slipway on the till cliffs	Construction may lead to destabilisation of the coastal edge.	Major	Digging into the cliff face should be avoided and a coastal buffer zone maintained.	**Minor**
Construction of slipway on north side of the bay to augment or replace the current 'pier'				
Refurbishment of old slipway/'pier'	The presence of the existing slipway will mean that the pressures on the area are minimal	Minor	Ensure the stability of the till cliffs by putting a coastal buffer zone in place.	**Insignificant**

Residual effect

10.4.3 With the appropriate monitoring protocols and avoidance of major disturbance to the till cliff and shingle bank the effect rating is considered to be minor.

10.5 Assessment of effects and mitigation – operational phase

Potential effects and mitigation

Diffraction and reflection

10.5.1 Reflection processes lead to increased wave heights offshore away from the breakwater structure in all models run. The sea conditions are therefore typically 'worse' offshore in the model than if the breakwater was not there at all, due to reflected waves. However, the model does not take into account of the anticipated operating behaviour of the structure. During operation of the energy conversion devices in the breakwater typically 65% of the inceident wave energy will be absorbed and therefore only 35% of the incident wave energy will be reflected. This means that the sea conditions offshore from the breakwater will not be as increased as modelling predicts, the modelling having assumed that 100% of the incident wave energy is reflected. The model presents a 'worst-case'.

10.5.2 Diffraction results in the wave crests wrapping around the breakwater edges and the waves decaying as they enter the sheltered zone. The diffraction around the breakwater edges is localised, affecting the margins of the sheltered zone.

10.5.3 In the model runs both diffraction and reflection of incoming waves are observed. Diffraction leads to a change in wave height 'gradient' at the edges of the breakwater, while reflection induces an increase in wave height away from the breakwater structure in the direction of incoming waves, due to wave-wave interaction. It appears that the reflection by the straight breakwater generates waves of greater height offshore. For example, for an incident wave 1 m high from 315˚ north results in reflection and 1.4 m wave heights, whereas for the basecase the wave heights do not exceed 1.2 m in the same area (300 m offshore from the breakwater). However, the incident wave conditions presented are perpendicular to the breakwater, thus represent a 'worst-case'; other incident wave conditions will have varying effects. This also does not take account of the absorption of wave energy by the breakwater. The diffraction and reflection effects of the breakwater described here can be observed in the 3D computer animations contained in the enclosed CD.

Wave climate effects on coastal morphology

10.5.4 The northern headland of Siadar Bay is controlled by the geological structure of the Lewisian Gneiss. The change in wave climate is unlikely to affect this hard rock. Where the Lewisian Gneiss is overlain by glacial till deposits there may be local potential for increased erosion, but is not considered significant in the overall nature of the coastal retreat.

10.5.5 The till dominated south headland may be eroded by incoming waves; potentially changing the form of the bay system. However, the wave modelling appears to show a calming of the wave climate around the southern till cliffs for incoming waves perpendicular to the breakwater (315˚ north) (Figures 10-6 and 10-7).

Figure 10-6 Wave disturbance study - base case (Mott MacDonald, 2007)

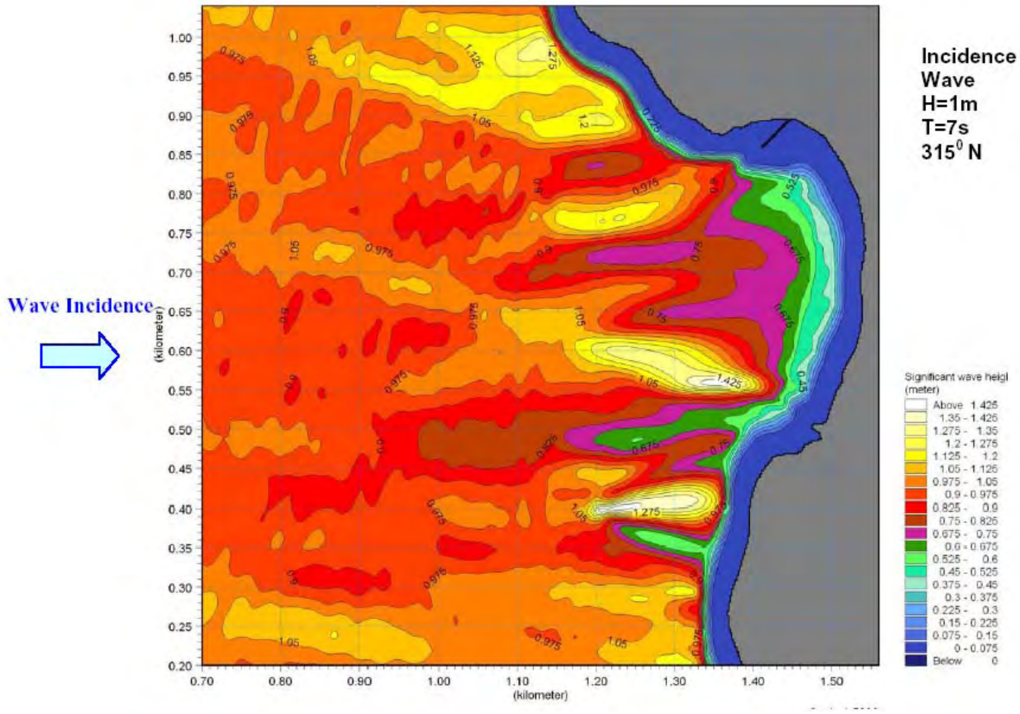
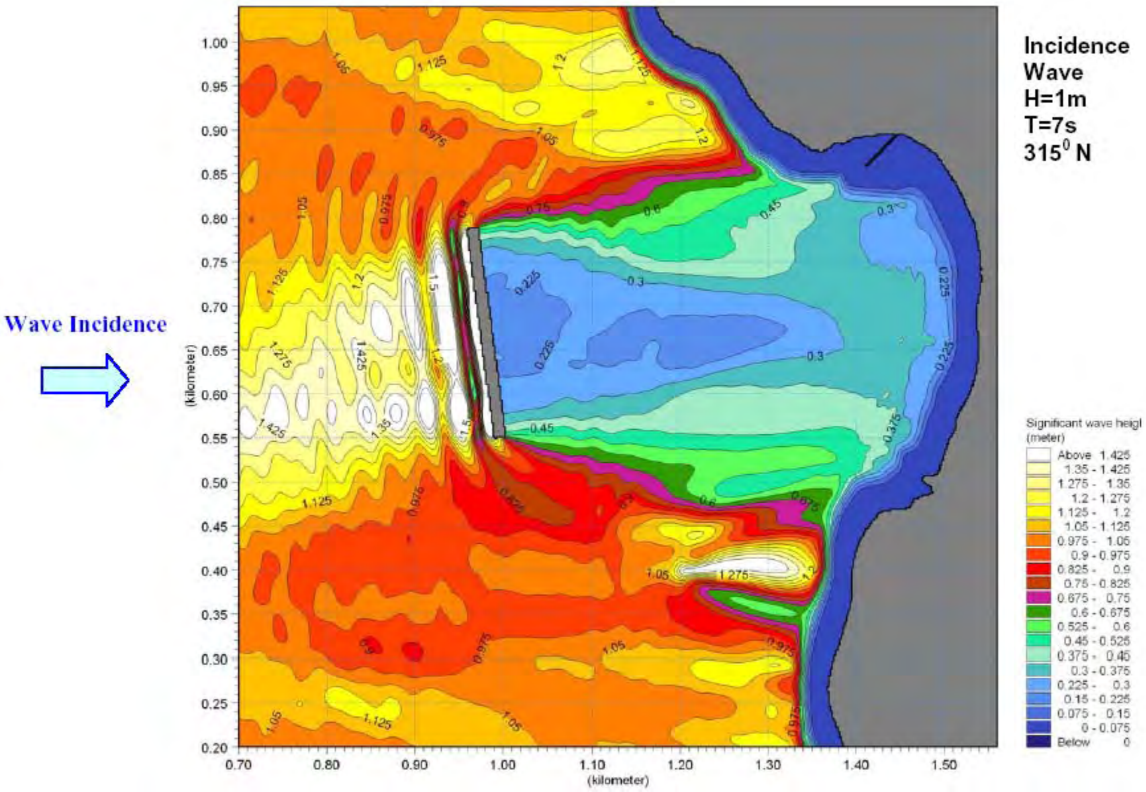


Figure 10-7 Wave disturbance study, new breakwater scenario (Mott MacDonald, 2007)



10.5.6 The shingle bank is in a dynamic equilibrium with the prevalent forces such as the waves. The waves can erode and lower the shingle bank but they also act to maintain the profile and position of the bank. The construction of the breakwater will reduce the wave energy reaching the beach. This may lead to the shingle bank achieving a shallower angle or becoming over-vegetated due to the reduction in disturbance to the shingle bank by waves. If the shingle bank becomes over-vegetated it is unlikely to have a particularly adverse effect on the bank, but it is probable that the shingle bank could loose its character. The impact is anticipated to be **minor**.

Sheltering effects

10.5.7 The breakwater contributes to create a sheltered zone on its leeward side to the coastline. Within that area, for the 1 m incident wave modelled, the wave height does not exceed 0.5 m (see Figure 10-7 and 10-8) whereas for the 'Base Case' (i.e. no breakwater) wave heights of 1.4 m are observed less than 150 m from the shore (see Figure 10-6). Indeed, in the 'Base Case Scenario' wave heights become greater when approaching the shoreline, which is related to the local decrease in water depth (see Bathymetry in Figure 10-3 and 10-4).

10.5.8 It is evident from the modelling that the straight breakwater proposed by npower renewables offers a sheltered zone in the pier area (see Figure 10-7) with a decrease in wave height and a decrease in the gradients of wave heights leaving the sheltered zone. The maximum wave height in the pier area is predicted as 0.5 m while the waves are closer to 1 m in the base case (for an incident wave height of 1 m). Such a scenario is considered to be relevant for typical swell wave orientations encountered. The impact is judged to be **major**.

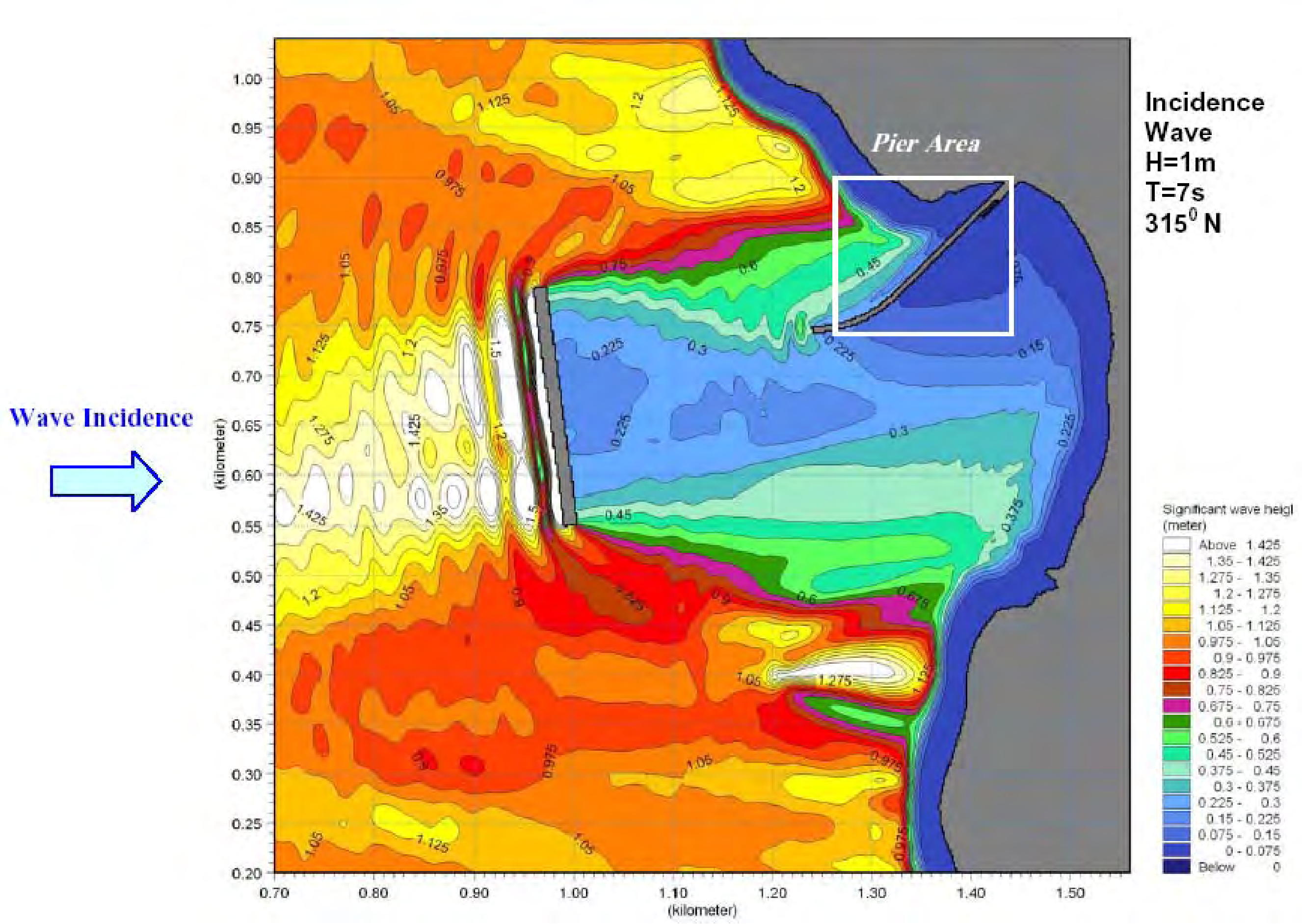
Fixed link

10.5.9 The presence of the breakwater with a fixed link (see Figure 10-8) leads to a slight change in wave regime by the fixed link (see white rectangle in Figure 10-8), likely to be due to wave reflection from the fixed link structure for the case presented. There is a similar effect for other cases considered. The effect of a part length rubble mound causeway fixed link can be seen in the 3D computer animation contained on the enclosed CD. The impact is judged to be **minor**.

Slipway

10.5.10 No wave modelling was carried out to assess the effect of a possible replacement slipway in the south of the bay on the wave climate. As such the slipway would only be likely to affect conditions very close to the shore where the waves are severely depth limited. The impact is judged to be **insignificant**.

Figure 10-8 Wave disturbance study – new breakwater and fixed link scenario (Mott MacDonald, 2007)



Potential effects and mitigation – summary table

10.5.11 The operational phase is considered here to be 50 years as it is expected that the structure will remain operational for a 50 year timescale (see Table 10.7).

Table 10.7 Predicted effects of the operational phase

Event	Predicted impact	Significance	Mitigation measures	Residual significance
Operation of the breakwater structure				
Change in sediment dynamics	There is little mobile sediment in the area but cobbles and shingle may impact the structure during storm conditions and may settle in the calmer water	Minor	This is unlikely to have a large effect on the bay, especially if a permeable means of access (such as the bridge or by boat) is used.	**Insignificant**

Event	Predicted impact	Significance	Mitigation measures	Residual significance
Change in the tidal regime.	Prevailing tidal forces may lead to funnelling of water between the breakwater and the shoreline. The funnelling of the tidal flows may lead to an increase in velocities and thus may cause scour.	Moderate	Scour is unlikely to occur as the tidal velocities are generally low in the area and the wave cut platform is gneiss dominated. Sediments are unlikely to be moved due to their coarseness. The most vulnerable area would be the southern headland. Tidal flows will be less of an issue if a permeable fixed link is used.	**Insignificant**
Change in wave climate	The breakwater is anticipated to provide shelter to the coastline but increase the severity of the wave climate offshore due to reflection.	Minor	Reflection could be countered by the placement of rock armour or the re- profiling of the seaward caisson face, this is unlikely to be appropriate as it would affect the energy generation potential.	**Minor**
Use of the pier	The shelter benefit in the lee of the breakwater is considered to assist the launching of craft from the slipway. However, craft launched from the pier and needing to exit from the sheltered zone would have to go from the side with no breakwater or bridge in all conditions.	Minor	The central section of the bridge will be at a height of +8.6 m CD. This should give at clearance under the bridge of between 4.4 m and 8.0 m allowing sufficient clearance form small boats and vessels.	**Insignificant**
	However leaving the shelter of the breakwater through the refracted waves may be onerous.	Minor	Ensure that people using the breakwater are informed of the potential change in wave conditions offshore	**Insignificant**

Event	Predicted impact	Significance	Mitigation measures	Residual significance
Use of the bay for Surfing	The local break in Siadar Bay will be lost due to the construction of the breakwater. The edge effects of the breakwater and the diffraction of the waves around the breakwater.	Minor	The break in Siadar Bay only worked under certain conditions and it was seen by local surfers consulted to not be as good as nearby breaks (identified as being ~3 km to the north and ~5 km to the south). The effect of the breakwater on breaks along the coast is likely to be minimal due to the enclosed nature of the bay and the local nature of the disturbance as observed from the wave modelling.	**Insignificant**
Erosion of the coastline	The erosion of the Siadar Bay is expected to slow due to the reduction in wave energy reaching the bay. The wave modelling does not give cause for concern in terms of reflection and refraction of incident waves which would not occur in the base case.	Minor	The maintenance of the scheme should include an active watch on any erosion which may occur in the bay	**Minor**
Erosion of the Geological Conservation Site (GCR)	The Site of Geological Conservation described as 'North West Coast of Lewis' (#1450) stops about 1 km north east of the Siadar Bay.	Moderate	Due to the enclosed nature of Siadar bay and the localised impact of the wave disturbance and sediment transport by the structure it is anticipated that there will be little impact on the GCR site	**Insignificant**
Operation of fixed link – i.e. rock armour fixed link, bridge or slipway.				
Effect on hydrodynamics	The construction of a rubble mound fixed link within the bay is likely to have a localised impact on hydrodynamics by preventing water flow through the bay	Moderate	Use a bridged or slipway solution if possible as this will have minimal effects on hydrodynamics.	**Minor**

Event	Predicted impact	Significance	Mitigation measures	Residual significance
Effect on Scottish Water Outfall	A fixed link may cause a reduction in tidal flushing of the bay resulting in an increase in the concentration of pollutants	Minor	Use of a bridged fixed link or slipway will maintain tidal flushing; alternatively the outfall could be extended so that it discharges outside of the shelter zone.	**Insignificant**
	The rubble mound causeway or caisson launch facility may be built over the existing outfall affecting its structure.	Moderate	Re-route the outfall or protect it during fixed link construction	**Insignificant**
Scour at the landward end of the fixed link, bridge or slipway	Scour is likely to be minimal where the fixed link will be founded on Lewisian Gneiss. Where the fixed link is founded on till an increase in erosion rate due to scour may be observed.	Moderate	Keep an active watch on the bay to ensure that any changes in erosive regime are recorded and responded to. If the till begins to erode rock armour or similar may need to be put in place	**Minor**
The use of a slipway if positioned in the south of the bay	The till cliffs may scour at the base of the slipway due to wave forces and the effect of the stream during spate.	Moderate	Maintain an active watch of the till cliffs. Possibly moving beach material up the beach toward the cliff if scour occurs to protect the cliff base.	**Minor**
Operation of onshore works				
Cabling	Any maintenance or replacement of the cabling may disturb the beach material and till	Minor	Minimise disturbance to the till as much as possible and ensure that beach material is replaced and re-profiled.	**Insignificant**
Increased footfall on the low till cliffs.	An increase in visitor numbers may result in an increase in people wishing to get onto the beach.	Minor	Keep an active watch on the condition of the till cliffs to ensure that increased visitor numbers is not leading to loss of vegetation and erosion of the bank. Sensitive areas, such as the till cliffs may need to be fenced off.	**Insignificant**

Residual effect

10.5.12 Siadar Bay is a largely insensitive coastal system given the predominance of Lewisian Gneiss on the foreshore and north cliffs, as well as the lack of mobile sediments in the coastal system. The change in wave climate may lead to localised erosion due to peripheral effects of the structures changing the foci of the wave energy to areas which have been relatively quiescent to date. However, the overall affect of the breakwater on wave climate will be to protect the bay. Assuming that the sensitive till cliffs and shingle bank are protected from any environmental pressures bought about by the more people visiting the site the residual effect of the operation phase is considered to be **minor**.

10.6 Assessment of effects and mitigation – decommissioning phase

10.6.1 The active breakwater structure is designed to have a minimum design life of 50 years. The decommissioning phase will involve the removal of the energy generating equipment from the caissons. The breakwater will remain in situ and will act as an artificial reef until it is broken down by the sea.

10.6.2 The breakwater may accrete surrounding cobbles or marine material in the very long term as a series of storms may lead to piling up of cobbles in the lee of the breakwater. The pattern of sediment transport beyond 50 years into the future may change because of greater erosion of the Western Isles coastline as a result of climate change and increased storminess. Predicting the effects of changes in the erosional and depositional regime beyond 50 years into the future is problematic. However, the presence of an impermeable access to the breakwater is likely to cause greater long term sediment issues than if a bridged or slipway access is used.

10.6.3 Sea level rise and an increase in storminess will mean that the breakwater is likely to provide less protection to the shoreline through time. Thus the structure will have less of an effect on the shoreline as sea level rises. Predicted sea level rises for Siadar are that a 50 year rise (to 2058) is predicted to be +285 mm. The calculations are based on Defra 2006 guidance, (which is generally accepted in Scotland). The presence of the breakwater and the minimisation of wave energy reaching the beach may mean that roll back and breaching of the shingle bank does not occur as quickly as it would in the natural state. However, increased natural pressures due to future sea level and storminess may lead to roll back of the shingle bank causing re-alignment of the bay and flooding of the hinterland.

10.6.4 Owing to the severity of storms in the area and the presence of cobbles within the bay it is likely that the breakwater may begin to be broken down by abrasion during severe events, causing concrete fragments to enter the system.

Residual effect

10.6.5 The decommissioning phase relates to the removal of the energy generation kit. However it is the long term presence of the structure in the bay and its breakdown which is relevant from the perspective of the coastal processes. Due to increases in storminess and sea level the breakwater will have a diminishing effect on the bay into the future. Thus the residual effect of the decommissioning phase is considered to be **insignificant**.

10.7 Cumulative effects

Construction phase

10.7.1 There are no other known projects which could result in a cumulative effect on the coastal dynamics of the Siadar Bay.

Operational phase

10.7.2 The operational phase of the project may have a detrimental effect if an increase in use of the area compromises the stability of the particularly sensitive areas, such as the till cliffs and shingle bank. Maintenance work on the structure or onshore facilities shall lead to increased access and egress from the slipway or causeway which could lead to erosion of the till cliffs and/or shingle bank. These factors may be detrimental but are anticipated to be of limited impact.

10.7.3 If large pieces of kit need to be replaced or repaired there may be a significant impact on the coastal system if the sensitive areas of Siadar Bay (till cliffs and shingle bank) are disturbed.

Decommissioning phase

10.7.4 The decommissioning phase is anticipated to have no cumulative effects in the area.

10.8 Summary and conclusions

10.8.1 The coastline of the study area is a rocky bay facing north-west. The foreshore is dominated by cobbles and boulders of gneiss, the dominant bedrock of the area. There is little sediment transport in the area owing to the lack of fine grained sediment offshore from the west coast of the Western Isles. The high energy environment and the coarseness of the sediment means that sediment movement is characterised by pulsed changes in response to low-frequency, high-magnitude events.

10.8.2 The breakwater structure shall result in the provision of a sheltered zone landward of the structure. This sheltered zone is likely to reduce the coastal erosion in the bay and provide some shelter to people wishing to launch craft from the slipway in the bay. Increased wave reflection and diffraction will affect the wave climate offshore. However, due to the strength of the gneissic wave cut platform the scour at the seaward side of the breakwater should be minimal.

10.8.3 A highly sensitive part of the bay is the glacial till cliffs. Where present they will need to be protected during construction and regular observations during site visits (involving the taking of pictures and measurements) made post-construction. The shingle bank is also a very important and sensitive part of the beach system as it provides natural protection to the hinterland. The construction pressures on the shingle bank should be minimised to reduce any potential destabilisation and crest lowering.

11 Onshore Noise

11.1 Introduction

11.1.1 This Section investigates the potential for noise and vibration impact on the surrounding environment as a result of the construction, operational and decommissioning phases of SWEP. The predicted effects have been assessed in the context of appropriate legislation and guidance and have been determined on the basis of recognised protocols.

11.1.2 The assessment methodology encompasses a number of stages, including baseline noise monitoring, computational modelling of effects, prediction of the likely effects on nearby noise sensitive receptors (NSRs) through analysis of relevant standards and guidelines, and to identify as necessary, appropriate mitigation measures requiring implementation. A NSR may be any dwelling house, hotel, hospital, educational establishment or any other place of high amenity that requires the absence of noise at nuisance levels for proper use.

11.1.3 The noise attributable to construction plant items is variable and largely dependent on usage. Construction noise will occur mainly through the use of large plant items such as lorries, compressors and excavators. Noise emissions can generally be controlled through the application of accepted industry practice, however, the noise levels generated by construction and decommissioning activities may retain the potential to affect nearby NSRs during some activities.

11.1.4 Key sources of operational noise for SWEP include the offshore operating turbines; the switchgear contained within the control building; and operational support vehicle movements. The noise levels produced by the SWEP turbines generally increase with rising incident wave energy levels. In addition, a correlation exists between the operational noise effects of the SWEP and the prevailing background noise conditions at nearby NSRs. Such a relationship means that in conditions where the highest noise levels are produced by the SWEP (i.e. as a result of increased incident wave energy levels), normal background noise conditions are also likely to be elevated. This effect is likely to suppress received SWEP generated noise levels at each NSR during these periods.

11.2 Legislative framework and regulatory context

11.2.1 The Scottish Government provides broad guidance and strategy in relation to the possible noise impact from new developments. These regulations are detailed in the documents specified below:

- Circular 10/1999: Planning and Noise;
- Planning Advice Note 56 (PAN 56): Planning and Noise;
- Planning Advice Note 45 (PAN 45): Renewable Energy Technologies;
- Planning Advice Note 58 (PAN 58): Environmental Impact Assessment;
- Planning Advice Note 50 (PAN 50) Annex A: The Control of Noise at Surface Mineral Workings;
- Control of Pollution Act, 1974 (CoPA); and,
- Environmental Protection Act, 1990 (EPA).

11.2.2 Circular 10/1999 acknowledges the role of planning authorities by stating:

"*…the planning system has a role to play in preventing and minimising the impact of noise through its influence over the location and design of new developments. It should aim to do this without placing unreasonable restrictions on development or adding unduly to the costs and administrative burdens of business*".

11.2.3 A number of recommendations are made in PAN 56 in relation to the control and prediction of noise. The guidance states that a noise impact assessment will assist planning authorities where developments could raise significant noise issues. The noise impact assessment should seek to:

"*Measure or predict and describe noise levels (including traffic noise) to be generated by the proposed development; or that the proposed development is to be subjected to criteria for assessing the impact of noise on its surroundings and outline measures available to reduce noise impact to acceptable levels*"

11.2.4 Further guidance from PAN 56 in relation to construction noise states:

"…Notice can be served in advance of works and site conditions set to control activities".

11.2.5 Guidance on the planning and assessment of renewable technologies is detailed in PAN 45. Reference is made to hydro and shore-line wave power developments, and recognition is given to measures that may be used to mitigate noise:

"The reduction / elimination of noise is [can be] achieved by use of appropriate materials in the construction of the turbine generators and aerodynamic designs that minimise noise generation".

11.2.6 PAN 58 identifies the need for a noise impact assessment to be carried out that includes consultation with planning authorities and consultees, where appropriate. The importance of the use of relevant indices and methods for noise assessment are noted in the guidance. The role of Annex A of PAN 50 is to:

"*…provide advice on how the planning system can be used to keep noise emissions from surface mineral workings within environmentally acceptable limits without imposing unreasonable burdens on minerals operators*".

11.2.7 The CoPA allows operating restrictions to be imposed by the Local Authority (Section 60) and for the developer to establish operating procedures in advance of site activities (Section 61). PAN 56 recommends the use of the CoPA and BS 5228 for the prediction of construction site noise.

11.2.8 A Local Authority has a duty to investigate a complaint of noise from vehicles, machinery or equipment under Part III of the EPA, as amended by the Noise and Statutory Nuisance Act 1993. An abatement notice will be served by the Local Authority if an environmental health officer is satisfied that a statutory nuisance has occurred.

11.2.9 In addition to Government guidance, the following British and international standards are applicable to the assessment of the SWEP:

- British Standard 4142 (BS 4142): Method for Rating Industrial Noise Affecting Mixed Residential and Industrial Areas;
- British Standard 5228 (BS 5228): Noise and Vibration Control on Construction and Open Sites;
- British Standard 6472 (BS 6472): Evaluation of Human Exposure to Vibration in Buildings;
- British Standard 7385 (BS 7385): Evaluation and Measurement for Vibration in Buildings;
- British Standard 7445 (BS 7445): Parts 1 - 3 - Description and Measurement of Environmental Noise;
- British Standard 8233 (BS 8233): Sound Insulation and Noise Reduction for Buildings – Code of Practice;
- ISO 9613: 'Acoustics – Attenuation of Sound During Propagation Outdoors'. Part 1: Calculation of the absorption of sound by the atmosphere and Part 2: General Method of Calculation; and,
- Calculation of Road Traffic Noise (CRTN), Her Majesty's Stationery Office, 1988.

11.2.10 A number of the Planning Advice Notes specify the use of the British Standards detailed above. The assessment techniques of some are outlined in the methodology section.

11.3 Methodology

Scoping and consultation

11.3.1 Consultation in relation to the noise and vibration assessment has been undertaken with the bodies listed in Table 11.1. The issues detailed in the table include those raised in the Scoping Opinion.

Table 11.1 Consultees and their key concerns

Name of organisation	Key concerns	Comment
Comhairle nan Eilean Siar (Environmental Health Department)	Consider impact of noise on onshore receptors	Discussed baseline monitoring requirements/duration, including agreement of appropriate NSRs and assessment methodology.
Comhairle nan Eilean Siar (Planning Department)	Onshore noise. Wave action without wind is not uncommon; therefore an assessment is required.	Onshore noise assessment includes consideration of variances in background noise levels.

Construction

Assessment methodology

11.3.2 The noise attributable to construction plant items is variable and largely dependent on usage. Noise emissions can generally be controlled through the application of accepted industry practice; however, the noise levels generated by construction activities will nonetheless retain the potential to effect nearby NSRs. Noise will be produced at each stage of the construction process and will arise from a variety of static and mobile sources with differing heights and sound emission characteristics.

11.3.3 The potential effects of construction noise have been determined in accordance with the principles of BS 5228. The standard provides information on how best to minimise the level of noise intrusion experienced by the occupiers of nearby properties, and provides guidance on noise measurement and prediction methods. Typical noise levels of construction plant items and typical activities are detailed in the standard.

11.3.4 The BS 5228 assessment methodology allows the effects of construction noise levels to be established using both pre-existing ambient noise levels as a point of reference and through the use of noise limit criterion. The recommended limits help determine the likelihood of complaint as a result of construction operations.

11.3.5 The effects of increased public road network activity have been assessed using the methodology outlined in Calculation of Road Traffic Noise (CRTN). CRTN is an internationally accepted method of calculating future noise levels as a result of changes to road traffic flows or design. The methodology uses measured or predicted movements, road type, average speed data and traffic flow composition (percentage of HGV's) to determine noise levels at each NSR as a result of project and no-project scenarios. This method was developed to assess road traffic noise levels from new roads as required by the Noise Insulation Regulations 1975 and the Noise Insulation Regulations (Amended) 1988.

11.3.6 The guidance on the assessment of ground borne vibration in BS 5228 has been followed. BS 5228 (Part 1) makes reference to other methods of assessing vibration, specifically BS 6472 and BS 7385, and the recommendation made therein have been followed.

Significance criteria

11.3.7 A range of factors are key to the acceptability of construction site noise, these include site location relative to NSRs, activity duration, hours of work, baseline conditions, screening, ground effects, equipment percentage on-time, the nature of work being carried out, and the attitude of the receptor and site operator.

11.3.8 It is generally accepted by Local Authorities that due to the temporary nature of construction noise, it warrants less stringent controls on noise emissions than that of a permanent operational development. Strict noise control measures can also be difficult to impose due to the transient nature of the works and may also hinder site progress.

11.3.9 The type of equipment used will vary in sound power level, with heavy plant items such trucks, excavators, cranes being the most significant source of noise. These sources of noise typically have a greater low frequency noise content (20 Hz to 200 Hz) and their emissions are generally not attenuated as effectively by atmospheric effects and ground absorption as mid and high frequency noise. This has the effect of low frequency noise being more audible at greater distances.

11.3.10 No fixed limits apply to construction site noise in the UK. Although BS 5228 specifies a noise and vibration prediction methodology, it does not recommend a method determining the level of potential disturbance arising from the received noise levels. In this instance, a significance criterion has been developed based on the guidance of the Department of Environment's Advisory Leaflet 72 (DoE AL 72).

11.3.11 DoE AL 72 recommends that the daytime noise levels outside the nearest occupied room in a noise sensitive property should not exceed the levels recommended in Table 11.2 over a normal working day. The noise parameters used in the assessment are total 'A' weighted levels, as this parameter is capable of mimicking the frequency response of the human ear at 40-phons.

Table 11.2 DoE AL 72 recommendations for construction noise

Environment	Recommended noise level dB(A)
Urban areas near to main roads in heavy industrial areas.	75
Rural, suburban and urban areas away from main road traffic and industrial noise.	70

11.3.12 Based on the guidance of DoE AL 72, BS 5228, BS 6472 and BS 7385, the significance criteria defined within Table 11.3 has been used in the assessment of the construction phase.

Table 11.3 Magnitude of impact for the assessment of construction noise

Magnitude	Definition
Major	Daytime facade noise levels in excess of 70 dB(A), L_{Aeq}, 12hr.
Moderate	Daytime facade noise levels in the range of 60 to 69.9 dB(A), L_{Aeq}, 12hr.
Minor	Daytime facade noise levels in the range of 50 to 59.9 dB(A), L_{Aeq}, 12hr.
Negligible	Daytime facade noise levels below 49.9 dB(A), L_{Aeq}, 12hr.

11.3.13 A NSR is taken to be a place where a change in the noise environment is most unwelcome. The receptor sensitivity defined within Table 11.4 is proposed.

Table 11.4 Receptor sensitivity

Sensitivity	Definition
High	Residential properties, hospitals, schools, places of worship, designated environmental areas, nature areas, and graveyards.
Medium	Offices, recreational areas, and footpaths/cycle paths.
Low	Scrub land, public open spaces, and industrial areas.
Negligible	Derelict land.

11.3.14 For the purposes of the assessment, all NSRs at the SWEP location are judged to be of a high sensitivity due to their residential status. The effects of the SWEP are assessed in accordance with Table 11.5. Those criteria in red text are the residual effects considered significant under the EIA regulations.

Table 11.5 Effect significance matrix

Magnitude	Sensitivity			
	High	Medium	Low	Negligible
Major	**Major**	**Moderate**	Minor	Insignificant
Moderate	**Moderate**	**Moderate**	Minor	Insignificant
Minor	Minor	Minor	Insignificant	Insignificant
Negligible	Insignificant	Insignificant	Insignificant	Insignificant

Operation

Assessment methodology

11.3.15 The guidance of BS 4142 provides a means of forecasting whether noise emissions from an industrial site are likely to provoke complaints from the occupiers of a building. It applies a relative noise limit based on the permitted increase in noise with respect to the background noise level, and includes an adjustment for the character of the noise, where tonal, impact or intermittent components to the noise are penalised.

11.3.16 The standard compares the measured or predicted noise level at a NSR during operation of an industrial development, with the pre-existing background noise level at the same position.

11.3.17 Noise limits in Planning Conditions are usually established on the guidance of BS 4142. The Standard offers the following direction:

- If the predicted received contribution, corrected for its character, is more than 10 dB below the measured background noise level, then this is a positive indication that complaints are unlikely;
- If the predicted received contribution, corrected for its character, is more than 5 dB in excess of the pre-existing background noise level then the likelihood of provoking complaints is marginal; and,
- If the predicted received contribution, corrected for its character, is more than 10 dB in excess of the pre-existing background noise level, the indication is that complaints are likely to be provoked.

11.3.18 The noise parameters used in the above criteria are total ‘A’ weighted levels. These may be applied during day time or night-time, the latter being the most sensitive time of day.

Significance criteria

11.3.19 The magnitude of change in noise level is a function of the degree to which predicted changes are at variance with the baseline conditions at the defined NSRs. The significance criteria for operational effects have been derived based on the guidance of the Institute of Acoustics (IoA)/Institute of Environmental Management and Assessment (IEMA) draft guidelines for noise impact assessment, as outlined in Table 11.6 below.

Table 11.6 Magnitude of impact for the assessment of operational noise

Magnitude	Definition
Very major	Change in noise level in excess of 10 dB(A). Equivalent to more than a subjective doubling/halving in level of noise at project NSRs.
Major	Change in noise level in the range of 5 to less than 10 dB(A). Up to a subjective doubling/halving in level of noise at project NSRs.
Moderate	Change in noise level in the range of 3 to less than 5 dB(A). A noticeable change in level of noise at project NSRs.
Minor	Change in noise level in the range of 0.1 to less than 3 dB(A). Barely perceptible change in level of noise at project NSRs.
None	Change in noise level of below 0.1 dB(A). No change in environmental conditions.

11.3.20 The results of the baseline survey are drawn together and assessed against the magnitude of the change resulting from the proposed SWEP at the NSRs. In turn, this is used to ascertain the significance of the predicted effects on NSRs. Again, Table 11.4 defines the receptor sensitivity proposed for operational noise (this is the same as for construction noise).

11.3.21 Similarly, for the purposes of the operational assessment, all NSRs at the SWEP location are judged to be of a high sensitivity due to their residential status. The effects of the SWEP are to be assessed in accordance with Table 11.7. Those criteria in red text are the residual effects considered significant under the EIA regulations.

Table 11.7 Effect significance matrix

Magnitude	Sensitivity			
	High	Medium	Low	Negligible
Very major	**Major**	**Major**	**Moderate**	Minor
Major	**Major**	**Moderate**	Minor	Insignificant
Moderate	**Moderate**	**Moderate**	Minor	Insignificant
Minor	Minor	Minor	Insignificant	Insignificant
Negligible	Insignificant	Insignificant	Insignificant	Insignificant

11.4 Baseline conditions

Description of baseline environment

11.4.1 The SWEP will be situated along the sparsely populated north-western coastline of the Isle of Lewis, where the ambient noise climate is dominated by natural sound sources such as those produced by the Atlantic Ocean, meteorological associated effects, wildlife and watercourses. The Atlantic Ocean is the primary contributor to the local noise climate at NSRs, with wind generated noise affecting background levels when increased wind speeds are experienced.

11.4.2 The A857 is the only main road in the area and it maintains a relatively low traffic flow throughout the day, therefore its contribution to the overall acoustic environment is less than that arising through natural sources of noise. All other roads are generally single track or private with very low traffic movements. Other modes of transport including aircraft and motor boat activities do not have a discernable effect on ambient noise levels.

11.4.3 The SWEP area has numerous isolated crofting and residential settlements. The nearest dwellings are in an elevated position relative to the proposed SWEP and are located approximately 440 m from the shoreline and some 940 m from the operational site. A total of four measurement locations were chosen as being the most representative NSRs and are detailed in Figure 11-1 and Table 11.8.

11.4.4 Ambient sound levels at these NSRs have been measured in accordance with the principles of BS 7445 and BS 4142 in order to establish pre-existing conditions over an appropriate measurement period.

Table 11.8 Baseline measurement positions

Receptor	Distance to SWEP (m)	Easting	Northing	Sensitivity
NSR 1 - No. 1 Baile an Truiseil	950	137510	953995	High
NSR 2 - No. 10 Lower Siadar	1230	138655	954690	High
NSR 3 - No. 22 Upper Siadar	1330	138835	954755	High
NSR 4 - No. 8 Lower Siadar	940	138330	954610	High

11.4.5 All monitoring was carried out on private property, where the residents were consulted in order to obtain site access. Each monitoring position was located approximately 5-10 m from the façade of the nearest residential property. Care was taken to minimise the effects of screening and extraneous sources of noise at each NSR.

11.4.6 Monitoring was carried out in free-field conditions using pre-polarised microphones positioned 1.5 m above ground level and removed from vertical facades. All non external sound equipment (sound level meter and gel-cell batteries) were placed in a locked weatherproof case and the sound level meter was fitted with a wind shield at all times.

11.4.7 The baseline measurements comprised of a continuous environmental monitoring regime logging LAeq, 10 min and LA90, 10 min indices using a 'fast' time weighting. A number of other environmental indices such as wind speed and wave height were recorded during the survey to further characterise the noise climate. All noise monitoring was carried out between the 13th March 2007 and 10th April 2007.

11.4.8 All data was acquired using unmanned sound-logging devices compliant with the Type 1 requirements of IEC651 Specification for Sound Level Meters and IEC804 Specification for Integrating Averaging Sound Level Meters. The sound level metres were omni-directional and check calibrated before and after the surveys were completed. No significant drift was observed on each occasion. The following instrumentation was used throughout the survey:

- Four Bruel & Kjaer 2238 Integrating Data-logging SLM, Serial Numbers: 234 3794/234 3795/234 3796/234 3797.
- Class 1 Acoustical Calibrator.

Baseline survey results

11.4.9 A summary of the acquired baseline environmental noise data at each of the nearest NSRs is detailed in Table 11.9. Only the nearest NSRs have been included in the assessment and are deemed to be representative of the wider local environment. The table illustrates the maximum and minimum noise levels for the equivalent continuous sound pressure level and background noise (90th percentile) descriptors over the measurement period.

11.4.10 An instrumentation malfunction was experienced at NSR 2 (No. 10 Lower Siadar), resulting in the loss of data. The lowest conditions from the other monitoring positions have been used at this location instead.

Table 11.9 Summary of baseline measurements

Receptor	Continuous Noise Level, L_{Aeq}, 10 min dB(A)			Background Noise Level, L_{A90}, 10 min dB(A)		
	Minimum	Maximum	Mean	Minimum	Maximum	Mean
NSR 1 - No. 1 Baile an Truiseil	28.1	79.5	56.3	**26.0**	65.0	49.5
NSR 2 - No. 10 Lower Siadar	24.5	69.9	50.6	**23.5**	65.0	46.8
NSR 3 - No. 22 Upper Siadar	26.3	66.3	51.5	**24.0**	61.5	47.2
NSR 4 - No. 8 Lower Siadar	24.5	69.9	50.6	**23.5**	65.0	46.8

11.4.11 To be consistent with the overall conservative approach to assessing the impact of the environmental noise from the SWEP, it is appropriate to consider the minimum LA90, 10 min levels measured at each NSR. These values are indicated as bold within Table 11.9, each of which occurred during night-time (between 23:00 and 07:00). The baseline measurements demonstrate that each NSR has a mean daytime noise level in excess of 50 dB LAeq and 46 dB LA90. The mean baseline night-time noise levels are approximately 1.5 dB and 1.2 dB higher than each of these levels, respectively.

11.4.12 A wide variation in noise levels is expected over the course of a given year due to fluctuations in ocean states and wind speeds. Baseline noise measurements were therefore obtained over a continuous 4 week measurement period in order to include a wide-range of calm and inclement meteorological conditions.

11.4.13 Measured wind speeds varied from 0 m/s to 21 m/s and wave heights recorded during the same period varied between approximately 55 cm to 185 cm. Consequently, the survey is likely to have measured a diverse and wide range of noise conditions that prevail at site.

11.4.14 It was noted by the surveying engineer that the dominant source of noise at each NSR during installation and decommissioning of the sound level meters was that of the ocean. Wind generated noise was also deemed to be a major source of noise. Other sources such as road traffic and agricultural activity are expected to have less influence on the background noise levels over a typical day.

Variation of background noise and environmental conditions

11.4.15 A basic correlation between background noise and site wind speeds, in addition to background noise and wave height, was carried out in order to ascertain the dependency of the local noise climate on meteorological effects and incidental wave height.

11.4.16 Analysis of available data sets has established that environmental conditions have a significant effect on background noise levels at Siadar. The incident wave energy seems to strongly influence the noise climate in particular.

<u>Wave height to background noise correlation</u>

11.4.17 Whilst survey data acquired over a period of approximately one week is not sufficient in terms of establishing a definitive correlation, it does however indicate an apparent relationship between wave height and background noise levels. This association is illustrated in Figure 11-2.

11.4.18 The depth of this relationship can be examined by plotting wave height against background noise levels, as demonstrated in Figure 11-3. In the case of NSR 3, it is clear that background noise levels increase with an escalation in incident wave energy.

Figure 11-2 Correlation between background noise and wave height

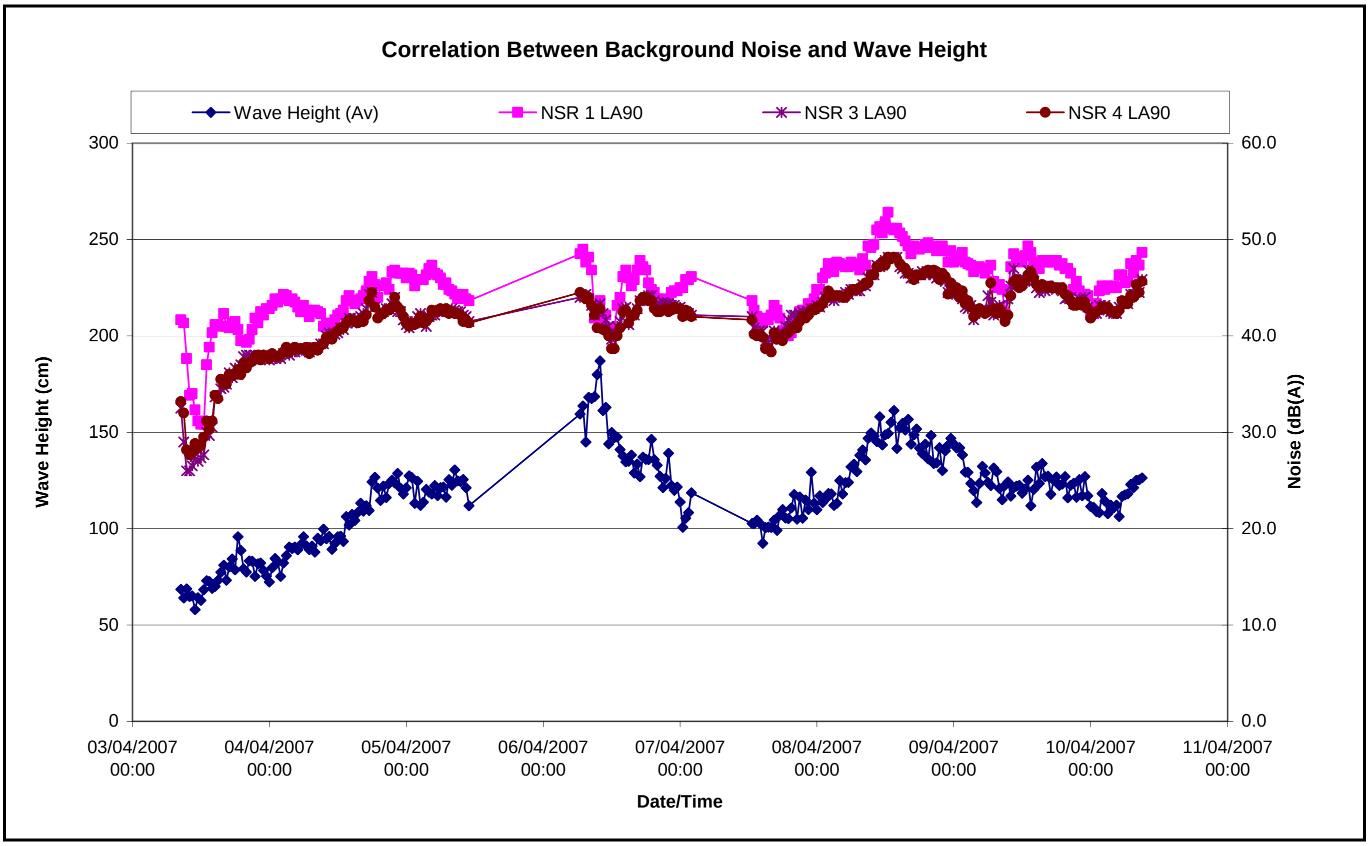
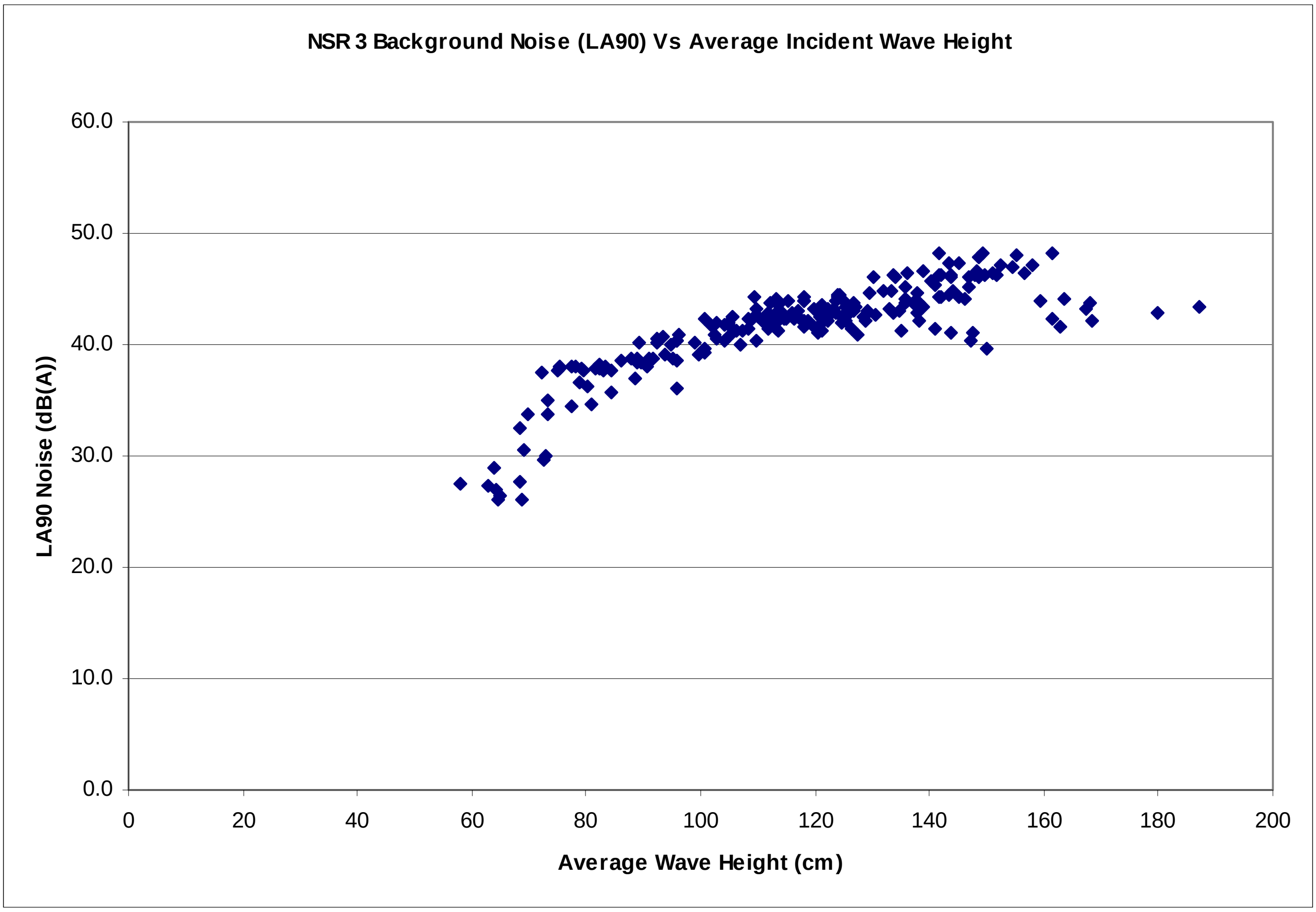


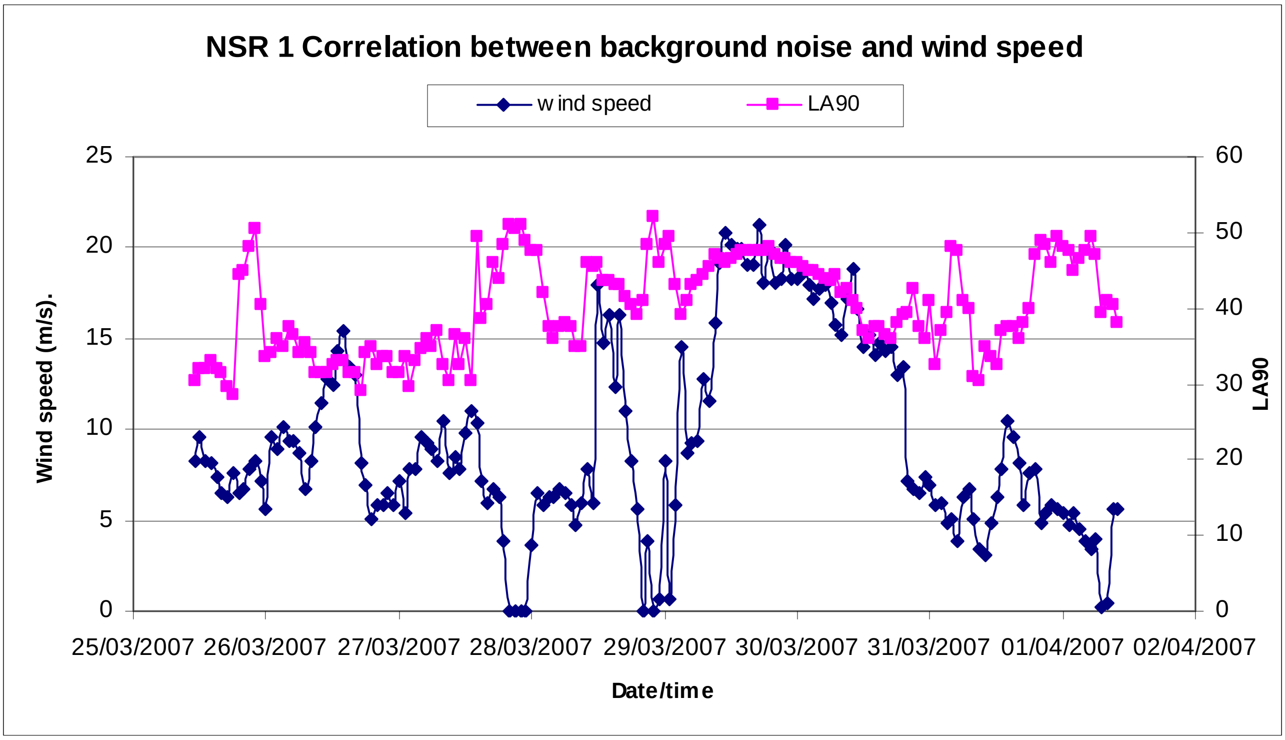
Figure 11-3 Background noise level versus average incident wave height (NSR 3)



Wind and background noise correlation

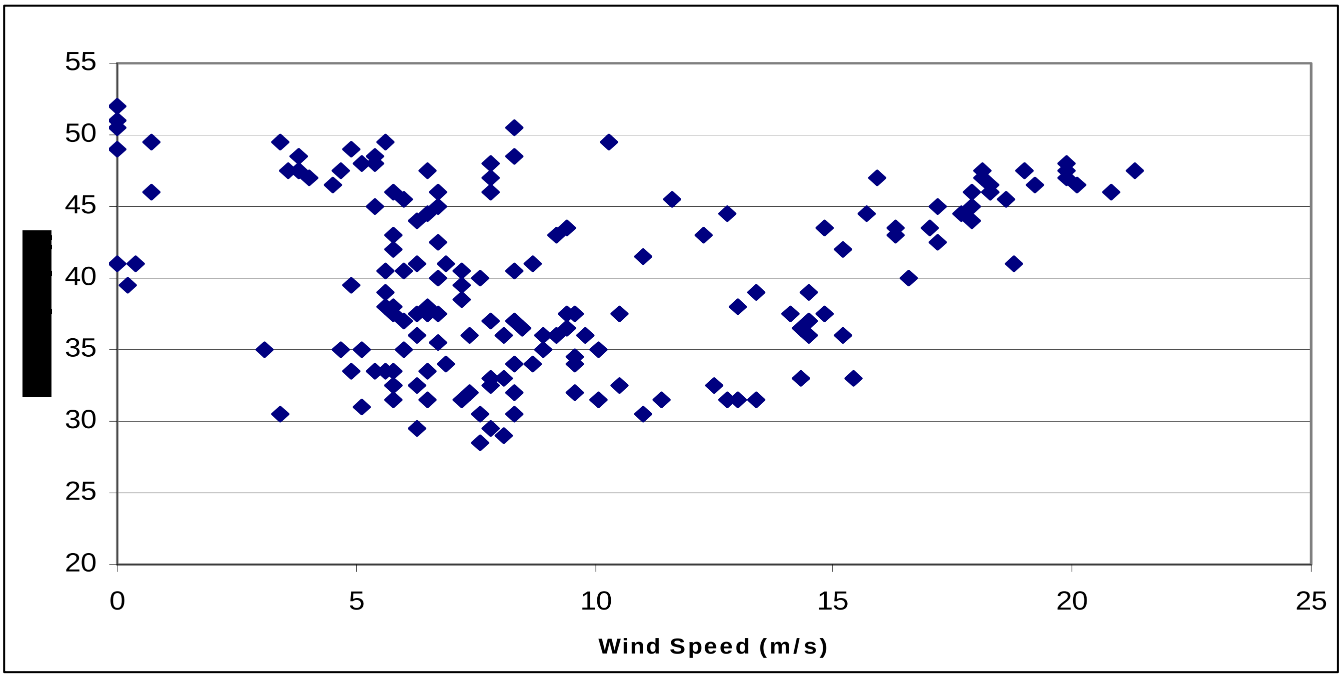
11.4.19 A similar technique can be carried out to establish the effect of wind speed and direction on background noise levels. This has been performed using meterological data from the Dell weather station which is approximately 10 km from the site and captured wind data from a range of directions over the baseline measurement period. This is illustrated in Figure 11-4.

Figure 11-4 Correlation between background noise and wind speed at NSR 1



11.4.20 The most notable correlation occurs on the 30th March 2007 when the wind is from a north easterly direction, as detailed in Figure 11-4. At other times there is a modest correlation between the wind and background noise. A clear relationship is not established when wind speed is plotted directly against noise, as detailed in Figure 11-5.

Figure 11-5 Background noise versus wind speed (NSR 1)



Conclusion

11.4.21 Analysis of available wind data suggests that winds from an east and north easterly direction generally contribute strongly to background noise levels. Very similar results have been derived from the other noise monitoring locations, possibly reflecting a local trend. From the data presented above, it could be surmised that in most conditions the noise of waves breaking on the shore dominates the background noise level, but in conditions where the wind is blowing from onshore to offshore (east to northeast) this effect is suppressed and the wind dominates the background noise climate.

11.5 Assessment of effects and mitigation – Construction Phase

11.5.1 The impact of the construction phase of the SWEP is derived by comparison of the predicted change in noise levels at NSRs and the significance criteria as previously defined.

Modelling of impact

11.5.2 The prediction of construction noise has been carried out based on the methodology outlined in BS 5228. There are a number of unknowns at this stage, both in terms of the equipment and methodology to be used, therefore a number of assumptions have been necessary and these are based on experience of similar projects. It has therefore been necessary to use worst case levels of construction noise in this assessment, i.e. selection of plant and vehicles that will emit higher noise levels than may actually be the case.

11.5.3 The sound power level of all equipment likely to be used in the construction process has been included in the assessment. Ground attenuation, reflections and screening have been considered in order to perform an assessment that is representative of actual site conditions. The method used on this analysis is described as follows:

- Establish type and number of plant items to be used during each stage of construction;
- Establish the % of time and sound power levels of plant items during each phase;
- Establish vehicle type and total number of movements;
- Model noise propagation from site and establish received noise at sensitive receptors; and,
- Compare modelled results with recommended limits of DoE AL 72.

11.5.4 The cumulative construction and transportation effects of the SWEP have been determined using specialist computational modelling software. The potential change in the prevailing noise climate at each NSR has been calculated using the ISO 9613 algorithms, 'Acoustics – Attenuation of

Sound During Propagation Outdoors' Part 1: *Calculation of the Absorption of Sound* by the Atmosphere and Part 2: *General Method of Calculation*.

11.5.5 Features such as distance attenuation, topography, the built environment, ground cover, atmospheric absorption and meteorological conditions are considered in the ISO algorithm. The computational model has assessed the cumulative impact of all sound sources based on overall sound power levels. The methodology of CRTN (Calculation of Road Traffic Noise, 1988) has been followed for road traffic noise effects.

<u>Sources of construction noise</u>

11.5.6 Noise emissions during the construction phase will arise from a wide variety of sources, and may be static or transient in nature. Typical noise producing activities are likely to involve:

- Potential road upgrade;
- Extraction of stone from potential borrow pit;
- Offshore piling (drilled piles);
- Site preparation works;
- Transportation of concrete and aggregate to the site;
- Transportation of construction and permanent plant items to site (use of articulated vehicles);
- Assembly of the caissons;
- Assembly of final plant;
- Assembly of control building;
- Construction plant item movements; and
- Car/van movements.

11.5.7 The noise emissions from small items of construction plant such as generators and compressors have low sound power levels when compared to larger plant items such as, excavators, dump trucks and road rolling equipment.

11.5.8 In general, the majority of construction activities will take place at the construction compound. A distinction can therefore be made between the potential road upgrade activities and general construction, the primary and lengthiest source of construction noise.

11.5.9 Source noise levels are based on those detailed in BS 5228 or manufacturer data. The modelling assumes worst-case conditions, whereby simultaneous operation of construction plant items takes place at the edge of the construction compound site, at the nearest point to the NSRs. This scenario is unlikely to occur at any point during construction activities, and has been necessary as accurate work locations are not yet known.

Predicted construction noise impact

11.5.10 The construction phase of the SWEP requires plant item data from which the potential degree of impact is derived by comparison of the predicted change in noise levels at NSR and the significance criteria of Section 11.3.

11.5.11 Construction noise levels have been calculated based on an indicative construction programme supplied by npower renewables. A worst case construction compound and work activity area of approximately 8.5 hectares (21 acres) is proposed for an area of low lying coastal land to the south east of the River Siadar. The site is approximately 150 m to the northeast of the nearest NSR (No. 1 Baile an Truiseil) and will be levelled with a layer of hardcore laid to establish a suitable work area. It is envisaged that the existing track running adjacent to the Baile an Truiseil main access road will be widened for construction activity purposes, and will form the eastern boundary of the site.

11.5.12 A potential borrow pit site has been identified at a location 400 m west of No. 1 Baile an Truiseil. An access track of approximately 600 m in length will be required between the borrow pit site and the existing track end.

11.5.13 Construction activities have been divided into several separate stages. The key activities identified for the construction phase, expected length of the phase, the plant items required, the respective worst-case sound power levels (LWA) of each plant item and the overall received noise at each NSR is detailed in Table 11.10. The calculations have been performed where a construction activity is planned to take place.

11.5.14 Where a large area, such as the construction compound, has been identified for construction activity, the plant items are assumed to be located at a position that is closest to the nearest NSRs. This means that noise modelling has accounted for construction activities taking place at worst-case locations.

Table 11.10 Summary of construction plant inventory and predicted noise levels

Activity	Plant	No.	Indicative duration	L_{WA}	NSR1	NSR2	NSR 3	NSR4
Borrow pit activity								
Ripping/blasting	Wheeled excavator	2	10 months with varying intensity	110	63.6	48.7	46.8	52.9
	Generator	1		111				
	Dump truck	2		110				
	Crushing/screening	1		112				
	Pump	1		109				
	Dozer/drilling	1		112				
	Tracked loader	1		110				
Road construction								
Spoil removal	Wheeled excavator	2	2 weeks	106	68.7	44.1	43.7	53.3
	Lorry	10		108				
Road surfacing	Asphalt melter	2		103	66.5	38.3	36.9	49.0
	Asphalt spreader	1		110				
	Road roller	1		96				
	Chip spreader	1		108				
Site preparation								
Tipping	Dump truck	8	2 months	110	64.9	46.9	45.0	59.0
Spreading	Wheeled excavator	3		106	63.8	48.0	46.1	60.2
	Dozer	5		112				
Levelling ground	Dozer	5		112	64.6	47.4	45.1	61.0
	Grader	3		84				
Trenching	Wheeled excavator/loader	2		110	64.6	47.4	45.4	59.6
	Lorry	4		108				
	Tracked excavator	2		109				
	Compressor	4		112				
	Pneumatic breaker	4		115				
	Trenching machine	1		105				
Trench filling	Wheeled excavator/loader	2		110	70.6	50.8	49.1	63.1
	Tracked excavator	2		109				
	Dumper	2		102				
	Tracked loader	2		110				
Unloading and Levelling hardcore/rolling	Tipper lorry	6		113	65.0	44.8	43.1	56.7
	Tracked loader	2		110				
	Road roller	1		108				
Compacting fill/earth	Vibratory roller	1		102	68.9	48.0	46.3	59.9
	Dozer	4		114				

Activity	Plant	No.	Indicative duration	L_{WA}	NSR1	NSR2	NSR 3	NSR4
	Compactor rammer	4		108				
General site activities								
Air/electricity/pumping	Compressor	4	6 months	105	71.7	52.8	51.0	64.8
	Generator	4		111				
	Pump	2		109				
Distribution of materials	Dumper	2		96				
	Wheeled crane	2		112				
	Tracked crane	2		114				
	Lorry	6		108				
Pumping concrete	Truck mixer	1		100				
	Concrete pump	1		107				
Building foundations	Truck mixer	1		116				
	Lorry mounted crane	2		116				
	Vibratory poker	4		98				
	Concrete batching plant	1		108				
Excavation and cable laying								
	Wheeled excavator	1	1 month	110	55.6	40.5	38.7	52.6
	Lorry	1		108				
Control building construction								
	Wheeled excavator	2	3 months	110	54.6	43.6	41.4	55.7
	Lorry	2		108				
	Dumper	2		96				
Dredging and breakwater positioning								
	Tracked crane	2	6 months	114	64.8	55.9	57.2	67.2
	Winch gear	2	8 months	112				
	Drilled piling	2	1 month	121				
	Dredging	1	1 month	115				
	Rock blasting	1	1 month	125				

11.5.15 Predicted construction work noise levels indicate that the SWEP will be in compliance with the relevant daytime noise criteria of 70dB(A) outlined above (DoE AL 72) at each NSR for all but two activities; trench filling and general site activities. Only NSR 1 is predicted to be in receipt of this excess.

11.5.16 The impact of construction noise is predicted to range from negligible to moderate for all activities other than trench filling and general site activities where a **major** impact has been calculated for NSR1.

Vibration Effects

11.5.17 Vibration is most likely to arise through the construction stage of the project and is primarily associated with the technique employed for piling and will only be a short-term activity. The transmission distances to NSR's are such that vibration is unlikely to be perceptible during the construction phase.

11.5.18 It should be noted that in addition to anti-vibration techniques employed at the site, the transmission distances to the nearest receptors are such that vibration is not considered to be a source of nuisance.

Mitigation Measures

11.5.19 In addition to ensuring plant items are properly maintained and located near the centre of the site where appropriate, the following measures in line with BS 5228 will be implemented:

- Earth moving plant - The use of efficient exhaust sound reduction equipment and ensuring manufacturers enclosure panels are closed at all times. Alternative super silenced plant may be available;
- Compressors and generators - The use of efficient sound reduction equipment, dampening of the metal body casing and ensuring manufacturers enclosure panels are closed at all times. Screening may be erected and some equipment may be placed in a ventilated acoustic enclosure;
- Breakers and drills - The use of mufflers, sound reduction equipment, fixing any air line leaks, use dampened bits, screening and enclosures;
- Cement mixing, materials handling and batching plant - The use of efficient engine sound reduction equipment, enclosing the engine, ensuring aggregate and other materials don't fall from an excessive height and avoiding hammering the drum; and,
- General - Machines and plant that may be in intermittent use will be shut down between work periods or throttled down to a minimum. Material stockpiles and other structures should be effectively utilised, where practicable, to screen sensitive receptors from noise from on-site construction activities.

11.5.20 Non-engineering related mitigation measures include informing residents and the local authority of changes to the construction programme that may result in increased noise levels and appointing a member of staff on site to handle noise complaints should they occur.

Residual Effects

11.5.21 It should be noted that the model has assumed worst case positioning of plant items, continuous operation, and a lack of screening and other noise mitigation measures. If mitigation measures are taken to reduce noise levels, the predicted effects will decrease considerably. With the major effect identified from a received noise level just over the 70 dB threshold for two types of activities and affecting one receptor site, NSR 1, it should readily be possible to adjust the location of the problem activities to increase separation and utilise the mitigation measures outlined above to quiten these activities so that the received noise level drops to more acceptable levels. If the received levels drop under 70dB the residual effect would be **moderate** or **minor** depending upon how successful these measures are.

11.6 Assessment of effects and mitigation – Operational Phase

11.6.1 The impact of the operational phase of the SWEP is derived by comparison of the predicted change in noise levels at NSRs and the significance criteria previously defined.

Sources of operational noise

11.6.2 The primary source of noise will be the forty turbines housed in the caissons at sea. The only other significant source of noise will be transformers and switchgear; however, these are to be contained within the onshore control building.

11.6.3 The estimated maximum noise emission from a single turbine operating at maxmum output is 135.5 dB(A), as included in Table 11.11. This peak noise level has been modelled assuming the simultaneous operation of forty such turbines located in plenum chambers and venting to atmosphere through silenced exits. Such a maximum load and ensuing noise level will occur infrequently as sea states dictate and will be substantially reduced by the breakwater structure and the attenuation provided by the plenum and exit vents. As such the modelling is considered to be worst case scenario.

11.6.4 Switchgear has been modelled as a continuous source of noise from within a control room building, which will provide attenuation of the source. Like the modelling of the turbines, this scenario is worst case.

Table 11.11 Major noise sources modelled

Source	Octave band centre frequency (Hz)										
	31.5	63	125	250	500	1k	2k	4k	8k	Total	
										A-Wt	Lin
Turbines	-	-	-	-	-	-	-	-	-	135.5	-
Switchgear	94.4	103.2	104.1	100.6	91.2	83.0	80.8	74.0	69.1	95.2	108.0

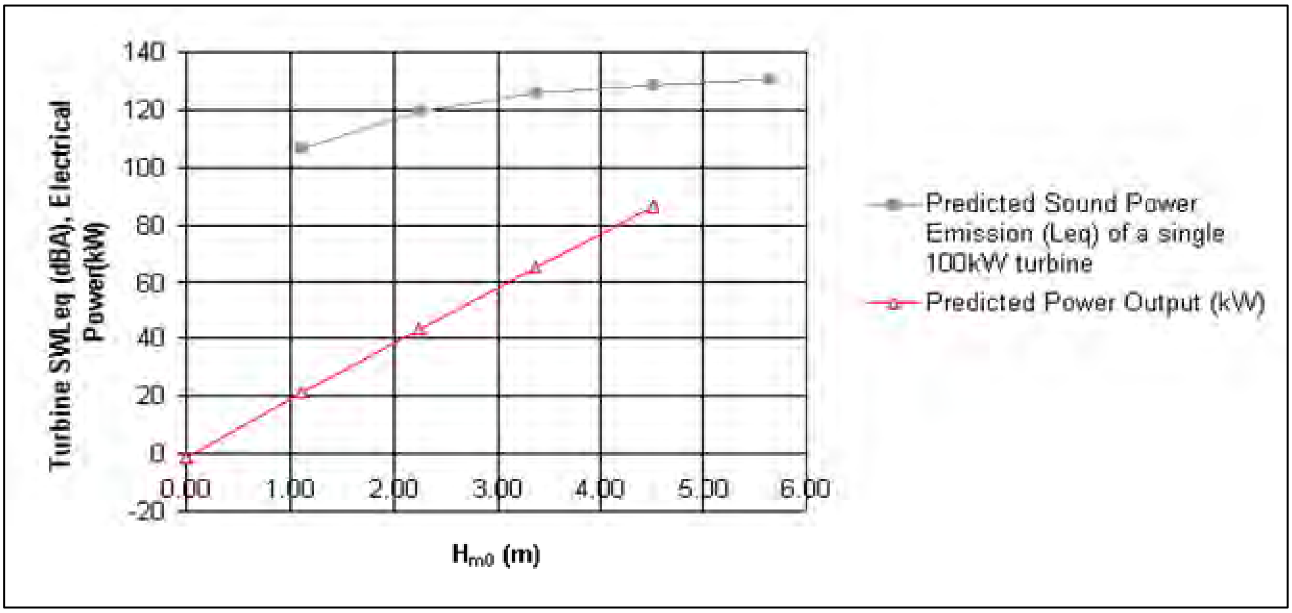
11.6.5 There will also be miscellaneous noise emissions associated with the operation of the plant such as a limited number of car or van movements, these being in the order of, in the worst case, one to five per week. Noise emissions from such activities will be negligible and have therefore not been modelled.

11.6.6 The use of a warning foghorn or similar device is not planned at Siadar and therefore not been considered in this assessment.

Variation in turbine noise with sea state

11.6.7 Long term performance monitoring of the LIMPET plant on Islay has enabled Wavegen to build up an understanding of the equivalent noise level (LAeq) of the plant across a wide range of sea states. Figure 11-6 indicates that the energy output from the LIMPET plant increases with escalating incident wave height, as there is more energy available for extraction. The figure also shows that noise emissions increase with higher energy output from the turbine. A direct relationship therefore exists between the incident wave height and the predicted noise of a single turbine of the type to be used within SWEP. The noise emissions range from approximately 100 dB(A) at lower energy outputs to 135.5 dB(A) at full output. This variation in output will alter over hours and days as the incident wave energy changes.

Figure 11-6 Estimation of noise level for a single SWEP turbine



11.6.8 As the turbine noise varies with each wave cycle, the noise will oscillate with the maximum output occurring twice per cycle. The duration of the cycle will vary with the duration of the incident waves, and this type of intermittent noise will be subject to the +5 dB character correction of BS 4142.

Modelling of operational impact

11.6.9 The operational noise modelling was based on an early preliminary design slightly different to that discussed in previous chapters of this ES. The main difference is that the earlier design was slightly curved, whereas the most recent scheme is of a linear design. The SWEP has, however, been modelled with the same number of turbines and silenced exits as the latest design, and uses the most recent caisson height. As such, it is assumed that the modelled slightly curved shaped design is of minimal consequence to operational noise emissions.

11.6.10 As with the construction phase, the predicted received noise levels at each of the representative NSRs have been calculated through the use of advanced acoustic propagation modelling software using the ISO 9613 algorithms. The nearest NSR, namely NSR 4, has been modelled approximately 940 m from the breakwater.

11.6.11 The following steps were taken in order to simulate an accurate indication of emission characteristics at site:

- Topographical information was imported over a 10 km grid to create a 3D model capable of evaluating the attenuation effects of distance and the natural landscape; and
- A digitised 3D bespoke model of on-site structures and noise sources (including dimensions) was developed. Sound power levels, frequency spectra and transmission loss characteristics were assigned to each noise source.

11.6.12 The computational model has assessed the impact of all sound sources based on an octave band frequency range of 31.5 Hz to 8 kHz and overall sound power levels where octave band levels are unavailable.

11.6.13 Anticipated steady-state noise levels from the plant have been modelled under maximum operational load conditions, therefore the predicted noise levels are considered to be conservative. Caisson facades and the roof sections have been modelled as noise radiating area sources, and the model has also accounted for weaker elements of the facade such as silenced exits.

11.6.14 No screening from these sources is anticipated and therefore the noise emissions from these plant items have been calculated on the basis of full line of sight view at each sensitive receptor. The ground absorption at the SWEP site (the source region) has been modelled using a conservative coefficient, meaning that modelled noise levels will propagate further than is likely to actually occur. The ground absorption assigned to the mid and receiver regions are that which most represent the existing ground cover conditions and have mid to high ground absorption qualities.

Predicted operational noise impact

11.6.15 The operational impact assessment intends to calculate the level of noise at NSRs that is attributable to the SWEP, and determine the impact based on the difference in received noise and the prevailing background conditions. The comparison between the maximum predicted operational noise (including the BS 4142 character correction) and the minimum LA90, 10 min noise levels are outlined in Table 11.12 and illustrated in Figure 11-7. This is an extremely conservative means of assessment, where the operational noise produced by high levels of ocean activity are compared with the lowest recorded noise levels at each NSR. Such an occurrence is unlikely ever to occur.

Table 11.12 Summary of predicted operational noise levels

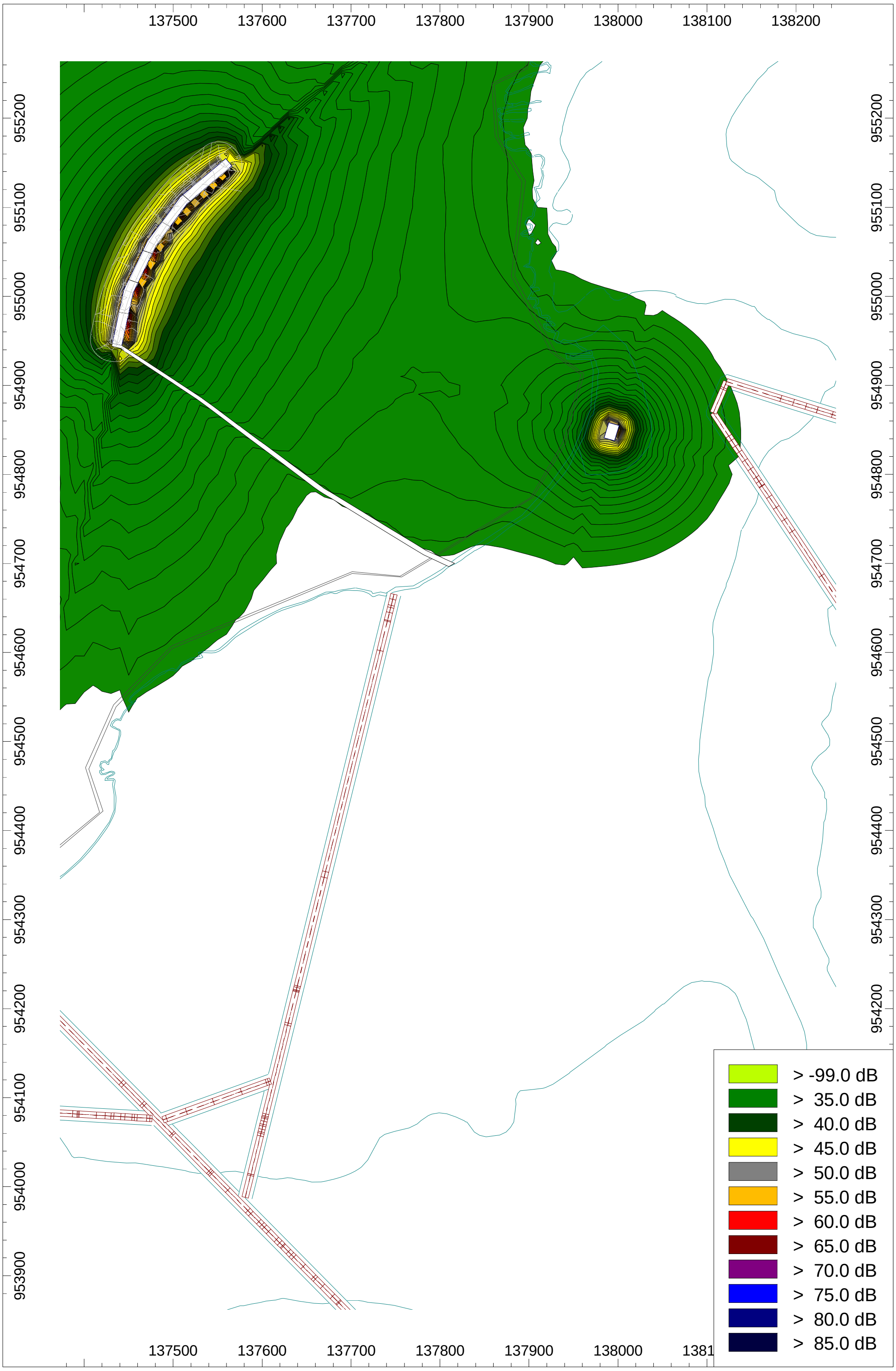
Receptor	Predicted SWEP contribution dB(A)	Addition of 5dB character correction dB(A)	Minimum baseline L_{A90} dB(A)	Predicted change dB(A)
NSR 1	20.6	25.6	26.0	-
NSR 2	17.3	22.3	23.5	-
NSR 3	16.9	21.9	24.0	-
NSR 4	22.5	27.5	23.5	+ 4

11.6.16 The predicted worst-case impact as received at each NSR indicates a maximum increase over minimum existing LA90, 10 min noise levels of 4 dB(A) at NSR 4. No surplus over background conditions is calculated at any of the remaining NSRs. The predicted change of noise levels (see Table 11.12) can be compared to the IoA / IEMA draft guidelines for noise impact assessment, as adapted in Table 11.13, and compared with significance criteria previously defined.

Table 11.13 IoA /IEMA guideline criteria for noise impact assessment

<table>
<tr><th>Change in Noise Level dB(A)</th><th>Subjective response</th><th>Impact significance</th><th>NSR 1</th><th>NSR 2</th><th>NSR 3</th><th>NSR 4</th></tr>
<tr><td>0</td><td>No change</td><td>None</td><td rowspan="5">None</td><td rowspan="5">None</td><td rowspan="5">None</td><td rowspan="5">Moderate</td></tr>
<tr><td>0.1 – 2.9</td><td>Barely perceptible</td><td>Minor</td></tr>
<tr><td>3.0 – 4.9</td><td>Noticeable</td><td>Moderate</td></tr>
<tr><td>5.0 – 9.9</td><td>Up to a doubling/halving in noise</td><td>Major</td></tr>
<tr><td>> 10.0</td><td>More than a doubling/halving in noise</td><td>Very Major</td></tr>
</table>

Figure 11-7 Operational noise contour emissions (Mott MacDonald, 2007)



11.6.17 The impact significance of the SWEP under worst-case conditions is rated as moderate at NSR 4. All other receptors are predicted to receive an impact of no significance. This indicates that the operational noise levels may be noticeable at NSR 4 following the application of the 5 dB character correction as recommended in BS 4142, assuming maximum load and minimum background noise conditions.

Vibration effects

11.6.18 Vibration monitoring equipment is likely to be included on the generation plant for control, operation and maintenance reasons. If necessary, the plant may employ vibration isolation and damping systems.

11.6.19 These design features coupled with plant foundation designs have the combined effect of minimizing the ground borne vibrations to such a degree that any disturbance of the earth will be barely detectable by a human in close proximity to the equipment, and is therefore unable to cause any form of disturbance or damage to a neighbouring area. Due to the offshore location of the SWEP and these factors, it is considered that vibration from the operation phase will not be of any significance to the NSRs.

Mitigation Measures

11.6.20 The potential operational noise reduction measures used at SWEP include:

- Thorough consideration will be given to noise emission levels at the detailed design stage.
- Reductions in turbine noise will be implemented through aerodynamic design, acoustic treatment and the control strategy;
- Reductions in overall plant noise will be implemented through appropriate design of plenum chamber and air intake/exit vents, taking due regard for environmental noise criteria;
- Appropriate measures will be taken to maintain low levels of machinery vibration in order to prolong life of equipment and reduce noise levels; and,
- Transformers will be located indoors and transformer room design will consider acoustic aspects if necessary.

Residual Effects

11.6.21 A moderate effect was identified under worst case conditions at NSR 4. As the more typical and realistic operating and environmental conditions are considered, where the increased background noise coincides with the increased output and noise from the turbines, the received noise levels above background will diminish to zero and will typically be lower than background. The operational noise impact of the SWEP is expected to be in the range of minor to insignificant for all other meteorological and or sea state conditions at all NSR locations. Further, with implementation of the mitigation measures described above it should be possible to reduce the noise emissions from the structure. Therefore, the residual effect from operational noise will be either **minor** or **insignificant**.

11.7 Assessment of effects and mitigation – Decommissioning Phase

11.7.1 The breakwater will remain in situ at the end of the operational life. As such, the noise produced during the decommissioning phase of the SWEP will be less than that produced during construction works, in addition to the operational phase. Lower noise levels are expected due to the absence of high impact operations and a reduced need for large plant items. The assessment of decommissioning noise is therefore not proposed as the assessment of construction effects is deemed representative of a 'worst-case' assessment.

11.8 Cumulative effects

11.8.1 In terms of proposed developments, possible construction of the AMEC wind farm on Lewis (a portion of which would be located close to the Siadar area) may occur at the same time as the construction of the SWEP development. One of the temporary construction compounds for the proposed Lewis wind farm is located approximately 3.5 km from the proposed SWEP development. However even if the two project were to be constructed concurrently, for there to be any cumulative impact in terms of noise the site would need to be located within 2 km of the SWEP location. It is therefore considered there will be no significant cumulative effects from the proposed Lewis wind farm development.

11.9 Summary and Conclusions

11.9.1 A noise impact assessment has been carried out for the SWEP, assuming worst-case conditions. The evaluation has been undertaken in accordance with the latest relevant guidance in order to establish the acceptability of the scheme in terms of noise impact. The purpose of the assessment was to determine the impact as a result of each phase of the project at the nearest NSRs.

11.9.2 A major impact has been predicted for two activities in the construction phase, however, the model has assumed worst case positioning of plant items and a lack of screening and other noise mitigation measures. If reasonable steps are taken to reduce noise levels, this impact will be significantly reduced to **moderate** or lower. All other effects are deemed to be moderate or negligible in nature, and no special mitigation measures other than good site management practice are likely to be required due to the temporary nature of the work.

11.9.3 During operation, the predicted worst-case impact as received at each NSR indicates a maximum increase over minimum existing LA90, 10 min noise levels of 4 dB(A) at the closest receptor location, and signifies a moderate impact. Such an impact would require high levels of ocean movement in conjunction with the lowest recorded background noise levels. Such an impact is very unlikely to occur due to the strong relationship between ocean activity and background noise levels and for most meteorological and sea state conditions impact significance is considered to be **minor** to **insignificant**. Other than the four closest NSRs, received noise over background conditions is not calculated at any other NSRs in the area.

11.9.4 The impact of the decommissioning phase of the SWEP will be significantly lower than that arising from construction activities. This is due to the breakwater remaining in position at the end of its operational life and a reduced need for high impact operations and large plant items.

12 Landscape and Visual

12.1 Introduction

12.1.1 This section studies the effects of both the offshore and onshore aspects of the project on the landscape/seascape character and visual amenity of the local area. It covers all aspects of the project from construction through to operation and eventual decommissioning, though visualisations will concentrate on the operational phase, in particular the breakwater, fixed access link and control building, as this will have the most prolonged effect on the landscape/seascape. The effects studied involve both objective and subjective effects such as changes in perception of the local landscape and seascape. The assessment includes consideration of effects on the setting of local cultural heritage interests.

12.1.2 Landscape effects are changes in the character and quality of the landscape as a result of a particular development. The process of landscape character assessment (LCA) is used to assess these changes to enable better landscape planning, conservation, restoration, management and enhancement. LCA is based on the principle that all landscapes have a range of features and characteristics, which not only give them their appearance, but also contribute to their wider character, for example through historical, artistic and social associations. In combination, these features and characteristics provide landscapes with their ‘character’ or ‘distinctiveness’.

12.1.3 Visual effects are a subset of landscape effects. The assessment is a subjective process as it involves individual perception, aesthetic tastes and visual comprehension. It is possible, however, to bring objectivity to the assessment and treatment of visual impact by considering the factors which influence it, including height, colour, size and associations with nearby features, including (in the marine environment) the presence of rock outcrops, small islands and existing manmade features. These factors are ultimately influenced by meteorological, topographic position, season and observer characteristics.

12.1.4 The aim of landscape and visual impact assessment is to assess the sensitivity to change in the area and to identify the appropriate mitigation measures, such as design guidance and detailed siting requirements.

12.2 Legislative framework and regulatory context

12.2.1 A full study of all the necessary regulatory frameworks relevant to the landscape and visual assessment was carried out prior to this assessment. Legislation, policies and associated guidance that have been taken into consideration include:

- Environmental Impact Assessment (Scotland) Regulations (1999);
- Scottish Government Planning for Natural Heritage: Planning Advice Note 60 (2000);
- PAN 58 Environmental Impact Assessment;
- SNH Policy Statement No. 01/02: Renewable Energy;
- SNH Service Level Statement: Renewable Energy Consultations;
- SNH Good Practice Guidance: Visual Representation of Windfarms;
- National Planning Policy Guidelines of relevance to this assessment:
    - NPPG 5 Archaeology and Planning;
    - NPPG 6 Renewable Energy Developments (revised 2000);
    - NPPG 14 Natural Heritage;
    - NPPG 18 Planning and the Historic Environment;
- Local planning policies of relevance to this assessment:
    - DM1 Location of Development;
    - DM5 Availability of supporting infrastructure;
    - DM7 Assessment of Development Proposals;
    - DM9 Developer consultation and community benefit;
    - RM6 Coastal development;
    - ED2 Development of Alternative and Renewable Energy Resources;
    - ED14 Neighbour Amenity; and
    - T4 Road Safety, Highway Improvements and Traffic Management.

12.3 Methodology

12.3.1 The methodology techniques used to assess the landscape and visual impact character of the development site followed the guidance of the 'Landscape Character Assessment guidance for England and Scotland prepared by the Countryside Agency and Scottish Natural Heritage'

(Swanwick, 2002). The assessment was also consistent with the impact assessment methodology advocated by the Landscape Institute in 'Guidelines for Landscape and Visual Impact Assessment' (Landscape Institute, 2002).

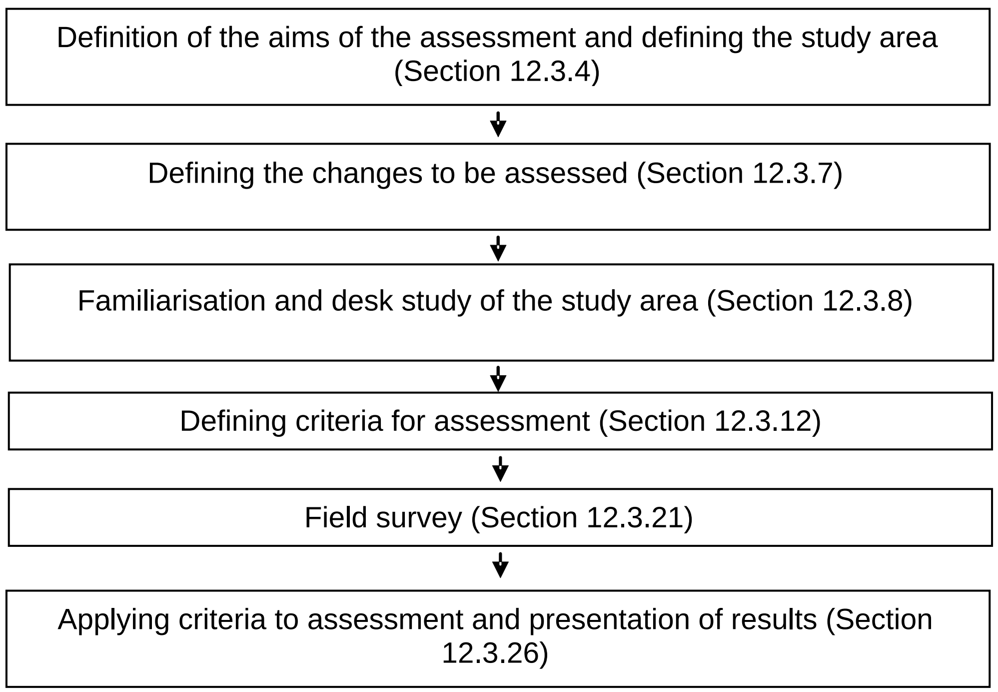
12.3.2 Although these guidelines are applicable to most landscape types, little reference is given to coastal and marine developments. Hill *et al* (2001) have provided a 'Guide to best practice in seascape assessment' as part of a project in support of the Protection of the Marine and Coastal Environment of the Maritime (Ireland-Wales) of the INTERREG Programme (1994-1999) which is administered by the Marine Institute (Ireland) and the National Assembly of Wales. This methodology has also been applied to the assessment of effects from the SWEP project. The seascape assessment is an extension of the landscape character assessment rather than a separate specialism. It is regarded that there are other elements onshore which are significantly different or entirely absent in seascape features. These include:

- The effect of historical and cultural issues related to the marine environment. This includes the areas important for shipping, fishing and amenity users (in particular tourism);
- The coast as an edge or an interface between two fundamentally different environments. One is stable (land) which changes little and the other (marine) is constantly changing. Perspectives from either environment can vary dramatically. Views from the land to the sea and from the sea to the land frequently offer completely different perceptions of the same general area;
- Variability and dynamism. Variability in determining the character of the sea are wind, light and shade and the clarity of the atmosphere;
- Principles of visual movement. Horizon lines provide visual focus plains and are therefore visually sensitive. The coastline often marks an abrupt change in horizon line, and therefore the point where land and horizon meet is more visually sensitive;
- Amenity functions and uses of the seashore. Some amenity users are more sensitive to changes in the visual environment than others. Sections of the coastline that are accessible, yet offer seclusion and a wilder 'natural' character will be more sensitive and vulnerable to change than areas of the coast with a heavily developed resort setting; and
- Functions and uses of the sea. There are water based leisure activities that may depend on the character and quality of the seascape for the user's enjoyment, and which may also affect the appearance of the coast.

Methodology process

12.3.3 The assessment of landscape/seascape and visual impact character is essentially a systematic and chronological process through the steps shown in Figure 12-1. The methodology used for the assessment includes a baseline survey, identification of the effects and sensitive receptors, description and quantification of the changes to the baseline, and the evaluation of predicted effects, together with criteria used and the measures proposed to avoid, reduce, remedy or offset any negative effects.

Figure 12-1 Outline of the landscape/seascape methodology



<u>Aims of the assessment and defining the study area</u>

12.3.4 The initial stage of the landscape/seascape and visual assessment is to define the scope. This will critically influence the scale and level of detail of the assessment, the resources required, those who should be involved in its preparation, and the types of judgement that are needed to inform decisions. The changes to be assessed should be clearly defined. A further aim is to identify the appropriate mitigation measures, such as design guidance and detailed siting requirements.

12.3.5 Hill *et al* (2001) recommend the following for defining the study area:

- Coastal - 15 km is the maximum limit of visual significance and therefore the length of coastline which would require to be surveyed would be 30 km which ignores coastline indentations. However, it must be noted that theoretical visibility will be much greater than significance visibility.

- Inland - The significance of views to the sea diminish with distance, so while the sea may theoretically be visible from the top of mountains at a distance over 30 km from the shore, the assessors judgement will be required to define a realistic landward limit. A limitation of 10 km is recommended for consideration as a visual boundary or buffer zone.

- Offshore - The unity offshore should extend up to 15 km; however this may be extended where there is elevated topography in close proximity to the shore.

12.3.6 Significant sea view boundaries have been defined using the table of distance of sea horizon for given heights (Esso, 1998). In practice, light bends very slightly as it passes through the atmosphere. If the air temperature is higher than the sea temperature then light bends to follow the curve of the earth (Bartlett, 2002). The calculation to the horizon is: 1.92 x h where h is the square root of eye height level.

Defining the sites to be assessed

12.3.7 All aspects of the SWEP project were clearly defined and included a description of the following: location; features present; and arrangement of those features.

Desk based assessment

12.3.8 In order to determine the potential landscape/seascape and visual impact associated with the development, it is important to first understand the physical and human factors associated with the coastal, hinterland and the marine environment. It is also important to identify the potential viewers and receptors. Contributing factors to landscape and visual characteristics include:

- Landform and geological characteristics;

- Coastal shape and dynamics;

- Identification on human influences, trends and pressures on the land and sea;

- Extent and screening potential of existing vegetation; and

- Location of houses and settlements, roads and walking trails as well as the identification of significant sites, views and viewing locations.

12.3.9 A desktop investigation was undertaken identify sensitive viewpoints for the production of photomontages. The sites identified were a combination of those suggested by Scottish Natural Heritage (SNH) as well as those required from a cultural heritage perspective (in consultation with Historic Scotland). Standard forms were completed which provided a basis for carrying out subsequent fieldwork. They were used to define the landscape/seascape character of the area around the proposed developments, identify principle viewpoints in the study area and highlight potential sensitive receptors.

12.3.10 A computer-generated Zone of Theoretical Visibility (ZTV, Figure 12-2a), was generated to delineate the likely zone of visual influence. The ZTV was generated using a program developed by Northstar New Media, Orkney, and used 10 m resolution OS height data with a viewing height of 1.6 m (average human eye height). The ZTV is considered to represent worst-case visibility, as it assumes a bare terrain and does not take into account the localised screening effects of buildings, trees etc.

Defining criteria for assessment

12.3.11 In order to provide a level of consistency to the assessment, the prediction of magnitude and assessment of significance of the residual landscape/seascape and visual effects have been based on predefined criteria.

12.3.12 The sensitivity of the landscape/seascape is not fixed, but varies according to the existing landscape/seascape, the nature of the proposed development and the type of change being considered. The determination of the sensitivity of the landscape/seascape resource to changes associated with the proposed development is based on interpretation of a combination of parameters, as follows:

- Pattern and scale of the landscape/seascape;
- Visual enclosure/openness of views and distribution of visual receptors;
- The scope for mitigation which would be in character with the existing landscape/seascape; and
- The value placed on the landscape/seascape.

12.3.13 A three level system can be employed to describe relative levels of landscape/seascape sensitivity. This is shown in Table 12.1.

Table 12.1 Levels of landscape/seascape and cultural heritage site sensitivity

Sensitivity	Definition
High	Sensitive characteristics and features are present such as a simple or indistinct pattern, few existing foci, sense of intimacy and shelter and sense of wildness, and these contribute significantly to the distinctiveness of the landscape/seascape character type. The distinctive characteristics of the landscape/seascape are widely experienced and contribute significantly to the value of the landscape/seascape at a local, regional and national level. Such landscapes/seascapes may be designated. Designated monument which is an obvious feature in the landscape and likely to attract visitors.
Medium	Sensitive characteristics and features are present but may integrate with the proposed development, such as a landscape with a distinct pattern, with occasional prominent foci, large scale structures, a sense of enclosure and landform into which the development could fit. The development would not affect the key characteristics that contribute to the distinctiveness and/or value of the landscape/seascape. The distinctiveness of the landscape/seascape is only experienced and/or only contributes to the value of the landscape/seascape at a regional level. These may be locally valued landscapes/seascapes that are not designated, and in which it is possible to site and design a development to have minimal effects within the landscape/seascape. Designated monument which is not an obvious feature in the landscape and unlikely to attract visitors.
Low	A landscape/seascape where the proposed development would not affect the key characteristics that contribute to the distinctiveness and/or value of the landscape/seascape. Characteristics and features which do not make a significant contribution to landscape character or distinctiveness locally, or which are untypical or uncharacteristic of the landscape/seascape character type. Areas where the proposed development would fit the key characteristics of the existing landscape/seascape and/or where this can easily accommodate landscape/seascape change subject to careful design. Distinctive characteristics are only experienced locally and it is possible to site and design a development to have minimal effects within the landscape/seascape. Historical site which is not designated.

12.3.14 The sensitivity of visual receptors is based on an interpretation of a combination of parameters as follows:

- The location of the viewpoint;
- The context of the view;
- The activity of the receptor; and
- The frequency and duration of the view.

12.3.15 Visual receptor sensitivity is defined as high, medium, low or negligible as shown in Table 12.2.

Table 12.2 Levels of visual receptor sensitivity

Sensitivity	Definition
High	Walkers on a designated footpath or others whose attention may be focussed on the landscape/seascape e.g. boat users; Important seascape/landscape features with physical, cultural or historic attributes; Residents; Beauty spots, recognised viewpoints and picnic areas.
Medium	Those in transit through or past the landscape/seascape, e.g. road users; Walkers on unmarked/undesignated paths.
Low	Those engaged in outdoor recreation whose focus is not the landscape/seascape e.g. birdwatchers; Commercial buildings; Merchant ships.
Negligible	Heavily industrialised areas.

12.3.16 The magnitude of change arising from the proposed development at any particular viewpoint is described as substantial, moderate, slight or negligible based on the interpretation of a combination of largely quantifiable parameters, as follows:

- Distance of the viewpoint from the development;
- Duration of impact;
- Angle of view in relation to main receptor activity;
- Proportion of the field of view occupied by the development;
- Background to the development; and
- Extent of other built development visible, particularly vertical elements.

12.3.17 Levels of magnitude are defined as major, moderate, minor or negligible as shown in Table 12.3.

Table 12.3 Levels of magnitude

Level of magnitude	Definition of magnitude
Major	Total loss or major alteration to key elements of the baseline conditions prior to development, resulting in a fundamental change.
Moderate	Partial loss or alteration to one or more key elements of the baseline conditions prior to development, resulting in a partial change.
Minor	Minor loss or alteration to one or more key elements of the baseline conditions prior to development, resulting in a discernible change, but with baseline conditions remaining similar to the original.
Negligible	Very minor loss or alteration to one or more key elements of the baseline conditions prior to development, resulting in a barely distinguishable change.

12.3.18 The significance of any identified seascape/landscape or visual impact has been assessed as major, moderate, minor or no impact. These categories have been determined by consideration of seascape/landscape or visual sensitivity and predicted magnitude of change as described above. The following matrix (Table 12.4) is used as a guide to correlating sensitivity and magnitude to determine significance of effects. Those criteria in red text are considered significant under the EIA regulations.

Table 12.4 Effect significance matrix

Landscape/seascape and visual sensitivity	Magnitude of change			
	Major	Moderate	Minor	Negligible
High	**Major**	**Major**	**Moderate**	**Minor**
Medium	**Major**	**Moderate**	**Moderate**	Minor
Low	**Moderate**	**Moderate**	Minor	Minor
Negligible	**Moderate**	Minor	Minor	None

12.3.19 Where the seascape/landscape or visual effects have been classified as major or moderate, this is considered to be a significant impact. It should be noted that significant effects need not be unacceptable or necessarily negative and may be reversible.

Field survey

12.3.20 The field survey, undertaken on the 29^{th} and 30^{th} August 2007, was used to confirm the visual influence of the developments, principle viewpoints and sensitive receptors identified during the desk based study. The weather on 29^{th} was overcast with persistent rain and poor visibility, so more distant receptors were visited on 30^{th} when visibility was improved, with bright sunshine interspersed with cloudy spells and rain.

12.3.21 Principle representative viewpoints within the study area were identified during the field visit. At each survey point both subjective and objective observations were recorded. Objective observations note the intrinsic qualities of the landscape itself while subjective observations record the response of the assessor.

12.3.22 The field investigation specifically involved onsite evaluation of the following elements:

- Regional and local landscape characteristics;
- Site visibility and important viewing locations;
- Significant visual site features; and

- Surrounding land and sea users.

12.3.23 Photographs were also taken at each survey location by a local Lewis-based professional photographer when suitable conditions were available and using standard photographic methodologies for this work.

12.3.24 The computer-generated ZTV was ground-truthed in the field by walking on footpaths, roads and vacant land, noting the localised screening effects of buildings, trees, walls, fences and banks. This is reported in diagrammatic format as the Zone of Visual Influence (ZVI, Figure 12-2b) with the position of each photograph being noted. Some areas on the periphery of the ZTV were not visited due to their remoteness, however even if a line of sight was possible from these areas, they are considered to offer such marginal views as to be insignificant and are therefore not represented in the ZVI.

Applying criteria to the assessment and presentation of results

12.3.25 The assessment criteria were applied to the field survey findings in a systematic way, using impartial judgement. The diagrammatic representation of the ZVI aids judgement on the likely residual impact of the SWEP project.

12.3.26 Although views of the proposed development may be attained from the boundaries of the study area defined in Figure 12-2a, the most significant views which are considered to have the greatest impact on visual amenity are from less than 1.5 km (close views) and from elevated middle distant views of less than 3 km. The proposed development viewed at a distance greater than 3 - 4 km is considered to represent a small feature.

12.3.27 Table 12.5 lists sources of background data utilised for this assessment.

Table 12.5 Sources of data: Landscape and visual assessment

Topic	Subject	Source
Cultural heritage	Scheduled Ancient Monuments (SAMS) in the viewshed.	Siadar Active Breakwater Scheme: Desk–based assessment, walkover survey and recommendations (archaeology). Barrowman (2007).
Landscape	Landscape character types present.	Western Isles landscape character assessment. Richards (1998).
	Landscape capacity in the area.	Landscape capacity study for onshore wind energy development in the Western Isles. SNH commissioned report No. 042. Benson *et al* (2004).

Topic	Subject	Source
	Landscape features present.	Ordnance survey map for Stornoway and North Lewis. Ordnance Survey (2001).
Seascape	Seascape character types present.	An assessment of the sensitivity and capacity of the seascape in relation to windfarms. SNH commissioned report No. 103. Scott *et al* (2005).

Photomontage production

12.3.28 Using the site photographs and detailed technical design drawings, as featured in Section 3, it was possible to produce correctly scaled and positioned computer generated photomontages of the project. The design options used were specified in accordance with Table 12.7. In total 7 photomontages of the scheme were produced from various viewpoints.

Scoping and consultation

12.3.29 Consultation in relation to the landscape and visual assessment has been undertaken with the bodies listed in Table 12.6 below. The issues detailed in the table include those raised in the Scoping Opinion.

Table 12.6 Consultation: Landscape and visual

Name of Organisation	Key Concerns	Comment
SNH	A full landscape and visual impact assessment must be conducted, with assessments from fixed locations to be agreed between the developer, SNH and the local authority.	Fixed locations included in this assessment have been agreed with SNH.
	Reference should be made to ‘Landscape capacity study for wind farms in the Western Isles’.	This assessment references the recommended text.
Historic Scotland	A Zone of Visual Influence (ZVI) map should be used to identify effects on the setting of cultural heritage features.	A ZVI map has been used to identify all significant impact areas.
	The visual impact of the proposed development and its associated construction works should be assessed for all Scheduled Ancient Monuments (SAMs) visible from the development.	Visual effects from all SAMs within the ZVI are considered in this assessment.
	Photomontages should be created where significant effects are predicted using CAD software to give a realistic idea of visual impact.	CAD software has been used to create photomontages for this assessment.
	Expect cross referencing between	Landscape and visual effects on cultural heritage

Name of Organisation	Key Concerns	Comment
	landscape and visual and cultural heritage sections of the ES.	are considered in this section and referenced in Section 9.
	Cumulative effects should be considered, both in terms of the different components of the development itself and in combination with potential wind farm developments.	Both types of cumulative impact are covered in this assessment.
Comhairle nan Eilean Siar	Landscape and visual effects are a significant issue, particularly with regard to associated buildings and land-based infrastructure. Viewpoints from where the assessment was to be taken from were agreed with CnES in mid-2007.	All landscape and visual aspects will be addressed in this assessment, including photomontages of the permanent control building. More temporary infrastructure will also be addressed, but only in a qualitative manner, as accurate montages of this are impossible and potentially misleading.
Local community	Concerns raised about visual intrusion for residents of Siadar village.	Potential visual intrusion considered in this assessment with photomontages produced from key local vantages and residences.

12.4 Pre-assessment of worst case design options

12.4.1 The worst case design option that has been used for the landscape and visual assessment is as follows: a breakwater 250 m in length and located approximately 350 m offshore due west of Siadar, with a fixed permanent access link to shore, within which would be embedded ducted cables leading to the onshore control building. This control building would be located at the point where the fixed permanent access link meets the shore adjacent to the existing slipway. The fixed permanent access link would be constructed of part rubble mound and part steel truss bridge. Table 12.7 outlines the details of each visual component in the worst case design to be assessed in detail.

12.4.2 The alternative design options involve no major facilities which will not be present in the worst case design. The major difference is the location of the onshore control building/boathouse.

12.4.3 The construction site, possible borrow pit and temporary access track will have mainly temporary effects and will be reinstated as far as possible on completion of construction. As a result these effects are discussed in the text of this assessment only and not represented in any visualisations of the development.

Table 12.7 Visual component details

Visual structure	Details
Permanent features	
Breakwater	10 x 24 m concrete caissons. 250 m long, 16.5 m wide, 16.5 m high on -5 m CD seabed at this location.
Fixed link	250 m long rubble mound (crest level +6 m CD), followed by 250 m steel truss bridge (road level +8.6 m CD) with a light rail system or roadway wide on top.
Onshore control building	Longhouse design approximately 31 m long, 8.5 m wide and 6 m high. Stone and timber clad with sheet metal roof. Interpretation boards may be incorporated onto the exterior of this structure.
Lighting	During operations, the control building will feature external lighting during maintenance or in the event of an emergency callout. The walkways and access areas on the breakwater structure may also have some safety lighting in the operational phase. Navigational lighting of the offshore structure will also be installed in accordance with NLB requirements.
Improved access roads	The existing route by Baile an Truiseil may need to be maintained during construction and made good at the end of the works and tracks may also need to be widened in places.
Temporary features	
Construction compound	Approximate 8.5 ha compound containing construction site for caissons, site accommodation for 10-20 people, materials storage including bunded tanks, topsoil storage, two cranes and winch equipment.
Lighting	Lighting of the construction compound will be required. During construction, the offshore components of the site may also require lighting during working hours.
Borrow pit	Stripping off of peat topsoil and a shallow skim of rock extracted over a large area to supply aggregate materials to the site as demand dictates. Located within 1 km of the development.
Access track to borrow pit	A track leading from the construction compound to the borrow pit. This would be either a hard base road, which would mean the stripping and storing of topsoil or a floating road which would leave all but the surface level of soil undisturbed.

12.5 Baseline conditions

12.5.1 Figure 12-2a defines the study area as established by the ZTV and Figure 12-2b shows the ground-truthed ZVI for the breakwater. The area comprises a 4.5 km radius circle centred on the breakwater site, this being sufficient to encompass the landward viewshed. Guidance from Hill *et al* (2001) and knowledge of topography in the area aided the decision on study area extents.

12.5.2 The study area extends just over 3 km inland, covering an area of coast from Upper Barbhas in the south to the settlement of Bhuirgh in the north. Figures 7-1 and 12-3 show landscape character types and conservation designations in the study area.

General landscape/seascape characteristics

12.5.3 The study area comprises four elements; the open sea, an area of low rocky coastline rising to small cliffs in places which forms the transition between land and sea, this in turn giving way to gently sloping croft land on the coastal fringe, backed by gently undulating peat moorland.

12.5.4 The scale of the landscape is large with open views commonplace. The landform is, however, occasionally dissected by small, steep-sided river valleys which provide localised enclosure. The coastline is exposed and relatively linear, with the absence of any landform off the coast affording clear, long distance views out to sea.

12.5.5 At the proposed development location, the coastline consists of a small rock bay backed by a cobble beach, areas of exposed bedrock and small cliffs. Several bedrock outcrops occur in the area, particularly on either side of the bay and adjacent coastline. These are interspersed with more cobble beaches and eroding cliffs. The nearshore seabed is shallow and primarily a continuation of bedrock.

Settlements

12.5.6 Settlement in the study area, which is predominantly rural in character, comprises a few small-scale linear and grid-type crofting villages, this pattern relating to land use management. The majority of houses in the area are harled grey and of one or two stories. These settlements are quiet with some streetlights which illuminate localised areas at night.

Cultural heritage

12.5.7 The archaeological assessment of the site identified five SAMs within viewing range of the proposed development. These are shown in Figure 12-2b.

Agriculture

12.5.8 The Western Isles Local Plan (2005) identifies an area of Locally Important Agricultural Land within the study area. This is shown in Figure 7-1 (Section 7) and is primarily used for the grazing of sheep.

Infrastructure

12.5.9 Access to the north coast of Lewis is via the A857, which runs north west from Stornoway to Barabhas, then parallel to the coast through the study area and on to Port Nis in the northeast. The remaining roads in the study area are limited to minor roads through villages, toward the coast and inland toward moorland. Often these roads lead to tracks which become unsuitable for most forms of traffic, particularly where they lead into moorland.

Marine users

12.5.10 Sea users in the area that may experience views of the development include:

- **Fishing vessels** these include local near-shore vessels; and
- **Recreational craft** these may very occasionally pass by; the RYA assigns the region of north west Lewis as an area of light usage.
- **Surfers** several surfing sites are located along the north coast of Lewis approximately 3 - 4 km from the proposed development and breaks at the south of Siadar Bay.

Tourism

12.5.11 Tourists likely to be visiting the Siadar area will be those engaging in outdoor pursuits such as cycling, hiking, angling and surfing or other activities such as visiting cultural heritage sites and wildlife watching, and coach parties also pass through the area.

Landscape character

12.5.12 The landscape character of the study area is described in Richards (1998), and is revised in Benson *et al.* (2004) and the seascape character is described in Scott *et al.* (2005). These have been used to inform the assessment of the proposed development. The landscape and seascape character types in the study area are illustrated in Figure 12-3.

12.5.13 Richards (1998) identifies two landscape character types in the study area. These are ‘crofting one’ and ‘boggy moorland’ Landscape Character Types (LCTs). Benson *et al.* (2004) further subdivided the ‘boggy moorland’ LCT into ‘boggy moor 1’ and ‘boggy moor 2’. The subtype present in the study area is ‘boggy moor 1’. Scott *et al.* (2005) identify the seascape as being ‘low rocky island coast’ Seascape Character Type (SCT). The key characteristics of these character types are described below.

Crofting one

12.5.14 This landscape character type constitutes most of the coastal fringe of the study area. It is characterised by long, sweeping gentle slopes, often domed and ending in long curving beaches to the seaward and merging evenly into boggy moor 1 elsewhere. Occasional small, steep-sided river valleys dissect the even outlines. Low skylines, 'toothed' with croft houses and other buildings are characteristic, the houses being of similar size and shape and arranged in a repetitive pattern of either a linear or grid-type.

12.5.15 The scale of this landscape is large with open views commonplace, though occasionally landform variation combines to give a more intimate scale. The exposed nature of this landscape mean it is open to the elements.

12.5.16 Visual diversity is largely derived from land use management patterns and there tends to be little or no transition between managed grasslands and moorlands. A rectangular field pattern often overlies the gently rolling landscape; however this does not override the underlying large scale character, particularly as fences tend to be made up of post and wire only.

12.5.17 Individual buildings are small and often detached. In many cases the original croft houses have been replaced/ added to by more modern and less characteristic. The repetitive pattern of croft houses backed by crofting strips is a strong, unifying feature to this landscape. Settlements within the study area contain both linear and grid type arrangements. In linear sections such as those at Baile an Truiseil and Upper Siadar, views out to sea and over moorland give a perception of rural remoteness, however in the more grid-type Siadar and Coig Peighinnean Bhuirgh the impression is one of more expansive and widespread habitation.

Boggy moor 1

12.5.18 The remainder of the coastal fringe and the landward side of the study area, south of the A857, is classified as boggy moor 1. This landscape is characterised by large scale, gently undulating peat moorlands indented with large and small lochs which are frequently interconnected by narrow slow moving rivers. Lochs in boggy moor 1 are an occasional rather than a main feature. Loch edges are highlighted by their deep, dark peat margins and rivers are cut into smaller peat edged valleys. Occasional small shallow sided hills rise from the gently undulating surroundings.

12.5.19 Where the moorland extends to the coast it often terminates in sea cliffs with deeply eroded gullies. This can be observed on the coast to the southwest of the proposed breakwater site.

12.5.20 Relatively few elements contribute to this character type, these tending to be simple and contrasting. The muted tones of moorland vegetation, gently rolling topography, reflective water bodies and inland location of much of the moorland combine to give the area a remote upland character which is unusual in a lowland area.

12.5.21 Cultural elements of diversity in this landscape include peat cuttings, tracks, ruined sheilings and re-seeds and sheep are also grazed here. Despite these human influences, the overall perception is of a predominantly uninhabited landscape.

12.5.22 There are a few very small areas of coniferous woodland in the study area, two of these occurring on the moorland side of Siadar and Upper Siadar. Their strong vertical edges, uniform colour and small scale contrast strongly with the expansive large scale nature of the surrounding moorlands. Their small size and infrequent occurrence, however, means they have little impact on the overall open character of the landscape but do give shelter and introduce an element of diversity whilst providing some localised screening.

Low rocky island coast

12.5.23 Low rocky island coast is the only seascape character type in the whole of the study area. This landscape is characterised by low rocky coastline rising to cliffs in places, backed by moorland behind a coastal fringe of crofting settlements.

12.5.24 The transition between land and sea is marked by two beaches of large cobbles to the south and southwest of the proposed breakwater site. The cobbles built up to the rear of these beaches obscure views to sea from immediately behind this area.

12.5.25 The exposed coastline is strongly defined and linear with open views of the Atlantic occasionally limited by undulating landform. The combination of moorland, low key crofting and exposure to open sea makes the perception of this seascape very remote. There is a strong sense of being on an island here.

12.5.26 The scale is large and fairly open with some small ridges running perpendicular to the coast providing some limited containment; however the hinterland is generally flattish and open with wide views of the open sea.

12.5.27 Settlements are the main foci in the area, but are not large enough to create any consistent visual screening of the sea which is a dominant characteristic. The elements and natural landscape dominate, so there is a strong sense of naturalness even around settlements.

12.5.28 The aspect is west facing the open Atlantic. The sun setting will be the dominant focus at night. The area of sea visible from here is dark without any significant shipping, only very occasional ships and boats. The elements dominate the sense of movement, which is mainly caused by wind and waves.

Designated areas

12.5.29 There are no landscape designations within or around the study area, including NSAs. The only designated area close to the proposed development is one of Locally Important Agricultural Land; however this area would not be directly affected by the proposed development. Nature conservation designations which occur in the periphery of the study area are listed in Table 4.1 and shown in Figure 7-1 and cultural heritage sites are shown in Figure 9-1 (Section 9). The location of the five Scheduled Ancient Monuments are provided in Figure 12-2b.

12.6 Potential effects on landscape/seascape character

12.6.1 This section identifies the changes in landscape/seascape character which may result from the construction, operation and decommissioning of the proposed development. Some changes in the landscape and seascape character areas will arise from the proposed development. The following sections outline the potential landscape/seascape effects associated with each aspect of the project.

Assessment of effects - construction

General

12.6.2 The changes in landscape/seascape character during construction will commence with the arrival and presence of workmen, lighting and construction equipment as described in Section 3. The volume of road and sea traffic within the aforementioned landscape/seascape character areas in the study area will be affected temporarily throughout the anticipated 18 month construction period.

12.6.3 Following construction, the land will be reinstated back which should after some time return to near original state. The assessment of changes during construction therefore refers to those features which will not be permanent. The one potential exception to this is the concrete slip which may be installed to facilitate the floating of the breakwater caissons out to sea.

<u>Landform</u>

12.6.4 Excavation activities associated with the establishment of the construction compound, borrow pit, access track, control building, fixed link and cable laying under the foreshore may affect landform through the grading out and storage of excavated material. Stockpiling of the stripped topsoil to screen the compound will also affect landform to an extent in the immediate area. Such effects will, however, be temporary in nature.

12.6.5 The excavation of aggregate material from the borrow pit site will lead to a more permanent change in landform, however the scar produced will have minimal impact on landform as although taken over a wide area, it will be shallow and not a distinctive feature on the landscape. The reinstatement of topsoil and vegetation following aggregate removal will leave a mark similar to peat scars, which are numerous in the area.

12.6.6 Dredging and foundation preparation for the breakwater and caissons will impact upon landform at low tide due to the presence of mounds of dredged material. This impact will, however, be temporary as dredged material will be reused in construction. Dredging for the construction slipway will also cut a trench 20 m wide which would be visible at low tide.

<u>Land use and landscape pattern</u>

12.6.7 Construction activities will encroach upon areas of sheep grazing land for the duration of the construction phase. This will, however, be temporary as following construction grazing land will be reinstated.

<u>Man-made features</u>

12.6.8 Construction activities associated with the development will result in the temporary introduction of site offices, storage compounds, protective fencing, construction lighting, additional traffic and associated workforce into the 'crofting one' landscape. Sea traffic directly involved in offshore construction, carrying construction materials to site and possibly disposing of dredge material offsite, will increase in the 'low rocky island coast' seascape during the construction period.

Assessment of effects arising from construction operations

12.6.9 The assessment of the effects of the above changes is influenced by the following factors:

- Duration of the construction period;
- Type of plant and equipment;
- Size of workforce proposed;
- Extent of reinstatement works to be undertaken; and
- Nature and scale of construction operations.

12.6.10 It is considered that all landscape and seascape character areas in the study area are of medium sensitivity, as they are not designated landscapes/seascapes, and although sensitive characteristics are present, these may integrate with the proposed SWEP development; it is not considered that the development would affect the key characteristics that contribute to their value. With this in mind, and considering that the magnitude of change in the 'crofting one' LCT and the 'low rocky island coast' SCT as a result of construction activities will be moderate (i.e. resulting in a partial change to baseline conditions), the effect on these areas as a result of construction activities will be **moderate**. There will be **no impact** on the 'boggy moor 1' LCT as no construction activity will occur here.

12.6.11 Following completion of construction activities all temporary fencing, construction lighting, plant and construction equipment will be removed from site and the necessary reinstatement works carried out to restore the land back to its original state (rough grazing).

Assessment of effects - operational

Landform

12.6.12 During the operational phase of the project, the following permanent changes to the landform of the 'crofting one' LCT and 'low rocky island coast' SCT will remain:

- Fixed link from shore extending from either the location of the existing slipway or the construction site; and
- Minor alterations to the adjacent landform through improvement of existing access roads.

Land use and landscape pattern

12.6.13 The only permanent changes to land use and landscape pattern in the 'crofting one' LCT would be possible loss of a small area of marshland behind the bay to accommodate the onshore control building adjacent to the existing slipway, with some adjustments to the managed, modified water courses nearby.

Man-made features

12.6.14 Following construction, the operational phase will result in the introduction of the permanent features listed in Table 12.7 to the 'crofting one' LCT and 'low rocky island coast' SCT.

12.6.15 Maintenance of the proposed structure would also mean the occasional presence of a temporary workforce with associated vehicles and equipment.

Significance of effects associated with the operational phase

12.6.16 The main changes which will occur in the character of the 'low rocky island coast' SCT during the operational phase of the development will be:

- The addition of a large-scale, man-made element in the form of the breakwater and associated fixed link to shore;
- The use of concrete and steel for the larger elements of the development introducing an industrial element to an otherwise wild seascape;
- The introduction of large, regular geometric structures into a comparatively irregular seascape;
- The intrusion of the breakwater and fixed link as a new foreground feature into the open outlook characteristic of this area;
- The introduction of structural lighting;
- The introduction of navigational lighting; and
- The introduction of additional boat traffic and increased presence of boats which utilising the improved sheltered inshore area.

12.6.17 Following analysis of the above changes in the 'low rocky island coast' SCT, which is considered to be of medium sensitivity, and given the moderate magnitude of change, it is considered that the proposed development will result in a **moderate** impact on the existing seascape character of the area.

12.6.18 The main changes which will occur in the 'crofting one' LCT during the operational phase of the proposed development will be:

- The addition of a relatively small-scale built element in the form of a control building which will be single story and built with a design taking into consideration the local vernacular and using traditional materials;
- Possible small scale alterations to landform at the reinstated borrow pit;
- Possible loss of a small area of marsh or rough grazing land;
- Possible redirection of managed, modified water courses;
- The improvement of a stretch of single track road;
- The introduction of structural lighting; and
- Additional vehicles in the area.

12.6.19 Following analysis of the above changes in the medium sensitivity 'crofting one' LCT, and considering the moderate magnitude of change, it is considered that the proposed development will result in a **moderate** impact to the landscape character of the area, these effects being mainly localised to the immediate coastal area behind the bay.

12.6.20 The operational aspects of the proposed development will result in no change and therefore **no impact** to the surrounding 'boggy moor 1' LCT.

Assessment of effects - decommissioning

12.6.21 At the end of the schemes operational life, electrical and mechanical components will be removed from the breakwater and any openings made safe. The breakwater and fixed link will remain, primarily as they would have a continued use in providing shelter for the bay. Any electrical cables are likely to be left in situ provided the likelihood of exposure is shown to be limited, thus minimising the need for further excavations.

12.6.22 The decommissioning phase will be temporary, and as it involves no major works other than some increased traffic and human activity for a short period in the 'crofting one' LCT and 'low rocky island coast' SCT. The change in these areas as a result of decommissioning will therefore be negligible, resulting in a **minor** impact.

12.6.23 The decommissioning of the proposed development will result in no change and therefore **no impact** to the surrounding 'boggy moor 1' LCT.

Impact on the setting of Scheduled Ancient Monuments (SAMs)

12.6.24 The proposed SWEP development will only be visible from two of the five SAMs in the ZVI (see Figure 12-2b). These are Clach an Truiseil standing stone and Teampall Pheadair ruined chapel and settlement. The impact of the development on the settings of these monuments is considered below. There will be no impact on the settings of the remaining three SAMs, i.e. Steinacleit, Clach Stei Lin and Loch an Duin.

Teampall Pheadair

12.6.25 This site is considered to be of medium sensitivity, as although it is a SAM, it is not an obvious feature on the landscape, is unsignposted and unlikely to attract visitors. Although the proposed breakwater will be clearly visible from this monument, it will be in general keeping with the existing setting of the monument, which overlooks the existing slipway and rocky foreshore. In comparison with the proposed SWEP development, however, the existing slipway is much less noticeable; therefore the magnitude of change is moderate and a moderate impact on the setting is predicted.

12.6.26 The proposed sites of the construction compound and borrow pit have the potential to have a greater impact as they potentially cover a larger area. However, the proposed location of the construction compound will be between 0.5 and 0.8 km away from Teampall Pheadair, and situated behind a shingle bank in an area already housing sewerage pipes and access tracks. As such it will not represent a significant change to the setting, which has already been subject to low-key intrusive works. The proposed location of the borrow pit is further to the west, up to 1.2 km away. The works associated with the proposed breakwater will therefore result in a change of negligible magnitude, and as this affects a setting of medium sensitivity, there will be a minor impact, particularly as the construction site will be temporary, and reinstatement works will be undertaken at both the construction site and borrow pit following construction. The conclusion of a minor effect assumes that quarrying at the borrow pit will not be extensive in depth or spread. Were the quarrying to be more extensive, a greater (moderate) impact on the setting of the Teampall Pheadair site will be expected.

12.6.27 Overall, the impact on the setting of Teampall Pheadair is judged to be **moderate.**

Clach an Truiseil

12.6.28 This site is considered to be of high sensitivity, as it is the tallest standing stone in Scotland and likely to attract tourists. Clach an Truiseil is 1.2 km away from the proposed breakwater, which will be just visible in seaward views from here, resulting in a negligible change and having a minor impact on the setting of the site. This monument is closer to the southern edge of the area proposed for the temporary construction compound (between 0.5 and 0.85 km away), and the possible borrow pit area to the west (between 0.45 and 1 km away). However, Clach an Truiseil is already set in an area of later settlement and crofting, and as such is not in an 'empty' landscape. There already exists a small, modern quarry 0.5 km from the stone, which is only just visible from the site. The proposed construction compound and borrow pit will therefore lead to a negligible change, and will have a minor impact on the setting. However, if the borrow pit is extensive, there will be a higher (moderate) visual impact, which may detract from the setting of the site.

12.6.29 Overall, the impact on the setting of Clach an Truiseil is judged to be **minor to moderate**, depending on the size and depth of the proposed borrow pit.

Summary of effects upon landscape/seascape resource

12.6.30 In examining the changes in the key characteristics of the existing landscape/seascape resource, the following are considered to be critical factors:

- The landscape/seascape of the study area currently has a remote character with very few large-scale, man-made elements. The introduction of additional man-made structures will adversely affect the relatively undisturbed character of the bay and its immediate surrounds.
- The development will be constructed in an area in which a man-made construction (the slipway) already exists, though this is barely noticeable in scale compared to the development proposed.
- The establishment of the permanent infrastructure associated with the development is likely to result in the loss of a small area of marshland/grassland, however it is not considered that this will cause any substantial alterations to the coverage and pattern of land use within the study area.
- The landscape of the study area currently has a strong horizontal emphasis, into which the development will introduce an additional horizontal element.

- The development will introduce large, modern, geometric manmade structures into an area where built features are generally small-scale and of older origin (albeit in a relatively modern style) and where landform is irregular.
- The open outlook which is characteristic of the 'low rocky island coast' SCT will be interrupted locally by the development, which will introduce a new dominant foreground focus which will be lit occasionally.
- Additional road, sea and pedestrian traffic will be introduced into and concentrated within a small part of the study area where such movement is currently limited to a few visitors, fishermen, surfers, ramblers and dog walkers.
- The development will be a permanent feature of the landscape of the study area.

12.6.31 It is concluded that, prior to mitigation, the development has the potential to have a **moderate** impact on the character of the 'low rocky island coast' SCT and a **moderate** impact on the 'crofting one' LCT. There will be **no impact** on the surrounding 'boggy moor 1' LCT. Overall it is concluded that the development will have a **moderate** effect on the landscape/seascape of the study area as a whole.

Mitigation measures

12.6.32 A number of mitigation measures will be employed to reduce the effect of the development on the landscape/seascape resource. These include:

Construction

- Sensitive siting of construction offices, plant and materials to minimise effects of the works during construction wherever possible;
- Existing access tracks will be used as far as possible and where a new track is required, this will be temporary with reinstatement following construction;
- The rock used to construct a rubble mound fixed link will wherever possible be similar to the local naturally occurring stone and be randomised in size and arrangement wherever possible to tie in with the surrounding natural and varied rock forms;
- Wherever possible the colour of the concrete and other aggregate materials employed in the construction will be chosen to coordinate with the local rock, which will assist in relating the colour of the new structure to nearby natural rocks/outcrops and stone structures;
- If deemed suitable, rock spoil generated during construction activities will be reused as a source of aggregate for construction, thus minimising the amount of material that needs to be excavated from the borrow pit; and

- The improvement of road sections to improve access may have small scale effects upon the adjacent landform. Where the road cuts into existing slopes or where it is elevated above existing ground, the tops and toes of the slopes will be gently rounded to ensure that any grading-out is sympathetic to the surrounding landform.

Operation

- The primary mitigation measures associated with the reduction of potential adverse effects on landscape character involved the consideration and development of scheme alternatives. The proposed SWEP development will be located in an area already affected to some extent by manmade structures and will have minimal impact on the character of the area as the landform means that the effect on the landscape/seascape will be localised;
- If the fixed link is to be of a similar orientation to the existing pier, this will build on an existing feature in the landscape rather than introducing an entirely new feature;
- Orientation of different aspects of the development will be such as to blend as far as possible into the wider landscape; and
- The final design of the control building will build upon the indicative designs which adopted a local style and contained a single storey 'long-house design'. This design incorporates natural materials (wood and stone) to blend in well with the local landscape minimise intrusion on the landscape.

Reinstatement

- The reinstatement of areas disturbed during construction will be fundamental to ensuring that the scheme is absorbed as much as possible into the existing landscape. A reinstatement plan will be developed with the project ecologists in consultation with SNH to ensure this can be achieved;
- The construction compound area and borrow pit access track will be fully reinstated following construction, with the exception of any area where the control building would be located; and
- A shallow skim excavation of the borrow pit followed by full reinstatement in a profile best suited to tie in with the surrounding landscape. A layer of at least 1 m of peat or sufficient to allow proper reinstatement will be replaced on top of the rock.

Lighting

- Control of lighting on the structures will be implemented to ensure that it is only provided as and when necessary; and

- Wherever possible, and without compromising safety standards, road markings, lighting or other structures associated with the access road will be kept to a minimum.

Residual effects on landscape/seascape following mitigation

12.6.33 Despite the proposed SWEP development being an obvious feature in the local landscape/seascape, it affects just a small area of only two landscape/seascape character areas of medium sensitivity. However, the greatest effects upon the landscape resource of the study area will arise predominantly from the large scale and geometric form of the proposed breakwater and associated fixed link which will be permanent features of the development. The mitigation measures outlined above will contribute to the integration of the proposed development into the affected landscape/seascape character areas; however there is a limit as to how far these measures can go to reduce the overall landscape/seascape effects. The overall residual impact of the site on landscape/seascape character therefore remains **moderate**.

12.6.34 Table 12.8 provides a summary of the impact of each of the scheme phases on each individual landscape/seascape character type.

Table 12.8 Impact of scheme phases on individual landscape/seascape character types

Phase	Impact on landscape/seascape character types		
	Crofting One	**Boggy Moor 1**	**Low Rocky Island Coast**
Construction	Moderate	No Impact	Moderate
Operational	Moderate	No Impact	Moderate
Decommissioning	Minor	No Impact	Minor

12.7 Potential visual effects and photomontages

12.7.1 This section assesses the potential visual effects arising from the proposed development. Figure 12-2b, which shows the ZVI for the breakwater and associated permanent infrastructure, demonstrates that the associated viewshed will be largely limited to the sea and a relatively short stretch of coastal fringe. The area of sea from which the breakwater will theoretically be visible is large, though the presence of headlands to the northeast and southwest of the site will prevent views from the areas of sea behind these headlands. The ZVI on land is essentially limited to the coastal fringe to the seaward side of the A857; however views from distant hilltops on the landward side are also theoretically possible.

12.7.2 One of the most important parameters to consider when assessing the potential visual impact of the proposed development is distance. Beyond the boundaries of the study area, in the heart of the Lewis Peatlands, it is theoretically possible that views of the development could be obtained from distant hills, however these areas are remote and relatively inaccessible and this, coupled with the fact that coastal topography was on the site visit found to prevent views from even nearby hills, meant that these distant sites were not included in the study area.

12.7.3 The potential visibility of the proposed development varies throughout the study area. A range of potential sensitive receptors which were identified within the area are detailed below. Photomontages were generated from photographs taken to represent views from each potential sensitive receptor. These show how the development will appear as viewed from each receptor (Figures 12-4 to 12-12).

Potential sensitive receptors

12.7.4 Assessment is based on the potential visibility of the proposed development throughout the study area and the detailed analysis of possible visual effects from 9 potential sensitive receptors (viewpoints). These are detailed in Table 12.9 and shown in Figure 12-2b. Only two of the five SAMs in the ZVI were considered potential sensitive viewpoints (i.e. Clach an Truiseil and Teampall Pheadair), as these are the only SAMs from which the proposed SWEP development will be visible. Views of the development will not be possible from the remaining three SAMs (i.e. Steinacleit, Clach Stei Lin and Loch an Duin).

12.7.5 An initial 5 viewpoints (1 - 5 on Table 12.9) were selected based on consultation with SNH, with another 4 (6 - 9 on Table 12.9) being added following a desk study and subsequent site visit. The final viewpoints chosen represent views from a range of representative landscape and visual receptors, in particular local communities. These viewpoints also represent different distances, elevations and directions from the proposed development.

Table 12.9 Viewpoint details

Number	Viewpoint description	Grid reference	Distance to breakwater (km)	Direction to breakwater	Aspect of development visible	Key receptors
1	Public access point to bay.	NB 3795, 5495	0.5	NW	Breakwater, construction site.	Walkers.
2	Closest dwellings at Upper Siadar.	NB 3830, 5462	0.9	NW	Breakwater, construction site, borrow pit.	Residents, road users.
3	Clach an Truiseil standing stone SAM.	NB 3758, 5374	1.4	N	Breakwater, construction site, borrow pit.	Residents, tourists.
4	A857 directly opposite the breakwater site.	NB 3827, 5365	1.6	NW	Breakwater.	Road users, residents.
5	Southernmost limit of visibility from A857.	NB 3695, 5258	2.5	NNE	Breakwater.	Road users.
6	Track past Teampall Pheadair ruins SAM.	NB 3841, 5522	0.9	WSW	Breakwater, construction site, borrow pit.	Walkers.
7	Coast to the southwest of the site.	NB 3699, 5431	1.0	NE	Breakwater, construction site, borrow pit.	Walkers.
8	Track leading to Lewis Peatlands SPA.	NB 3965, 5345	2.9	NW	Borrow pit.	Walkers, birdwatchers.
9	End of track within Lewis Peatlands SPA.	NB 4028, 5295	3.5	NW	Construction site.	Walkers, birdwatchers.

Assessment of effects for sensitive receptors

12.7.6 For the purposes of assessing effects on visual amenity, the sensitivity of the receptors is as defined within the assessment methodology previously described. Visual receptor sensitivity to change is defined as being high, medium, low or negligible depending on the activity of the receptor (see Table 12.2). It should also be noted that the assessment of potential effects at any viewpoint cannot be extended to conclude the same effects on the whole of the landscape area within which the viewpoint occurs, as the impact described applies specifically to that locality. Assessment of each viewpoint is outlined in the following sections.

Viewpoint 1 (Figure 12-4)

12.7.7 This viewpoint is located approximately 0.5 km to the southeast of the breakwater site at the public access point to the bay. The main visual receptors at this location are walkers.

Existing view

12.7.8 Currently this viewpoint affords a long distance view out onto the Atlantic to the right and a view across the bay to a headland on the left. The existing slipway can be seen in the foreground, with large cobbles on either side. The view is a relatively open one with nothing on the horizon at sea.

Magnitude of change

12.7.9 The proposed breakwater will be situated approximately 0.5 km from this location, with the fixed link possibly originating from the viewpoint itself. The development will therefore lead to a major change in the view from here.

Effects on visual amenity

12.7.10 This viewpoint represents views obtained by walkers on an undesignated path, who are considered to be of medium sensitivity to change. The effect on visual amenity associated with the proposed development at this location is therefore considered to be **major**.

Viewpoint 2 (Figure 12-5)

12.7.11 This viewpoint is located approximately 0.9 km southeast of the breakwater site and is near to the closest dwellings to the site by a minor road leading down to the bay through Upper Siadar. The main visual receptors at this location are residents and road users.

Existing view

12.7.12 Long distance views out onto the Atlantic are also possible from this location. The foreground comprises rough crofting grassland, which leads to an area of marshland behind the cobble beach which in turn leads to an area of rocky foreshore before joining the sea. Teampall Pheadair, the remains of a chapel and settlement, can just be made out in the middle distance on a small coastal promontory in the right of the view.

Magnitude of change

12.7.13 The proposed breakwater and fixed link will be clearly visible from this location and will dominate views out to sea from here. The development will lead to a permanent and obvious change in the view from here, therefore the magnitude of change is considered to be major.

Effects on visual amenity

12.7.14 This viewpoint represents views obtained by residents, who are considered to be of high sensitivity to change, and road users, who are considered to be of medium sensitivity. The effect on visual amenity associated with the proposed development at this location is therefore considered to be **major**.

Viewpoint 3 (Figure 12-6)

12.7.15 This viewpoint is located approximately 1.4 km southwest of the breakwater site at Clach an Truiseil standing stone SAM. As the tallest standing stone in Scotland, this is likely to attract tourists here and residents will also experience this view, as there are houses nearby.

Existing view

12.7.16 Distant views out across the Atlantic are possible from here, but the foreground dominates the view. This is crofting land used for sheep grazing, which slopes gently downhill and incorporates regular field boundaries of both traditional drystone wall and post and wire. A relatively modern residence and its associated outbuildings, one of which is in a traditional style and may be the original crofthouse, can be seen in the foreground on the left hand side. The bay where the proposed development is planned can be viewed to the right hand side in the middle distance, with the Atlantic disappearing into the horizon beyond.

Magnitude of change

12.7.17 Due to the relative elevation here, the breakwater and fixed link will be clearly visible, and will be permanent feature in the middle distance on the right. For the duration of the construction period, the construction site will also be visible on the left hand side of this view; however this will constitute a temporary and reversible change. The overall magnitude of change at this viewpoint will be moderate.

Effects on visual amenity

12.7.18 This viewpoint represents views obtained by residents and tourists, who are considered to be of high sensitivity to change. The effect on visual amenity associated with the proposed development at this location is therefore considered to be **major**.

Viewpoint 4 (Figure 12-7)

12.7.19 This viewpoint is located approximately 1.6 km southeast of the proposed development on the main road (A857). This is the only route along the north west coast of Lewis so passing road users will be one of the main visual receptors here. As this viewpoint is within Siadar itself, some residents will also have this view.

Existing view

12.7.20 In the foreground can be seen crofting land used for rough grazing, which dominates the relatively featureless view here, incorporating a network of post and wire fences. The grass appears to get progressively boggier toward the middle distance, where a powerline cuts across the horizon. The view behind this drops straight to the sea, as due to the undulation of the land the shoreline cannot be seen, after which the open view of the Atlantic disappears into the horizon. A small bump on the coastal promontory just visible to the right in the middle distance marks the location of the Teampall Pheadair ruins.

Magnitude of change

12.7.21 The breakwater and fixed link will be partially visible from here; however the near-shore aspects will be occluded by the undulating landform. The overall magnitude of change at this viewpoint caused by the development will be moderate.

Effects on visual amenity

12.7.22 This viewpoint represents views obtained by road users, who are considered to be of medium sensitivity to change, and to a lesser extent residents, who are considered to be of high sensitivity to change. The effect on visual amenity associated with the proposed development at this location is therefore considered to be **moderate**.

Viewpoint 5 (Figure 12-8)

12.7.23 This viewpoint is located approximately 2.5 km southwest of the proposed development on the A857 at the point at which views of the development become possible. Road users will be the main visual receptors here.

Existing view

12.7.24 Distant views out onto the Atlantic are possible from here, with boggy moorland which has been subject to peat cutting in the foreground. The middle distance is bisected by a line of telegraph poles and the edge of the bay is just visible on the right hand side, however otherwise the view is relatively featureless.

Magnitude of change

12.7.25 The proposed development will be partially visible from here; however its near-shore aspects will be occluded by the undulating landform and the underlying composition of the baseline conditions would be similar to pre-development circumstances. The overall magnitude of change at this viewpoint is therefore considered to be minor.

Effects on visual amenity

12.7.26 This viewpoint represents views obtained by road users, who are considered to be of medium sensitivity to change. Views will be transient, as they are only possible from a short stretch of road here; meaning road users will not experience prolonged exposure to this view. The effect on visual amenity associated with the proposed development at this location is therefore considered to be **moderate**.

Viewpoint 6 (Figure 12-9)

12.7.27 This viewpoint is located approximately 0.9 km northeast of the proposed development on a track which leads past the Teampall Pheadair ruins. The main visual receptors here will be walkers.

Existing view

12.7.28 This view looks straight down the track as seen by a walker walking toward the bay. There is crofting grassland on either side, with boundaries marked by wire and post fencing. The bay and its rocky outcrops can be seen in the middle distance, with the headland to the south side of the bay visible in the distance. An area of open Atlantic can be seen on the right hand side; however this view is relatively enclosed in comparison with those previous.

Magnitude of change

12.7.29 The construction site and borrow pit will be seen on the distant left hand side at this location. Views of the breakwater and fixed link will be obscured by the undulating landform in the middle distance. Overall, the magnitude of change at this viewpoint is considered to be minor.

Effects on visual amenity

12.7.30 This viewpoint represents views obtained by walkers on an undesignated path, who are considered to be of medium sensitivity to change. The effect on visual amenity associated with the proposed development at this location is therefore considered to be **moderate**.

Viewpoint 7 (Figure 12-10)

12.7.31 This viewpoint is located approximately 1 km southwest of the proposed development. The main visual receptors here will be walkers.

Existing view

12.7.32 This view looks out across eroded banks of rough grassland and low lying rock shore out into and across the bay. The headland to the north of the bay can be seen on the distant left and the settlement of Siadar occupies the horizon to the right. Long distance views over the Atlantic can be obtained past the headland on the left.

Magnitude of change

12.7.33 The breakwater and fixed link will be seen in the middle distance from this viewpoint, as will the temporary construction site. Overall, the magnitude of change caused by the development at this viewpoint will be moderate.

Effects on visual amenity

12.7.34 This viewpoint represents views obtained by walkers on an unmarked path, who are considered to be of medium sensitivity to change. The effect on visual amenity associated with the proposed development at this location is therefore considered to be **moderate**.

Viewpoint 8 (Figure 12-11)

12.7.35 This viewpoint is located approximately 2.9 km southeast of the proposed development on a track leading into the Lewis Peatlands. The main visual receptors here are walkers and birdwatchers visiting the Lewis Peatlands designated area.

Existing view

12.7.36 The view here is dominated by boggy land used as rough grazing, with wire and post fencing and a metal gate in the foreground. A copse of coniferous trees can be seen on the right in the middle distance with the settlement of Baile an Truiseil visible on the left. A distant view of the Atlantic is possible between the settlement and the copse.

Magnitude of change

12.7.37 Neither the permanent features of the development nor construction site would be visible from this point, however a view of the borrow pit may be possible, and this will be reinstated as far as possible following construction. The overall magnitude of change at this viewpoint is therefore considered to be negligible.

Effects on visual amenity

12.7.38 This viewpoint represents views obtained by walkers on an undesignated path, who are who are considered to be of medium sensitivity to change, and birdwatchers, who are considered to be of a lower sensitivity. Considering the remoteness of the location and the fact that the borrow pit will only just be visible from here, the effect of the development on visual amenity here will be **minor**.

Viewpoint 9 (Figure 12-12)

12.7.39 This viewpoint is located approximately 3.5 km southeast of the proposed development at the end of a track within the Lewis Peatlands designated area. The main visual receptors here are walkers and birdwatchers visiting the Lewis Peatlands designated area.

Existing view

12.7.40 The view here is dominated by heather moorland which stretches to the horizon on the left and right and is broken only in the centre where the land dips slightly to reveal a distant view of the

Atlantic. The houses of Baile an Truiseil can be seen on the centre left and a copse of coniferous woodland on the centre right.

<u>Magnitude of change</u>

12.7.41 None of the permanent features of the development would be visible from here. A distant view of the construction site may be possible in the centre of this view; however this aspect of the development is temporary. The overall magnitude of change at this viewpoint is therefore considered to be negligible.

<u>Effects on visual amenity</u>

12.7.42 This viewpoint represents views obtained by walkers on an undesignated path, who are who are considered to be of medium sensitivity to change, and birdwatchers, who are considered to be of a lower sensitivity. Considering the remoteness of the location, the fact that the construction site will only just be visible from here, and its temporary nature, the effect of the development on visual amenity here will be **minor**.

Summary of effects on visual amenity

12.7.43 A ZVI map (Figure 12-2b) has been produced showing the actual spread and pattern of visibility within the study area. Analysis of this has shown that the proposed development will result in a relatively limited area of visibility in the immediate vicinity of the development. Widespread views are not possible due to the undulating nature of the landscape in the area, and the settlements themselves will have a screening effect. The following sections describe the potential effects of the development in relation to sensitive visual receptors.

<u>Settlements and local residents</u>

12.7.44 As has been demonstrated in the ZVI (Figure 12-2b) and the assessmenent of various viewpoints above, the proposed development will be visible from a number of dwellings in Siadar, Upper Siadar and Baile an Truiseil, although the view from many dwellings, particularly in Siadar itself, will be screened by the topography undulation of the land and other buildings.

12.7.45 The device will employ navigational lights, additional operational lighting being used only when access is required Those residents of the surrounding settlements which will have views of the development are the key receptors of this aspect of the development. It should be noted that the lights used will be similar to those on other navigation aids and vessels, and therefore would not result in the introduction of a completely new element, however, as there are no other navigation lights in the immediate vicinity and vessel traffic in the area is particularly light, especially at night, it is an element that is not experienced often here. There are, however, other sources of light around the settlements, such as street lighting and light from the dwellings themselves, therefore it is expected that lighting associated with the development will have a minor impact on the local receptors.

12.7.46 Residents are considered to be of high sensitivity to change in visual amenity, however it is important to stress that the majority of dwellings in the study area will have no view of the development, and therefore the majority of residents will not experience fixed views of the site. Overall therefore, the change associated with the proposed development in relation to visibility from residents will result in a **moderate** effect on visual amenity.

Transport routes

12.7.47 The proposed development will be visible from some stretches of minor and main roads within the study area. The main routes affected would be minor roads and tracks running through the settlements between the development and the main road (A857). On the A857 itself, views are restricted to two very short stretches of road, one on higher ground whilst driving north, and one directly opposite the development itself. Overall, the change associated with the proposed development in relation to visibility from roads will be moderate, resulting in a **moderate** effect on visual amenity.

12.7.48 With regard to potential views from sea transport routes, the change associated with the introduction of the proposed development will be minimal due to the long distance between the development and commercial shipping routes. Therefore, although the device will theoretically be seen, the distance, combined with the fact that it will blend in with the land in the background, means its visual prominence will be limited. Navigation lights on the breakwater will be visible therefore it is in the interests of shipping traffic that the device lighting be visible across a range of conditions. Overall, the change associated with the proposed development in relation to visibility from commercial shipping will result in a **minor** effect on visual amenity.

Recreational resources

12.7.49 Many of the viewpoint locations assessed are of relevance to recreational users in the area. These will mainly be walkers and sightseeers, as there is limited water based recreation in the area. One thing which may attract walkers and tourists in particular is the rich cultural heritage of the area.

12.7.50 The proposed development would be visible from a number of cultural heritage sites, including two SAMs. These are Clach an Truiseil standing stone at Baile an Truseil (viewpoint 3) and Teampall Pheadair chapel and settlement at Siadar (near viewpoint 1). Of these two, the former is likely to attract most visitors as it is well known as the tallest standing stone in Scotland. Views of the breakwater will not be possible from other SAMs in the study area. Although views from other cultural heritage sites in the region will be numerous, these are thought to be of limited importance as such sites are unlikely to attract many visitors, particularly as they are not signposted and often not clearly visible.

12.7.51 Birdwatchers are another potential receptor to the change brought about by the development; however it is considered that their main area of interest will be designated sites on the periphery of the study area and they will not be focussing on the landscape in particular.

12.7.52 Views are also possible from certain points along the coast which may be used by walkers, and a track leading into the Lewis Peatlands, however there are no designated footpaths in the study area. It is considered that the change associated with the proposed development in relation to visibility to walkers and tourists will result in a **moderate** effect on visual amenity.

12.7.53 Overall, taking into account the number and types of viewers affected and the fact that a wave energy project is not inappropriate in this high energy environment (and will include a control building likely to be of interesting design) it is considered that the proposed development will have a **moderate** effect on visual amenity in the study area as a whole.

Mitigation measures

12.7.54 All the mitigation measures previously described in relation to landscape and seascape effects are also fundamental to managing the effects on visual amenity, see section 12.6.32.

12.7.55 The one impact of the proposed development which relates directly to visual amenity is that of night-time lighting both in terms of navigational lights on the structure and lighting of the inshore control building. As this lighting is a technical requirement, its visual effects cannot be altered. The lighting of the onshore control building will, however, be limited to that which is necessary for safe operations.

12.7.56 The installation of interpretation boards by the control building on the shore near the breakwater will identify the development, describe the structures and outline the objectives of the project, and could reduce adverse reaction to the appearance of the project by outlining its positive aspects to the public. Indeed, the finished development itself could be of interest to some visitors, who may wish to view it on their tour of the area.

Residual effects on visual amenity

12.7.57 The mitigation measures to be employed will contribute to the integration of the proposed development within the affected views through the use of materials and finishes in keeping with the surroundings. These measures will not, however, reduce the moderate effect of the development on the visual amenity of the study area.

12.7.58 Table 12.10 provides a summary of the collective visual effects associated with the proposed development, the numbers being representative of the number of viewpoints from which a particular effect will be experienced. It should be noted that this table takes into account only the viewpoints which were visited during the field survey. The summary indicates that for most receptors, the effect on visual amenity of the project as a whole will be **moderate**.

Table 12.10 Summary of visual effects

No. of Receptors	Effect on visual amenity			
	Major	Moderate	Minor	Negligible
Settlements and local residents	2	1	-	-
Users of transport routes	1	2	-	-
Individuals engaged in outdoor recreational activity	1	3	1	1

12.8 Cumulative Effects

12.8.1 Cumulative effects can arise from the intervisibility of a range of developments, and can also impact upon the landscape/seascape of an area and the setting of historic monuments. A potential separate development which may occur in the region in the foreseeable future which would lead to a cumulative impact is the planned Lewis Wind Farm. Certain turbines which are part of the proposed wind farm development would be located approximately 3.5 km from the SWEP development. These developments would, in the main, only be visible in the same view as the wave energy project from viewpoints at sea; however they would add to the overall visual experience on land. One of the temporary construction compounds for the Lewis Wind Farm would be located approximately 3.5 km from the proposed SWEP development, within the ZVI defined in Figure 12-2b, at the approximate location of viewpoint 9 in the Lewis Peatlands. Even if the two projects were to be constructed concurrently, due to the undulation of the land and the remote nature of its location, it is unlikely that this will be visible in the same view as any aspect of the SWEP development. In any case, the Siadar construction compound would also be reinstated on completion of construction works and would therefore only temporarily contribute to any cumulative effect.

12.8.2 A cumulative impact resulting from the proposed SWEP development and the planned Lewis Wind Farm may be experienced by individuals who are passing through the area, for example on roads or walking along a potential coastal footpath which is planned for the area. This cumulative impact would result from the visibility of one development, followed by another when travelling through the landscape. Walkers would be the main receptors of this impact, due to the limited visibility of the proposed SWEP development from the road, however any effect would be transient.

12.8.3 Due to the comparatively small scale of the proposed wave energy development it is not considered that it would add significantly to the cumulative impact caused by the wind farm itself, which would be of a larger scale and cover a much wider area.

12.9 Effects of different design options

12.9.1 The scenario studied in this chapter has considered the landscape/seascape and visual impact of the 'worst case scenario' development design. There is a possibility, however, that alternative design options will be implemented, which involve a slipway instead of a permanent link to shore and the onshore control building located at the southern end rather than the northern end of the bay.

Effect on landscape character

12.9.2 The impact on the landscape in the 'crofting one' LCT will remain moderate and there will be no impact on the 'boggy moor 1' LCT whatever the scenario.

Effect on seascape character

12.9.3 In the case of the alternative design options, the absence of a permanent fixed link to the breakwater would lower the magnitude in the 'low rocky island coast' SCT from moderate to minor, therefore having a minor impact on this SCT as opposed to the moderate impact associated with the 'worst case' design option.

Effect on visual amenity

12.9.4 In terms of visual amenity, the magnitude of change from most viewpoints will be lessened, therefore lessening the overall impact of the development on visual amenity from moderate to minor.

12.9.5 Overall it is considered the alternative design options for the proposed SWEP development will result in marginally lessened landscape/seascape and visual effects on the surrounding area when compared with worst case scenario.

12.10 Summary and Conclusions

12.10.1 It is concluded that following mitigation, the proposed SWEP development will have a **moderate** effect on the landscape/seascape and a **moderate** effect on the visual amenity of the study area. It should be noted, however, that these conclusions are based on the appearance of the development within the landscape/seascape in clear, dry conditions and at low tide. On days when visibility is poor, for example, in the wet/foggy weather which is common on Lewis, the development will be much less visible and views may only be possible from viewpoints 1 km or less from the development.

12.10.2 Visual and landscape effects will be minimised as far as possible through a variety of mitigation measures and careful consideration of scale, design and location and will not significantly effect designated sites or areas. The proposed development should not have an unacceptable effect on amenity of residents and tourists; indeed it is considered that the development itself may actually attract visitors, as it will be one of the first wave energy projects in the world. This, in addition to the fact that the development will make use of and improve upon existing infrastructure and reinstate land used during construction as far as possible, means that it should not be considered to compromise any policy objectives.

13 Transport and Route Access

13.1 Introduction

13.1.1 This section assesses the effects that the project will have on the local area due to increased traffic levels. It covers all aspects of transport and site access both via land and sea and covers the project from construction through operation and into the decommissioning phase.

13.2 Legislative framework and regulatory context

13.2.1 A full assessment of all the necessary regulatory frameworks was carried out prior to the study of transport issues. Legislation, policies and general guidance that have been taken into consideration include:

- Coast Protection Act 1949 (Section 34);
- Scottish Government Planning for Transport: Planning Advice Note (PAN) 57;
- Scottish Government Planning for Renewable Technologies: Planning Advice Note (PAN) 45;
- Marine Guidance Note (MGN) 275 – 'Proposed UK Offshore Renewable Energy Installations (OREI) – Guidance on Navigational Safety Issues';
- National Planning Policy Guidelines of relevance to this assessment:
    - NPPG 6 Renewable Energy Developments (revised 2000);
    - NPPG 17 Transport and Planning (April 1999).
- Local planning policies of relevance to this assessment:
    - DM7 Assessment of Development Proposals;
    - T1 Improving the Transport Infrastructure;
    - T4 Road Safety, Highway Improvements and Traffic Management.
- Institute of Environmental Assessment:
    - Guidance Notes No.1: Guidelines for the Environmental Assessment of Road Traffic.

13.3 Methodology

Scoping and consultation

13.3.1 Consultation in relation to the transport and route access assessment has been undertaken with the bodies listed below (Table 13.1). The issues detailed in the table include those raised in the Scoping Opinion.

Table 13.1 Consultees and their key concerns.

Name of organisation	Key concerns	Comment
Comhairle nan Eilean Siar (Transportation Services)	Road from the A857 to the shore through Siadar is not an option for construction traffic.	This route will not be utilised – instead the road through Baile an Truiseil will be used and made new at project end.
	The main road on Lewis (the A857) is not suitable for high numbers of HGV vehicles and damage is likely.	Mitigation measures will be put in place regarding the weight of material carried and the number of axles per vehicle.
	Roads built on peat; therefore concern over heavy and intensive traffic movements.	A full traffic management plan for the final project scope will be produced prior to construction.
Scottish Executive	Heavy loads during construction phase impacting on the road network as well as operational phase traffic.	Assessment of considered routes to be carried out in consultation with Comhairle nan Eilean Siar (Transportation Services) and the local community.
	Potential for heavy loads to result in road damage.	Appropriate mitigation measures to be agreed with Comhairle nan Eilean Siar (Transportation Services).
SEPA	Presence of access tracks and how they will be dealt with post construction.	All new access tracks will be reinstated and will not be required into the future of the project.
	Effects on shipping/local vessels and slipway access.	Assessed in line with MCA guidance as part of the EIA.
	Effects on the road network due to heavy loads.	Appropriate routing of traffic will be carefully selected.
Comhairle nan Eilean Siar (Harbour Master)	No key concerns regarding the placement of the structure	Little vessel traffic in the area as the major shipping channel is 11 km from the proposed Siadar breakwater site. Potential effects assessed in line with MCA guidance.
MCA	Unlikely to have impact but navigation requirements must be considered.	Appropriate consultation has been and will continue to take place with the NLB and MCA. Consultation with local groups (incl. fisheries related groups) has been carried out.

Name of organisation	Key concerns	Comment
NLB	Appropriate navigational lighting/marking is required throughout construction and operation.	Recommendations to be implemented according to final structure design.
RYA	No key concerns as unlikely to impact on recreational boating or present a navigational hazard.	Appropriate navigational guidance for the structure to be implemented.
The Chamber of Shipping	Navigational impact on shipping.	Negligible effects on transiting shipping.
Western Isles Fishermans Association	No concerns, but note must be made of the presence of creel and sea angling boats in the area.	Effects on such vessels have been assessed.

Studies and information sources

Marine

13.3.2 Following an initial desk study review of the marine traffic using the area of the proposed Siadar project, the MCA were consulted for their views on the most appropriate method of assessing the navigational effects of the project. The Maritime and Coastguard Agency (MCA) advised that the assessment should follow the guidelines within MGN 275 'Proposed UK Offshore Renewable Energy Installations (OREI) – Guidance on Navigational Safety Issues'; as the submission would be judged on that basis.

13.3.3 The navigational risk assessment undertaken for the project (full report provided in Appendix C) provides a thorough, qualitative investigation of the potential for effects upon the full range of vessel traffic, based upon the guidance within MGN 275, but has also been influenced by identification of the significant potential issues.

13.3.4 The proposed project site does not experience any large vessel, or transiting, vessel traffic. It is sited close inshore, at the mouth of a shallow rocky bay, on a predominantly exposed and hostile lee shore; it is thus perhaps more properly referred to as a coastal installation, than offshore. As a result, the only direct navigational interaction that can be reasonably predicted for the project is with a limited number of small, typically <10 m, locally-based fishing vessels.

13.3.5 Given the primary interest in small vessels, navigating in very close proximity to the shore, the method of data gathering was tailored accordingly and the primary mode of data collection has been through consultation with experienced local mariners, fishery organisations, and other navigational stakeholders, rather than via a project-specific vessel traffic survey.

13.3.6 The data collected has been confirmed with a review of other existing data-sources, in particular surveys of marine vessel traffic data undertaken in 1997 and 2004, which were summarised in a single report produced for Comhairle nan Eilean Siar in 2005 (Eagle Lyon Pope Ltd. & Safety at Sea Ltd., 2005).

Road traffic

13.3.7 A desk study was undertaken to identify and assess the road traffic numbers for the area and the main routes which it is served by. This could then be compared with the expected traffic levels associated with the development – provided by npower renewables. The baseline traffic figures were obtained from Transport Scotland. The Transport Scotland figures related to two studies, one at Port of Ness and one in Stornoway. Both these data have been utilised in this study as the worst case scenario for traffic levels relating to the project would be onsite construction of the caissons with offsite concrete batching. Therefore, the HGV's required will likely affect Stornoway roads initially and then the roads in the Siadar area (the same route that serves Port of Ness) and the assessment has thus included reference to both sets of data.

13.3.8 The increase in any traffic levels and their receptor effects were assessed against Institute of Environmental Assessment (IEA) Guidelines (IEA, 2003). IEA Guidelines on traffic state that assessment is required where traffic movements or HGV movements increase by >30 %, or more than 10 % where there are sensitive receptors likely to be affected.

Significance criteria

13.3.9 The significance criteria employed for this section is based on the methodology defined in Section 5.3. The sensitivity and magnitude are defined in Table 13.2 and Table 13.3 below.

Table 13.2 Definition of sensitivity of effect

Sensitivity	Definition
Very high	Very sensitive sites such as several built-up areas and / or areas including schools, pedestrian crossings and / or will add to high volumes of sea use / traffic in the area. Additionally has the potential to add unacceptable and / or prolonged loadings to roads unsuitable for such traffic level increases or proposed vehicles.
High	Development traffic will travel through at least one built-up area with sensitive receptors as mentioned above or has the potential to significantly add unsuitable loadings to the road

	infrastructure of the area. Or the development will add significantly to sea traffic issues in the area.
Medium	Development traffic will at most travel through one built-up area with sensitive receptors as mentioned above or has the potential to increase loadings to the road infrastructure of the area. Or the development will add considerably to sea traffic issues in the area.
Low	Development traffic is unlikely to travel through any built-up areas and / or will not add additional loadings to the road infrastructure. Or the development will add to sea traffic issues in the area.
Negligible	Little / no alteration / damage to the existing infrastructure or disturbance to any receptors. Or the development will be unlikely to add to sea traffic issues in the area.

Table 13.3 Definition of magnitude / frequency of effect

Magnitude	Definition
Very Major	Very major alteration to key elements / features of the baseline conditions such that the character / composition / attributes will be fundamentally changed. Guide: >100% increase in baseline conditions.
Major	Major alteration to key elements / features of the baseline conditions such that character /composition / attributes will be fundamentally changed. Guide: 71-100% increase in baseline conditions.
Moderate	Alteration to one or more key elements / features of the baseline conditions such that post deployment character / composition / attributes of baseline will be partially changed. Guide: 31-70% increase in baseline conditions.
Minor	Minor shift away from baseline conditions. Change arising from the loss / alteration will be discernible but underlying character / composition / attributes of baseline condition will be similar to pre-development circumstances / patterns. Guide: 11-30% increase in baseline conditions.
Negligible	Very slight change from baseline condition. Change barely distinguishable, approximating to the “no change” situation. Guide: 1-10% increase in baseline conditions.

13.3.10 The sensitivity and magnitude of the potential effect are combined to define the significance of the effect, as shown in Table 13.4. Those criteria in red text are the residual effects considered significant under the EIA Regulations.

Table 13.4 Effect significance matrix

Magnitude	Sensitivity				
	Very High	High	Medium	Low	Negligible
Very Major	**Major**	**Major**	**Major**	**Moderate**	Minor
Major	**Major**	**Major**	**Moderate**	Minor	Insignificant
Moderate	**Major**	**Moderate**	**Moderate**	Minor	Insignificant
Minor	**Moderate**	**Moderate**	Minor	Insignificant	Insignificant
Negligible	Minor	Insignificant	Insignificant	Insignificant	Insignificant

Pre-assessment to identify worst case design options

13.3.11 A summary of the proposed options in relation to the assessment of effects on transport and route access is shown in Table 13.5.

Table 13.5 Scheme design options

Aspect	Options	Description	Discussion
Caisson construction	Local construction; construction compound established adjacent to the Scottish Water works at Siadar	Compound area approximately 8.5 hectares would be required. Offsite concrete batching. Temporary vehicle bridge over the River Siadar may be required as well as floating road along the shingle bank. Requirement for local borrow pit including access track.	Worst case because larger volumes of materials (primarily concrete) are required to be brought into the area by road due to onsite construction of all caisson structures. Small numbers of marine vessels will be required for the installation process.
	Remote construction – caissons are floated to site for installation	Smaller compound area approximately 1.5 hectares would be required. The compound would be in the same location as the compound required for local construction. Temporary vehicle bridge over the River Siadar may be required as well as a floating road along the shingle bank. Requirement for borrow pit including access track.	Lower significance due to smaller volumes of traffic entering the area. Similar levels of marine vessels as above will be required for the installation process.
Operation and maintenance to the breakwater	Fixed permanent access to link the breakwater to shore by rubble mound fixed link	Would require construction of a new fixed permanent link.	Worst case because new structure requires large volumes of aggregate and metal work to be transported into the area.
	Fixed permanent access to link the breakwater to shore by part rubble mound, part steel truss bridge		
	Boat access from onsite slipway.	Would require upgrades to existing slipway.	Lower significance because only modifications to existing structure which would require smaller amounts of material to be transported in to the area.
Control building	Located adjacent to existing slipway	Potential requirement to move the alignment of an existing drainage ditch and impact on a marshland through land reclamation.	Worst case, as the proposed floating road will remain on the shingle bank to transport materials in for the building construction.
	Located adjacent to	The existing footbridge over the	Lower significance, due to slightly

Aspect	Options	Description	Discussion
	existing Scottish Water works	River Siadar could be improved or renewed to improve the amenity of the area.	lower level use of the shingle bank which is not needed to access the control building for construction.

13.3.12 This assessment has examined the worst case option, with all other options assessed at the end of each subject.

13.4 Baseline conditions

Baseline maritime traffic data

13.4.1 The baseline shipping traffic levels have to be understood in order that any effects during the various phases of the project can be assessed. Typical large vessel traffic in the Hebrides traverses that area with the use of two separate routes. The first is to the east of Lewis, through the Minches. The development will have no impact on this route. The second route, a charted Deep Water Route (DWR), is off the west coast of Lewis – and is 6.4 km (4 miles) from the shore at its nearest point (off Gallan Head) and approximately 11 km from the Siadar breakwater site. The International Maritime Organisations (IMO) recommends that laden tankers of over 10, 000 gross tonnage use this route, weather conditions permitting, in preference to sailing through the restricted waters of the Minches.

13.4.2 A report commissioned by Comhairle nan Eilean Siar (CnES) and The Highland Council was tasked to look into the maritime traffic levels in The Minches and the Deep Water Route west of the Hebrides. This report compared two vessel traffic surveys, one in 1997 and the other in 2004. There were differences in the numbers and types of traffic utilising the west coast of Lewis between the report in 1997 (autumn) and 2004 (summer). It cannot be said for sure whether such differences were related to true traffic differences between the years of the survey or if they were due to seasonal differences relating to the timing of each of the surveys.

Table 13.6 DWR traffic figures comparing the two surveys summarised in Eagle Lyon Pope Ltd. & Safety at Sea Ltd. (2005). Figures in bold are actual counts whilst those in brackets are as a percentage of the total number of vessels.

Traffic type	1997 autumn survey	2004 summer survey
Tanker (oil/chemical/shuttle)	**41** (35%)	**47** (25.3%)
Merchant (bulk carrier/cargo/reefer)	**17** (14.5%)	**26** (14%)
Supply/standby	**5** (4.3%)	**9** (4.8%)
Ferry/passenger	**0** (0%)	**1** (0.5%)
Pleasure	**0** (0%)	**2** (1.1%)
Fishing	**42** (35.9%)	**86** (46.2%)
Fishery protection	**-**	**3** (1.6%)
Military (naval/army)	**6** (5.1%)	**8** (4.3%)
Unknown/not called	**6** (5.1%)	**4** (2.2%)
Total number of vessels	**117**	**186**
Average traffic density	3.9 vessels per day	6.4 vessels per day

Notes: 1 – The season during which the counts were taken differed between the two years.
2 – The data utilised differing categories which have been combined to allow direct comparison.

13.4.3 The local lobster and velvet crab fishery operates approximately ten vessels in the area. Due to the exposed nature of the coastline the site is only fished during the summer months. The boats generally travel to the area from the south (Loch Roag and Loch Carloway) and from the north (Port of Ness) and tend not to use the existing slipway for access to Siadar Bay. However, a recent survey noted one 27 ft creel boat utilising the existing slipway at Siadar Bay in the summer and autumn months.

13.4.4 Stornoway Sea Angling Association also uses the area for fishing, launching their vessels from Bragar, with these vessels at times plying the waters off Siadar. They are generally targeting herring, mackerel and dogfish.

13.4.5 The north west coast of Lewis has been categorised by the Royal Yachting Association (RYA) (2005) as a light usage area, with only several recreational crafts seen during summer months. The project site is out with any areas regarded as general sailing areas, and only as a place where day tripping and other boating activities occur.

Baseline road traffic data

13.4.6 The A857 is the primary trunk route in Lewis connecting the main town of Stornoway with the Siadar area and further north. This road has the ability to take standard European 40 tonne HGVs. However, as parts of the road network on Lewis are built onto peat it is unclear what density of such vehicle use could be maintained without serious road damage. On a recent survey of the area a HGV passed by the surveyors and the ground was felt to move up and down considerably, highlighting the peaty, and therefore spongy, nature of the ground onto which the roads are constructed (D. Watson & S. Coey pers. obs.).

13.4.7 There are no traffic counts specifically for the village of Siadar, therefore counts must be inferred from numbers taken elsewhere in Lewis. The two most recent Transport Scotland counts providing data to this section were taken in the summer and the autumn of 2006, both lasting a day at two different sections of the A857. The data from both of these surveys were provided by Transport Scotland and are summarised in Table 13.7. The count on the 15th May 2006 was taken from just outside of Stornoway (NGR 140300, 939400) while the count on the 2nd of October 2006 was taken near the end of the A857 at Port of Ness (NGR 153300, 963600). Table codes are summarised below the table.

Table 13.7 Road traffic figures for Stornoway and Port of Ness.

Codes	Stornoway (15/05/06)	Port of Ness (02/10/06)
CC1 – Pedal Cyclists	3	0
CC2 – Twin Wheeled Motor Vehicles	10	2
CC3 - Cars	1534	298
CC4 - Buses	54	13
CC5 – Light Goods Vehicles	514	77
CC6 – Rigid 2 Axle HGVs	74	8
CC7 – Rigid 3 Axle HGVs	30	2
CC8 – Rigid 4 Axle HGVs	6	0
CC9 – Articulated 4 Axle HGVs	0	0
CC10 – Articulated 5 Axle HGVs	2	0
CC11 – Articulated 6 Axle HGVs	3	0

13.5 Assessment of effects - construction

Maritime

Potential effects

13.5.1 The construction phase of the SWEP requires the use of a certain number of marine vessels/boats. These will add to the slight levels of traffic in the coastal zone of the area. However, they will be small in number and temporary in nature as the construction phase is due to last 18-months only. Of this 18-month construction phase for the project it is expected that marine operations will only last for 6-months. The marine traffic addition to the coastal zone will vary little between onsite and offsite construction of the caisson units. The only additional vessel involved will be the delivery vessel if the caissons are constructed offsite. Other than this addition the expected traffic figures, and duration of their presence, are set out below.

- **Jack up barge** – a single barge will be present in the bay for about 3 months and will be involved in the drill piling and seabed preparation operations required for the placement of the caisson units.
- **Tugs** – two tugs will be present for about 3 months (after the jack up barge has prepared the site) for use in the placement of the caisson units.
- **RIB** – a single RIB will act as a safety boat throughout the maritime operations phase.

13.5.2 The area of Siadar Bay where construction will be taking place is little used by local fishing vessels, due to its depth and exposure. The impact upon this small number of local vessels is seen as being insignificant due to the limited duration of the construction phase and the small number of vessels involved in this giving a low magnitude and the small number of vessels in the area giving a low sensitivity rating.

13.5.3 The primary difference in vessel numbers relates to the onsite or offsite construction of the caissons and if they are required to be towed into the area from afar. This will add vessel traffic either towing the caissons around the Butt of Lewis and/or from the south up the west coast. As a maximum of ten caissons are to be constructed this will result in only 10 journeys to and from the site by the towing vessel.

13.5.4 The maritime traffic in the area primarily operate in routes further offshore and will not be directly impacted by the construction of the breakwater structure, which is in very shallow waters. However there is an inshore fishing fleet which utilises the area, which will be directly impacted.

13.5.5 The aforementioned inshore fishing fleet does not heavily utilise the area proposed for the SWEP. The creelers and the angling boats fishing the area tend not to use the existing slipway, due to its current condition. However, one 27 ft creel boat has been noted to use it during the summer and autumn months. If there is to be refurbishment of this facility then both of these sea-users will be able to make better use of the area.

13.5.6 Based on the fact there are no major users of the bay by marine traffic and the temporary nature of additional vessels during construction the impact of construction on the safety of navigation will be **insignificant**.

Mitigation

13.5.7 Construction vessels on site will continue to meet all the statutory and best practice requirements with respect to seamanship, navigational practices, radio operation, offshore construction, etc.

13.5.8 Appropriate detailed marking and lighting systems for use during construction will be implemented with respect to consultations with the NLB and MCA.

Residual effects

13.5.9 Due to the low levels of marine traffic utilising the area and the location of the SWEP in an area not extensively used for fishing/creeling the residual effect of the SWEP construction on this traffic is considered to be **insignificant**.

Non worst case

13.5.10 The non worst case scenario will involve local vessel traffic only and will not require the caissons to be towed in from an offsite location. Therefore, the number of vessel numbers outwith the bay will be reduced. The residual effect relating to this scenario should also be considered to be **insignificant**.

Road traffic

Potential effects

13.5.11 The construction phase of the SWEP requires the use of a certain number of vehicle road movements, which will vary depending on the construction option chosen. These have the potential to add considerably to the current low levels of traffic on the primary trunk route serving the Siadar area (the A857). However, the additional traffic will be temporary in nature as the entire construction phase is due to last 18-months only, with road traffic impacting the area for only 16-months of this period. The road traffic addition will vary considerably between onsite and offsite construction of the caisson units as well as between onsite and offsite concrete batching associated with the onsite construction of the caissons. The addition of construction traffic (regardless of whether the caissons are to be constructed onsite or offsite) to the roads in the area will be largely concentrated within a 6 month window during the construction period. Not only do the vehicles add to traffic volumes in the area but vehicles leaving the construction and/or borrow pit site could add dirt and dust to the local roads.

13.5.12 The impact assessment has first assessed the traffic volumes associated with the construction phase of the project followed by an assessment of effects as per the IEMA Guidance.

13.5.13 The baseline count data specific to Port of Ness is likely to be more representative of the Siadar area as all traffic travelling to and from Port of Ness on the A857 passes Siadar. Additionally, as the traffic figures are lower than for the count site just outside Stornoway, this can be presumed to be the worst case scenario against which to assess the effects of the project.

13.5.14 These data highlight the light nature of the traffic on Lewis – both in vehicle numbers and weight of vehicle. Therefore, it is of particular importance that the present traffic levels and the roads are not impacted by the projects construction traffic unnecessarily. As the roads in the area are primarily constructed on peat they are prone to the effects of vibration from larger and heavier vehicle movements.

13.5.15 Once the construction traffic reaches the Siadar area a specific route for all construction traffic will be taken. This route runs through Baile an Truiseil as this road has historically been utilised by HGVs and is wider, with the houses set further back from the road, than in Siadar itself. The tracks from this road leading to the Scottish Water works will then be widened or passing places added. Additionally, there is the potential for a temporary bridge across the River Siadar and a floating road along the shingle bank in order that vehicles will be able to access the northern end of the bay without going through the village of Siadar.

<u>Onsite caisson construction and offsite concrete batching</u>

13.5.16 This scenario for the construction of the materials required for the development provides the 'worst-case' scenario with regards road traffic increases for the area. It should be noted that the village of Siadar will not be affected by this increase in traffic as the vehicles will turn off of the A857 at Baile an Truiseil prior to reaching Siadar. The road through Baile an Truiseil is already used by heavy vehicles, as is the track that connects this road to the Scottish Water site on the shore by the mouth of the River Siadar. This track will, however, be widened or passing places will be introduced to accommodate the level of traffic expected during construction.

13.5.17 From the Transport Scotland surveys (Table 13.7) it is shown that up to 115 HGVs can be expected to use the A857 on a daily basis on the outskirts of Stornoway. It should be noted that these are primarily 2 and 3 axle HGVs. Larger HGVs are uncommon – a maximum of 11 being recorded in a day during the summer survey at this location.

13.5.18 Considerably less HGV traffic is noted at the Port of Ness end of the A857. Here a total of 10 HGVs, all of which had 2 or 3 axles, were recorded in a day.

13.5.19 The worst case scenario for increases in HGV traffic to the area sees an increase of 16 HGV movements per day (Table 13.8). This would be equivalent to an increase in HGV traffic of 14 % at the Stornoway end of the A857 and 160 % for the portion of the A857 between Barvas (where the road travelling west from Stornoway splits north / south) and Port of Ness. Therefore, there is the potential for the development to add significantly to the HGV traffic levels operating on the A857. Increases in traffic levels of over 30 % are deemed significant under IEA guidance and would lead to a moderate impact (Table 13.3). It is considered that the projected increases in the levels of HGV traffic associated with this scenario during the construction phase will give a minor impact on the roads in the vicinity of Stornoway and a very major impact in the Siadar area.

Table 13.8 Average daily traffic movements during the primary months of the construction phase of the project and the overall traffic increases at both Stornoway and the Port of Ness

Vehicle	Month															
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
HGV	0	0	0	3	4	2	2	16	16	16	16	11	1	1	1	1
Small Vehicle	2	2	2	10	12	16	16	16	16	16	16	16	12	12	12	10
Total	**2**	**2**	**2**	**13**	**16**	**18**	**18**	**32**	**32**	**32**	**32**	**27**	**13**	**13**	**13**	**11**
Vehicle numbers (Stornoway)	2217	2217	2217	2217	2217	2217	2217	2217	2217	2217	2217	2217	2217	2217	2217	2217
% increase	0.1	0.1	0.1	0.6	0.7	0.8	0.8	1.4	1.4	1.4	1.4	1.2	0.6	0.6	0.6	0.5
Vehicle numbers (Port of Ness)	398	398	398	398	398	398	398	398	398	398	398	398	398	398	398	398
% increase	0.5	0.5	0.5	3.3	4.0	4.5	4.5	8.0	8.0	8.0	8.0	6.8	3.3	3.3	3.3	2.8

13.5.20 The worst case scenario for the increases in small vehicle movements would only see an increase of 5.4 % to current levels, when using the Port of Ness data, and 1 % when using the Stornoway data. Increases in traffic levels of less than 10 % are negligible in magnitude; however the sensitivity of the area is high due to the housing present. Therefore, the increases in the levels of small vehicle traffic associated with this scenario during the construction phase would give an **insignificant** impact.

13.5.21 Traffic travelling between the construction compound and the borrow pit is contained entirely within the development site and avoids the public road network, although there will be a crossing point at the north western end of Baile an Truiseil. However, this is **not expected to impact** upon the area, its road users or any pedestrians.

Mitigation

13.5.22 Through consultation with the Comhairle nan Eilean Siar (Transportation Services) the best solution to additional traffic levels associated with the project was that the existing road network be utilised on the proviso that any road damage is made good at the end of the project. Monitoring of any such road damage will be an integral part of the project specific Traffic Management System (TMS).

13.5.23 A full TMS will be developed prior to the inception of the construction phase of the project. This will detail all mitigation measures to be undertaken, including:

- Time separation between movements of HGVs.
- Wherever possible the avoidance of peak hours to reduce effects on other traffic and pedestrians;
- Monitoring of road damage along the transportation route;
- A full assessment of truck loadings and number of axles to minimise road damage and vibrations affecting cultural heritage sites;
- If necessary dirt and dust washing areas for construction vehicles to prevent this impacting built-up areas;
- If necessary loads will be covered to reduce dust pollution.

Residual effects

13.5.24 Increases in all forms of traffic on the outskirts of Stornoway during the construction phase are below the 30 % threshold level indicated as significant by the IEA Guidelines. Therefore, as the receptors and the roads are used to such traffic in this area, so the impact is seen as being **insignificant**. However, the increases in HGV traffic levels above this 30 % threshold nearer to the construction site, and the fact that the A857 at this point is constructed on peat, means that the sensitivity of the area near to the site is considered to be high to the predicted increases in traffic levels. Therefore, the overall impact in this area is seen as being **moderate**.

13.5.25 Table 13.9 summarises the above impact assessment using IEA Guidance on traffic to assess specific receptors and the environmental effects that that they are exposed to. This assessment summary looks at the 'worst-case' construction traffic issues during the peak of construction which lasts about 4 months and concentrates on the roads close to the site where the baseline traffic is light and will, therefore, be impacted upon the greatest. Each is afforded 'Sensitivity', 'Magnitude' and 'Significance' levels as drawn from the significance criteria defined in Tables 13.2, 13.3 and 13.4 respectively and then a post-mitigation residual effect significance level. These residual effect levels range from **moderate** to **insignificant** in nature.

Table 13.9 Significance criteria for a 'worst-case' analysis of traffic levels on the A857 near Siadar. This assumes a potential 160% increase in traffic levels and the sensitivity of these passing though the Baile an Truiseil area.

Environmental effect	Receptor	Magnitude of effect	Sensitivity of receptor	Significance of impact	Comment	Residual effect
Noise	Human/Fauna	Very Major	High	Major	Significant increase in HGV and overall traffic with associated increases in noise levels during working hours. Mitigated by TMS and speed limits.	**Moderate**
Vibration	Human/Fauna	Very Major	High	Major	Significant increase in HGV and overall traffic with associated increases in vibration levels during working hours. Mitigated by TMS and fast response to road repairs.	**Moderate**
Visual	Humans	Very Major	High	Major	Significant increase in visual impact due to increases in HGV traffic during working hours.	**Minor**
Severance	Humans	Very Major	Medium	Major	Minimised by the timing of construction traffic road use to avoid peak travel times and the low overall traffic volumes.	**Insignificant**
Driver Delay	Humans	Very Major	Low	Moderate	Predicted traffic increases unlikely to add to driver delay. Mitigated by timing of road use to avoid peak travel times and the low volumes of traffic already present.	**Insignificant**
Pedestrian Delay	Humans	Very Major	Negligible	Minor	Minimised by the timing of construction traffic road use to avoid peak travel times and the minimal numbers of pedestrians in the area.	**Insignificant**
Pedestrian Amenity	Humans	Very Major	Low	Moderate	Additional HGVs can intimidate pedestrians. Mitigation will avoid peak travel times and other sensitive times (e.g. school closing times).	**Insignificant**
Accidents & Safety	Humans	Very Major	Low	Moderate	Junctions and the narrower roads and tracks in the area of Baile an Truiseil will be monitored.	**Minor**
Hazardous & Dangerous Loads	Humans	Very Major	Low	Moderate	Most hazardous load will be cement.	**Insignificant**
Air Pollution	Various	Very Major	Low	Moderate	Not significant due to minimum receptors and low overall traffic level increases.	**Insignificant**
Dust & Dirt	Various	Very Major	Low	Moderate	Traffic primarily utilises tarmac roads. All aggregate lorries will be sheeted and vehicle wash-down facilities will be available onsite.	**Insignificant**
Ecological Impact	Flora/Fauna	Very Major	Negligible	Minor	Track widening will not significantly affect the ecology of the area.	**Insignificant**
Heritage & Conservation Areas	Various	Very Major	Negligible	Minor	All sites have been identified and will be avoided by any additional tracks. Vibration effects will be monitored.	**Insignificant**

Non worst case

13.5.26 The non worst case scenario with offsite caisson construction would lead to considerably lower volumes of traffic (in particular HGV levels). At the peak of construction under this scenarion about 3 to 4 HGVs movement per day would be expected. Therefore, in this case, the residual effect is considered to be **minor**.

13.6 Assessment of effects - operational

Maritime

Potential effects

13.6.1 Post construction the breakwater, and possible fixed link, will act as a navigational hazard for vessels operating in the area. Such vessels are likely to be small in nature and number. The steel trussed bridge proposed to connect the breakwater with the rubble fixed link will have sufficient head-room to allow most vessels which utilise the area at present safe passage at certain tidal ranges. At high tide (MHWS) there will be a minimum clearance of about 4.4 m between the steel truss bridge and the water surface.

13.6.2 If the fixed link to the breakwater is not constructed then a single vessel (proposed to be a RIB approximately 6 m in length) will be in operation to service the breakwater. As the servicing of the breakwater is not expected to be frequent in nature the intrusion of this vessel and the additional navigational hazard it may cause is considered to be **insignificant** to local maritime traffic.

13.6.3 The breakwater structure is a potential navigational hazard for vessels using the area, however all appropriate procedures will be put in place regarding appropriate navigational assessment and lighting/marking. A detailed assessment of the navigational risk during operation has been made in accordance with the MCA's MGN 275. This is detailed in full in Appendix C. This study has concluded that the impact of operation on the safety of navigation will be negligible. There is a moderate beneficial effect to local small boat users from the presence of the breakwater which will provide a more sheltered access to the sea. These local vessels will be well aware of the structure and therefore the potential collision hazard caused by the presence of the breakwater and the fixed link is considered minor.

13.6.4 During all phases of the project the presence of vessels, the breakwater and the fixed link will create navigational hazards for other vessels transiting/utilising the area. Large vessel traffic is slight and is generally offshore in nature as it utilises the DWR off the west coast of Lewis, which is about 11 km from the Siadar site. Again, this shipping and the potential for interaction with the SWEP has been considered in the navigational risk assessment in Appendix C. However, the only boats likely to be impacted by operations in the Siadar area will be local fisherman in smaller creeling boats and leisure users.

Mitigation

13.6.5 Appropriate navigational procedures will be put in place and advertised locally through the Siadar Pier Group. The slipway, if used to access the breakwater, will also have to be kept in a good state of repair and kept clear to allow reliable access to these facilities, should any small boats require it.

13.6.6 Any on site operational vessels will continue to meet all the statutory and best practice requirements with respect to seamanship, navigational practices, radio operation, etc.

13.6.7 Dependant on the final design of the project the appropriate navigational lighting will be installed. The National Lighthouse Board (NLB) have already consulted on the appropriate lighting required for the breakwater, the potential fixed link, the potential subsea cable and vessels operating in the area. Prior to the start of the construction phase notices will be advertised locally stating the extent and duration of the works. Additionally the UK Hydrographic Office will be informed after the project to allow for the updating of the appropriate Admiralty Chart (BA2720).

Residual effects

13.6.8 The small number of vessels in the area, the marking and lighting of the structures in accordance with NLB requirements together with compliance by vessels with the International Regulations for Preventing Collisions at Sea 1972 as amended, gives an overall **minor** rating of effects to marine traffic.

Non worst case

13.6.9 If a fixed link were not to be constructed then there will be less physical barriers to vessel movements in the area. However, the breakwater will remain a physical barrier and there will be additional vessel movements involved in the maintenance of this structure and the turbines within. The overall rating remains **minor**.

Road traffic

Potential effects

13.6.10 During operation, the electrical and mechanical turbines and other equipment onsite, will be subject to a operation and maintenance regime which will require manned visits. Under normal circumstances the frequency of such servicing will add approximately 1 – 5 traffic movements per week to the baseline traffic levels. This applies regardless of the scheme design options and the numbers will be low in relation to the background traffic levels. If the fixed link structure or control building is to be built from the north end of the bay then there will be the need to use the roads through Upper Siadar village as an access route. Otherwise, the access through Baille an Truiseil will be used to access a control building adjacent to the Scottish Water works.

13.6.11 Additionally there may be other trips arising from more significant maintenance activities, monitoring activities, meter reading, public visitors and slipway users. These cannot, however, be quantified at this time, but again will utilise small vehicles or cars suitable for the roads in the area. Therefore, due to the small vehicle nature these trips, as has been shown for small vehicle movements, are considered to be negligible with regards overall traffic movements in the area.

Mitigation

13.6.12 Only light vehicles will be required for such operations.

Residual effects

13.6.13 It is considered that there will be an **insignificant** impact to the baseline traffic levels in the area during the operational phase of the SWEP.

13.7 Assessment of effects - decommissioning

Maritime

Potential effects

13.7.1 Appendix C has assessed all issues relating to decommissioning. The overall conclusions are that the SWEP will have a negligible impact on navigational routes and a minor adverse effect on local vessels with regards accidental collisions. However, this is countered by the moderate beneficial effect to these local vessels through the shelter benefits afforded.

13.7.2 It is expected that the main breakwater structure will remain in place at decommissioning therefore resulting in a significantly lower level of vessel activity during this phase in comparison with the construction phase. If structures are to remain then the navigational marking will also remain in operation.

13.7.3 The duration of this phase is also likely to be shorter than for the construction phase. This is primarily down to the fact that it is proposed that the main breakwater structure will remain in place with the electrical and mechanical components and other steel work being removed and the structure made safe. If a fixed link is constructed then there will be no additional marine vessel movements required and all works are expected to be conducted utilising road vehicles accessing the breakwater via the fixed link.

Mitigation

13.7.4 Any on site decommissioning vessels will continue to meet all the statutory and best practice requirements with respect to seamanship, navigational practices, radio operation, etc.

13.7.5 Appropriate detailed marking and lighting systems for use during decommissioning will be implemented with respect to consultations with the NLB. No other consultees have indicated any additional requirements to date, however further comments will be considered as applicable.

Residual effects

13.7.6 As it is only expected that the electrical and mechanical components and other steel work is to be removed so the impact is expected to be lower than that for the construction phase. Additionally, if the main breakwater structure is to remain so the navigational lighting of this structure will also continue to operate. The impact of the decommissioning phase with regards safety and navigation is, therefore, considered to be **insignificant**.

Road traffic

Potential effects

13.7.7 The level of traffic associated with the decommissioning phase of the project will depend on the number of vehicle movements required to remove the electrical and mechanical components of the scheme and any other components required to be decommissioned.

13.7.8 The control building, as with the breakwater, may be viewed locally as having a post project use to the community and could be left to the community for their uses.

13.7.9 With this in mind the traffic pressures will be significantly less than the 'worst-case' scenario assessed for the construction phase of the project and more similar to those associated with off site caisson construction which numbered at most 3 - 4 HGV movements per day.

Mitigation

13.7.10 It can be assumed that the mitigation measures for the construction phase assessment will also hold for the decommissioning phase, if all structures are to be fully removed.

Residual effects

13.7.11 If only the electrical and mechanical components, as well as the steel components such as the trussed bridge, are to be removed and the breakwater structure made safe, then the magnitude of decommissioning traffic levels is considered to be moderate with the sensitivity to such increase rated medium. Therefore the overall impact in relation to additional onsite traffic is rated as **moderate**.

13.8 Cumulative effects

13.8.1 In terms of the maritime traffic the installation phase of the project will not result in any significant cumulative impact due to the low baseline vessel traffic in the area.

13.8.2 During the operational lifetime of the project the presence of the breakwater and enhanced slipway facilities will increase the potential for local small vessels to access the coastal waters offshore Siadar, thereby representing a positive impact to the local community.

13.8.3 Consultation with Comhairle nan Eilean Siar (Transportation Services) has indicated that there is potential for cumulative traffic related effects if the proposed AMEC Lewis Wind Farm project goes ahead. This is as yet uncertain and the likely timing for its construction phase unknown.

13.8.4 However, in the event that both projects are being constructed at the same time there is likely to be cumulative traffic issues with regards HGVs transporting materials to both developments. Any cumulative effects will centre on the portion of the A857 to the east of the site – between the site and Stornoway and only during the short construction period of the Siadar project. Therefore, there will be no cumulative effects near to the area of Siadar and/or Baile an Truiseil. Any cumulative effects on the A857 will be discussed between the developers and the Comhairle nan Eilean Siar (Transportation Services) in order that such issues can be incorporated into the TMS.

13.8.5 During the operational lifetime of the project there will be a cumulative impact to the traffic in the area. This is, however, likely to be limited in number (servicing and employee vehicles only) and will consist of light vehicles only.

13.9 Summary and conclusions

13.9.1 The proposed SWEP development will have an **insignificant** effect on the marine traffic in the area, primarily due to the low levels of baseline traffic utilising the area and the shallow water location of the primary structures. The nearshore shallow water positioning of the breakwater assists in the avoidance of areas utilised by local fishing vessels and more significantly is well away from the large shipping Deep Water Route some 11 km off shore.

13.9.2 Although the proposed SWEP development will lead to a significant increase in the number of HGV movements on the roads, particularly in the area around Siadar during the construction period of the scheme, with the appropriate mitigation measures, including the development of a comprehensive TMS and anti-dust and dirt measures, in place the overall effect is likely to be **moderate** to **insignificant**. The road traffic impact of the scheme during the operational phase will only involve small numbers of light vehicles and is considered to be **insignificant**, whilst during the decommissioning phase is considered to be **minor**, a level which will depend on the extent of the decommissioning works.

14 Socio-economic Impact

14.1 Introduction

14.1.1 This socio-economic analysis relates both to the construction phase of the project and its period of operation. Net benefits are assessed, and quantified where possible, for:

- The local area (the village of Siadar, north to Port of Ness and south to Barvas).
- The Western Isles as a whole.

14.1.2 The analysis encompasses:

- Employment and income benefits from the work that will have been undertaken during the design and construction phase (2009-2011 as currently envisaged).
- Employment and income benefits associated with the operation and maintenance of the facility (over up to 50 years).
- Potential economic benefits from tourism generated by the project.
- Recreational effects (positive and negative).
- Other identifiable local benefits.

14.1.3 The EIA included assessment of both positive and negatives socio-economic aspects of the project, in particular in relation to recreational issues. Due to generally remote and presently unused nature of the area of coastline and the nature of the proposed scheme in terms of it providing both a renewable energy source and additional shelter to the existing slipway, the positive recreational effects were deemed to outweigh the potential negative effects.

14.1.4 One of the main potential negative effects on recreational and tourism from the proposed project are the landscape and visual effects of the project. These effects are considered in Section 12 of this ES.

14.1.5 The village of Siadar comprises just 290 people (approximately). The wider zone on the west coast of Lewis specified above as the local area for the purposes of this impact study has a population of approximately 3,100 people[8].

14.1.6 The scheme is expected by npower renewables to generate sufficient electricity to meet the average annual needs of around 1,500 homes – approximately a fifth of all of the homes on Lewis and Harris.

[8] Available statistics do not allow a precise measure of the area's population.

14.2 Methodology

Economic impact methodology

14.2.1 During the construction phase, employment and income benefits to the Western Isles will arise through work undertaken on the project by Western Isles companies and its workforce, and through materials and services sourced locally. Also, people coming over to the Western Isles to work on contracts or deliver supplies will make local purchases. Prior to the appointment of contractors and sub-contractors, these effects are inevitably speculative, however a range of possible effects is provided. Given the wide differences between scheme options, all scenarios potentially relevant to economic impact in the Western Isles have been identified and assessed.

14.2.2 The key variables, in terms of effects on the Western Isles, are the location for construction of the caissons; whether a fixed access link is developed; the extent to which island aggregate is used; and whether the current slipway at Siadar is upgraded or replaced.

14.2.3 During the operational phase, effects will arise through routine inspection and maintenance, any repairs that might be required, and periodic replacement of components and structures. These effects, cumulatively, will depend on the life of the project, which is expected to be at least 25 years.

14.2.4 Conventionally, employment effects are expressed in terms of FTE jobs and allowance is made for the "multiplier".

14.2.5 The multiplier comprises "indirect" effects and "induced" effects. Indirect effects are generated through the spending of contractors on local supplies and services; and induced effects through the local spending of proprietors and employees who earn additional income through direct and indirect effects.

14.2.6 FTE jobs are converted into household income generated through applying an estimate of how much the average job would pay.

14.2.7 Through the measure of FTE job years, construction phase and operational phase effects can be aggregated. For the purposes of this analysis, an FTE represents a FTE job year[9].

14.2.8 The employment generation in the Western Isles from the construction and operational phases that is estimated in this assessment relates to work that could be undertaken by Western Isles

[9] An alternative approach is to regard an FTE as a full time equivalent job that lasts for ten years.

residents. Specialist work that Western Isles residents are unlikely to have the skills for is excluded.

14.2.9 In practice, however, a proportion of the work that will be carried out within the Western Isles is likely to be taken by contractors' employees from the mainland, by migrant workers, or by others recruited by employers from outwith the Western Isles – for example, people who might have worked on comparable contracts elsewhere.

14.2.10 The employment and household income effects assessed for the Western Isles should therefore be considered as maximum.

14.2.11 Tourism impact can be established in FTE's through assessing how much additional expenditure might be incurred in the area in which impact is being assessed as a result of a development project and applying an appropriate ratio of FTE's (adjusted for the multiplier) to £'000 of visitor expenditure generated. In this case, tourism effects will tend to build up over time as complementary investment is made on the west side of Lewis to cater for this market, and short term effects are likely to be small. Again, this impact is very difficult to quantify (both short term and longer term).

14.2.12 The economic impact estimates were informed by the Western Isles Regional Accounts, 2003 (University of Aberdeen, August, 2005) and the Outer Hebrides Tourism Update 2007 (Snedden Economics Ltd).

Recreational benefits

14.2.13 In the short term, these benefits (for both local residents and tourists) will arise through:

- The improved shelter for boats and water sports between the shore and the breakwater (which is likely to be greater if the fixed access link is constructed).
- The launching potential from the slipway, if it is restored – either as part of the project, or through funding raised by the local community.
- Walks from the car park by the shore that will be provided as part of the project, especially if local footpaths are upgraded and interpretation of the area's natural and cultural heritage is provided.

14.2.14 These benefits are difficult to quantify and will tend to depend on:

- Complementary development in and close to Siadar.
- Guided walks that might be offered.

- Use of the slipway by outdoor activity operators, local clubs, and individuals and groups.
- How well the improved facilities are promoted.

14.2.15 Galson Estate Trust, under community ownership, will be undertaking a range of initiatives as its plans progress and as income is generated for investment (most probably principally through wind farm development). Its activities will tend to be important in the extent to which both the recreational and tourism opportunities offered by the Siadar project are realised.

14.2.16 Recreational benefits are assessed qualitatively rather than quantitatively.

Consultation

14.2.17 Research for this impact analysis has included:

- Liaison with npower renewables and Wavegen on construction and operational aspects of the proposed project, scenarios for construction and contracting, and indicative budgets for the development.
- Liaison with Murdo Murray, a locally-based technical consultant.
- Discussions with staff of Comhairle nan Eilean Siar (Economic Development, Access Officer, Harbourmaster).
- Discussions with the property manager of HIE Innse Gall relating to the possibility of using the Arnish yard for construction of the concrete caissons.
- Discussions with:
    - Representatives of the Galson Estate Trust;
    - The Galson Estate Ranger;
    - Representatives of the Siadar Pier Group;
    - Members of the Siadar and Baille an Truiseill communities;
    - Local boat owners;
    - Local historical specialists;
    - Activity holiday providers;
    - Representatives of Stornoway Canoe Club, Diving Club, and surfers.

14.2.18 Recent knowledge of the area from a feasibility study carried out for the Steering Group set up to explore community ownership options for Barvas Estate and a Business Plan being produced for Comunn Eachdraidh Nis (Ness Historical Society) was also relevant. These studies have also involved considerable local consultation.

14.3 Baseline Description

14.3.1 Various meetings and discussions have been held over the past 18 months between the project developers and members of the local communities, including Airidhantuim Community Council, the community co-ordinators, the local Councillor, Galson Estate Trust and Iomairt Nis, and there is generally strong support for the SWEP.

14.3.2 Some of the community's support relates to the possibility that the pier will be restored as a multi-purpose slipway – indeed this location was originally put forward for the wave energy project by Siadar Pier Group members to improve sea access.

14.3.3 Others see the project as complementary to other initiatives (current or proposed) or as a catalyst for other activity. At present Siadar itself has little economic activity, although there is a primary school, and a community hall is being built in Borve. The only commercial operation in Siadar, the post office, closed early in 2008 following the resignation of the postmistress. It is however understood from a local contact that the new owners of Borve Tavern might re-open it as a hotel.

14.3.4 The Western Isles as a whole is one of the highest priority areas in Scotland for new development due to demographic and economic trends, and relatively low incomes. The following statistical information is taken from the Western Isles Socio-Economic Overview, September 2007 (CnES).

- The decline in population between 1996 and 2006, 7.9%, was the highest of any Local Authority area in Scotland. The longer term decline between 1901 and 2001 was 43%. The population has fallen from 46,000 in 1901 to 26,530 in 2006.
- The total population of the Western Isles is projected to fall by a further 15% (3,847 people) between 2004 and 2024, compared with a projected decline of just 1% in Scotland. A 31% decline is projected in the 0-15 year age group in the Western Isles between 2004 and 2024, and a 21% decline in the 16-64 age group. The Western Isles is projected to experience the largest percentage decline in annual births of any Local Authority area in Scotland.
- The 2003 Regional Accounts study estimated Gross Regional Domestic Product (GRDP) in the Western Isles per head of population at 66% of the UK average and 78% of the EU25 GDP per capita. The estimated growth of the Western Isles economy (net of inflation) between 1997 and 2003, 2.5%, was significantly lower than that of the UK. In 2003, the Western Isles had an external trade deficit of £163.4 million.
- The 2003 Rural Scotland Price Survey (Snedden Economics for HIE) found that the overall price of the selected goods and services covered by the survey in the Western Isles was 3.7% higher than the average for rural Scotland, and the second highest in Scotland, aFTEr Shetland (where incomes are relatively high).

- The unemployment rate in the Western Isles fell from a high of 9.3% in 1996 to a low of 2.4% in July 2007, although the annual average rate remains significantly above that of both GB and Scotland.

14.3.5 A 2004 Communities Scotland report (Scottish House Condition Survey, 2002) found that the Western Isles had the highest fuel poverty rate in 2002 of all 33 Scottish Local Authorities. 34% of households were "fuel poor" – defined (in summary) as households that would be required to spend more than 10% of their income on all their fuel use.

14.3.6 As noted in the Scottish Fuel Policy Statement (Scottish Executive, 2002), fuel poverty contributes to ill health and poor quality of life, and also prevents financial resources being used in more beneficial ways.

14.3.7 Although peat is used for heating in the Western Isles and community energy schemes are starting to develop, the islands are heavily dependent on imported fuel and energy, which can be relatively expensive. Through the Siadar scheme and other proposed projects, the Western Isles is moving towards self-sufficiency.

14.3.8 Also, as an embedded generator within the local grid network in the Western Isles, the Siadar scheme could reduce the incidence of power cuts in the area.

14.3.9 A major report commissioned by CnES, Western Isles Enterprise and Communities Scotland by Hallaitken and the National Centre for Migration Studies, "Outer Hebrides Migration Study", January 2007, concluded that a sustainable and desirable situation in 10-15 years would be "A stable and growing economy based around a skilled workforce adding value to the wealth of natural resources (food production, renewable energy, crafts)." Key features of this would include:

- A skilled and capable construction sector that supports a strong and indigenous demand.
- Tourism growth through addressing under-investment in tourism infrastructure and marketing that promotes the area's strengths.

14.3.10 The suggested aim is to increase the area's population to almost 30,000 by 2019 through in-migration amongst under-45's increasing by 40% on 2004/05 levels, and reducing out-migration amongst the 16-24 age group by a third.

14.3.11 According to the report: "The potential for exploiting the significant renewable energy resources in the Outer Hebrides provides one of the few opportunities for sustainable and high value economic growth"

14.3.12 One of the ways of achieving this potential put forward in the report is: "Encouraging energy producing companies to set up and / or fund Research and Development centres in the Hebrides"

14.3.13 Arnish Point, near Stornoway, is identified in HIE's Operating Plan 2007-10 as a key strategic project, with opportunities in the renewable energy supply chain prioritised as the key activities to be attracted to the site – in particular turbine blade production, turbine assembly and marine device production. Around £12 million has been invested in the site by HIE.

14.3.14 A recent £5 million order to build 49 towers for a Turkish windfarm at Arnish will require around 70 staff working day and night shifts to complete the contract within six months. Altissimo re-opened the site in 2007 under the Camcal name.

14.3.15 A consortium of four Highland-based contractors and a consulting engineering firm have recently signed a memorandum of understanding with Lewis Wind Power, who await approval from Scottish Ministers for a 181 turbine wind farm proposal. This memorandum is designed to secure work for the consortium during the construction phase of the project, with Arnish the preferred location for manufacturing the towers. The consortium comprises RJ Macleod, Hydro Contracting, Bardon Hebrides, Highland Alternative Energy (the latter chaired by Camcal's managing director), and Halcrow.

14.3.16 The Outer Hebrides Community Planning Partnership, in its strategy "Creating Communities of the Future", identifies Renewable Energy Innovation, Tourism and Culture and Heritage as three of the six drivers for achieving its long term vision for the area.

14.3.17 The west side of Lewis is considered a relatively high priority area for new employment. The area has lost population (to an extent to Stornoway), crofting has declined in importance, and many residents now commute to Stornoway.

14.3.18 The population of the Civil Parish of Barvas declined by 861 between 1981 and 2001 from 3,994 to 3,133, a reduction of 21.6%, compared with a reduction of 16.8% in the Western Isles as a whole. The reduction in the parish's population between 1901 and 2001 was 53.5% – falling from 6,736 to 3,133.

14.3.19 The main sectors of employment in the Council's Sustainable Communities Area of Westside and Carloway[10] in 2001, other than the public sector, were manufacturing (14.1%

[10] Galson to Garynahine (including Siadar)

compared with 9.0% in the Western Isles) and construction (12.2% compared with 10.5%). Unemployment was 5.6%, compared with 5.0% in the Western Isles.

14.3.20 The Galson Estate Trust incorporates 56,000 acres of North West Lewis. The Estate has a population of around 3,000, with 20 crofting townships from Port of Ness in the north to Upper Barvas.

14.3.21 In the words of the Trust:

"*The Galson area's way of life is about the intricate interaction between a crofting lifestyle, a panoramic landscape and a diverse natural environment. The area boasts fantastic coastal scenery and white sands; large Special Areas of Conservation and Special Protection Areas; a variety of flora and fauna including golden eagles, fulmars and gannets; excellent sea and fresh water fishing; and, most importantly, a kindly, 'down-to-earth' community that works together to bring about a better future for themselves and future generations*."

14.3.22 The Galson area maintains strong links with the international Gaelic community and is at the forefront of progressing Gaelic culture and arts."

14.3.23 Approximately 90% of Galson Estate Trust land is under crofting tenure, and Lower Siadar and Baille an Truiseill and Upper Siadar are two of the eight Common Grazings areas covered by the Estate.

14.3.24 The Siadar area currently lacks infrastructure, facilities and employers, and is not currently able to capitalise on the growing tourism market.

14.4 Assessment of effects-construction phase

Introduction

14.4.1 This phase encompasses initial investigations and design, as well as the construction work and the installation of the turbines, cabling, etc. Prior to contracts being let, it is very difficult to assess either the probable involvement of Western Isles (or west side) businesses as contractors or sub-contractors or the extent to which employees resident in the Western Isles will benefit from this contract or sub-contract work. The difficulty is compounded by uncertainty currently over whether:

- The caissons (the major cost item) will be constructed on-site or off-site, and, if off-site, whether Arnish will be used (which would tend to provide construction work for local labour even if the main contractor is external).

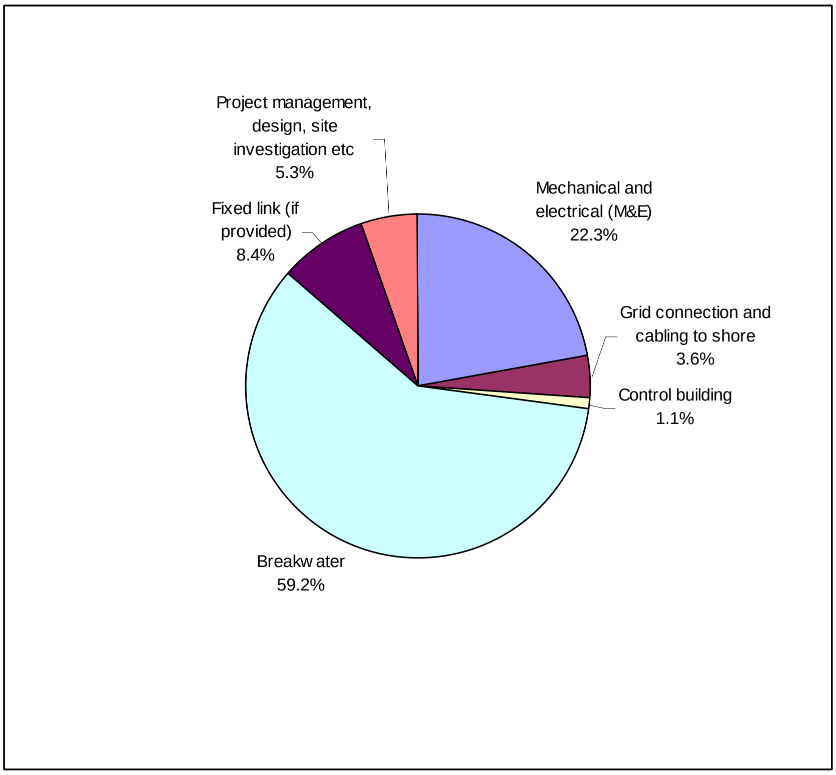
- The slipway at Siadar will be restored for flexible use – either as part of the project (if the fixed link is not built) or as a community-led project. The uncertainty associated with the latter relates to availability in sourcing sufficient public funding.

14.4.2 These issues are discussed below, and a range of assumptions are made. The potential economic impact in the Western Isles of the construction phase ranges from modest to high, and a large number of scenarios are possible. These will narrow down as project planning proceeds – in particular, once contracts have been let.

Construction costs

14.4.3 The capital cost of the scheme will not be known definitively until the scheme has been put out to tender and the successful contractor appointed. However, construction contractors and the technology provider Wavegen have provided budget cost estimates of the key elements of the scheme. From the figures received so far, the budget price for the scheme, depending on a range of factors, in particular the inclusion or absence of the fixed link, would be between £14M and £18M. The approximate apportionment of the expenditure on the key scheme items is shown in Figure 14-1.

Figure 14-1 Approximate apportionment of expenditure on key scheme items.



14.4.4 Liaison with npower renewables and Wavegen staff has helped to assess the possible value-added in the Western Isles through the above expenditure, and in Scotland as a whole.

14.4.5 The breakwater cost, as shown above, would represent 59% of the total project cost, and this project element could potentially generate the greatest impact in the Western Isles.

14.4.6 The concrete caissons used to form the breakwater would either be constructed locally in a compound established adjacent to the Scottish Water works at Siadar, with a ramp facilitating their movement from the foreshore to the sea; or they would be constructed remotely and floated to the site for installation.

14.4.7 If it is built, a permanent fixed link would give access to the breakwater for commissioning, operations and maintenance. The alternative would be boat access from an on-site slipway. This would either be through refurbishing and upgrading the existing slipway with the boathouse adjacent to it, or retaining the slipway used for launching locally constructed caissons, with the boathouse part of the adjacent control building.

14.4.8 If a slipway is required for operational boat access to the scheme, it would need to be of high specification (though less costly than the fixed link access). A slipway that would be required to serve the Siadar Pier Group, in the event that a fixed access link is built to access the breakwater, would be considerably less costly than the slipway that would be required by npower renewables to service the breakwater reliably. If this community slipway were built in addition to the fixed link, it would be cost-effective to carry out the slipway work while plant was on site for the main project. A detailed estimate of the cost of a slipway at Siadar has to be produced and will depend upon the synergies with the main project but as a reference the Bragar slipway, about 12 km to the southwest of Siadar, was built in the year 2000 at a cost of about £250,000.

14.4.9 During the current project development phase, Wavegen is carrying out front-end engineering design for the mechanical and electrical systems, performing wave tank tests to assess performance, and assisting npower renewables.

14.4.10 Wavegen will be responsible for the detailed design and procurement of electrical and mechanical equipment for the project, and the detailed civil design will be npower renewables responsibility.

Potential effects of the construction stage

14.4.11 Data from the Regional Accounts for the Western Isles and other information suggests that, on average, c1FTE job (inclusive of the multiplier) would be supported by £40,000 of construction work in the Western Isles, where most materials, e.g. aggregate, are locally sourced. This project, however, will be materials-intensive, and the bulk of the materials (including the steel to reinforce the concrete in the breakwater) and the specialist parts will be imported.

14.4.12 Also, much of the work would be specialist (e.g. underwater), and specialist contractors would tend to bring suitably skilled people over with them to undertake the work.

14.4.13 Thus, the local labour inputs (direct and indirect) for most aspects of the overall project are expected to be much lower than 1FTE to £40,000 contract value. The estimates below for the different elements of the project were derived from advice from the specialists who have provided npower renewables with indicative costings.

Mechanical and electrical

14.4.14 A detailed estimate of the labour requirements to carry out the design and procurement of the equipment has not yet been carried out, but the work could take around 2 years and employ an average of 6 engineers and support staff in Inverness (i.e. 12 FTE's in total at an average rate of pay of c£35,000 per annum).

14.4.15 The equipment would be sourced from elsewhere in the UK or overseas, but installation could employ Western Isles labour, and direct earnings from this impact might total £200,000. At £27,000 per FTE, this would support approximately 7.5 FTE's; **9 FTE's** inclusive of the multiplier (to include indirect and induced effects). This would give a multiplier-inclusive income total of £225,000.

Overall project management, design & site investigation

14.4.16 These activities are likely to be carried out by UK personnel. A site engineer from the Western Isles might be paid approximately £40,000 (**1 FTE**), rising to approximately £50,000 in household income generated through the multiplier.

Control building and grid connection

14.4.17 Work carried out by Western Isles labour might total approximately £300,000 in value. Applying the average ratio of 1 FTE per £40,000 for construction work in the islands referred to above would give an employment benefit from this of **approximately 7.5 FTE's** (inclusive of the multiplier) and associated household income of approximately £175,000.

The Fixed Link

14.4.18 On-site work undertaken by Western Isles residents might total approximately 6.5 FTE's and approximately £180,000 in household income (£27,000 per average FTE).

14.4.19 Materials sourced from the Western Isles might total approximately £100,000 in value, which might support **approximately 1.5 FTE's** – giving approximately £40,000 in household income.

14.4.20 Adding 20% to these direct and indirect effects for induced effects would give total potential job generation in the Western Isles of **approximately 9.5 FTE's** and approximately £245,000 in household income from this element of the project (if the fixed link is constructed).

The breakwater

14.4.21 Three scenarios are considered.

On-site construction of the caissons

14.4.22 Work undertaken by Western Isles residents might total approximately 23.5 FTE's and approximately £630,000 in household income (£27,000 per FTE).

14.4.23 Materials sourced from the Western Isles might total approximately £410,000 in value, which would support approximately 6.5 FTE's – giving approximately £175,000 in household income (£27,000 per FTE).

14.4.24 Adding 20% to these direct and indirect effects for induced effects would give total potential job generation in the Western Isles of **approximately 36 FTE's** and approximately £895,000 in household income from this element of the project.

Construction of the caissons at Arnish

14.4.25 This scenario includes the construction of a slipway at Arnish, which would be required for the work to be carried out there.

14.4.26 Work undertaken by Western Isles residents might total approximately 19 FTE's and approximately £515,000 in household income (£27,000 per FTE).

14.4.27 Materials sourced from the Western Isles might total approximately £320,000 in value, which would support approximately 5 FTE's – giving approximately £135,000 in household income (£27,000 per FTE).

14.4.28 Adding 20% to these direct and indirect effects for induced effects would give total potential job generation in the Western Isles of **approximately 29 FTE's** and approximately £730,000 in household income from this element of the project.

Construction of the caissons elsewhere

14.4.29 This would most probably be within Scotland. The Kishorn yard in Wester Ross was used to build the caissons for the Skye Bridge in the early 1990's, and the caissons for the current £3 million Kallin harbour development at Grimsay in the Western Isles were built at Troon. This latter contract provided perhaps £250,000 of work within the Western Isles.

14.4.30 If the caissons work were carried out outwith the Western Isles, its share of the breakwater contract (including the provision of aggregates and other materials) might reduce to **approximately 10 FTE's** and approximately £280,000 in household income (inclusive of indirect and induced effects).

The slipway

14.4.31 Construction of a lower cost slipway that would be complementary to a fixed link might generate a total of approximately 3 FTE's in the Western Isles and approximately £80,000 in household income, increasing to **approximately 3.5 FTE's** and approximately £90,000 in household income adding induced effects.

Expenditures in the Western Isles by external contractors, staff & suppliers

14.4.32 Over the construction phase of approximately a year, time would be spent in the Western Isles by staff working on contracts normally resident elsewhere, suppliers of materials and others associated with managing and delivering the project. Overnight stays would be shared between hotels, guest houses, B&B's and other accommodation.

14.4.33 The expenditure impact of this where the caissons are constructed on-site at Siadar or at Arnish are assessed (approximately) to average:

- 250 nights x 20 people x £40 average spend = £200,000

14.4.34 Adding day visit expenditure might increase this to approximately £240,000.

14.4.35 As noted below, £40,000 of visitor spending supports approximately 1 FTE job in the Western Isles inclusive of the multiplier. Thus, £240,000 of expenditure would support **approximately 6 FTE's** and £95,000 in household income.

14.4.36 If the caissons are constructed outwith the Western Isles, this benefit might reduce by approximately 50%, giving **3 FTE's** and £50,000 in household income.

Aggregate construction phase impact

14.4.37 Summing the seven elements above would give a potential Western Isles impact in the range **30.5-72.5 FTE's** and £780,000 – £1,775,000 in household income.

14.4.38 It is possible that approximately a quarter of this benefit would accrue to the local area (Barvas to Ness), i.e. **7.5-18 FTE's** and £195,000-£444,000 in household income. This is based on the assumption that locally based workers are more likely (on balance) to be taken on by project contractors and sub-contractors than the average Western Isles worker.

14.4.39 Ferry and air services would also benefit from personnel and freight carryings (not quantified above).

14.5 Assessment of effects – operational phase

Introduction

14.5.1 Maintenance of the electrical and mechanical installations and of the civils are considered separately below.

Electrical and mechanical

14.5.2 The operation and maintenance phase of the scheme will involve a number of activities. The power conversion system on the breakwater is mechanically simple and would be expected to operate for long periods unattended. In early 2008, a prototype of the turbine to be used at Siadar will be installed at LIMPET (on Islay), and this will yield information important to the operational and maintenance regime at Siadar.

14.5.3 The experience gained from the operation of the LIMPET plant to date indicates that the operation and maintenance requirements will not be onerous. The following estimates assume that a contractor based on Lewis will perform the work.

Scheduled Maintenance

14.5.4 It is proposed that the plant will be inspected initially every month and then every three months. At the same time the dampers will be serviced.

14.5.5 The generator bearing life is currently estimated at 7 years. A programme of bearing replacement should commence after 5 years. It is also conservatively assumed that turbine blades would be replaced at the same time as the bearings.

14.5.6 The electrical control system requires no regular maintenance, but an annual visual inspection is required.

14.5.7 It is anticipated that this work will require **1.5 FTE's** per annum. Most of the labour input will be local to the island.

Unscheduled maintenance

14.5.8 The control system is self checking and regularly tests for correct value and instrument function. In the event of a problem, an alarm will be generated, requiring operator intervention. Given the large number of relatively small units, there is significant potential for occasional failure, but it is anticipated that intervention could be combined with the scheduled maintenance, requiring an additional **0.5 FTE** per annum.

Operation and monitoring

14.5.9 Normally, the plant will operate fully automatically. Throughout the life of the project, the plant (and individual turbine) performance will be monitored to ensure that system performance is maintained. Data logging is automatic but examination of the results will require operator intervention. The estimated time for analysis and standard report is **1 person day per month** (off-site).

Civils and cabling

14.5.10 The civil works would be inspected annually, and, as discussed above, the costs associated with the operational phase of the civils are envisaged to be minimal, unless significant repairs are required to the breakwater or fixed link (if provided).

Potential operational & maintenance effects in the Western Isles

14.5.11 Altogether, the above Western Isles effects sum to approximately 2 FTE jobs per annum, including 0.5 FTE allocated to an average year from periodic repair work, replacement of components, etc.

14.5.12 Replacement mechanical would be purchased from overseas and replacement turbine blades probably from the UK.

14.5.13 Applying an employment multiplier of 0.25 to allow for induced and indirect effects would give a total of **2.5 FTE's**.

14.5.14 These FTE's might pay an average of approximately £25,000, which would give £62,500 per annum in household income generated in the Western Isles.

14.5.15 Local benefit would depend on the residence of the people carrying out the maintenance and repairs. Indicatively, **0.5 FTE** and £11,000 in income is allocated per annum to the local area.

14.6 Potential tourism benefits

14.6.1 Conventionally in local economic impact analysis, additional spend by residents related to new facilities is not taken to generate net impact. In this case, for example, expenditure by Western Isles canoeists or divers using the Siadar slipway (assuming that it is restored) would be considered to be displaced from elsewhere in the Western Isles (e.g. they would otherwise have used an alternative location for the activity). There might be a degree of spending in the Siadar study area rather than in the Western Isles as a whole, but this would be small given the very limited spending opportunities in the Siadar area (at least currently).

14.6.2 Additional tourist spending, however, will support additional employment in the Western Isles. Extra spending by visitors to the Western Isles might be generated through:

- Extended stays in the west side study area through pursuing activities on-shore, or at sea using the slipway and / or the more sheltered harbour. These might be lengthened stays during the day or involve overnight stays (which generate more impact).
- Additional trips to the Western Isles generated by the new facilities (including repeat visits, recommendations from previous visitors, bookings with an activity operator, and visits by people interested in seeing one of the first wave energy schemes in the world).

14.6.3 Yachts sailing off the Western Isles would not be expected to use Siadar Bay (except in an emergency), although there might be some occasional use by people kayaking up or down the coast (though with minimal additional local impact).

14.6.4 According to the Outer Hebrides Tourism Update, visitors to the Western Isles grew from 180,000 in 2002 to 196,000 in 2006 (+ 8.9%). Tourism is an increasingly important industry in the Western Isles, and tourism related sectors contribute approximately 10% of its FTE employment.

14.6.5 Currently, few visitors to the Western Isles stop in the local Siadar area unless they are aware of and interested in monuments such as Clach an Truiseil – the tallest known standing stone in Scotland.

14.6.6 A large number of tourists, however, visit the west side to the south of Barvas. Attractions in this area on or close to the main road include the Callanish Stones, Calanais Visitor Centre (19,600 estimated visitors in 2006), Gearrannan Blackhouse Village at Carloway (11,600 visitors), and Morven Gallery (9,000 visitors). Fewer people travel north beyond Barvas towards Ness, where attractions include the Butt of Lewis Lighthouse, Taigh Dhonnchaidh arts and music centre, Ness Historical Society (with catering provision), the Rona Cross and Rona Stone, Loch Stiapabhat Local Nature Reserve, and Borgh Pottery in Borve. The Scottish Visitor Attraction Monitor does not provide visitor numbers for any of these facilities.

14.6.7 Thus, there is scope to intercept general tourist visitors already travelling through Siadar and to persuade more to venture further north – to the potential benefit of tourism-related operators north of Siadar. These existing and new tourist visitors might be interested in seeing the wave energy device (with the onshore interpretation), using the improved sea access (if activities are on offer or they have their own boat, surfboard, etc), or taking walks from the improved car park. The extent of this increased demand will depend on advance publicity, signage, activity provision, improved footpaths, interpretation on walking routes, etc. The historical and natural heritage information collated for this report would be a good starting point for a local interpretive strategy.

14.6.8 In addition, those with a professional interest in seeing the wave energy device, media representatives, etc would travel to the Western Isles specifically (although perhaps generally only staying one night, unless visiting with their family). This has been the experience in Islay with the LIMPET project and with the European Marine Energy Centre (EMEC) wave and tidal test facility in Orkney.

14.6.9 Building up this increased tourism in the Siadar area would take time, and publicity and overnight stay effects would be increased through new accommodation businesses becoming established or existing accommodation businesses expanding or diversifying. Currently, in the area between Barvas and Galson, there is only one guest house, which can accommodate 8 people (plus a bunkhouse with 8 beds), and one Bed and Breakfast with 4 bedspaces. There is also self-catering at Siadar. These businesses would benefit from increased trade, but a significant increase in benefit from overnight stays would require additional bedspaces. There are no cafes or shops in this local area to capture daytime spending. The nearest café is at Morven Gallery, Barvas to the south and the nearest shops are at Barvas and at Borve (to the north). Further north at Ness and south of Barvas, there is more provision for tourists, but the tourism economy on the west side of Lewis is relatively underdeveloped considering the area's potential and the overall growth in visits to the Western Isles noted above.

14.6.10 The new Siadar facilities complemented by Galson Estate Trust activities would be a catalyst for increased commercial provision for tourists, which should build up further in the longer term through increased visits.

14.6.11 One of the key objectives of Galson Estate Trust's Business Plan is to promote tourism based on the unique cultural, environmental and historical assets of the area. This will largely be achieved through encouraging and facilitating investment by others, but its own investments in infrastructure and services could become significant if its plans for a community wind energy project came to fruition. This would generate a substantial annual surplus for the Trust, while it would also receive a high annual payment as landowner if the Lewis Wind Power project proceeds. Rental payments and a proportion of the income from electricity generation would also be received from npower renewables for the Siadar project, and this is currently under negotiation. This income would enable the Trust, with grant aid, to invest in tourism facilities in the area.

14.6.12 The Estate's Ranger is looking to develop more walks on the Estate, and parking is generally an issue. Toilets, shelter and interpretation are also lacking on some other walks. The Ranger considers that Siadar could become a focal point, with its parking provision, birdlife and archaeological interest. It could also act as a "gateway" with information provided there about the Estate. The Ranger has an annual programme of walks, mainly interpretive, and Siadar could be included in this programme. There would be scope to give pre-organised guided walks to groups, including cruise liner parties from ships anchored at Stornoway, but the area's lack of eating and drinking facilities would be a drawback.

14.6.13 The Council's Coastal Access Project, which can provide information boards and guides, has offered support to the Siadar Pier Group. Also the RSPB has offered to provide information about birdlife in the area, which would complement information about the wave energy project, encouraging people interested in wildlife to visit the area.

14.6.14 Discussions with people involved in Lewis in canoeing, diving and surfing suggest that there would be some scope to use Siadar Bay as one of a number of suitable locations for visitor activities – although there are doubts about how sheltered the sea behind the breakwater would be, and whether the breakwater would reduce the current ability to surf (see further below).

14.6.15 Visitors to the Western Isles are increasingly bringing their own equipment over on the ferry for outdoor activities, and these people are not dependent on outdoor operators' businesses. Establishing Siadar on websites as a suitable location for water sports would therefore be important in order to put it on visitors' maps before they arrive.

14.6.16 The area's historical environment is currently under-exploited. Points of interest include the tallest standing stone Scotland, a medieval or possibly pre-medieval temple just up from the slipway, holy wells, a building that is believed to be an old nunnery, and the general landscapes which many people overlook. In the past, coastal erosion has led to the fear locally that the temple would eventually disappear, but the shelter benefit of the scheme could reduce the rate of this erosion.

Potential tourism related effects

14.6.17 Very speculatively, it is assumed that the following additional visitor expenditure would be generated annually in the Siadar study area (i.e. the area from Barvas to Ness) in the short term.

Table 14.1 Short term additional annual visitor expenditure in the Barvas to Ness area

Type	Level	Expenditure
Daytrippers	10 people per day x 250 x £5	£12,500
Overnight stays	4 people per week x 40 weeks x 1.5 nights x £30	£7,200
	Total	**£19,700**

14.6.18 Data from the 2003 Regional Accounts report and the 2007 Tourism Update suggest that 1 FTE job would be supported in the area by £40,000 of visitor spending, inclusive of the multiplier.

14.6.19 This would give 0.5 FTE's generated. In the longer term, especially as places to stay and eat and drink develop, this should at least double to 1 FTE.

14.6.20 Assuming that average pay per FTE would be £16,000, this would give £8,000 per annum in household income generated in the short term, and £16,000 in the longer term.

14.6.21 In the Western Isles as a whole, inclusive of displacement, the short term effects might be:

Table 14.2 Short term additional annual visitor expenditure in the Western Isles as a whole

Type	Level	Expenditure
Daytrippers	2 people per day x 250 x £15	£7,500
Overnight stays	2 people per week x 40 weeks x 5 nights x £50	£20,000
	Total	**£27,500**

14.6.22 For the Western Isles as a whole, 1 FTE job would be supported by approximately £35,000 of visitor spending, inclusive of the multiplier. To the nearest 0.5 of an FTE, this would give **1 FTE** generated. If this expenditure generated also doubled in the longer term, the annual employment generation would be **1.5 FTE's**.

14.6.23 This would give £12,500 per annum in household income generated in the short term and £25,000 in the longer term.

14.7 Recreational issues

14.7.1 These would fall mainly into two categories: walking / sightseeing and water sports.

14.7.2 Walking and sightseeing would be encouraged by the availability of parking, and shelter, interest in seeing the offshore wave device (with onshore interpretation), and the range of sites of historical interest and wildlife in the area (promoted through interpretation, leaflets, etc). A waymarked coastal walk (which has been proposed) signposted from the main road connecting to paths to the north and south would help to promote local walking. Toilet provision would enhance visits.

14.7.3 The ground would benefit from being drained, as water tends to lie on the surface in the winter. The low level walking opportunities in the area are potentially suitable for all abilities.

14.7.4 Although Western Isles residents and visitors have many walking options already, a "new" area would attract interest, and, if commercial facilities could be developed in Siadar, trade from these visitors would be useful.

14.7.5 Cycling (on mountain bikes) is increasingly popular in the Western Isles, and cyclists would also be able to use reasonably dry paths in the area.

14.7.6 With regard to water sports, the west side of Lewis, being exposed to the Atlantic, is generally unexploited, despite the attractiveness of the coastline. Piers that have been constructed elsewhere on the west side of the Western Isles, e.g. at Bragar, have not been as well used as had been anticipated – largely due to the lack of shelter from the westerly winds. Safety is the main concern for launching small boats and ribs – width and steepness of the slipway, angle to the tide, etc. With the protection offered by the breakwater (and possibly the adjacent fixed link), the Siadar pier should be relatively safe to use up to quite high wind speeds.

14.7.7 Although Siadar might not be the best location on the west side of Lewis for diving, surfing and windsurfing, it would offer an option, and the breakwater would give protection between it and the shore for kayaking and windsurfing learners. The waves for surfing to the south of the breakwater should not be much affected. Also, offshore reefs create areas that are good for surfing, and improved access up and down the coast from Siadar could open up these areas to a greater level of use.

14.7.8 As with tourism visits, water sports usage would tend to build up over time as people become familiar with the area and its advantages, especially if the pier / slipway are improved.

14.8 Other benefits

14.8.1 In the longer term, success of the project could lead to other similar (or more advanced) installations elsewhere in the Western Isles, with substantial economic and energy generation benefits – with scope to roll out this success across Scotland, the UK and internationally. It is estimated that the Scottish based marine renewables industry has the potential to deliver 7,000 jobs in Scotland directly concerned with marine renewable energy (FREDS Marine Energy Group, 2004)

14.8.2 The more sheltered sea access with a slipway would enable local fishing boats to stay in the water at times that would not otherwise be possible on the west side. Creeling off Siadar is said to be good, and the additional fishing benefit might sum to a few extra days fishing per year, with a modest economic impact. Also, young people in the area might be more encouraged to take up fishing (at least as a part time occupation).

14.8.3 The local Grazings Committee would receive 50% of the income paid by npower renewables for leasing the land at Siadar for the construction project and the onshore building. As noted above, the annual sum has not yet been agreed.

14.8.4 There would be scope to collaborate with the UHI Millennium Institute / Lews Castle College (Stornoway) Greenspace Research and Hydrogen Lab, for example in analysing energy outputs and efficiency and remote monitoring. There is also a great opportunity to learn about the interactions between marine energy schemes and the environment, on which there is currently limited knowledge. Through collaborations, such as the above, the understanding of this technology and its interaction with various receptors should be improved.

14.8.5 Local children would learn about wave energy through seeing the device and the interpretation to be provided, and interpretation on local archaeology would also be beneficial.

14.9 Summary of potential economic benefits

14.9.1 The construction phase would generate the most substantial benefits in the Western Isles in the short term. As estimated above, these could total:

- 30.5-72.5 FTE's and £780,000-£1,775,000 in household income in the Western Isles.
- 7.5-18 FTE's and £195,000-£444,000 in household income in the local area.

14.9.2 The operational phase (maintenance and repairs) might generate:

- 2.5 FTE's and £62,500 per annum in household income in the W. Isles.
- 0.5 FTE's and £12,500 per annum in household income in the local area.

14.9.3 Tourism benefits, after an initial period, might generate:

- 1.5 FTE's and £25,000 per annum in household income in the Western Isles.
- 1 FTE and £16,000 per annum in household income in the local area.

14.9.4 These annual operational and tourism benefits could last for up to 50 years (the design life of the project), although this could be extended.

14.9.5 Success, if it led to further comparable wave energy installations in the Western Isles, would multiply all of the above effects.

14.9.6 Other effects, not quantified, include increased scope for sea fishing, land rental income for Galson Estate Trust and local crofters, a potential role for UHI / Lews Castle College, and recreational benefits (walking, cycling, sightseeing and water sports).

14.10 Cumulative benefits

14.10.1 On the above estimates, over the first 25 years of operation, operational and tourism benefits, added to the high scenario construction phase effects would total 172.5 FTE's and £3,962,500 in additional household income in the Western Isles and 55.5 FTE's and £1,156,500 in additional household income in the local area.

15 Underwater Noise and Electromagnetic Effects

15.1 Introduction

15.1.1 This section assesses the effects that the project will have on the species in the vicinity due to the underwater noise generated during construction and operation of the scheme and electromagnetic effects due to the cabling connecting the structure with the foreshore. It covers all aspects of the project from construction (including piling effects) through operation and into the decommissioning phase. The process will concentrate on the worst case scenario for increases in noise levels and electromagnetic effects to the area; however, all other scenarios will also be qualitatively assessed.

15.2 Legislative framework and regulatory context

15.2.1 A full assessment of all the necessary regulatory frameworks was carried out prior to the study of underwater noise and electromagnetic issues. Legislation, policies and general guidance that have been taken into consideration include:

- Nature Conservation: Implementation in Scotland of EC Directives on the Conservation of Natural Habitats and of Wild Flora and Fauna and the Conservation of Wild Birds (the 'Habitats and Birds Directive'). Revised Guidance updating Scottish Office Circular No. 6/1995;
- Offshore Marine Conservation (Natural Habitats &c) Regulations 2007;
- Conservation of Seals Act 1970;
- Wildlife and Countryside Act 1981;
- Biodiversity: the UK Action Plan, CM 2428, HMSO, January 1994;
- Western Isles Local Biodiversity Action Plan (LBAP) Audit Report 2004;
- National Planning Policy Guidelines of relevance to this assessment:
    - NPPG 13 Coastal Planning (August 1997);
    - NPPG 14 Natural Heritage (January 1999);
- Scottish Government Planning Policy Guidelines of relevance to this assessment:
    - SPP 6 Renewable Energy;
- Scottish Government Planning for Renewable Technologies: Planning Advice Note (PAN) 45;
- Western Isles Structure Plan:
    - RM11 Habitats and Species;

  - RM12 Conservation Areas;
- Western Isles Local Plan;
- Joint Nature Conservation Committee (JNCC) Guidelines:
  - Guidelines for minimising acoustic disturbance to marine mammals from seismic surveys (JNCC, 2004).
  - The deliberate disturbance of marine European Protected Species: Interim guidance for English and Welsh territorial waters and the UK offshore marine area (JNCC, 2007).

15.3 Methodology

Scoping and consultation

15.3.1 Consultation in relation to the potential noise and electromagnetic effects in the marine environment has been undertaken with the bodies listed below (Table 15.1). The issues detailed in the table include those raised in the Scoping Opinion.

Table 15.1 Consultees and their key concerns

Name of Organisation	Key Concerns	Comment
Comhairle nan Eilean Siar (Planning Department)	Noise at sea is not a planning issue, but may become one if connected by a fixed link.	Assessment of potential effects from noise, both underwater and aerial, carried out as part of the EIA.
	Physiological and behavioural effects of underwater noise and vibration resulting from construction operations.	Assessment of potential effects has been carried out.
	Physiological and behavioural effects of underwater noise and vibration resulting from operation.	Assessment of potential effects has been carried out.
The Association of Salmon Fishery Boards & Institute of Fisheries Management	Physiological and behavioural effects of underwater noise and vibration resulting from construction operations.	Assessment of potential effects has been carried out.
	Physiological and behavioural effects of underwater noise and vibration resulting from operation.	Assessment of potential effects has been carried out.
	Effects of magnetic fields due to the presence of electrical cables.	Assessment of potential effects has been carried out.
	Noise predictions to be carried out for airborne and underwater noise relating to the turbines and other activities (e.g. blasting and piling) and operational noise of the active breakwater.	Assessment of potential effects has been carried out.

Name of Organisation	Key Concerns	Comment
SNH	Atlas of Cetacean Distribution in NW European Waters indicates the presence of white beaked dolphin, Risso's dolphin and Atlantic white sided dolphin directly off the coast at Siadar. Survey of cetaceans should be undertaken at earliest opportunity.	Particular reference to be given to cetaceans in ES. Desk study sufficient for the assessment and no baseline cetacean survey necessary. Effects of noise relating specifically to cetaceans, discussed in depth with Fiona Manson at SNH Battleby (Oct 2007).
	Noise from construction, operation and decommissioning, foghorns and other warning devices on mammals and fish are required to be covered.	Assessment of potential effects has been carried out.
Scottish Government; Enterprise, Transport & Lifelong Learning Department (Energy and Telecommunications Division)	Noise and vibration effects during construction and operation.	Assessment of potential effects has been carried out.
SEPA	Noise and their effects on marine receptors.	Assessment of potential effects has been carried out.
	Noise predictions to be carried out for airborne and underwater noise relating to the turbines and other activities (e.g. blasting and piling) and operational noise of the active breakwater.	Assessment of potential effects has been carried out.
FRS (Pitlochry)	Noise and effect on salmonids migrating towards the River Siadar.	Assessment of potential effects of noise on salmonids has been carried out.
WIFT	Noise and effect on salmonids migrating towards the River Siadar.	Assessment of potential effects of noise on salmonids and other fish has been carried out.

Desk study

Underwater noise

15.3.2 The assessment of potential effects of noise on likely marine receptors, in particular marine mammals and fish, including migratory salmonids, was made using present knowledge from literature and known/modelled noise levels and frequencies for the project. The assessment has also considered the requirements of the JNCC (2007) interim guidance on the assessment of significant affects on European Protected Species.

15.3.3 Few field studies have as yet been undertaken to look at the underwater noise impact of wave and tidal renewable projects, with the main focus of any studies to date generally being on effects associated with offshore wind projects. Although no specific noise field trials have yet been carried out on the proposed wave generation device, an assessment has been made into practicalities and issues associated with noise measurements of a similar operational device in

Islay (NEL, 2006). In addition, modelled noise information for the Siadar operational turbines has also been provided (Wavegen, 2007).

15.3.4 A desk study methodology was implemented due to the highly complex nature of the shallow water environment and the complications this has for the modelling of noise propagation. Due to the novel nature of the project and lack of comparable operational experience from elsewhere, there is no clear understanding of how the turbine noise will transmit into the underwater environment. Many variables exist which complicate the transfer of noise including temperature, salinity, wave action, angle at which noise reaches the air – water interface, etc. Noise also travels differently in water then it does in air and is particularly complicated in shallow water areas. Therefore, this transfer of noise from air to water cannot be modelled accurately. It was agreed with SNH that the most practical approach was to undertake a desk study as part of the EIA and undertake monitoring during the operational phase of the project to assist in the future impact assessments and potential modelling for other such renewable energy systems.

15.3.5 There is a considerable amount of literature available related to underwater noise effects associated with other offshore industries, in particular on how they impact marine mammals and fish. Notably, much research has been carried out on oil and gas industry activities such as seismic surveys and drilling operations, as well as shipping movements, offshore construction activities (e.g. drill-piling and dredging) and various sonar operations. An initial review of this information was made to determine whether noise characteristics of any of these activities are comparable to those modelled for the Siadar project. This literature was also used to identify typical noise sensitivity characteristics for marine mammals and fish relevant to the project area.

15.3.6 To further clarify the complexities in the assessment of effects from underwater noise, it is important to understand that the speed of sound waves varies considerably between different mediums. For example, the speed of sound in water is much greater than the speed of sound in air (for a given pressure of sound wave). Therefore, relative sound intensities in air and water are not directly comparable. Reference intensities have, therefore, been created. These are 1 microPascal (1 µPa) for underwater sound and 20 microPascals (20 µPa) for air. Sound waves with the same intensity in air and water differ in their relative intensities by 61.5 dB. This must, therefore, be subtracted from the relative intensities in water (referenced to 1 µPa) to obtain the relative intensity in air (referenced to 20 µPa). These reference differences account for 26 dB and density of the medium and sound speeds account for the remaining 35 dB. It should be noted that a difference of 60 dB in relative intensity represents a million fold difference in power.

Electromagnetic fields

15.3.7 Electromagnetic fields (EMF's) associated with industry standard electricity cables involve both an electric field (E-field) plus a magnetic field (B-field). The E-field is generally retained within industry standard cables, however the B-field is detectable outside the cable, and also induces a second electric field outside the cable (known as the iE-field). During impact assessments it is, therefore, the B-field and iE-fields that are of interest.

15.3.8 An electromagnetic fields review has been made by Gill *et al.* (2005) to update the most recent knowledge and information on potential effects of electromagnetic fields associated with offshore wind farm subsea power cables. This, and other information, has been reviewed to determine any potential applicability to the SWEP which will include installation of a power cable from the breakwater to shore. This cable will be either ducted within the fixed link or installed on the seabed where there is no fixed link.

Field survey

Underwater noise

15.3.9 In the Scoping Opinion SNH had requested that a baseline cetacean survey should be carried out as part of the EIA. Following a review of the cetacean data available for the area, including data supplied by the Sea Mammal Research Unit (SMRU) and further consultation with SNH, it was agreed that a baseline cetacean survey was not appropriate for the project.

Electromagnetic fields

15.3.10 No field survey considered appropriate.

Significance Criteria

15.3.11 The significance criteria employed for this section is based on the methodology defined in Section 5.3. The sensitivity and magnitude are defined in Table 15.2 and Table 15.3 below.

Table 15.2 Definition of sensitivity of effect

Sensitivity	Definition
Very high	Very sensitive such as on an important cetacean migratory route or at the opening to a major salmon river. Additionally has the potential to add unacceptable and / or prolonged noise / electromagnetic levels to the local marine environment.
High	Area known to possess a local population of sensitive cetaceans or allows access to an important salmonid spawning river. Additionally has the potential to significantly add prolonged excessive noise / electromagnetic levels to the area.
Medium	Area known to be visited regularly by sensitive species. Additionally has the potential to add excessive and / or prolonged noise / electromagnetic levels to the area.

Low	Area known to be visited occasionally by sensitive species. Additionally has the potential to add to baseline noise / electromagnetic levels for the area.
Negligible	Area known to be rarely visited by sensitive species. Baseline noise / electromagnetic levels for the area unlikely to change.

Table 15.3 Definition of magnitude / frequency of effect

Magnitude	Definition
Very major	Very major alteration to the baseline noise / electromagnetic conditions. Guide: Physical damage to hearing apparatus / electromagnetic field completely blocks faunal navigation or prevents sensitive species entering the area.
Major	Major alteration to the baseline noise conditions. Guide: Masking the detection of other sounds (e.g. for communication and echolocation) / electromagnetic field interferes with navigational or sensory capabilities.
Moderate	Moderate alteration to the baseline noise / electromagnetic conditions. Guide: Animals react behaviourally and/or physiologically when close to source.
Minor	Minor alteration to the baseline noise / electromagnetic conditions. Guide: Animals are able to detect the sound / electromagnetic source.
Negligible	Very slight alteration to the baseline noise / electromagnetic conditions. Guide: Very few animals are able to detect the noise / electromagnetic levels and only at the extremity of their perception range.

15.3.12 The magnitude and sensitivity of the potential effect are combined to define the significance of the effect, as shown in Table 15.4. Those criteria in red text are the residual effects considered significant under the EIA regulations.

Table 15.4 Effect significance matrix

Magnitude	Sensitivity				
	Very high	High	Medium	Low	Negligible
Very major	**Major**	**Major**	**Major**	**Moderate**	Minor
Major	**Major**	**Major**	**Moderate**	Minor	Insignificant
Moderate	**Major**	**Moderate**	**Moderate**	Minor	Insignificant
Minor	**Moderate**	Minor	Minor	Insignificant	Insignificant
Negligible	Minor	Insignificant	Insignificant	Insignificant	Insignificant

Pre assessment to identify worst case design options

15.3.13 A summary of the proposed options in relation to the assessment of effects on underwater noise and electromagnetism is shown in Table 15.5.

Table 15.5 Scheme design options (marine aspects)

Aspect	Options	Description	Discussion
Caisson construction	Local construction; construction compound established adjacent to the Scottish Water works at Siadar	Slipway from which caissons are to be launched and trench dredged to give area of deep water in which to float them. Seabed preparation for	Worst case because trenching operations are required and the construction of a slipway; both of these activities will generate underwater noise.

Aspect	Options	Description	Discussion
		breakwater. Drilled pile installation.	
	Remote construction – caissons are floated to site for installation	No slipway or trenching required for the caissons. Seabed preparation for breakwater. Drilled pile installation.	Lower significance due to lack of trenching and slipway construction, although there will be noise generated from vessels used to float the caissons to site.
Operation and maintenance to the breakwater	Fixed permanent access to link the breakwater to shore by rubble mound fixed link	Would require construction of a new fixed permanent link, including drill piling if the steel truss bridge is to be incorporated into the design.	Worst case for underwater noise because new structure requires drill piles and/or some form of seabed preparation takes place. Lower significance for electromagnetic effects as cable ducted within the fixed link structure.
	Fixed permanent access to link the breakwater to shore by part fixed link, part steel truss bridge		
	Boat access from onsite slipway.	Would require upgrades to existing slipway.	Lower significance for underwater noise because only modifications to existing slipway. Worst case for electromagnetic effects as cable laid on the seabed.

15.3.14 This assessment has examined the worst case option, with all other options assessed at the end of each subject.

15.4 Baseline conditions

15.4.1 This section provides baseline information on the underwater noise levels and electromagnetic fields in Siadar Bay. Baseline information is also provided on the marine mammals (cetaceans and seals) and fish species which are sensitive to underwater noise and electromagnetic fields.

Underwater noise

15.4.2 The proposed project site is in shallow waters, approximately 5 m (LAT) water depth. The area consists primarily of hard substrate, with an exposed aspect subject to substantial wave action. Consequently, the ambient noise in the proposed project area is substantial. In absence of site specific data and as a guide, ambient sea noise around the UK is estimated to be 85 dB re 1 μPa. Ambient shallow water noise levels are typically considered to be higher than deeper water; however currently there are not sufficient shallow coastal water background noise measurements to apply a reliable range.

15.4.3 Low frequency ambient noise (<10 Hz) is mainly a result of turbulent pressure fluctuations from surface waves and motion of water at boundaries. It depends on both wind strength and water currents, especially in shallow waters. Low frequency noise can propagate and be heard where turbulent noise does not dominate. Within the 10-100 Hz range, distant anthropogenic noise begins to dominate, usually as a result of a collection of sources at distance such as shipping traffic. At >100 Hz, the ambient noise level depends on weather conditions, with wind and wave related effects creating sound.

Electromagnetic fields

15.4.4 The baseline electromagnetic levels in the area will essentially be nil. There are, at present, no other sources of electromagnetism that increase levels above natural background levels.

Marine mammals

15.4.5 Seals and cetaceans have been identified as being present in the project area (Section 4). A survey of possible seal haul-out sites was carried out during the summer of 2007 during which seals were seen foraging in Siadar Bay. There are no haul out sites for grey or commons seals in or around Siadar Bay. The Western Isles is a rich area for cetaceans, with 20 species recorded within 60 km of the coast, primarily sighted in and around headlands (such as the Butt of Lewis to the north), offshore islands and banks, the continental shelf and the area of sea between the Scottish mainland and the east coast of the Western Isles known as 'The Minches', which is particularly rich in cetacean life. Harbour porpoise tend to favour more sheltered locations. Based on the data presently available and the knowledge of cetacean populations in general around the UK, the Siadar site is not expected to be frequently visited by cetaceans, and those in transit would tend to be further offshore in deeper waters. This was confirmed by data supplied by SMRU and consultation with SNH.

15.4.6 Species of cetacean present to the west of the Hebrides include:

<u>Inshore populations</u>

White-beaked dolphin (*Lagenorynchus albirostris*); Risso's dolphin (*Grampus griseus*); Harbour porpoise (*Phocoena phocoena*)

<u>Inshore and offshore populations</u>

Long-finned pilot whale (*Globicephala melas*); Bottlenose dolphin (*Tursiops truncatus*); Killer whale (*Orcinus orca*)

Offshore populations

Atlantic white-sided dolphin (*Lagenorynchus acutus*); Common dolphin (*Delphinus delphis*); Sperm whale (*Physeter macrocephalus*); Fin whale (*Balaenoptera physalus*)

Migratory species

Minke whale (*Balaenoptera acutorostrata*); Sei whale (*Balaenoptera borealis*); Humpback whale (*Megaptera novaeangliae*); Blue whale (*Balaenoptera musculus*); Sowerby's beaked whale (*Mesoplodon bidens*); Northern bottlenose whale (*Hyperoodon ampullatus*); Beaked whale spp. (*Ziphiidae*)

Fish and shellfish

15.4.7 The area in and around Siadar Bay will support a varied assemblage of commercial and non-commercial fish and seafish. This includes salmon, sea trout, mackerel, herring, pollock, dogfish, rays, rockling, gobies etc.

15.4.8 The west coast around Siadar supports important lobster and velvet crab habitats which are exploited by a small local fishery.

15.4.9 Salmon and sea trout are also common along the west coast of Lewis. They are both known historically from the River Siadar; however, salmon have not been identified from this watercourse for a number of years and are more prevalent in rivers further to the south (e.g. Barvas). Sea trout migrate up the River Siadar annually to spawn; migrating upstream as adults in Oct/Nov with the new smolts returning to the sea during May/June. These new smolts will return to the river in which they were spawned in order to breed when they are mature enough to do so. At present the River Siadar is not a regulated / managed angling river. The only other migratory fish expected to be impacted by the project is the eel. This species is also known from the River Siadar.

Otters and sea turtles

15.4.10 Occurrences of the European Otter (*Lutra lutra*) have been recorded on the shores and nearshore waters at Siadar. Recent survey data shows they primarily use the area for foraging but that there are no holts, couches or other rest areas present along the coastline. These are all situated further inland around the freshwater lochans.

15.4.11 Leatherback turtles (*Dermochelys coriacea*) have been recorded off the west coast of Lewis; however, sightings are considerable distances offshore and it is not expected that any turtles will venture close enough to the shoreline to be affected by the SWEP.

15.5 Assessment of effects – species sensitivity to underwater noise

15.5.1 Prior to the assessment of potential effects from the underwater noise associated with the SWEP project, the following sections present background information on species sensitivities to underwater noise.

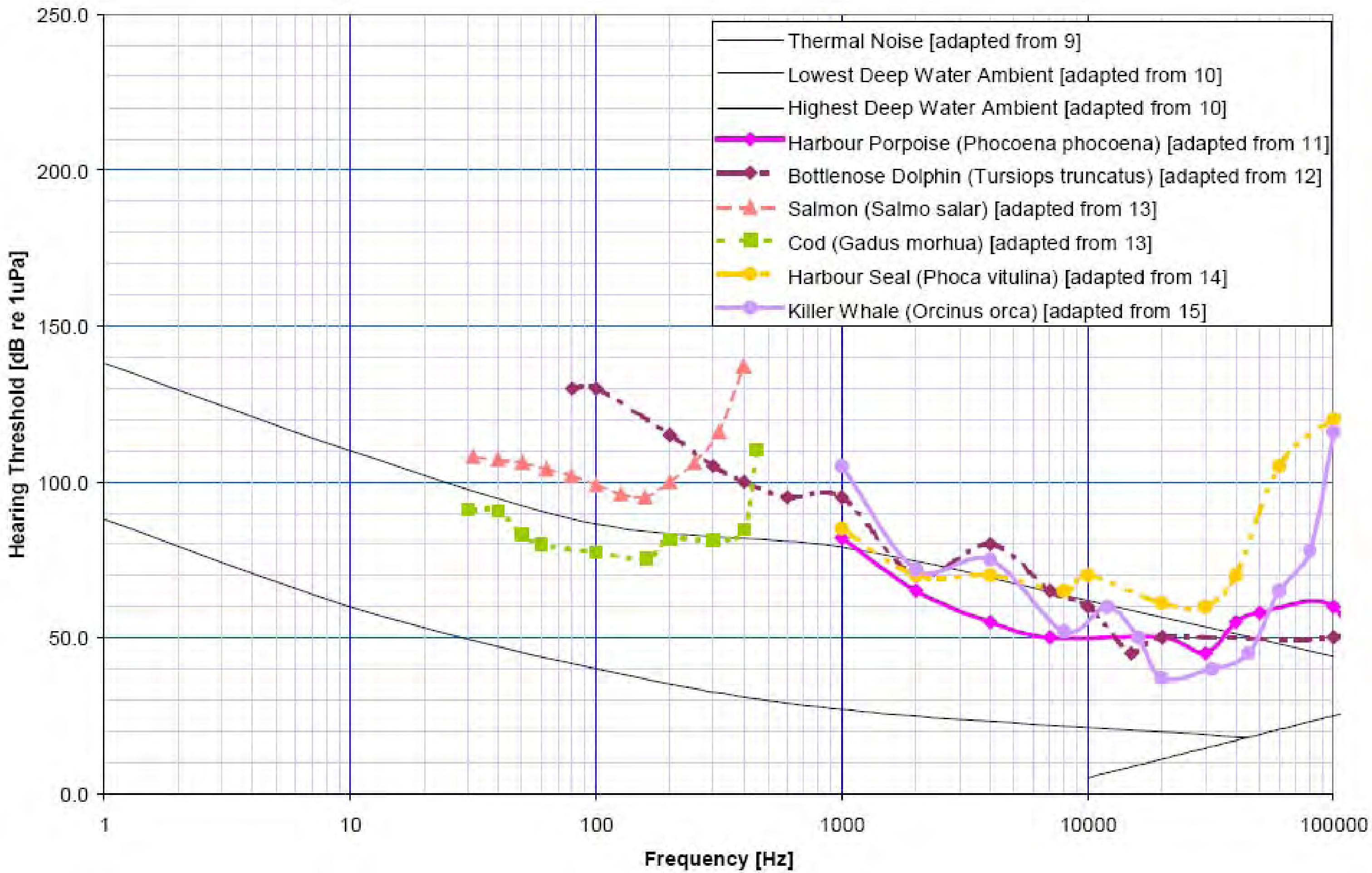
Marine mammals

15.5.2 Whales, dolphins and porpoises are collectively known as cetaceans. Cetaceans are divided into two groups, the Odontocetes (toothed whales, dolphins and porpoises) and the Mysticetes (baleen whales). It is important to distinguish between the two groups as they differ in their sensitivity to underwater noise.

- **Odontocetes** hunt and eat relatively large single prey, including squid, fish, and in a few cases (e.g. killer whale) marine mammals. This group can be further divided into six families and includes the porpoises, oceanic dolphins, sperm whales and beaked whales. Odontocetes communication calls are mainly at moderate to high frequencies (1,000 - 20,000 Hz). Many species also have highly developed echolocation (the location of objects by reflected sound) systems operating at high frequencies (20,000 - 150,000 Hz).
- **Mysticetes** are large whales that filter crustaceans or small fish with baleen plates made of stiff hairs that hang from the roof of the mouth. This group can be further divided into two families to include the rorquals and the right whales. The rorquals generally migrate over long distances between warm-water winter breeding grounds and cold-water summer feeding grounds. Baleen whales appear to be more sensitive to low and moderate frequency sounds (12 - 8,000 Hz) and lack a high frequency echolocation system.

15.5.3 When attempting to determine potential effects to a particular species it is important to compare its frequency spectrum (Hz) with its known or estimated auditory range (dB re 1 µPa). The relationship between these two parameters for individual species is commonly illustrated on an audiogram, which in turn helps to pinpoint particular sensitivity ranges for that species. Figure 15-1 shows an example of audiograms for common European marine species.

Figure 15-1 Examples of species' audiograms, with extent of ambient noise for reference (taken from Nedwell & Howell, 2004)



15.5.4 There is currently no nationally or internationally agreed acceptance limits for underwater noise; however, a number of sources do provide guidance levels that are commonly quoted when considering underwater noise (NEL, 2006):

- Source levels of 93 dB/Hz re. 1 µPa at 1 m at 50,000 Hz; 130 dB/Hz re. 1 µPa at 1 m at 1,000 Hz; and 135 dB/Hz re. 1 µPa at 1 m at 10 Hz (ICES-CRR209);
- Received level of 130 dB re. 1 µPa at 100 m from a source, 45-7,100 Hz range (MarLIN Benchmarks);
- Received level of 120 dB re 1 µPa for continuous noise as a criterion for responsiveness in cetaceans defined by Richardson *et al.* (1995).

15.5.5 Marine mammals as a group have a wide functional hearing range of 10 - 200,000 Hz, with hearing thresholds near 40 - 50 dB re 1 µPa. All marine mammals are potentially affected by sound sources of 300 Hz or higher. With reference to Table 15.6, the following possible marine mammal categories related to sound level responses have been proposed:

- Low Frequency Cetaceans (all Mysticetes)
- Medium Frequency Cetaceans (most Odontocetes)
- High Frequency Cetaceans (porpoises, dolphins etc.)
- Pinnipeds (Seals) when underwater
- Pinnipeds (Seals) when hauled out on beaches

15.5.6 Where a source noise level is above the hearing threshold for a particular species at a corresponding frequency, then it becomes audible to that species. The higher the level above the hearing threshold, then the greater the potential impact at the given frequency. It has been proposed that when a sound exceeds about 90 dB dB re 1 µPa above the species hearing threshold, it is likely to cause significant behavioural effects and in particular avoidance, and at 70 dB dB re 1 µPa mild behavioural reactions will occur.

15.5.7 To assess the potential scale and likelihood of underwater impact effects to marine receptors, four categories of noise influence between the source and receiver have been defined by Richardson *et al.* (1995). This categorisation has been developed to help predict measure and manage noise generating activities. Starting closest to noise source, these zones are generally:

- **Hearing Loss** area nearest the noise source where the sound level is high enough to cause tissue damage. This could potentially result in damage such as temporary threshold shift (TTS) or permanent threshold shift (PTS).

- **Masking** region within which noise is strong enough to interfere with detection of other sounds (e.g. communication or echolocation). This zone can be highly variable depending on the source and the receptor.
- **Responsiveness** region in which the animal reacts behaviourally or physiologically.
- **Audibility** areas within which the animal is able to detect sound.

15.5.8 Depending on the type of source, the species of interest, its known habits and acoustic behaviours, one or several of these categories can help determine an appropriate safety range specific to the activity and species of interest (URS, 2004).

15.5.9 In summary, those species that are likely to be affected by low frequency source effects are generally all Mysticetes. By contrast most pinnipeds (seals) have high sensitivity in 1,000 - 15,000 Hz, while Odontocetes have peak sensitivities at high frequencies >20,000 Hz. The harbour porpoise relies heavily on sound for orientation and foraging and is amongst one of the most acoustically sensitive species (Au *et al.*, 1999). Its best hearing is around 100,000+ Hz and therefore is sensitive at high frequencies; however communication calls tend to be within a lower frequency range.

Fish and shellfish

15.5.10 Hearing structures in fish are diverse. The hearing range of many fish is typically between 30 and 1,000 Hz. Some fish however have a hearing range <20 Hz, whilst some are >20,000 Hz (Thomsen *et al*., 2006), demonstrating an overall wide auditory range. Table 15.6 highlights the low frequency hearing range characteristic of some common European fish species.

15.5.11 Swim bladder arrangements of fish also influence sensitivity, particularly when subject to large sound pulses such as those generated by seismic airguns, pile-driving and blasting operations. Fish with air-filled swim bladders are generally more sensitive to such pulses, and amongst these, those with bladders unconnected to the oesophagus are the most sensitive (URS, 2004).

Otters and sea turtles

15.5.12 Few data are available on noise affecting otters and the effects of human activities on their behaviour, reproduction, and distribution.

15.5.13 Sea turtles (Leatherback) have been recorded off the west coast of Lewis. All records have been a significant distance offshore and unlikely to be affected by the project.

15.5.14 Little is known about sound perception in sea turtle normal activities. It has been speculated that migrating turtles may use various acoustic cues and that acoustic disturbances might interfere with their navigational ability (Swan *et al.*, 1994). The auditory sensitivity of sea turtles is reported to be within 400 - 1,000 Hz range, with a rapid drop off of noise perception on either side of this range (Richardson *et al*., 1995). Other studies align with this, predicting a 250 - 300 Hz to 500 - 750 Hz best hearing range (LGL Ltd., 2000). This range matches their low vocalisation abilities which are also in the low frequency range (100 - 700 Hz).

Summary

15.5.15 A summary of all the aforementioned faunal groups along with their noise creation and hearing ranges is provided in Table 15.6.

Table 15.6 Faunal groups and their associated noise creation and hearing levels

Species	Communication call Freq (Hz)	Echolocation Freq (Hz)	Hearing range (Hz)	Comment
Odontocetes (toothed whales)	Med – High (1,000 – 20,000)	Med – Very High (20,000 – 150,000)	Up to 150,000	Porpoises and dolphins at the high end frequency levels
Mysticetes (baleen whales)	Low – Med (12 – 18,000)	-	Low – Med (20 – 3,000)	Lower frequency range to odontocetes due to lack of echolocation
Pinnipeds (seals)	Low	-	High (<70,000 underwater & <30,000 on land)	Best hearing 8,000 – 16,000 Vocalisation can be masked by vessel noise
Salmon	Low	-	Low (<380)	Potential for physical damage from blasting operations at up to 2.2 km
Herring	Low	-	Low – Med (30 – 4,000)	Similar to effects on other fishes
Cod	Low	-	Low (150 – 160)	Low-medium frequencies detectable at up to 4 km
Dab	Low	-	Low (30 – 250)	Similar to effects on other fishes
Turtles	Low (100 – 700)	-	Low (500 – 1,000)	Unlikely to be affected due to rare offshore presence

15.6 Assessment of effects - construction

Underwater noise

Potential effects

15.6.1 Typical noise levels (dB), frequency ranges (Hz) and characteristics for construction activities such as offshore piling, dredging and vessel movements, which are likely to be associated with the SWEP, are referenced from existing literature. Table 15.7 provides a summary of typical noise characteristics for various marine activities.

Table 15.7 Noise source levels and frequencies for construction activities (Source adapted from various including Nedwell and Howell, 2004; Richardson *et al.*, 1995)

Noise source	Freq (Hz)	dB	Source type
Drill piling	Low (250)	115 – 190 re 1 µPa @ 1 m	Continuous
Blasting	High	Up to 270 re 1 µPa @ 1 m	Pulsed
Marine Dredging	Low (20 – 8, 000)	100 – 150 re 1 µPa @ 1 m	Variable / Continuous
Vessel operation (construction and operation)	Low (37 – 6, 300)	150 – 170 re 1 µPa @ 1 m	Variable / Continuous
Turbine operation	Low – Med (22 – 11, 300)	Up to 143 re 20 µPa @ 1 m (per caisson)	Oscillating/Variable
Rough weather and precipitation	Low (100 – 500)	80 – 120 re 1 µPa @ 1 m	Variable
Shrimp and fish	Low (>12)	80 – 120 re 1 µPa @ 1 m	Regular / Continuous
Cetaceans (Odontocetes)	Med – Very High (100, 000)	180 – 195 re 1 µPa @ 1 m	Transient
Cetaceans (Mysticetes)	Low – Med (12 – 18, 000)	170 – 195 re 1 µPa @ 1 m	Variable (continuous or transient)
Turtles	Low (100 – 700)	N/A	Transient

15.6.2 **Marine dredging**: Some shallow water measurements indicate a peak spectral source level from dredging of up to 177 dB re 1 µPa @ 1 m, between 80 - 200 Hz. Marine animals with low frequency auditory sensitivity therefore have the highest potential for effects, e.g. Mysticetes cetaceans, harbour porpoise, pinnipeds, fish and possibly turtles. Documented reactions of animals to dredging noise are scarce, with mixed reactions observed. Based on evidence available it is likely that noise is audible to cetaceans up to several kilometres from source (Nedwell & Howell, 2004). No behavioural observations are available for other marine wildlife; however behavioural reactions would be likely at close range where source sound level is well above background noise. Because of rapid attenuation of low frequencies in shallow water, dredge noise is normally undetectable underwater at distances greater than 20 - 25 km (Richardson *et al.*, 1995).

15.6.3 Although over a short period of about 20 days of the construction process the magnitude of underwater noise from dredging is considered to be very major, and the sensitivity of the site is medium. Therefore, the overall significance criterion for dredging is considered to be **major**.

15.6.4 **Underwater blasting**: Explosive blasts initiate similar noise properties to pile driving therefore similar sensitivities could be inferred. A well used near source blast injury model is available based on North Sea wellhead severance blast measurements. Extent and range of response is a function of charge size. Models have inferred a strong correlation of injury with received level for submerged mammals and mortality for fish. Potential physical damage to fish within 2.2 km of blast, and observations of dead fish have been made in blast areas by marine mammal observers. Additionally, some cetacean avoidance observations exist (Nedwell & Howell, 2004).

15.6.5 Blasting may occur on a few occasions during the 60 days of seabed preparation for the caisson foundations. Therefore, the magnitude of the impact of blasting is considered to be very major, and the sensitivity of the site is medium. Therefore, the overall significance criterion for blasting is considered to be **major**.

15.6.6 **Drilling**: Again, higher potential sensitivities to low frequency animals (Mysticetes, harbour porpoise, pinnipeds and fish). Limited documented shallow water measurements and most information based on deeper water drilling activities, therefore limiting comparison of effects. Similar sensitivities to dredging could possibly be inferred. Studies report some response to playback tests, and conclude cetaceans avoid the area when the received level is well above background noise and hearing threshold (Richardson *et al.*, 1995).

15.6.7 Although over a short period of the construction process (60 days) the magnitude of drilling (drill piling in the case of Siadar) is considered to be major, and the sensitivity of the site is medium. Therefore, the overall significance criterion for dredging is considered to be **moderate**.

15.6.8 **Vessel movements**: Effects from vessel noise are not clear, with both attraction and avoidance reactions being observed in cetaceans and pinnipeds. There is the potential for lower frequency noise to be detected by harbour porpoises at distances of 1 km, and higher frequencies (2,000 Hz) up to 3 km, with masking of harbour seal low frequency vocalisations by ship noise possible at 15 km (Thomsen *et al.*, 2006). Zone of responsiveness is difficult to predict and it is also often difficult to differentiate visual and auditory behavioural reactions. Richardson *et al.*, (1995) define received level of 120 dB re 1 µPa for continuous noise as criterion for responsiveness in cetaceans, which would be equivalent to about 400 m (250 Hz) from vessel source for both harbour porpoise and harbour seal in open water. The low frequency nature of vessel noise means it is likely to be detectable by fish at large distances, depending on ambient conditions. Various data are available on the effects of vessels on fish. For example, cod and herring avoidance reactions have been observed, including shoal reactions. One study observes Temporary Threshold Shift (TTS) effects on fat-headed minnow due to ship engine noise (Yurk *et al.*, 2000; Culik *et al.*, 2001). Vessel movement noise is more likely to be additive to other project activities.

15.6.9 Vessel activities will be ongoing in Siadar Bay for about 6 months of the construction phase. The magnitude of noise from vessel movements is considered to be moderate, and the sensitivity of the site is medium. Therefore, the overall significance criterion for dredging is considered to be **moderate**.

15.6.10 **Cumulative noise**: It should be noted that the activities which create the greatest levels of underwater noise, such as dredging, drilling and blasting, are not expected to occur within Siadar Bay in a simultaneous fashion.

15.6.11 In summary it can be concluded that dredging, blasting and drilling are the activities that will have greatest effects on marine wildlife.

15.6.12 The only species of marine mammal expected to be present in Siadar Bay are the occasional harbour porpoise, and grey seal. The numbers of individuals present at any one time not considered to represent a significant percentage of the populations present offshore the Atlantic coast of the Western Isles. Porpoises and seals will be expected to avoid the bay and its immediate surroundings during these noisy operations.

15.6.13 Sea trout populations are known to be present in the River Siadar. Numbers of fish present in Siadar Bay will be greatest when the fish are migrating between the marine and freshwater habitats. Sea trout migrate upstream from the marine environment in October and November to spawn, and smolts (young fish) return to the marine environment in the following May and June. Fish are most sensitive to pulsed noises, which in the instance of the SWEP project will be blasting during seabed preparation. If blasting was to occur during these months fish migration and breeding patterns may be affected and the sea trout population of the River Siadar may not spawn in the that particular year. The fish would however be expected to return to the river the following year once construction activities were complete.

Mitigation

15.6.14 During the construction phase of the project Marine Mammal Observers (MMOs) will be used in advance of operations which generate significant quantities of noise, such as dredging, drill-piling and blasting to spot cetacean activity and only allow these activities to commence once the cetacean has vacated into the pre defined safe area which are a safe distance from the works. They will follow the principles of the JNCC (2004) 'Guidelines for minimising acoustic disturbance to marine mammals from seismic surveys' highlighting the procedures required to be followed for the starting and cessation of works in relation to cetacean activity. It is understood the JNCC Guidance has been slightly modified for activities at the European Marine Energy Centre (EMEC) in Orkney and this experience will also be considered by the project as appropriate. A European Protected Species (EPS) licence in relation to cetaceans will be applied for, if required, following further consultation with SNH and following the JNCC (2007) guidance.

15.6.15 Appropriate vessel speeds will be in place for the vessels employed throughout the construction, phase (if a vessel is required). This will prevent excessive noise being produced at source, which is generally associated with rapid movement and noise level changes (e.g. revving of engines).

Residual effects

15.6.16 All activities that will create significant noise levels in this area are to be conducted over relatively short periods of time (days to weeks), thus reducing their overall impact. Mitigation measures will be in place to treat all of these activities in the same manner; therefore, the use of MMO's will be standard throughout. However should noisiest operations occur during the months of October and November and May and June when sea trout will be migrating to and from the River Siadar effects could be impacted therefore the overall residual impact is considered **moderate**.

Non worst case

15.6.17 The non worst case scenario for the effects of underwater noise would be if the fixed link were not to be constructed and the caissons were constructed offsite. This would reduce the requirement for drill-piling associated with the construction of a steel truss bridge and dredging and would mean that only construction operations related to the breakwater would be required. However, drill-piling and other noisy operations would still be required for installation of the breakwater caissons, but span a considerably shorter period of time. In this case, and with the appropriate mitigation still in place, it could considered that the overall residual impact would still remain **moderate** depending on the exact timing of the operations.

Electromagnetic effects

Potential effects

15.6.18 No effects related to electromagnetic effects are expected to be associated with the construction phase of the project.

15.7 Assessment of effects - operational

Underwater noise

Potential effects

15.7.1 During the operational phase of the SWEP the noise generated by the Wells turbines within the structure is expected to be to the main source of underwater noise. Source noise frequencies for the turbines are within a low-medium frequency band (22 - 11,300 Hz) and tonal in nature; however this requires confirmation once the design is finalised. Noise output for one turbine at 1 m is predicted to range between about 110 and 135.5 dB(A) re 20 µPa across its operating range. Cumulative worst case noise at source for each of the ten caissons within the breakwater has been modelled to be approximately 143 dB re 20 µPa. During normal operation turbine noise would vary considerably at both small temporal scales (seconds), due to the wave cycle; and at larger temporal scales (hours/days/months), due to seasonality, tidal processes and variations in sea and weather patterns.

15.7.2 Of the species known to be present in the area marine mammals are thought to be the most sensitive. Sea trout are not expected to be sensitive as they locate their natal freshwater source through their sense of smell, therefore the noise from the SWEP is not expected to affect their navigation to these freshwater sources.

15.7.3 The modelled Siadar turbine acoustic characteristics (at source) could reasonably be compared to those of small vessel and shipping movements and marine dredging. However, it must be noted that the turbine noise here is at source (in air) and there is presently no data available on how and what proportion of this source noise will be transmitted into the marine environment. A recent study (Thomsen *et al.*, 2006) indicates that the noise generated from a single (1.5 MW) offshore wind turbine at 12 m/s has similar (but slightly lower) characteristics to the Siadar turbine (i.e. noise levels of 125-145 dB re 20 µPa, primarily within a low frequency spectrum [50-200 Hz]). It is considered therefore that information available on effects associated with these activities can be used as a reference point when considering the potential effects of the Siadar turbines once operational. Operational noise of the turbines is unlikely to cause physical damage to cetaceans. Evidence of offshore wind turbine disturbance can be drawn as the levels of noise at source are expected to be similar. Additionally, the site chosen faces the open Atlantic Ocean. Noise will, therefore, be transmitted out of the bay and will not create an ‘acoustic trap’ for any fauna in the area. They will always have the ability to simply move away from the source of the noise. The magnitude of the increased noise due to turbine operation in this high energy environment is considered to be moderate and the sensitivity of the receiving environment medium. Therefore, the overall significance effect is considered to be moderate.

15.7.4 If the fixed link to the breakwater is not constructed then a single vessel (proposed to be a RIB [Rigid Inflatable Boat] approximately 6 m in length) will be in operation. As the servicing of the breakwater is not expected to be frequent in nature the intrusion of this vessel and the additional noise effects it may cause is expected to be **minor** due to the minor magnitude of effect and the medium sensitivity of the area.

Mitigation

15.7.5 As the technology being proposed for the SWEP is an emerging technology there is, consequently, a lack of data available on the implications such a device will have for the underwater noise of the area. At present there is a lack of common methodology and international standards for the monitoring of such underwater noise. An appropriate mitigation regarding monitoring will be implemented in consultation with the European Marine Energy Centre (EMEC) who are developing a methodology for use within the marine renewables industry. All monitoring will provide data for future developments within the wave energy sector and will be used as a template for the assessment and permitting process for future similar projects. Such invaluable data will assist greatly this young energy sectors future potential.

15.7.6 Operational monitoring will be carried out to confirm the validity of such a comparison. Studies will also look to identify the level of noise attenuation through the concrete structure itself and into the sea. The appropriateness and practicalities of carrying out some initial noise studies at the Wavegen’s Islay site in 2008 will be given serious consideration and if merited will be implemented in order to provide some empirical data to aid the assessment of these effects for the SWEP.

15.7.7 Appropriate vessel speeds will be in place for the vessels employed throughout the operational phase (if a vessel is required). This will prevent excessive noise being produced at source, which is generally associated with rapid movement and noise level changes (e.g. revving of engines).

Residual effects

15.7.8 Due to the shape of the bay, the low numbers of cetaceans utilising this shallow water area and the reduction in noise from source (the caissons) to the marine environment the turbine operation effects are predicted to be **minor** in nature. Effects of vessels are considered to be **insignificant**.

Non worst case

15.7.9 The non worst case scenario for the effects of underwater noise would be if the fixed link were constructed. This would remove the requirement for boat access to the breakwater for operational purposes; however, this would only reduce noise levels in the area fractionally. Additionally, as the shelter provided by the structure will likely be exploited by local vessels it is expected that any reduction in noise from operational vessels will be replaced by noise from local vessels. Therefore, the effects of noise would remain **minor** for turbine operation and **insignificant** for vessel noise in the area.

Electromagnetism

Potential effects

15.7.10 The worst case scenario for electromagnetic effects on the fauna of the area would be if the cable was to be laid directly onto the seabed and not encased within part of the potential fixed link. The cabling for the SWEP is likely to be an 11 kV cable laid between the breakwater and the control building on the shore at one of two proposed locations.

15.7.11 Elasmobranchs (sharks, skates and rays) are the primary group of organisms that are likely to be affected by the electromagnetic field produced by the cable. They possess Ampullae of Lorenzini (AoL) which consist of a series of pores on the skin surface leading to canals which are filled with a conductive jelly, enabling them to detect very weak voltage gradients in the range 0.5 - 1,000 µV/m. It is this electroreception that they use as their principal sense for locating food. More open water species such as tope and spurdog may encounter iE-fields near the seabed but spend significant time hunting in water column, therefore are not impacted as much as other species. The potential for impact is considered to be highest for species that depend on electric cues to detect benthic prey (Gill *et al.*, 2005). There is general agreement that a field of sufficient strength to cause avoidance behaviour in elasmobranchs will only occur within 10 - 20 cm of the cable (figures based on a 33 kV cable).

15.7.12 Other species found in the area of Siadar, which do not possess specialised electroreceptors, but are able to detect induced voltage gradients associated with water movement and geomagnetic emissions include eels, salmonids, cod, plaice, crustaceans (shrimp, prawn, crab and lobster) and potentially turtles. This detection is via magnetic perception utilised primarily for navigation in some species. Such detection is also present in some cetaceans. Pinnipeds are not known to be magnetoreceptive (Gill *et al.*, 2005). Controlled experiments have also shown that EMF's appear to disrupt the transport of calcium ions in cells, which may be of importance to developing embryos. B-fields of 1 - 100 µT have been found to delay embryonic development in sea urchins and fish (Gill *et al.*, 2005).

15.7.13 Elasmobranchs (dogfish) are prevalent in the area due to the habitats available (Section 8). However, as behavioural effects are likely to only occur within 10 - 20 cm of the cable (based on a 33 kV cable) the impact is likely to be insignificant due to lower voltage cable for the SWEP (11 kV).

15.7.14 Disruption to migration routes of species which utilise magnetism is highly unlikely as migration generally occurs in open water, away from the seabed, whereas the cable will be in Siadar Bay in the shallow water lee of the breakwater structure. Therefore, the 11 kV cable is likely to only affect a very localised area on a typical Atlantic rocky shore. Additionally migratory salmonids and eels utilising the River Siadar are not considered to be impacted once they are close inshore as they are assumed to use their sense of smell rather than the earth's magnetic field to navigate (Robin Rigg ES, 2002). The magnitude of the effect is seen as being minor and the sensitivity of migratory species is considered to be low. Therefore, the overall impact is considered to be **insignificant** due to the proximity of the cable to the shore and the low numbers of eels and salmonids in the area.

Mitigation

15.7.15 The built in electromagnetic shielding of the cable will reduce potential electromagnetic effects.

Residual effects

15.7.16 The sensitivity of the area is considered to be negligible and the appropriate shielding of the cable gives a magnitude of effect which is low. Therefore, the overall residual effect of a cable running from the breakwater structure to the onshore control building is considered to be **insignificant**.

Non worst case

15.7.17 The non worst case scenario for the electromagnetic effects of the cable connecting the structure to the shore would be if the cable were embedded in a permanent fixed access linking the breakwater to the shore. Although this does not fully mitigate against electromagnetic effects it will reduce the potential effects as the cabel will not be submerged and there will be a greater separation between the cable and any receptors. In this instance the effects of cabling to shore would still remain **insignificant**.

15.8 Assessment of effects - decommissioning

Underwater noise

Potential effects

15.8.1 It is expected that the main breakwater structure will remain in place; therefore the noise effects associated with its removal are unlikely to occur. However, noise effects related to the removal of the turbines may well occur. If there is to be a fixed link connecting the breakwater to the shore then this will be done terrestrially; however, there is the potential that it may be carried out by maritime vessels.

15.8.2 Typical vessel numbers and effects will be similar to those for the construction phase of the project. The duration of this phase is also likely to be shorter than for the construction phase and the vessels smaller as the primary breakwater structure will remain in situ. Therefore, the impact of vessel noise during this phase is considered to be **insignificant**.

Mitigation

15.8.3 Appropriate vessel speeds will be in place for the vessels employed throughout the decommissioning phase (if a vessel is required). This will prevent excessive noise being produced at source, which is generally associated with rapid movement and noise level changes (e.g. revving of engines).

Electromagnetism

15.8.4 **No effects** related to electromagnetic effects are expected to be associated with the decommissioning phase of the project.

15.9 Cumulative effects

15.9.1 No other construction will be taking place during the construction phase of the project, therefore with regards dredging and drill piling there will be no cumulative effects. This period of the construction will be short in duration.

15.9.2 Small local fishing vessels using the area at the same time as the construction vessels will add to the vessel noise in this location. They will likely be transient in nature and the vessels associated with the construction will only be present for a short period. Additionally, the numbers of fishing vessels will be small and the noise levels that they are likely to produce will be at a considerably lower level than that produced by the vessels involved in the construction / marine installation process. The noise levels produced by these fishing vessels are likely to be greater than the noise generated by any vessel required during the operational phase of the project, should a fixed link not be constructed. Therefore, the project vessels are not expected to add considerably to the cumulative effects of vessel noise in the area.

15.9.3 During the operational phase of the project any additional noise will come from increased boat traffic in the area (e.g. leisure craft and the additional inshore fishing vessels taking advantage of the increased shelter aspects provided by the breakwater and fixed link structures as well as the potential boat servicing of the breakwater). However, this will be small-scale in nature and not expected to add significantly to the noise pollution of the intertidal or subtidal habitats and/or species.

15.10 Summary and conclusions

15.10.1 The proposed SWEP development will have a **moderate** effect on the marine species in the area, particularly during the short construction process, but only a **minor** effect during operation. These levels are reached primarily due to the shallow water location and the shape of the bay allowing for noise to dissipate into the greater Atlantic zone, thus preventing the acoustic trapping of any animals. This proximity to the open area of sea additionally allows for any animals to avoid noisy operations by moving away, further preventing their acoustic entrapment. The bay is not known to be frequented by species that are likely to be affected by the proposed noise sources and appropriate monitoring (e.g. the use of an MMO) will also be implemented. If a non worst case scenario is chosen where less drill piling and dredging is required then this will not affect the **moderate** nature of the impact as drill-piling will still occur and there is still the likelihood that sensitive cetacean species will be affected. Therefore, the precautionary approach has deemed that the effect of the impact remains **moderate**.

15.10.2 The effects of electromagnetism on the species in the area are deemed to be **insignificant** for all scenarios proposed. This is primarily due to the shallow bay not being particularly important for species which have any level of sensitivity and the mitigation measures (e.g. sheathing of the cable) being proposed.

16 Accidental / Non-routine

16.1 Introduction

16.1.1 This section assesses the potential for accidents and the occurrence of events likely to impact on the environment. It covers all aspects of the project from construction (including the potential for the caissons to be brought in by sea) through operation and into the decommissioning phase. After identifying the potential effects likely to occur with such a development it then assesses these and provides for mitigation and management systems which will reduce any potential effects.

16.2 Offshore construction, operation and decommissioning

Potential accidental/non-routine scenarios

16.2.1 The environmental risks from accidental and non-routine events associated with the construction and operation of the offshore facilities have been assessed and the main risks relate to:

- Oil/fuel/lubricant leaks/spills from vessels during seabed preparation, caisson positioning, drill-piling operations, cable installation, turbine installation, maintenance, and decommissioning;
- Vessel/vessel or vessel/breakwater/caisson collisions;
- Collapse of any structures (e.g. piles) during installation;
- Loss of caissons during towing operations due to bad weather; and
- Spills of chemicals/oils used on the structure.

Potential environmental effects

<u>Oil and/or chemical pollution</u>

16.2.2 Spilled oil at sea can have a number of environmental and economic effects. Actual effects depend on a wide range of factors including volume and type of oil spilt, and the sea and weather conditions at the time of the spill and whether environmental sensitivities are present in the path of a spill. These environmental sensitivities will have spatial and temporal variations.

16.2.3 The impact from small oil spills or leaks will be localised to the immediate vicinity of the spill and spilt oil will quickly disperse in the dynamic waters of the west coast of Lewis. Small spills/leaks will be most likely to originate from vessels being used during the construction phase of the operation. Major oil spills may result from a vessel collision or grounding and the discharge of oil from fuel tanks. Although the effects from such an incident may be of greater consequence, such events are extremely remote, particularly as the number of vessels being utilised for the construction of the SWEP is small in number.

Navigational hazard

16.2.4 Any collision between the caissons or loss of a caisson, as they are being transported into position may result in a navigational hazard to vessels operating in the area. This will also be the case regarding the collapse of any major structure such as the dolphin piles (used during the construction of the steel trussed bridge) as they are being positioned.

Management and mitigation

16.2.5 All vessels associated with the installation and operational phase of the SWEP will comply with IMO/MCA codes for prevention of oil pollution and have Shipboard Oil Pollution Emergency Plans (SOPEPs) and be lit in accordance with the International Regulations of Preventions of Collisions at Sea.

16.2.6 As far as possible vessels with an established track record of operating in similar waters where the conditions can become severe over a short period of time will be employed. They will also be familiar with the operating conditions in the area (e.g. bathymetry, tidal flows, etc.) and will adhere to all appropriate navigational standards and practices.

16.2.7 Appropriate times of year (primarily the summer months) will be utilised to avoid incidences of bad weather leading to potential cargo loss/damage (e.g. caissons).

16.2.8 If material is being brought in from other areas (e.g. the towing of caissons) then appropriate safe anchorages en route will be identified in the event of any emergencies, particularly due to bad weather.

16.2.9 Emergency procedures will be developed by npower renewables prior to the construction and operational phases to address the response to accidental and non-routine events.

Residual impact

16.2.10 The likelihood of a major oil spill from a vessel is very remote, and although the potential consequence could be severe, there are established procedures and practices in place to ensure that an efficient and effective response will be implemented to safeguard personnel and minimise potential environmental effects.

16.3 Onshore construction, installation and operation

Potential accidental/non-routine scenarios

16.3.1 The environmental risks from accidental and non-routine events associated with the construction and operation of the onshore facility have been assessed and the main risks relate to:

- Fire at the onshore facility and resultant pollution;
- Oil/fuel spill from refuelling of site vehicles during construction;
- Vehicle/vehicle collisions onsite or on the public roads;
- Load loss/concrete wash out waste discharge into water courses from vehicles or concrete production/holding tanks;
- Concrete contamination of the intertidal/subtidal during slipway construction; and
- Damage to pier/roads from vehicles associated with the development.

16.3.2 Specific effects will vary between the different scenarios identified but can be grouped in the following impact categories:

16.3.3 Fire water run off, spills and leaks, and concrete wash out could all potentially result in a pollution of land and/or water courses. The extent and significance of any impact will be dependant on the volume of discharge and the chemical composition e.g. toxicity, of the specific polluting substance.

16.3.4 In the event of a fire there will also be limited atmospheric pollution and potential particulate drop out.

16.3.5 Any major concrete spills during construction will smother local flora and fauna. In contract to sediment loading of the environment which will generally be quickly dispersed in the dynamic coastal environment, concrete spills are likely to solidify in situ and create virgin substrate.

Management and mitigation

16.3.6 All operations will adhere to relevant health, safety and environmental legislation which will ensure that facilities designed and operations are undertaken to minimise the risk of accidental events.

16.3.7 During onshore construction, a specific area will be designated for the refuelling of vehicles and to fuel the emergency generator. This area will be constructed to avoid surface run-off and also in accordance with SEPA PPG 2 ‘above ground storage tanks’. A spill kit will be maintained in a clearly labelled container and kept onsite to deal with spillages and staff trained in its use. In addition, a spill contingency plan will be developed in accordance with SEPA PPG21 'Pollution incident response planning'.

16.3.8 The construction contractor will consult with the Comhairle nan Eilean Siar Transportation Services prior to the commencement of works to identify any issues associated with the Lewis road network. Where possible, local based hauliers will be used to transport materials, and personnel, to the construction site. The design of the construction phase will also take into account the capacity of the local road network through a traffic management scheme (TMS) (also see Section 13). In addition, the contractor will make good any damage to roads post works.

16.3.9 Emergency procedures will be developed by npower renewables prior to the construction and operational phases to address the response to accidental and non-routine events.

Residual impact

16.3.10 The likelihood of a major oil spill from a vessel is very remote, and although the potential consequence could be severe, there are established procedures and practices in place to ensure that an efficient and effective response will be implemented to safeguard personnel and minimise potential environmental effects.

16.4 Summary and Conclusions

16.4.1 With appropriate mitigation and management plans in place the likelihood of a major environmental accident is remote.

17 Environmental Management / Mitigation Plan

17.1 Introduction

17.1.1 Marine renewable energies have been viewed as an environmentally beneficial way of generating power in the future. Nevertheless, the installation of any system in the marine environment has the potential to impact the environment and other users of the area. It is necessary therefore to manage the activities associated with marine renewable energy exploitation in a careful and enlightened manner in keeping with the modern principles of sustainable development. This section of these ES therefore describes how environmental management will be incorporated into the construction and installation, and ongoing operation of the SWEP project.

17.2 Environmental management plan

17.2.1 Environmental management of the project up to the time of completion of the ES is achieved primarily through the EIA process. EIA is an ongoing process that will continue following the production of the ES. It will encompass the consideration and adoption of mitigation measures highlighted, consent conditions applied, further stakeholder consultation and implementation of appropriate environmental monitoring and research programmes.

17.2.2 An important aspect of the EIA process is mitigation and management planning and the production of the environmental management plan (EMP). Proposed mitigation and management measures have been developed as part of the EIA process in collaboration with the project team and relevant stakeholders.

17.2.3 As a result an action checklist/EMP has been produced. This documents all the mitigation and management measures identified and detailed in this ES (Tables 17.1 and 17.2). These commitments will be incorporated into the npower renewables project management system to ensure they are carried through to implementation. It is expected that the EMP will evolve and be updated through final design prior to construction and installation.

Table 17.1 Construction and installation commitments

Terrestrial Geology, Hydrology and Hydrogeology
Surface water flows and levels
1. The temporary crossings of the Feadah Siorravig Burn, minor tributary, and River Siadar (assuming worst case scenarios) should be designed to take account of appropriate peak flows, and ecological needs.
1a. The structures will be designed such that they have sufficient capacity to prevent flooding and erosion.
1b. The structures will allow the continuation of the riparian corridor underneath the bridge, and minimise the need for bank reinforcement.
1c. The design of the crossings will follow SEPA best practice guidance for crossing of watercourses including minimisation (where practical) of hardstanding areas.
2. Should the existing footbridge at River Siadar require permanent modification, the crossing will be designed to accommodate the appropriate peak flow, to prevent flooding and erosion issues.
3. If the drainage ditch is permanently re-aligned (worst case) for construction of the control building, the new alignment will be designed to accommodate the appropriate peak flow, to prevent flooding and erosion issues. It would be designed to ensure no significant change to the hydrology of the stream resulted.
4. Where necessary, authorisation will be sought from SEPA on construction and design of the river crossings and re-alignment
5. The design of the crossings will follow SEPA best practice guidance for crossing of watercourses (currently under development by SEPA, due to be published in 2007) and the CAR regulations for engineering works.
6. Sensitive activities will be located as far as possible from any water courses: 200 m where practicable. Where this is not practical, all activities near watercourse will be appropriately managed to avoid adverse effects.
Surface and ground water quality
7. The contractor will develop a pollution prevention plan as part of the detailed method statements prior to works commencing. As a minimum, the pollution prevention plan will comply with SEPA's Pollution Prevention Guidelines, best practice as advocated by CIRIA and in addition include site specific measures.
8. The contractor will develop emergency procedures should a pollution incident occur (in consultation with SEPA).
9. Refuelling will be undertaken well away from watercourses and where practicable on an impermeable surface in a designated area.
8a. Spillage kits will be permanently placed at these locations to enable the quick containment and clear up of spillages.
10. Any fuels, oils and lubricants stored onsite during construction will be contained within a properly designed and maintained bunded area to minimise the risk of spillage and stored away from watercourses.
9a. Fuel / oil storage bunds will be drained through oil interceptors (or rainfall from the storage areas will be contained and pumped into tanker to be removed from site for safe treatment and disposal).
11. All appropriate personnel working on site will be trained in the use of the pollution prevention plan and emergency procedures.
Sedimentation and Erosion
12. Sediment generated during construction will not be allowed to enter watercourses
13. Silt traps, settlement lagoons and attenuation areas to remove or filter out sediment from access tracks or construction site drainage before it discharges to a watercourse will be provided. The most appropriate methods will be determined during construction, but may include such easily installed equipment such as straw bales as a filter medium, permeable check dams made from roughly graded rock fill, and silt fencing which will prevent the transport of most fine material.

14. Careful planning for the control of sediment in discharged water will be undertaken at the construction areas prior to the start of work. Control measures will be located as close to each construction area as possible. Straw bales and check dams will be installed at frequent intervals in the drainage system to slow the flow, create storage and allow settlement.
Terrestrial Habitats and Ecology
Habitats, Flora and Fauna
15. All areas of retained vegetation will be protected by fencing off work areas.
16. Following construction, the construction site, access road and borrow pit areas will be reinstated with local vegetation, in accordance with the appropriate Method Statements.
Birds
17. All vegetation clearance will be undertaken outside of the bird nesting season or following a breeding bird survey, in consultation with the RSPB, to protect nesting habitat.
18. Nesting or nest building birds at any construction location will be immediately assessed with the project ecologist in consultation with SNH and the RSPB.
19. Construction areas will be fenced off to reduce disturbance to birds in areas of retained habitat.
Otters
20. A pre-construction survey will be undertaken shortly before construction works commence to determine levels of otter activity at that time and if any new holts/couches have been established within the survey area.
21. An EPS licence will be obtained if required.
22. Construction and excavations will not occur where there are known otter breeding or resting sites. Where this cannot be avoided relocation under EPS license may be an option.
Migratory Salmon
23. Where possible no in-stream works in connection with the River Siadar will be carried out between October and June to avoid disruption to spawning and activity in the watercourse will be kept to a minimum.
24. If disturbance to juvenile fish habitat cannot be avoided, further consultation with WIFT will ascertain appropriate mitigation.
25. The mouth of the River Siadar will be monitored to ensure it is kept clear of obstructions that may have the potential to affect access to the river mouth by migrating salmonids.
Marine Habitats and Ecology
26. Works will be timed to incur minimum disturbance to sea trout and salmon entering and leaving the river (Oct/Nov and May/June) wherever it is practicable to do so. Works that do occur during these periods will be well managed.
27. Noise, dust and sediment loading of the intertidal zones will be minimal. There are not expected to be any effects on breeding populations, migrating populations and others utilising this zone.
28. At the start of the construction phase of the project a Marine Mammal Observer (MMO) will audit the site to confirm that works which generate significant quantities of noise are being carried out in accordance with appropriate guidance protocols.
29. Established procedures will be in place to react to and contain any spills of oil/fuel/lubricant/fluids.
Cultural Heritage – Terrestrial and Marine
30. The overall mitigation strategy will be based on the assumption that all internationally and nationally important archaeology remains will be preserved in situ and that all potential direct effects on such remains are avoided by sensitive design and implementation of the construction, operation, maintenance and decommissioning

elements of the project.
31. For all other remains a programme of detailed evaluation and survey will be carried out, in the instances where detailed design indicates a direct impact.
32. Following detailed design the final mitigation and monitoring approach will be agreed through discussion with and the Western Isles archaeologist.
33. The only two sites to be directly impacted by the proposed development (Sites 52 and 53) are located along the coastal fringe of the onshore construction compound and will be fenced off to avoid any direct impact.
34. During ROV surveys of the seabed area, any observations of potential cultural heritage effects will be recorded and communicated to the Western Isles archaeologist to ascertain their significance and establish any mitigation that might be required.
Coastal Processes
35. 10 m landward buffer zone around coastal edge to preserve safety and minimise impact to cliff
36. Construction of walkways for personnel and plant to use when getting to the beach
37. Crane to be positioned outside the 10 m buffer zone of the cliff or employ appropriate foundations
38. Appropriate drainage will be installed during site construction
39. Cabling will be imbedded in the fixed link or bridge structure where appropriate – where a fixed link is not used, the cabling shall be placed on the seabed with protective armour sleeves
40. The cabling should aim to minimise the disturbance of the till cliffs and have minimal impact on the cliff face
41. Blasted rock will remain in the bay area and where appropriate will be used as infill
42. A hardstanding, with appropriate drainage, will be created at the base of the current pier to ensure that the area is not eroded
43. Protect the shingle bank against culverting works by putting an agreed working methodology in place that: • Limits of work on the bank • Limits to the maximum allowable levels of plant equipment on the shingle bank • Includes details of reconstruction of the bank to its previous position and profile • Protects the bank material and ridge vegetation • Involves the construction of trackways that can be removed from the shingle bank
44. Digging into the cliff should be avoided unless necessary
Onshore Noise
45. Earth moving plant - The use of efficient exhaust sound reduction equipment and ensuring manufacturers enclosure panels are closed at all times. Alternative super silenced plant may be available.
46. Compressors and generators - The use of efficient sound reduction equipment, dampening of the metal body casing and ensuring manufacturers enclosure panels are closed at all times. Screening may be erected and some equipment may be placed in a ventilated acoustic enclosure.
47. Breakers and drills - The use of mufflers, sound reduction equipment, fixing any air line leaks, use dampened bits, screening and enclosures.
48. Cement mixing, materials handling and batching plant - The use of efficient engine sound reduction equipment, enclosing the engine, ensuring aggregate and other materials don't fall from an excessive height and avoiding hammering the drum.
49. General - Machines and plant that may be in intermittent use will be shut down between work periods or throttled down to a minimum. Material stockpiles and other structures should be effectively utilised, where practicable, to screen sensitive receptors from noise from onsite construction activities.
50. Residents and the local authority will be informed of changes in the construction programme that may result in

increased noise levels.
51. A member of staff will be appointed to handle noise complaints should they occur.
Landscape and Visual
52. Sensitive siting of construction offices, plant and materials to minimise effects of the works during construction wherever possible
53. Existing access tracks will be used as far as possible and where a new track is required, this will be temporary with reinstatement following construction
54. The rock used to construct a rubble mound fixed link will wherever possible be similar to the local naturally occurring stone and be randomised in size and arrangement wherever possible to tie in with the surrounding natural and varied rock forms
55. Wherever possible the colour of the concrete and other aggregate materials employed in the construction will be chosen to coordinate with the local rock, which will assist in relating the colour of the new structure to nearby natural rocks/outcrops and stone structures
56. If deemed suitable, rock spoil generated during construction activities will be reused as a source of aggregate for construction, thus minimising the amount of material that needs to be excavated from the borrow pit
57. The improvement of road sections to improve access may have small scale effects upon the adjacent landform. Where the road cuts into existing slopes or where it is elevated above existing ground, the tops and toes of the slopes will be gently rounded to ensure that any grading-out is sympathetic to the surrounding landform
58. The reinstatement of areas disturbed during construction will be fundamental to ensuring that the scheme is absorbed as much as possible into the existing landscape. A reinstatement plan will be developed with the project ecologists in consultation with SNH to ensure this can be achieved
59. The construction compound area and borrow pit access track will be fully reinstated following construction, with the exception of any area where the control building would be located
60. A shallow skim excavation of the borrow pit followed by full reinstatement in a profile best suited to tie in with the surrounding landscape. A layer of at least 1 m of peat or sufficient to allow proper reinstatement will be replaced on top of the rock
Transport
61. Construction vessels on site will continue to meet all the statutory and best practice requirements with respect to seamanship, navigational practices, radio operation, offshore construction
62. Appropriate detailed marking and lighting systems for use during construction will be implemented with respect to consultations with the NLB and MCA
63. Through consultation with the Comhairle nan Eilean Siar (Transportation Services) the best solution to additional traffic levels associated with the project was that the existing road network be utilised on the proviso that any road damage is made good at the end of the project. Monitoring of any such road damage will be an integral part of the project specific Traffic Management System (TMS)
64. A full TMS will be carried out prior to the inception of the construction phase of the project. This will detail all mitigation measures to be undertaken, including: • Monitoring of road damage along the transportation route; • Time separation between movements of HGVs; • Monitoring of road damage along the transportation route;

• A full assessment of truck loadings and number of axles to minimise road damage and vibrations affecting cultural heritage sites; • Dirt and dust washing areas to prevent this impacting built-up areas; • Where appropriate loads will be covered to reduce dust pollution.
Underwater Noise
65. Marine Mammal Observers will be used during dredging and drill-piling to spot cetacean activity and halt operations as and when necessary.
66. Appropriate vessel speeds will be in place for the vessels employed throughout the construction and operation.
67. Avoidance, where it is practical to do so, of certain activities at certain times of year (e.g. blasting during Oct/Nov and May/June)
68. The cable at Siadar will be sheathed, providing some shielding of electromagnetic or induced electric field effects
Accidental / Non-routine
69. All vessels associated with the installation and operational phase of the SWEP will comply with IMO/MCA codes for prevention of oil pollution and have onboard Shipboard Oil Pollution Emergency Plans (SOPEPs).
70. As far as possible vessels with an established track record of operating in similar waters where the conditions can become severe over a short period of time will be employed. They will also be familiar with the operating conditions in the area (e.g. bathymetry, tidal flows, etc.) and will adhere to all appropriate navigational standards and practices
71. Appropriate times of year (primarily the summer months) will be utilised whenever possible to avoid incidences of bad weather leading to potential cargo loss/damage (e.g. caissons).
72. If material is being brought in from other areas (e.g. the towing of caissons) then appropriate safe anchorages en route will be identified in the event of any emergencies, particularly due to bad weather.
73. All operations will adhere to relevant health, safety and environmental legislation which will ensure that facilities designed and operations are undertaken to minimise the risk of accidental events.
74. During onshore construction, a specific area will be designated for the refuelling of vehicles and to fuel the emergency generator. This area will be constructed to avoid surface run-off and also in accordance with SEPA PPG 2 ‘above ground storage tanks’. A spill kit will be maintained in a clearly labelled container and kept onsite to deal with spillages and staff trained in its use. In addition, a spill contingency plan will be developed in accordance with SEPA PPG21 ‘Pollution incident response planning’.
75. The construction contractor will consult with the Comhairle nan Eilean Siar Transportation Services prior to the commencement of works to identify any issues associated with the Lewis road network. Where possible, locally based hauliers will be used to transport materials, and personnel, to the construction site. The design of the construction phase will also take into account the capacity of the local road network through a traffic management scheme (TMS) (also see Section 11).

Table 17.2 Operational commitments

Terrestrial Geology, Hydrology and Hydrogeology
Effects on Surface Water Flows and Levels
1. Any maintenance works during the operational phase, potentially affecting surface water flows and levels, should be designed to avoid any increases in runoff or changes to flows in the watercourses.
2. Drains should be inspected periodically, to ensure that they are kept clear.

Effects on Surface Water from Spillages
3. All transformers containing oil will be in a bunded enclosure.
4. During operation the Pollution Response Plan from the construction phase should be updated to reflect the operational needs. This should be implemented, relating to specific activities being undertaken onsite.
5. During any maintenance, an additional specific Pollution Response Plan may be required depending on the nature of the works.
Sedimentation and Erosion Effects
6. Drainage will be inspected on a regular basis, and maintenance will be targeted at areas where erosion or silt accumulation is noted.
Effects on Groundwater Quality
7. During operation the Pollution Response Plan from the construction phase should be updated to reflect the operational needs. This should be implemented, relating to specific activities being undertaken onsite.
8. During any maintenance, an additional specific Pollution Response Plan may be required depending on the nature of the works.
Marine habitats and ecology
9. Access/egress to the River Siadar will be monitored for blockages.
10. Any on-site lubricants will be appropriately stored under SEPA's PPG 2 guidelines and appropriate emergency procedures will be in place including the maintenance of an on-site spill kit.
Coastal Processes
11. Preference would be the use of a permeable means of access to the bay i.e. bridge or boat.
12. Use bridged link or slipway to reduce effects on hydrodynamics and tidal flushing
13. Re-route Scottish Water outfall or protect it during fixed link construction
14. Active watch of Siadar Bay to respond to erosional changes
13a. If till begins to erode, rock armour or similar may need to be put in place
15. Active watch of Siadar Bay to respond to scouring at base of cliffs
14a. Dove beach material up the beach towards cliff if scour occurs
16. Active watch on the disturbance to the till cliffs
17. Active watch of shingle bank to ensure footfall not leading to loss of vegetation and erosion of the ridge
18. Fence of sensitive areas such as the till cliffs if and when necessary
Onshore Noise
19. Noise reduction measures include:
20. Reductions in turbine noise will be implemented throughaerodynamic design, acoustic treatment and control strategy
21. Reductions in overall plant noise will be implemented through appropriate design of plenum chamber and air intake/exit vents
22. Appropriate measures to be taken to maintain low levels of machinery vibration to prolong equipment life and reduce noise levels
23. Transformers located indoors and transformer room design will consider acoustic aspects if necessary
Landscape and Visual
24. The proposed SWEP development will be located in an area already affected to some extent by manmade structures and will have minimal impact on the character of the area as the landform means that the effect on the landscape/seascape will be localised

25. • If the fixed link is to be of a similar orientation to the existing pier, this will build on an existing feature in the landscape rather than introducing an entirely new feature
26. Orientation of different aspects of the development will be such as to blend as far as possible into the wider landscape
27. The final design of the control building will build upon the indicative designs which adopted a local style and contained a single storey 'long-house design'. This design incorporates natural materials (wood and stone) to blend in well with the local landscape minimise intrusion on the landscape
28. Control of lighting on the structures will be implemented to ensure that it is only provided as and when necessary
29. Wherever possible, and without compromising safety standards, road markings, lighting or other structures associated with the access road will be kept to a minimum
Transport
30. Appropriate navigational procedures will be put in place and advertised locally through the Siadar Pier Group. The slipway, if used to access the breakwater, will also have to be kept in a good state of repair and kept clear to allow reliable access to these facilities, should any small boats require it
31. Any on site operational vessels will continue to meet all the statutory and best practice requirements with respect to seamanship, navigational practices, radio operation, etc.
32. Dependant on the final design of the project the appropriate navigational lighting will be installed. The National Lighthouse Board (NLB) have already consulted on the appropriate lighting required for the breakwater, the potential fixed link, the potential subsea cable and vessels operating in the area
33. Prior to the start of the construction phase notices will be advertised locally stating the extent and duration of the works
34. UK Hydrographic Office will be informed after the project to allow for the updating of the appropriate Admiralty Chart (BA2720)
Underwater Noise
35. An appropriate mitigation regarding monitoring will be implemented in consultation with the European Marine Energy Centre (EMEC) who are developing a methodology for use within the marine renewables industry
24a. All monitoring will provide data for future developments within the wave energy sector and will be used as a template for the assessment and permitting process for future similar projects
36. The appropriateness and practicalities of carrying out some initial noise studies at the Wavegen's Islay site in 2008 will be given serious consideration and if merited will be implemented
37. Studies will also look to identify the level of noise attenuation through the concrete structure itself and into the sea
38. Appropriate vessel speeds will be in place for the vessels employed throughout the operational phase (if a vessel is required). This will prevent excessive noise being produced at source licensing requires additional monitoring.

17.3 Consultation

17.3.1 Throughout the EIA process there has been consultation with local and other stakeholders with regard to the various aspects of the SWEP and a number of constructive communication channels have been established. These will be maintained throughout all phases of the project.

17.4 Environmental monitoring

17.4.1 During the EIA process possible effects on the environment have been identified. It is important that once facilities are in operation that such possible effects are assessed, therefore a robust environmental monitoring strategy will be an integral aspect of the project.

17.4.2 Npower renewables has established communication with the Orkney based European Marine Energy Centre (EMEC) with regards to suitable monitoring protocols. Where monitoring programmes are required all attempts will be made to utilise the same protocols as for similar monitoring being undertaken at the EMEC wave test site. This will ensure that data collated at both sites will be comparable and enhance the value of data collated at both sites.

17.4.3 Such research data will be important to developers in order to support future applications for the development of commercial projects.

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19 Appendices

19.1 Appendix A: Local development policies

Table A.1 Local Development Policies as set out in the Western Isles Structure Plan relevant to the SWEP

Policy	Planning Considerations
Sustainable Development	
SC8 Cultural heritage	The council and community planning partners will seek land use and development solutions that sustain and enhance the cultural traditions and heritage of the islands, including Gaelic language and the historic environment, by respecting local cultural circumstances (such as building design, settlement patter and promoting the use of bi-lingual signs).
SC9 Sustainable management practices	Management practices and activities that meet sustainability objectives in the use of land, water and other natural resources will be encouraged. The council will further seek to sustain and enhance the quality of unique landscapes, natural environment and biodiversity of the Western Isles for the enjoyment and education of its residents and visitors.
SC10 Efficient use of resources	The council seeks to encourage land use and development solutions that assist in utilising resources efficiently, reducing pollution, minimising waste and promoting the use of recycled material where possible.
Development Management	
DM1 Location of development	Development proposals out with settlements and townships (i.e. open moorland, mountains, isolated or undeveloped coastlines and uninhabited islands) will only be supported when the proposal does not result in excessive additional public expenditure for site service and: • A specific location need has been demonstrated; or • It is for the sustainable development of a natural resource; or • It avoids a significant detrimental effect on natural and built heritage
DM5 Availability of supporting infrastructure	All development proposals should have regard to the availability of supporting infrastructure (e.g. water, sewerage, power) and early consultation with service providers will be encouraged, particularly during the site selection process. In areas where there is insufficient capacity, prospective developers should liaise with the council and service providers regarding connections and, if necessary, either investigate suitable alternative sites or be willing to make a financial contribution to ensure adequate capacity. Improvements should be undertaken in environmentally sensitive ways e.g. the undergrounding of cables and pipes should be considered in areas of landscape importance
DM7 Assessment of development proposals	In dealing with applications for development the Council will take into account of the requirements of other relevant Structure Plan policies and will ensure: • Quality siting, landscaping and designs that incorporate sustainable management techniques; • No undue harm to neighbouring uses as a result of the development; • The impact on the natural heritage is fully considered; • There will be no pollution out with prescribed limits to air, land, fresh water or seas; • There will be no likelihood of causing harmful erosion.
DM9 Developer consultation and community benefit	The integration of an element of art, sculpture, and craftwork or interpretation material in important development schemes will be encouraged.

Policy	Planning Considerations
Parallel Action	The extension of planning controls over developments below the low water mark e.g. marine aquaculture, off-shore wind, and tidal stream or wave energy generation proposals.
Resource Management	
RM3 Safeguarding locally important agricultural land	The Council will only support development proposals that would result in a loss of locally important agricultural land when all of the following are met: • The applicant has demonstrated that the development must proceed on the site identified; • The proposal does not threaten the viability of the township within which the proposal is located.
RM6 Coastal development	Proposals within areas of undeveloped coast where no township settlement exists, and along isolated coastline, will be assessed against the criteria set out in DM1.
RM8 International natural heritage designations	The Council will only permit development which would have an adverse effect on the conservation interest for sites proposed or designated under the Natura 2000 network (Special Area of Conservation or Special Protection Area) or Ramsar where: • There is no alternative solution; and • There are imperative reasons of over-riding public interest (including those of a social or economic nature); and • Measures which will minimise the adverse effects are incorporated into the plans
Economic Development	
ED2 Development of alternative and renewable energy resources	Development proposals for hydro, solar, wave, tidal and wind (on-shore and off-shore) energy schemes and associated infrastructure, including proposals for non-grid, domestic-scale schemes, will be viewed positively, subject to satisfactory assessment of all of the following: • The impact on local communities and any other existing or proposed land uses and interests; • The impact, including cumulative impact, on natural and built heritage resources; • The local and wider benefits that the proposal may bring; • The adequacy of reinstated arrangements; • The requirements of other Structure Plan policies.
ED8 Mineral working to satisfy island needs	The Structure Plan states specific areas where mineral extraction will take place for the foreseeable future, which includes the site at Barvas for extraction of sand. Other locations, not listed in the Structure Plan, to meet local (island) needs may be permitted when all of the following are met: 76. Extraction is in support of a clearly defined, local need or single development (e.g. road or construction project); 77. There are net demonstrable environmental or other sustainable benefits from developing the site, compared with using an established aggregate source; 78. Where extraction is for a single clearly defined need to extractions it is located within the immediate vicinity of the proposed development site.
ED14 Neighbour amenity	The Council will work with other relevant agencies and landowners to safeguard neighbours from actives and uses that could have a detrimental impact on the amenity they enjoy. The Local Plan will also consider defining exclusion areas around activities and uses that give rise to poor amenity to ensure that future incompatible uses are not located in close proximity to them.
Transportation	

Policy	Planning Considerations
T1 Improving the transport infrastructure	Other land use development proposals that contribute to the improvement of transport services (e.g. upgrading of single track roads, parking provisions, slipways and pontoons etc.) will normally be viewed favourably where they accord with the Local Transport Strategy and the requirements of other Structure Plan policies.
T4 Road safety, highway improvements and traffic management	Development proposals associated with new or improved roads and traffic management measures should take account of the following: • Surrounding natural and built heritage features • The impact of the proposal on the character of the area • Opportunities for carrying out landscaping and other enhancement to 'fit' the development into the surrounding area

19.2 Appendix B: Scottish Executive Scoping Opinion response

THE ELECTRICITY WORKS (ENVIRONMENTAL IMPACT ASSESSMENT) (SCOTLAND) REGULATIONS 2000

SCOPING OPINION FOR THE PROPOSED WAVE ENERGY GENERATING SCHEME AT SIADAR, ISLE OF LEWIS

APPLICATION FOR A SCOPING OPINION

1. Description of the development

Description of the Development

19.2.1 The proposed wave energy generating scheme is located on the North West coast of Lewis adjacent to the village of Siadar.

19.2.2 Using the active breakwater concept the proposed wave energy generating scheme would consist of 70 air turbines being used to capture energy from the wave driven flow in and out of a series of air chambers incorporated within a breakwater structure up to 250 m long and situated in relatively shallow water a short distance offshore. Capable of generating up to 4MW this is the first development of its kind in the UK

19.2.3 The wave energy device will be connected to the shore with sub-sea cables. The cables will run through the breakwater to shore, either within the causeway (if constructed) or on the sea bed. Any cables laid on the sea bed will either be buried or protected, as appropriate, to prevent exposure.

19.2.4 An onshore control building approximately 10 m x 4 m would be constructed near the shore. This would house all necessary control systems, transformers, switch gear and metering. From there, the scheme would be connected to the local grid. This will be via buried cables from the control building to overhead lines, either by existing lines that serve Siadar, or a short section of new wood pole-line connecting to the substation in Barvas to the south of Siadar.

19.2.5 The Scottish Ministers are of the view that the EIA process should inform the detailed site selection and design process. This Scoping Opinion should be used in conjunction with design considerations to provide a detailed description site layout construction and operational processes.

19.2.6 This Scoping Opinion sets out the environmental and other issues that should be considered in respect of the entirety of the project and then deal with the particular issues that should be addressed, section by section.

19.2.7 Planning Policy Background and Guidance

19.2.8 Although inshore developments are not subject to the land use planning system, the applicant should be aware of the following which will be of relevance to the proposed development

- National Planning Framework for Scotland
- SPP1: The Planning System
- SPP15: Planning for Rural Development (2005)
- SPP17: Planning for Transport (2005)
- SPP 20: Role of Architecture and Design Scotland
- NPPG5: Archaeology and Planning
- NPPG6: Renewable Energy Developments
- NPPG13: Coastal Planning
- NPPG14: Natural Heritage
- NPPG18: Planning and Historic Environment
- PAN42: Archaeology –The Planning Process and Scheduled Monument Procedures
- PAN45: 2002 Renewable Energy Technologies
- PAN51: Planning and Environmental Protection
- PAN56: Planning and Noise
- PAN58: Environmental Impact Assessment
- PAN60: Planning for Natural Heritage
- PAN68: Design Statements
- Designing Places: A Policy Statement for Scotland
- A Policy on Architecture for Scotland
- Planning Authority Development Plans, including Edinburgh and The Lothian's Structure Plan 2004 and The Lothians Local Plan (Finalised Version) 2005
- Section 3 of The Crown Estate Act 1961
- Section 5 The Food and Environmental Protection Act 1985

- Section 34 the Coast Protection Act 1949 (as amended by Section 36 of the Merchant Shipping Act 1988)
- Fresh Water For Fish Directive (78/659/EEC)
- Nature Conservation: Implementation in Scotland of EC Directives on the Conservation of Natural Habitats and of Wild Flora and Fauna and the Conservation of Wild Birds ("The Habitats and Birds Directive"). Revised Guidance Updating Scottish Office circular No 6.1995
- Water Framework Directive (2000/60/EC)
- The Water Environment (Controlled Activities) Regulations 2005
- Shellfish Waters Directive (79/923/EEC)
- Western Isles Local Plan
- Marine Guidance Note MGN 275 proposed UK Offshore Renewable Energy Installations (OREI)
- DTI publication Guidance on the assessment of the impact of Offshore Wind farms.

Decommissioning

19.2.9 At the end of the scheme's operational life, electrical and mechanical components would be removed and any openings made safe. The breakwater would remain, as would the causeway (if constructed), the main reason being that they would have use beyond that of energy generation (i.e. providing shelter for the bay). The electrical cables may be left in situ within the structure or seabed, if the likelihood of exposure was shown to be limited.

Safety

19.2.10 The Environmental Statement should demonstrate compliance in all respects with the Electricity Safety, Quality and Continuity Regulations 2002. The developers should also ensure that any measures proposed within the Environmental Statement do not conflict with the requirements of the Health and Safety at Work Act.

Design

19.2.11 Architecture+Design Scotland (A+DS) places particular importance on the layout design of any works and considers there is a need for a coherent, structured and quality driven approach to development. The appearance of any development is of particular interest to A+DS and it recommends the need for a coherent design strategy to be considered at scoping stage and to be prepared before submission of the Environmental Statement. The strategy should explain the design principles behind the layout plan in a rational way that can be easily understood

19.2.12 A+DS would suggest that a planning and design strategy should first look at the proposed location and address whether this is a sensible location in relation to wave generation, access to the grid and to the character of the land and seascape.

19.2.13 A+DS advice complies with the Scottish Executive's policies on design, which seek to promote good quality. It would therefore refer the developers to advice contained in PAN 68: Design Statements. A+DS recommends that the design strategy be expressed through a Design Statement. The Design Statement should follow the clear and effective presentation format set out on pages 10 and 11 of PAN 68. This would ensure that the wider advice contained in PAN 68 is being followed.

19.2.14 We recommend the Design Statement should clearly explain the proposed design strategies including a justification for the resulting layout and evidence that design ideas have been tested against the objectives.

19.2.15 The Statement should also set out the way in which it has dealt with advice in PAN 45: Renewable Energy Technologies and also the siteing, geometry and composition and detailed three dimensional layouts. This would allow the testing of alternatives against clearly set design criteria.

19.2.16 We also advise that the design statement should state whether the design is dependent upon the site boundaries.

19.2.17 We recommend that the Design Statement should be incorporated into the section of the Environmental Statement that describes the proposal and not in the sections dealing with landscape, seascape and visual assessment. We further recommend the use of diagrams and sketches to illustrate the principles of the design.

<u>Post Construction Monitoring.</u>

19.2.18 The Siadar wave energy project represents the first development of its kind in the UK and as such can be considered as a demonstration project. We recommend that the Environmental statement includes a detailed post construction monitoring program in order to inform future development in this sector.

<u>Other consents required</u>

19.2.19 The Crown Estate owns much of the foreshore and seabed from Low Water to 12 nautical miles (nm). An Agreement for Lease under Section 3 of the Crown Estate Act 1961 should be obtained providing the right of occupation of an area for the purpose of placing structures on, or passing cables over Crown Estate land.

19.2.20 The Scottish Ministers have a statutory duty to control the deposit of substances or articles in the sea/tidal waters. This duty is exercised under powers conferred by Section 5 of the Food and Environment Protection Act 1985, Part II requires that a licence be obtained from the Scottish Ministers for the following works:

- the placing of materials in the marine environment during construction and related actions
- the disposal of waste at sea (primarily dredged material)
- the introduction of tracers and biocides and certain other activities in the marine environment

19.2.21 Further information is available from the Fisheries Research Service Marine Laboratory, PO box 101, Victoria Road Aberdeen AB11 9DB (telephone 01224 876544)

19.2.22 Under Section 34 of the Coast Protection Act 1949 (as amended by Section 36 of the Merchant Shipping Act 1988) consent is required from the Scottish Ministers for the following operations:

- the construction, alteration or improvement of any works on, under or over any part of the seashore lying below the level of mean high water springs;
- the deposit of any object or materials below the level of mean high water springs;
- the removal of any object or materials from the seashore below the level of mean low water springs (e.g. the dredging of minerals).

19.2.23 Further information is available from Coast.protection@scotland.gov.uk

19.2.24 Under Section 37 of the Electricity Act 1989 consent is required from the Scottish Ministers in respect of any electricity line placed above ground and not situated within the premises under the occupation or control of the person responsible for its installation.

19.2.25 In the case of a generating station requiring consent under section 36 of the Electricity Act 1989 any application for consent under section 37 of the same provisions for the purpose of connecting to that generating station will also require an environmental statement.

2. Description of Aspects of the Environment likely to be affected.

19.2.26 The Environmental statement should contain a detailed description of those aspects of the environment likely to be significantly affected by the development including:

- Population
- Fauna
- Flora
- Sea bed and marine environment
- Water
- Air
- Climatic Factors
- Architectural and Archaeological Heritage
- Climate

19.2.27 The developer should ensure that the cumulative effect and interelatation between each factor is considered in addition to the factor in isolation. Because of the need for this approach this list may not be exhaustive. The developer should ensure that consideration is also given to any onshore impacts resulting not only from the offshore installation itself but also from any associated onshore development including grid connections.

3. Description of the Environmental Impacts (see paragraph 2 of Part 1 of Schedule 4)

19.2.28 The Environmental Statement should fully describe the likely significant

19.2.29 Effects of the development on the environment including direct effects and any

19.2.30 indirect, secondary, cumulative, short, medium and long term, permanent and temporary e.g. construction related impacts, positive and negative effects of the development which result from:

a) the existence of the development;

b) the use of natural resources;

c) the emission of pollutants, the creation of nuisances and the elimination of waste.

19.2.31 In addition a description of the methodology used in assessing the impact should be included.

19.2.32 Following a consultation exercise with key stakeholders we have identified the following aspects which we believe should be given particular consideration within the Environmental Statement. You will have been provided with copies of stakeholders comments.

<u>Visual</u>

- Seascape
- Landscape
- The significant impacts on recreational activities both on and off-shore
- The visual impacts on shipping activities
- Visual impacts arising from lighting during construction, and operation

<u>Ecology</u>

- Birds
- Sea mammals
- Fish
- Benthic enthology
- Vibration

19.2.33 Otters are listed on Annex IV of EC Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Flora and Fauna as a species of European Community interest and in need of strict protection. Further information on surveying otters is available at the following address:

19.2.34 http://www.english-nature.org.uk/LIFEinUKRivers/publications/otter_monitring.pdf

19.2.35 The Atlas of Cetacean Distribution on North-West European Waters indicates the presence of white-beak dolphin, Risso's dolphin and Atlantic white-sided dolphin directly of the Siadar coast.

19.2.36 We recommend, that a survey of otters and cetaceans be undertaken at the earliest opportunity prior to determining whether planning permission should be given

19.2.37 The scoping report indicates a feature called An Fideach that could indicate a perched saltmarsh at NB380547. We recommend that a Phase 1 survey be undertaken to identify saltmarsh and other sensitive habitats that may be present. Any works associated with the development should ideally avoid the saltmarsh area.

19.2.38 We consider it likely that sensitive bird species are likely to be recorded within the region, included red throated diver, which is listed on Annex 1 of the EEC Birds Directive 1979 and Schedule 1 of the Wildlife and Countryside Act 1981 and purple sandpiper. The Environmental Statement should also include an appraisal of bird populations in the area, and their likely sensitivity to the development during the construction, operational and decommissioning phases as well as mitigation. Guidance is available for the assessment of the impacts that onshore wind farms have on bird communities at the following address:

19.2.39 http://www.snh.org.uk/pdfs/strategy/renewable/bird_survey.pdf

19.2.40 While the proposed development does not involve a wind farm, the guidance should prove useful in determining a methodology for the appraisal of the Siadar Wave Energy Project.

Noise

- Construction
- Operational
- Decommissioning
- Foghorns and other warning devices
- Impact on mammals and fish

Water

- Quality
- Water Framework Directive
- Sub sea cabling

19.2.41 The ES should consider the impact of on site construction works and of the finished breakwater on the existing outfall Shader/ Barvas Sewerage treatment works and any appropriate mitigating measures.

Archaeology

- Sub Sea
- onshore

Statutory designations

- SSSIs/SACs/SPAs

19.2.42 Lewis Peatlands SPA is classified under the EC Directive 79/409/EEC on the Conservation of Wild Birds meaning that the provisions of the Revised Circular 6/95 and the Conservation Regulations 1994 apply.

19.2.43 The regulations require that, where an authority concludes that a development proposal unconnected with the nature conservation management of a Natura 2000 site is likely to have a significant effect on that site, it must undertake an appropriate assessment of the implications for the conservation interests for which the area has been designated.

19.2.44 Further guidance is set out in the "Nature Conservation: Implemented in Scotland of EC Directives on the Conservation of Natural Habitats and of Wild Flora and Fauna and the Conservation of Wild Birds Revised Guidance Updating Scottish Office Circular No.6/1995."

Fisheries

- Commercial fisheries
- Migratory fish and in particular migratory salmonoids
- Local fish stocks

Navigation

- Navigation lights and markers
- Hazard identification
- Marking of causeways and breakwaters.

Hydrology

- Erosion
- Scour
- Flooding
- Sedimentation
- Destabilisation of terrestrial landforms and habitats.
- Tidal currents

19.2.45 We recommended that the ES considers the wider impacts of the project on natural coastal processes beyond the construction and project site, and not just within the vicinity of the site itself.

19.2.46 The Dynamism of the littoral zone should be considered also. If there are large amounts of sediment passing along the coast within the vicinity of structures then these need to be considered thoroughly for the design, construction, operating and dismantling phases. This will have implications for structures which interrupt the sediment pathways.

Transport

- Construction traffic
- Impacts on shipping
- Anchorages
- Slipways
- Use of small boats

19.2.47 We recommend that the ES considers preferred routes for the movement of heavy loads via the main land trunk road network during the construction period as well as any potential impacts on the trunk road network once the development is operational.

19.2.48 The possibility of damage or deterioration particularly to roads resulting from construction traffic should also be considered, the environmental statement should identify appropriate mitigating measures to prevent or minimise any damage or deterioration to an acceptable level and a post construction reinstatement plan to return the site to its original state.

Leisure and recreation

- Sailing
- Wind surfing
- Shooting
- Fishing
- Other
- Impacts on those interests around development site in relation to setting and the changes in view which may arise as a result of the proposal
- Impacts of those travelling the A857
- Impacts that may create a barrier to the general right of access
- Increased noise and other changes in experience of the area from its present character.

19.2.49 The Environmental Impact Assessment should deal with the temporary and permanent effects of the proposals on recreation and access. We would expect that an assessment will be made of how current and future recreational use is likely to be affected during construction and subsequent operation of the wave power turbines.

<u>Onshore Development</u>

- Substation
- Cabling (Underground)
- Cabling (Overhead)

<u>Pollution</u>

- Construction
- Operational
- Decommissioning
- Prevention and clean up measures

4. Description of Methods to Offset Adverse Environmental Effects (paragraph 4 of Part 1 of Schedule 4)

19.2.50 This section should clearly set out a description of the measures envisaged to prevent, reduce and where possible offset any significant effects on the environment.

<u>General</u>

19.2.51 Habitats are particularly important and need to be addressed, including loss of seabed habitat, impacts on sediments, benthic environment, fisheries and marine food chains.

<u>Construction</u>

19.2.52 The applicant should be aware of information held by SEPA that may be of use during construction periods, further information is given in paragraph 4.12 and 4.13 below.

<u>Hydrology</u>

19.2.53 The Water Environment (Controlled Activities) Regulations 2005 came into force on 1 April 2006. These regulations introduce specific controls which impact on the water environment, for example concerning engineering works such as point source pollution and water crossings, in order to meet the requirements of the EC Water Framework Directive (2000/60/EC) as implemented by the Water Environment and Water Services (Scotland) Act 2003. Copies of the Regulations are available from Her Majesty's Stationary Office.

19.2.54 It is important that the developers examine all potential impacts on both the fresh water and marine water environment, especially during the construction phase. Potential impacts include impacts associated with cables/pipelines linking the site to the mainland and on those waters designated as Bathing Waters under the Bathing Water Directive (76/160/EEC), which requires that certain microbiological and physic-chemical quality standards are met in order to protect human health in addition shellfish water is designated under the shellfish Waters Directive (79/923/EEC) which requires that chemical and microbiological quality water standards are met in order to protect human health. It is important that SEPA, as indicated below, are fully involved in discussions on this proposal in order that proper mitigation measures are introduced.

19.2.55 Method statements should be produced for all aspects of site work that might have an impact upon the environment, containing further preventative action and mitigation to limit impacts. It is recommended that SEPA is provided with the opportunity to view these method statements in draft form prior to their being finalised should development take place.

19.2.56 A description of power requirements during operation should be included. If fuel needs to be transported to the site periodically, measures should be adopted that ensure the safe and appropriate storage and handling of potentially harmful substances such as fuel or oil.

19.2.57 Consideration should be given to the micrositing of all components of the wind farm be they temporary or permanent so as to minimise all environmental effects.

19.2.58 The Environmental Statement should identify mechanisms to ensure subcontractors are well controlled and aware of these issues. Consideration should be given to site presence of an appropriately qualified environmental scientist during construction to provide specialist advice. Additionally, details of emergency procedures should be provided.

Pollution

19.2.59 The Environmental Statement needs to address pollution issues. The developer should identify all potential pollution risks associated with the proposals and identify preventative measures and mitigation. Proposed discharges should be set out and dilution data provided. Sensitive uses need to be identified and potential impact upon them needs to be assessed.

19.2.60 The Environmental Assessment should show the development of appropriate intervention strategies for some worst case scenarios of spillages or releases of toxic substances. SEPA as the environmental and waste regulations authority should be contacted to provide advice on environmental protection and waste disposal.

Pollution – Guidelines

19.2.61 SEPA produces a series of Pollution prevention guidelines, several of which could be usefully utilised in preparation of an Environmental Statement and during development. These include SEPA's guidance note PPG4 Disposal of sewage where no mains drainage is available, PPG6: Working at Construction and Demolition Sites, PPG5: Works in, near or liable to affect Watercourses, and others, all of which are available on SEPA's website at www.sepa.org.uk/guidance/ppg/ppghome . SEPA would seek to have the principles contained within PG notes incorporated within the ES. SEPA also produces guidance for wind farms and a copy is attached to this opinion.

Waste

19.2.62 Proposed temporary and long term welfare arrangements both onshore and where necessary offshore and proposed methods for disposal of foul effluent at the site should be laid out in the Environmental Statement. Where appropriate reference can be made to SEPA's guidance note PPG4 "Disposal of sewage where no mains drain is available".

19.2.63 We recommend the preparation of a site specific method statement for waste management for the construction works. It would be advisable that at the time of compiling the method statement all works associated with waste streams and details of any proposed disposal routes are identified in order for SEPA to assess any waste management licensing requirements associated with the works.

Noise

19.2.64 Wave generators have the potential to create noise through both aerodynamic and mechanically generated noise which can be propagated underwater. Noise predictions should be carried out to evaluate the likely impacts of both airborne and under water noise from the wave generators and associated construction activities, including noise from blasting or piling activities, and through noise generated by the operation of the active breakwater.

Vibration

19.2.65 The ES should assess any potential reactions of sea mammals, salmonoids and other fish species during construction and operation of the wave generator. This would include whether vibration from the wave generator would cause avoidance reaction.

Electrical connection to land

19.2.66 The position and design of the sub sea connection to land and any associated onshore development should be specified and investigated to ensure there are no unacceptable impacts. It is essential that the design of any onshore facilities reflects the erosion nature of the coastline and fits into the sustainable management of the coastline.

5. Non Technical Summary (see paragraph 5 of Part 1 of Schedule 4)

19.2.67 This should be written in simple non-technical terms to describe the various options for the proposed development, and the mitigation measures against the adverse environmental impacts which would result.

19.2.68 Developers should be aware that the ES should also be submitted in a user-friendly PDF format which can be placed on the Scottish Executive website.

6. Difficulties in Compiling the Additional Information (see paragraph 6 of Schedule 4)

19.2.69 No specific requirements.

Signed ……………………………….

Authorised by the Scottish Ministers

to sign in that behalf

19.3 Appendix C: Navigational Risk Assessment (NRA)

Introduction

19.3.1 This appendix is structured to provide navigation stakeholders with all the information specifically relevant to the navigation assessment that has been carried out for the proposed Siadar Wave Energy Project.

19.3.2 The project summary section brings together a summary of the information most relevant to navigation issues, while also directing the reader to the location of more detailed information if required. This is intended to provide a clear, high-level description of key aspects of the project, as well as facilitating review of the document.

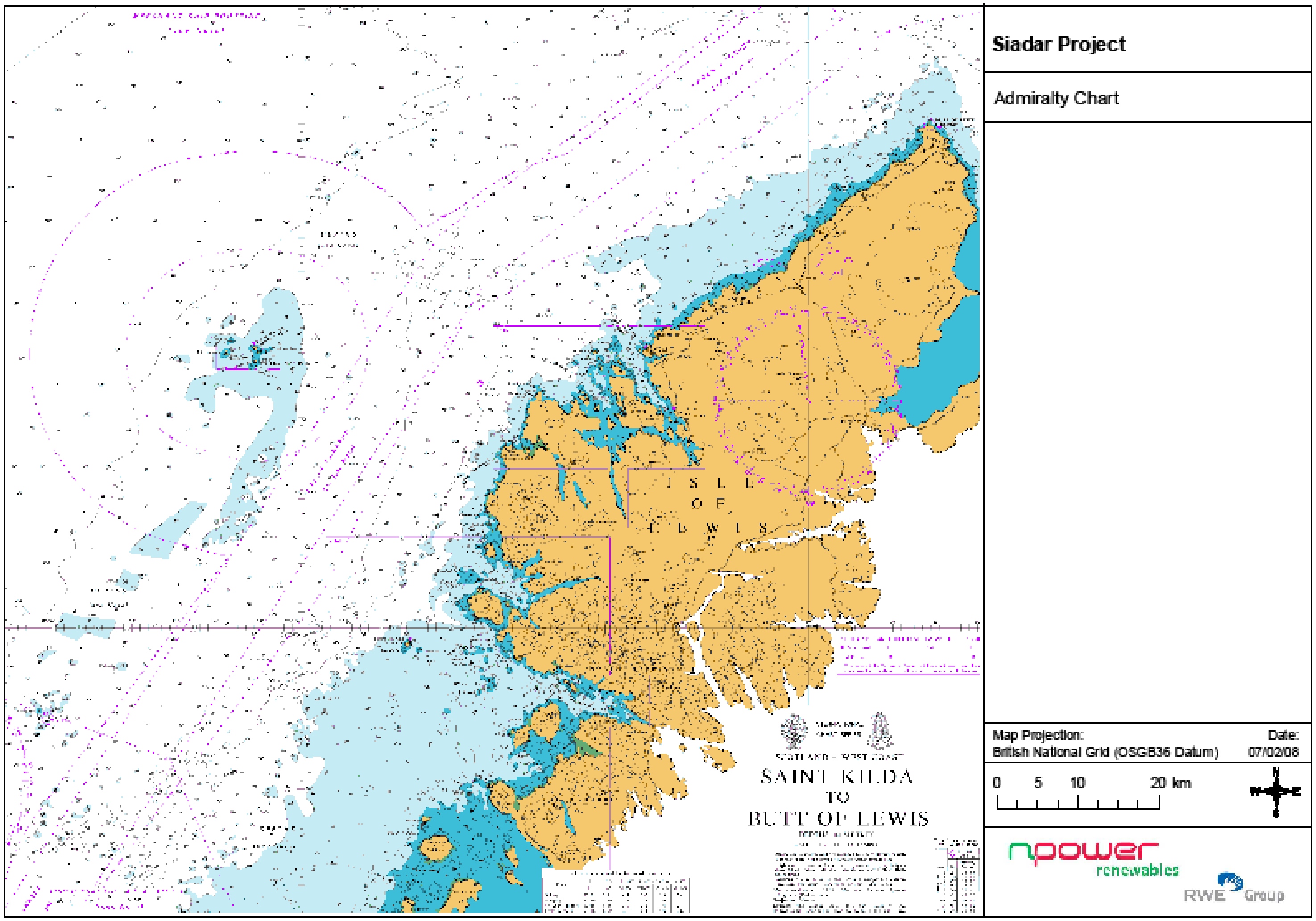
19.3.3 The methodology section gives a summary of the data collected to support this assessment. This includes a summary of the consultation responses received from relevant navigation stakeholders.

19.3.4 The largest section of the report is structured into the form of the MCA guidance document MGN 275 'Proposed UK Offshore Renewable Energy Installations (OREI) – Guidance on Navigational Safety Issues'; following the numbering system and headings used within that document.

19.3.5 The conclusions section draws out key elements from the report and includes a list of the key risk issues identified, and the significance ratings assigned to them.

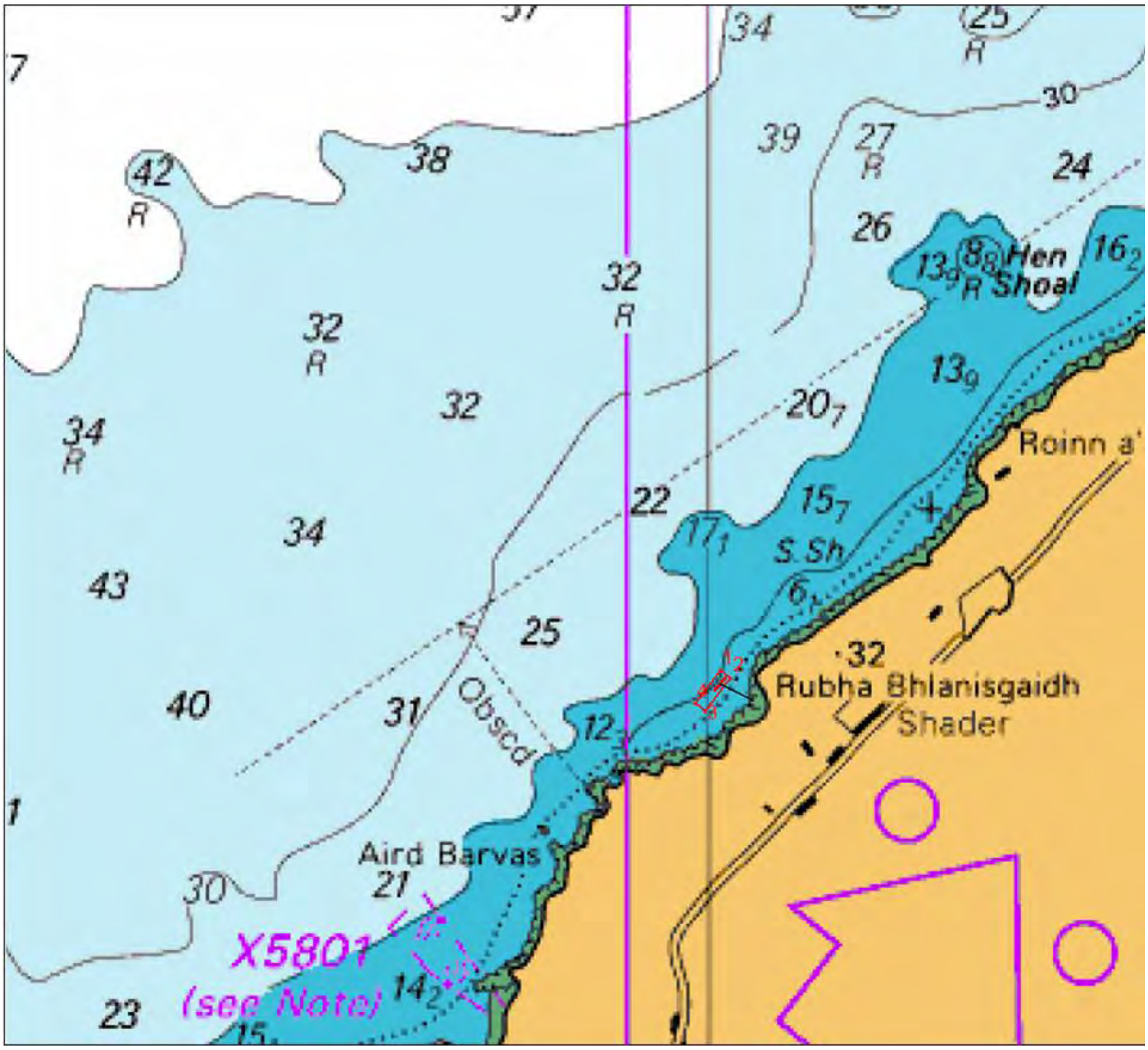
19.3.6 The Admiralty Chart for the area covers St Kilda to the Butt of Lewis and Siadar is marked as 'Shader' on the north west coast of Lewis. Figure 1-1 The inset map below shows a close up view of the project on the admiralty chart.

Figure 1-1 Admiralty chart showing the area of interest for the Siadar Wave Energy Project



File ref: S:\PROJECTS\Marine\Charts\Siadar\Site\Siadar_area_of_interest_Admiralty_Chart_07_02_08.mxd

Figure 1-2 Extract from Admiralty Chart showing location of the Siadar Project



Methodology

19.3.7 Over the course of the navigation assessment of the Siadar wave project, it has become apparent that the proposed project site does not experience any large vessel, or transiting, vessel traffic. The proposed project is sited close inshore, at the mouth of a shallow rocky bay, on a predominantly exposed and hostile lee shore; it is thus perhaps more properly referred to as a coastal installation, than offshore. As a result, the only direct navigational interaction that can be reasonably predicted for the project is with a limited number of small, typically <10 m, locally-based fishing vessels.

19.3.8 This navigational risk assessment does thoroughly investigate the potential for effects upon the full range of vessel traffic, but it has also been influenced by our identification of the significant potential issues. In particular, given our primary interest in small vessels, navigating in very close proximity to the shore, the method of data gathering was tailored accordingly.

- The primary mode of data collection has been through consultation with experienced local mariners, fishery organisations, and other navigational stakeholders, rather than via a project-specific vessel traffic survey.
- The data collected has been confirmed with a review of other existing data-sources.

Consultation

19.3.9 Consultations have been carried out with a wide range of navigational stakeholders. No specific navigational concerns were raised by any stakeholders during the project consultations. The table below summaries the key responses received.

Table 1.1 Summary of Key Navigation Consultation Responses

Name of Organisation	Key Concerns	Comments
SEPA	Effects on shipping/local vessels and slipway access.	Assessed in the ES.
Comhairle nan Eilean Siar (Harbour Master)	No key concerns regarding the placement of the structure	Little vessel traffic in the area as the major shipping channel is 6 miles offshore.
MCA	Unlikely to have impact but navigation requirements must be considered.	Appropriate consultation will take place with the NLB and MCA. Consultation with local groups (incl. fisheries related groups) must be carried out.
NLB	Appropriate navigational lighting/marking is required throughout construction and operation.	Recommendations to be implemented according to final structure design.
RYA	No key concerns as unlikely to impact on recreational boating or present a navigational hazard.	Appropriate navigational guidance for the structure to be implemented.
The Chamber of Shipping	Navigational impact on shipping.	No reason to object to development.
Western Isles Fishermen's Association	No concerns, but note must be made of the presence of creel and sea angling boats in the area.	Presence of such vessels to be assessed.

19.3.10 In addition, more detailed consultation meetings were held with experienced local mariners, including Mr Angus Martin, a local master mariner with over 40 years experience; and with Duncan MacInnes, a representative of the Western Isles Fishermen's Association.

Data review

19.3.11 In addition to the information collected from local mariners, a recent (Eagle Lyon Pope Ltd. & Safety at Sea Ltd. (2005)) survey of the charted deep water channel, to the west of Siadar was identified and reviewed to provide information on the traffic transiting along the north Lewis coast.

Baseline conditions

Project summary

19.3.12 The project description detailing the components of the scheme and their construction, operation and decommissioning is described in Section 3 of the ES. From a navigational perspective, the key features of the project to be considered will be the offshore components; These are shown in Figure 3-1 of the ES and comprise:

- breakwater with embedded wave energy converters;
- fixed access link comprising of a rubble mound causeway and steel truss bridge;
- improved existing slipway; and
- sub-sea cabling.

Environmental summary

19.3.13 A description of the location and environmental characteristics of the site is given in Section 4 of the ES. Figure 3-4 shows the project location and the local bathymetry and tide levels. The Coastal Processes section (Section, 10) also describes in detail the offshore characteristics of the site. The key offshore characteristics are:

- Tidal currents of negligible velocity exist broadly flowing in a roughly north east – south west direction.
- The prevailing wind blows from the west to north west, and the prevailing wave direction is from the north west (308 to 312 degrees).
- The waves are incident mainly from the North West at an angle of 308 degrees. The bay is thus very exposed and consistently experiences lee-shore wave conditions.

Local navigation summary

19.3.14 The north west coast of Lewis is a navigationally hostile area; there are limited safe havens, limited areas of navigational significance, and the prevailing weather conditions mean that it is typically a hostile lee shore. This means that transiting vessel traffic typically passes at a safe separation from the coast, and coastal traffic is light, and operates only in good weather.

19.3.15 As a result of the exposed coastline, the shallow water, the lack of detailed charts, and the lack of any major features within Siadar bay, it does not lie on any transit routes. All vessels passing along the coast do so at a greater distance offshore, and do not enter the bay itself.

19.3.16 The immediate vicinity of Siadar bay is only generally used by a few small local fishing vessels (up to 10m) engaged in creeling or lobster and crab fisheries. These vessels are based either in Siadar itself, or other nearby settlements and operate in fair weather and near shore.

19.3.17 There is heavy large vessel traffic passing offshore along the north coast of Lewis, primarily following the charted deep water route. The charted deep water route lies over 6 nm to the north and west of the project, and the traffic using that route passes Siadar bay at a separation of over 6 nm. Surveys of this route carried out in 2004 showed approximately on average 6.4 vessels per day to be using the route. As would be expected, none of the large, or transiting, vessel traffic closely approaches Siadar bay. Experienced mariners based in, and sailing out, of Siadar bay have confirmed that, as would be expected, this major transit route does not interact with Siadar bay, and instead passes well clear of the north Lewis coastline.

19.3.18 There is very limited recreational vessel traffic along the north west coast of Lewis, and no significant recreational traffic has been identified in the immediate vicinity of Siadar bay.

Consideration of MGN 275 (M) – Annex 1 – Considerations on Site Position, Structures and Safety Zones

19.3.19 A detailed examination of MGN 275 and it's relevance to the project has been undertaken. The following points address the points listed in MGN 275 and follow the format and structure of MGN 275 to aid comprehension.

<u>Traffic data</u>

19.3.20 The result of assessment on:

a. Proposed OREI site relative to areas used by any type of marine craft.

- The seas close to the north Lewis coast are exposed, with few safe havens, and are thus only lightly trafficked. Primary local activity is through fishing, with larger vessels transiting further offshore.
- There is a small local fleet of <10m fishing vessels which operate along the coast from the various slipways and landing facilities available. Some of these vessels can fish in to around the 4 or 5 m depth contour, and thus some might operate or transit in close proximity to the proposed Siadar structures.

- There are also a small number of recreational sea-angling vessels which operate from Bragar, but not generally in Siadar bay. There is little other recreational traffic.
- A charted deep water route, and its approaches, passes over 6 nm to the north and west of Siadar bay. This was surveyed in 2004 showing 6.4 vessels per day, including tankers and other large vessels. There is no known interaction between these transiting vessels and Siadar bay.
- There are no other significant marine activities known to take place in close proximity to Siadar bay.

b. Numbers, types and sizes of vessels presently using such areas.

19.3.21 Vessel numbers and types operating in or around Siadar bay have been identified in the table below:

Table 1.2: Local Vessel Traffic Details

Local Vessel Traffic (Collated through consultation with experienced local mariners and fishing organisations)		
Category	**Season**	**Details**
Vessels Launching and Recovering from Siadar	**Summer/Autumn**	**2-3 16ft day fishing boats** **1 27ft creel boat**
	Winter/Spring	**None**
Other Vessels Operating Near Shore **(in the vicinity of proposed structures)**	**Summer/Autumn**	**Around 2 boats per day potting in the area, or transiting** **(Locally, 6-8 fast work boats <10m in length operate out of Loch Roag for lobsters and velvet crab)**
	Winter/Spring	**Generally none**
Vessels Operating Further Offshore **(away from proposed structures)**	**Summer/Autumn**	**Typically 3 fishing vessels per week transiting in normal weather. In very good weather there may be a few more** **Occasional yachts in very good weather**
	Winter/Spring	**Very few vessels**

19.3.22 In addition to this local vessel traffic, there is a heavily used deep water route which passes over 6 nm from Siadar bay. For completeness the results of an official survey carried out in 2004 have been reproduced below, although there is not thought to be any interaction between this transiting traffic and Siadar bay.

Table 1.3: Transiting Vessel Traffic Details

Transiting Vessels – Using Deep Water Route (Collected during a 29 day official survey in 2004)					
Vessel Size		Vessel Type			
Group	GRT	Tankers	Dry cargo	Other	All vessels
1	less than 500	0	0	103	107
2	500-10,000	0	8	5	13
3	10,000-50,000	10	18	1	29
4	more than 50,000	37	0	0	37
	Total	47	26	109	**186**

19.3.23 The data presented above shows the results of a traffic survey carried out over a 29 day period from 7th July to 4th August 2004:

- A total of 186 vessels were observed, with details as shown above.
- The average traffic density in the DWR was about 6.4 vessels per day in the survey period.
- The DWR was mainly trafficked by fishing (46 %), tankers (25 %) and other merchant vessels. No ferries were observed during the survey period.

c. Non-transit uses of the areas, e.g. fishing, day cruising of leisure craft, racing, aggregate dredging, etc

- As discussed in point (a), the only known regular non-transit use of Siadar bay and its immediate surroundings is for local fishing activity.
- The numbers and types of fishing vessels which typically operate around Siadar bay are summarised in point (b).
- In addition to those activities known to take place in and around Siadar bay, there are also a small number of recreational sea-angling vessels which operate from Bragar, but these do not generally visit Siadar bay. There is little other leisure traffic in the area.

d. Whether these areas contain transit routes used by coastal or deep-draught vessels on passage.

- As the Siadar wave project is of small size, located close inshore, there are no transit routes directly affected by the proposal.
- There is a Deep Water Route over 6nm offshore from Siadar and used by deep draught vessels transiting the area. Numbers and types of vessels using this route have been identified in point (b) above. Vessels using this route are not thought to have any interaction with the vicinity of Siadar bay.

e. Alignment and proximity of the site relative to adjacent shipping lanes.

- As shown in the Admiralty Chart, the proposed Siadar wave project lies over 6 nm from shipping using the deep water route to the north and west.

f. Whether the nearby area contains prescribed routeing schemes or precautionary areas.

- A charted deep water route lies over 6 nm from the proposed structures at Siadar.

g. Whether the site lies on or near a prescribed or conventionally accepted separation zone between two opposing routes.

- There are no traffic separation schemes, or similar routeing measures, in the vicinity.

h. Proximity of the site to areas used for anchorage, safe haven, port approaches and pilot boarding or landing areas.

- Siadar bay contains a single slipway, in very poor condition. This is used by local small fishing vessels, which operate out of the bay in good weather. Due to the exposed location, it is not generally possible for vessels to anchor or moor in Siadar bay. It is noted that the local mariners have been closely involved in the Siadar wave project since its conception and are strong supporters of the project. As part of the scheme, the Siadar slipway will be repaired and upgraded to assist them with their operations, in addition it is expected that the breakwater structure will provide a degree of shelter on its landward side, and also for the slipway area in some weather conditions, thus improving the safety of some of their launching and recovery activities.
- Bragar, about 8 nm to the south, has a slipway facility. This is suitable for operating small vessels in good weather and does not include a protected anchorage. No effects at Bragar are anticipated.
- There is little significant port infrastructure in the vicinity of the Siadar proposal and thus they are not expected to be affected:
- The nearest port infrastructure to the Siadar proposal is at Carloway, a small local port c.15 nm to the south west.
- The nearest significant port is Stornoway, some 60 nm around the Butt of Lewis on the eastern coast of the island.
- There are no pilotage areas in the vicinity of the proposal.

i. Whether the site lies within the limits of jurisdiction of a port and/or navigation authority.

- The Siadar wave power proposal lies outside any port authority areas. It is located in Scottish territorial waters, within the authority of the MCA and the Northern Lighthouse Board, as General Lighthouse Authority.

j. Proximity of the site to existing fishing grounds, or to routes used by fishing vessels to such grounds.

- As discussed in point (a) the Siadar bay area is lightly used by local fishing vessels, indeed this forms approximately 100 % of the vessel traffic that could be directly affected by the proposal. The vicinity of the proposed wave power scheme is fished by local fishing vessels <10 m in length, and also transited by similar local vessels moving along the coast.

- Details of this local vessel traffic are given in point (b).

k. Proximity of the site to offshore firing/bombing ranges and areas used for any marine military purposes.

- There are no marine military activities known to take place close to the proposed Siadar wave power proposal.

l. Proximity of the site to existing or proposed offshore oil / gas platform, marine aggregate dredging, marine archaeological sites or wrecks, or other exploration/exploitation sites.

- There are no offshore exploration sites close to the Siadar project.

m. Proximity of the site relative to any designated areas for the disposal of dredging spoil.

- There are currently no designated disposal sites close to the Siadar project.

- During the preparation of the seabed for the caissons, making up the breakwater structure, excavations may be required. These may therefore require excavated spoil to be deposited, either as a levelling medium of the foundations or will be required to be safely disposed.

n. Proximity of the site to aids to navigation and/or Vessel Traffic Services (VTS) in or adjacent to the area and any impact thereon.

- There are no existing aids to navigation or VTS services close to the Siadar project.

o. Researched opinion using computer simulation techniques with respect to the displacement of traffic and, in particular, the creation of 'choke points' in areas of high traffic density.

- There is not expected to be any traffic displacement as a result of the Siadar proposal. The very light levels of local small vessel traffic are expected to be the only vessels directly affected by the proposal.

OREI structures

a. *Whether any features of the OREI, including auxiliary platforms outside the main generator site and cabling to the shore, could pose any type of difficulty or danger to vessels underway, performing normal operations, or anchoring. Such dangers would include clearances of wind turbine blades above the sea surface, the least depth of current turbine blades, the burial depth of cabling, etc.*

<u>Breakwater</u>

19.3.24 The breakwater structure will appear externally similar to a traditional concrete breakwater structure, with no exposed machinery or moving parts. There will be a series of submerged openings in the seaward face of the structure but these are not viewed as being a hazard to mariners.

19.3.25 There may be external structural elements, such as steel bracing on the landward side of the breakwater, which could pose a limited collision hazard to small vessels operating in immediate proximity to the structure. Such structures would be obvious and visible and therefore avoided.

<u>Fixed access link</u>

19.3.26 This causeway, and possibly steel-truss bridge, structure may be a component to the project. If built it would be a fairly traditional coastal/harbour structure, with no non-standard risks associated. It is assumed that the causeway would be marked and lit as appropriate.

<u>Power exporting cable</u>

19.3.27 The power export cabling will preferably be routed back to shore within a fixed access link structure. This arrangement would lead to no additional impact upon mariners.

19.3.28 If a fixed link is not constructed, sub-sea cables would be laid on the sea bed and will either be buried or protected, as appropriate, to prevent exposure. This may include external cable armouring, potentially fixed to the seabed by bolted saddles or occasional concrete mattress laid over the top of the cables. The protection for the cables will need to be substantial, given the aggressive sea conditions, and the cables would be signed and marked by as appropriate to indicate their location. Given the small size of local vessels and the lack of a safe anchoring area along the cable route, no significant navigational hazards are therefore expected to result from the presence of the power export cables.

b. Whether any feature of the installation could create problems for emergency rescue services, including the use of lifeboats, helicopters and emergency towing vessels (ETVs)

19.3.29 Given the inshore location, and lack of any external moving parts, there are not viewed to be any potential effects upon the emergency services.

c. How rotor blade rotation and power transmission, etc., will be controlled by the designated services when this is required in an emergency.

19.3.30 The project will be controlled remotely by a central control centre manned 24 hours. Although there are no external moving parts, it is assumed similar arrangements as used for offshore wind farms would be put in place to remotely stop the machinery or power transmission if required in an emergency situation.

19.3.31 It is proposed that an Emergency Response Code of Practice (ERCOP) form should be completed for the Siadar project, and appropriate communications channels and emergency procedures will be put in place.

Assessment of access to, and navigation close to, the OREI

a. Navigation within the site would be safe for which vessels:

19.3.32 Currently navigation in and around Siadar bay is safe only for small craft in good weather, and is typically only used by local fishing vessels up to approximately 10m in length.

19.3.33 This is not expected to change significantly as a result of the construction of the proposed Siadar wave power project. The proposed structures lack any external moving parts and are essentially fairly typical coastal structures, which are broadly compatible with small boat operations in good weather.

19.3.34 A safe means of boat access to the landward side of the breakwater structure will be provided, for use either during maintenance operations or generally in the case of emergency. This is likely to consist of an appropriately designed ladder arrangement.

b. Should navigation near the site be restricted:

19.3.35 Given the statements in point 3 (a) above, it is not felt to be necessary to restrict or prohibit navigation around the site. It is felt that the natural limitations upon navigation in the area, combined with appropriate safety mitigation and control measures (detailed fully in Annex 2) maintain adequate safety of navigation. As a result there are no plans to apply for a safety zone around the structures.

c. Exclusion from the site could cause navigational, safety or routeing problems for vessels operating in the area.

19.3.36 There is not expected to be any traffic displacement as a result of the Siadar proposal. The very light levels of local small fishing vessel traffic are expected to be the only vessels directly affected by the proposal.

Consideration of MGN 275 (M) – Annex 2 – Navigation, collision avoidance and communications

Navigation, collision avoidance and communications

1. The Effect of Tides and Tidal Streams:

i. Modelling undertaken for the project has indicated that the spring tidal range is approximately 3.6m. There are not expected to be any changes to the characteristics of the proposed structures between the two states of tide.

Given the water depths around the proposed Siadar project, tidal range is expected to have a small impact upon the operations of vessels in the shallow water immediately around the project, although it is not of great significance in the wider area. It is known in particular that the Siadar slipway is not currently accessible at low tide, which does restrict vessel movements at these times. It is expected that the slipway will be improved as part of the project, which may increase the flexibility of these local fishing activities, although it is not expected to increase the number of vessels significantly.

ii – vi. Tidal current speeds have been modelled as having negligible velocity, although flowing broadly along the coastline. Navigation in the area is not significantly affected by tidal currents, and it is not seen that the presence of the proposed Siadar structures could affect this situation.

vii. As part of the project, detailed consideration of the potential for changes to local sediment patterns has been assessed. This is detailed in Section 10 of the ES. The results of this work have shown there to be very little mobile sediment, as the seabed is constituted largely of rock. No effects upon major navigable channels are expected.

2. Weather:

i. In poor weather conditions, navigation in the area of Siadar bay is already extremely hazardous, with the local coastline a lee shore under the prevailing wind and wave climate. Experienced local mariners have stated that there is no vessel traffic close to the coast in poor weather conditions. If vessels were to closely approach the project in rough weather conditions, it is likely that they would already be in severe difficulties. In good weather conditions, the proposed Siadar structures are not expected to produce effects upon passing mariners different to traditional breakwater or pier structures.

The presence of the Siadar wave power project is not expected to significantly change the current situation in any weather conditions.

ii. The proposed Siadar structures are not expected to have wind masking characteristics different to any traditional breakwater or pier structures. They will therefore cause a degree of wind masking and turbulence in the immediate vicinity of the structure. There is no significant sailing vessel traffic reported in the vicinity.

3. Visual navigation and collision avoidance:

i. The proximity of the proposed structures to the coastline means that they cannot significantly affect the view of vessels underway, except those operating from the Siadar slipway themselves. The separation from the deep water route means that there will be no significant impact upon these transiting vessels operations.

ii. There are no significant navigational features, markers, or aids to navigation along the coast behind the Siadar structures. The Siadar breakwater structure will be appropriately marked and lit, and will thus form a new and readily identifiable navigational feature.

4. Communications, radar and positioning systems:

19.3.37 The structures proposed in Siadar bay have a number of features which will limit their potential impact upon marine navigation and communication systems:

- The structures are located in close proximity to the coast (a maximum distance of 400 m from the shore),
- The structures have a significant separation from most vessel traffic in the vicinity, other than small coastal fishing vessels <10 m in length,
- The proposed installations are externally and structurally similar to traditional port and harbour structures (concrete breakwaters, rubble-mound causeways, and steel truss piers). Their effects on marine systems are therefore expected to be similar to traditional structures, (and thus broadly similar to most other typical shoreline features).

i. Given the comments above, the proposed Siadar structures are expected to have only limited effects. It is foreseeable that radio communication and AIS systems will be interrupted on a line of sight basis. Given the location of the structures and the volumes and types of vessels operating immediately around the structures, this is not seen to be a significant issue.

ii. The Siadar structures are expected to have similar radar characteristics to typical breakwater and pier structures. They are therefore likely to negatively affect radar systems operating in close proximity to them to varying degrees. The large vessel traffic transiting offshore is viewed as too distant to be affected. Given the location of the structures and the volumes and types of vessels operating immediately around the structures, this is not seen to be a significant issue.

iii. The generating and electrical systems associated with the project are expected to meet the relevant UK regulatory requirements. Please see point (vi) below for further discussion.

iv. The design of the structures is similar enough to traditional coastal structures that no significant effects upon the use of military or civil active sonar are expected. With respect to passive sonar, there are no moving parts in the water and therefore underwater sound is expected to be low. There are therefore no significant sonar effects expected.

v. There are no fixed navigational sound signals in the vicinity of the Siadar wave project (and the NLB have not indicated that sound signals should be fitted to the structures). It is noted that the air turbines inside the breakwater structure that are the principle machinery within the project are a potential source of airborne noise. In order to minimise the transmission of this noise, the turbines are fully enclosed, with all external openings baffled and fitted with sound minimising vents. With such mitigation in place, noise levels outside the breakwater will meet standard working environment requirements. Taking into account the various characteristics of small motor fishing vessel operations, this is not viewed as a significant impact.

vi. Following on from point (iv) above, it is accepted that some degree of electromagnetic interference is possible in very close proximity to the generating machinery and cabling. This could potentially affect navigational systems such as compasses etc. Given the location of the structures and the volumes and types of vessels operating immediately around the structure, this is not seen to be a significant issue.

5. Marine navigation and marking:

i. How the overall site would be marked by day and by night taking into account that there may be an ongoing requirement for marking on completion of decommissioning, depending on individual circumstances.

19.3.38 The proposed structures will be provided with aids to navigation in accordance with the guidance provided by the Northern Lighthouse Board. Based upon our consultations with them so far, this is expected to include:

- The seaward most northerly point of the breakwater will be marked by a navigational light with an elevation of at least two metres above the finished surface of the breakwater, exhibiting a characteristic of Flash Green every five seconds (Fl G 5s), the range of this light being at least 2 nm.

- A similar navigation light may also be needed on the southerly extremity of the breakwater, which could exhibit Flash Red every five seconds (Fl R 5s), also with a range of at least 2 nm.
- During construction, the seaward extremity of the construction activities will be marked with yellow navigation buoys exhibiting Flash Yellow every five seconds (Fl Y 5s).
- We would expect to be guided further on the specific requirements of construction and decommissioning markings for navigational safety, and will continue to consult with NLB as our detailed plans develop.

19.3.39 Pending consultation with the MCA, there may also be a requirement to fit other lighting or marking systems, such as identification markings on the structure, with similar design and characteristics to the wind turbine identification characters described in MGN 275.

19.3.40 Cables running to the shore will be marked with cable marker boards on the shoreline, plus potentially clear signs on the breakwater structure, to indicate their locations.

19.3.41 In addition, during construction, any vessels engaged in installation operations will be marked and lit in accordance with the International Regulations of Preventions of Collisions at Sea.

ii. The overarching lighting and marking scheme will be guided by the instructions of NLB, given the nature of the proposal, there are to be no separated or isolated structures.

iii – v. There is no anticipated need to mark the site with a racon, AIS system, or navigational sound signal.

vi. The proposed site will comply fully with the lighting and marking requirements of both the relevant GLA (Northern Lighthouse Board (NLB)) and the MCA.

vii. npower renewables is experienced in the operation of aids to navigation on our existing offshore renewable energy installations. Existing internal requirements and operational procedures have been developed to meet or exceed the requirements of the GLAs for the maintenance and availability reporting of aids to navigation. Appropriate plans will therefore be developed in consultation with NLB, to ensure their specific requirements are met for the installations at Siadar.

viii. Appropriate systems will be developed to respond to casualties to the aids to navigation. These are likely to be based upon npower renewables existing experience with the maintenance of aids to navigation, as noted under point (vii) above.

Consideration of MGN 275 (M) – Annex 3 – Safety and mitigation measures recommended for OREI during construction, operation and decommissioning

Safety and mitigation measures during Construction, Operation and Decommissioning

i. Information on the construction, decommissioning, and other relevant operations will be disseminated through notices to mariners, notification of the UK Hydrographic Office, and other appropriate channels and media as identified.

ii. Construction and decommissioning vessels on site will continue to meet all the statutory and best practice requirements with respect to seamanship, navigational practices, radio operation, offshore construction, etc.

iii. Safety zones are not anticipated to be required for the structures; which will be externally similar to many typical harbour and coastal structures, with no exposed moving parts.

iv. There is no anticipated need to designate the site as an area to be avoided. The standard offshore construction notification and charting procedures are deemed to be appropriate in this case.

v. There is no anticipated need to implement routeing measures associated with the development.

vi. The site machinery will be continuously monitored at a remote control facility. There is no anticipated navigational safety reason to monitor the site via radar, AIS, or CCTV. However it is possible that other interests, such as security, may lead to the installation of similar systems, for instance CCTV.

vii. In the absence of safety zones, there is no need to monitor their status. This is therefore not applicable.

viii. The NLB will be consulted on detailed marking and lighting systems for use during construction, operation and decommissioning. No other consultees have indicated any additional requirements to date, however further comments will be considered as applicable.

Consideration of MGN 275 (M) – Annex 4 – Standards and procedures for wind turbine generator shutdown in the event of a search and rescue, counter pollution or salvage incident in or around a wind farm

19.3.42 Although this annex is predominantly directed at offshore wind farm structures, it is felt that some aspects are applicable to the Siadar project. Our response here therefore continues to follow the numbering within MGN 275. In addition, the revised MGN 275, currently under consultation includes several proposed changes within this section, which for the sake of completeness, will be taken into account for this work, in an additional section at the end.

Design requirements

i. Pending confirmation from the MCA, it is assumed that the breakwater structure may need to be marked with identification characters, similar in design to those required for offshore wind turbines, and detailed in MGN 275.

ii. The project will be remotely monitored and controlled 24 hours per day by a remote control centre. This will be capable of remotely stopping and controlling key aspects of the project machinery and electrical system. It will also be capable of some degree of remote condition monitoring, and fault detection. This control centre will be contactable by the MCA or emergency services as required.

iii. Where appropriate, the MCA and relevant emergency services will be consulted with regards emergency procedures. Please also refer to point (ii) above.

iv. The generating machinery, although fully enclosed within the breakwater structure, will be capable of being stopped from the remote control centre. Please also refer to points (ii) and (iii) above.

v. The top of the breakwater and potential fixed shore link will be appropriately designed for safe personnel access. It is assumed that this will include guardrails, and secure footing as a minimum.

vi. The breakwater structure will include some appropriate means of safe access by boat on the sheltered, landward side. This is likely to be some form of ladder system, but final designs are not yet finalised. This system(s) may be used for operational maintenance, but will also be designed to accommodate the requirements of emergency situations. The breakwater structure may be appropriate to act as a refuge in emergency situations, and appropriate handrails and basic safety systems will be in place (in line with its primary role as a place of work).

Operational requirements

i. The remote central control centre will be manned 24 hours per day, with capabilities as described in point 1(ii) above.

ii. The precise location, key details of, and charted surroundings, of the Siadar installations will be available to the central control centre.

iii. The contact details of the central control centre will be made available to the MCA. It is assumed that similar procedures to those in place for offshore wind farms will be used to provide this information.

iv. Charts indicating the layout of the Siadar installations will be provided to the MCA. It is again assumed that similar procedures to those in place for offshore wind farms will be used to provide this information.

19.3.43 As an additional point, it is noted that it is assumed that an ERCOP plan will be completed for the Siadar project, in consultation with the MCA, in a similar fashion to that required for offshore wind projects.

Operational procedures

i – ii. Appropriate emergency contact and shutdown procedures will be established with the MCA as required. It is assumed that this will follow the ERCOP framework, as noted in section 2 above.

iii. The MCA will be consulted as to the appropriate methods for testing and exercising these procedures.

Summary and conclusions

19.3.44 A detailed assessment, which has involved consultation with a wide range of local and national stakeholders, has been undertaken to assess the navigational risk posed by the Siadar Wave Energy Project. This assessment has concluded that the overall impact upon the safety of navigation is negligible.

- The project is over 6 nm from any shipping routes and is contained with the profile of the existing coastline. Coupled with the nature of the project and technology involved and the mitigation measures to be employed, the effect on major transient shipping is negligible.

- For local mariners, the project could provide enhanced sea access by providing a more sheltered location for sea access. This would be a moderate beneficial effect for small leisure craft users and fishing vessels. However, the increased presence of boats around the site allied to the presence of the project would obviously slightly increase the risk of an incident occurring. This has been assessed as having a minor adverse effect on local mariners.

B-4. ScottishPower Renewables & Pelamis Wave Power (formerly Ocean Power Delivery Ltd.), Multiple Wave Energy Converter Project, Environmental Report (2007)

ENVIRONMENTAL REPORT

MULTIPLE WAVE ENERGY CONVERTER PROJECT.

A project by: ScottishPower renewables

With: OCEAN POWER DELIVERY LTD www.oceanpd.com

ScottishPower,
Renewables and Major Projects,
Cathcart House,
Spean Street,
Cathcart,
Glasgow.
G44 4BE.

Ocean Power Delivery Ltd,
104 Commercial Street,
Leith,
Edinburgh.
EH6 6NF.

CONTENTS

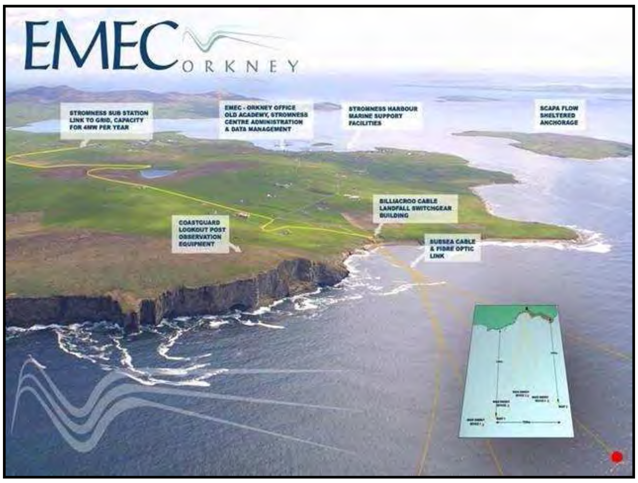
1.0 INTRODUCTION:

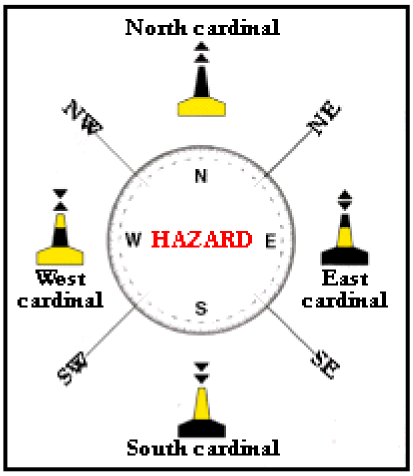
1.1 Document Outline.

This Environmental Report has been prepared in accordance with the *Environmental impact assessment (EIA) guidance for developers at the European Marine Energy Centre*[1], and to support the submission of the Project's application for consent, including application under the Coast Protection Act (1949) Section 34.

1.2 Project Outline.

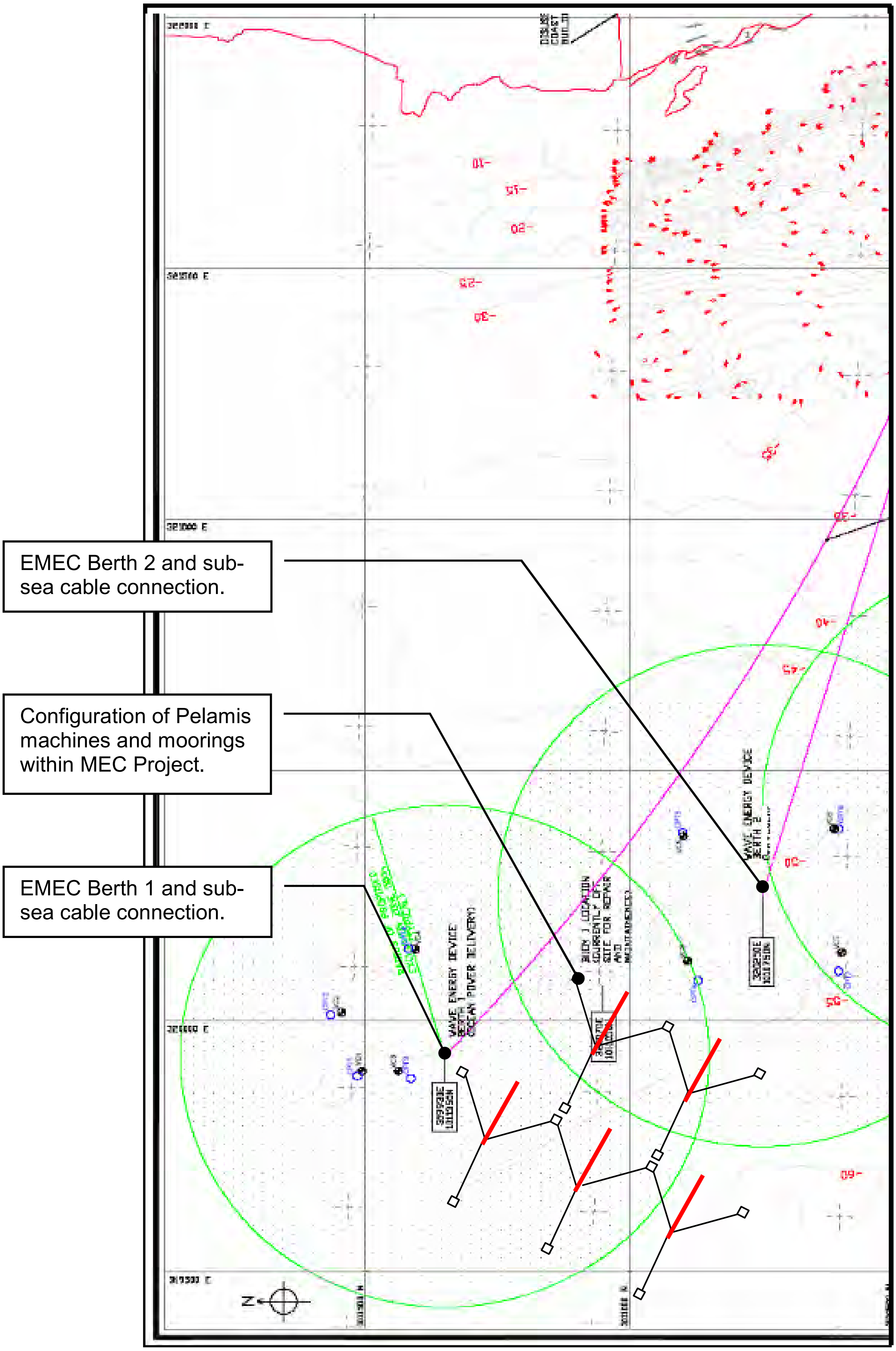
The Developer, CRE Energy Limited, proposes to install a Marine Energy Converter (MEC) Project (the Project) utilising the existing European Marine Energy Centre's (EMEC's) wave test facilities at Billia Croo, Orkney. The Project array will consist of five Pelamis wave energy converters as supplied by Ocean Power Delivery Ltd (OPD). Pelamis devices are capable of being moored in close enough proximity to one another to facilitate the sharing of a common grid connection cable and associated infra-structure. A layout of the configuration for 5 Pelamis machines at the proposed MEC Project is shown on the following page (the final layout design will be subject to design considerations and approvals). The Project will utilise both the subsea cables serving EMEC Wave Berth's 1 and 2. The area occupied by the Project will not exceed the boundary of the EMEC test area, and will lie within the area marked by the existing cardinal markers (Northerly marker @ 58º59'.35N, 03º23'.60W, Easterly marker @ 58º58'.52N, 03º22'.44W, Southerly marker @ 58º57'.77N, 03º23'.05W and Westerly marker @ 58º58'.53N, 03º24'.01W).





It is anticipated that the Project is installed and commissioned during 2007. With the individual Pelamis machine ratings for the Project at 750kW; the MEC Project will have an installed rating of 3.75MW and will provide invaluable experience into the overall operation and impacts of a multiple machine array. In the average annual wave conditions experienced at Billia Croo the Project is expected to produce enough clean electricity to supply the annual demands of 2,500 homes with an equivalent saving of approximately 10,000 tonnes of CO_2 emissions from gas turbine generation.

[1] *EIA guidance, as published by EMEC, has been developed to outline EIA requirements from developers interested in installing and operating marine energy conversion devices at EMEC, which has already been the subject of a full-scale EIA.*


EMEC Berth 2 and sub-sea cable connection.
Configuration of Pelamis machines and moorings within MEC Project.
EMEC Berth 1 and sub-sea cable connection.

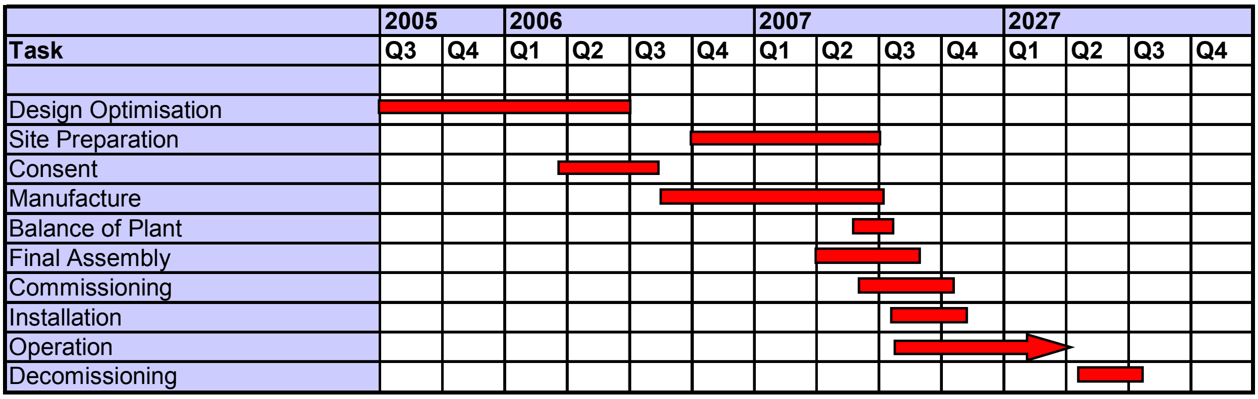
1.3 Project Parties.

ScottishPower; is an energy company with a remit for developing, operating and supplying electricity to their customers. One of the key components of ScottishPower's business is the development of power generation projects. ScottishPower are currently implementing an ambitious development programme in renewable energy. CRE Energy Limited is a wholly-owned subsidiary of ScottishPower plc with the responsibility for developing and maintaining the company's renewable energy portfolio.

Edinburgh based **Ocean Power Delivery** was formed in 1997, OPD spent 7 years of intensive research and development focused on the Pelamis wave energy converter technology. This programme covered extensive model testing, computer simulation and software development, full-scale power take-off testing and culminated in the independent design verification for a full-scale (750kW), pre-production prototype system, which was successfully manufactured and launched by OPD in 2004 for ongoing grid connected testing at EMEC. OPD have completed the manufacture and are now currently in the process of supplying and installing the world's first commercial wave farm array off the northern coast of Portugal. OPD has over 60 employees providing a wealth of experience in structural, electrical, hydraulic and offshore engineering and also covering production, assembly, installation offshore operations, maintenance and project management. OPD have raised funding through both the DTI New and Renewable R&D programme and private investment.

1.4 Project Timelines.

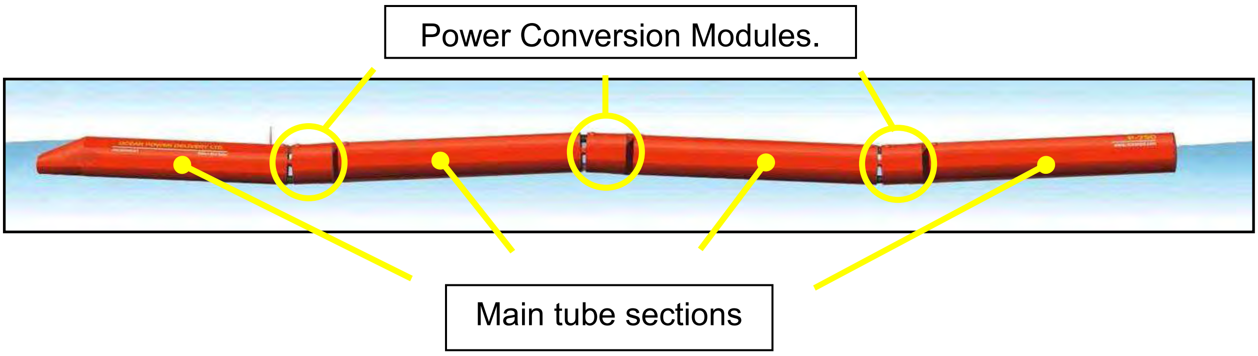
Installation of the project is planned to take place during the longer weather windows of Q2 & Q3 in 2007. Given the manufacturing lead-times for Pelamis machines, of which OPD have production experience of multi-unit supply, OPD have already commenced the process of re-design for the machines proposed for this project. The table below sets out the major project milestones.



2.0 MACHINE REVIEW:

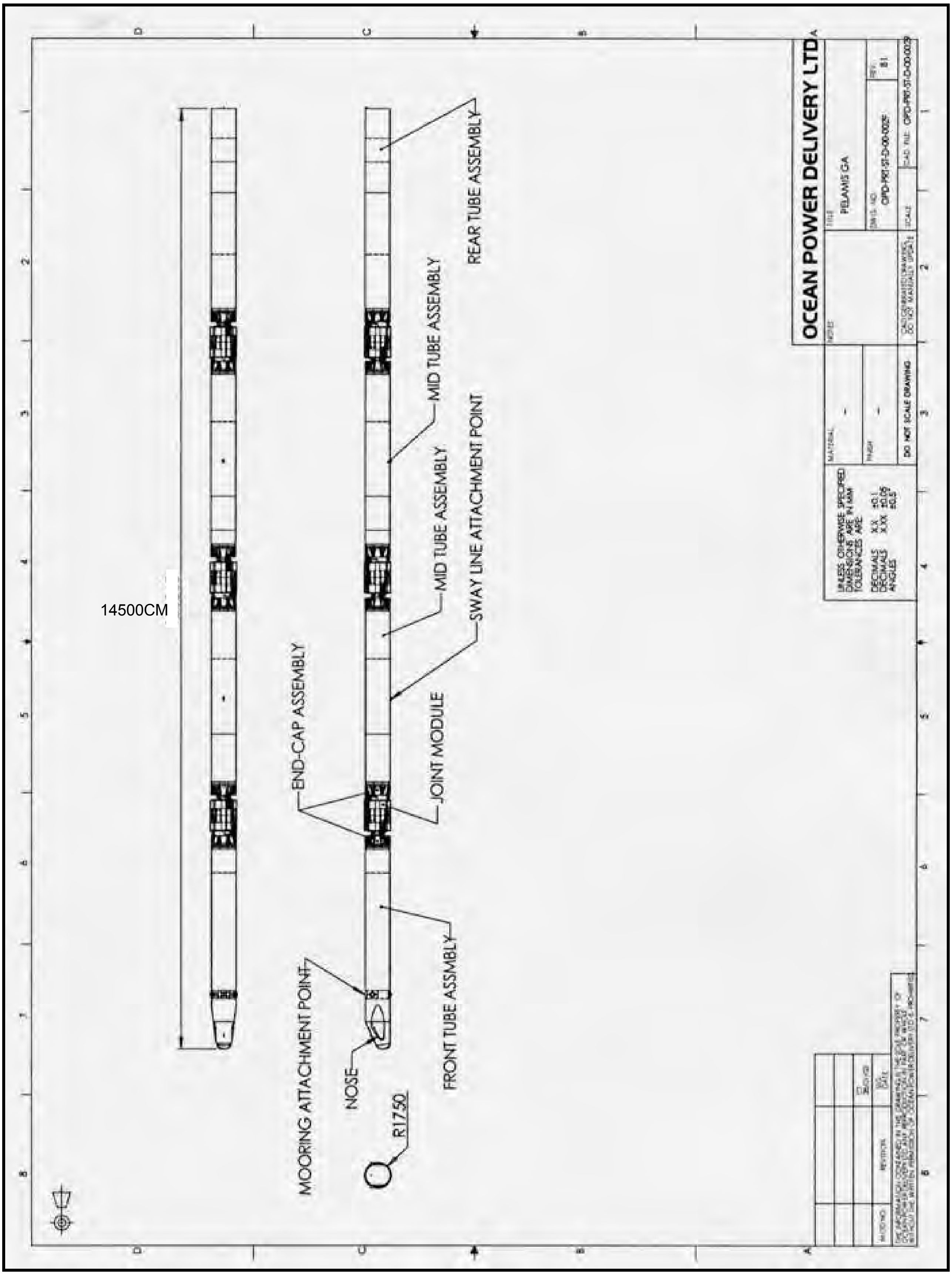
2.1 Pelamis concept.

The Pelamis is a semi-submerged wave energy converter with a simple geometry configuration based on individual cylindrical segments linked linearly by hinged joints. The wave induced motions of the separate segments relative to one another are resisted by hydraulic rams. Main tube cylinders are separated at each joint by shorter Power Conversion Module's (PCM's), each houses an independent power generation system consisting of two separate hydraulic circuits. Located at either end of the PCM's are pairs of hydraulic rams; one pair resisting a sway joint and the other end-pair resisting a heave joint. The hydraulic rams drive pressurised fluid into power smoothing, high pressure accumulators which then direct the fluid through variable displacement motors and back to low pressure fluid reservoirs. The variable displacement motor is directly linked to an asynchronous generator producing a 3-phase voltage. The maximum overall generating capacity of a single Pelamis machine is 750kW. The motor generator sets in each PCM feed the produced electricity onto a high voltage bus-line which runs the length of the device and feeds into a nose-mounted transformer. The transformer output is fed down to the seafloor via a flexible umbilical connector which is subsequently joined to a static high voltage cable on the sea bed taking the generated power to the shore and a suitable grid connection. The machine is moored in offshore depths >50m by a unique mooring spread which enables it to self-reference itself and maintain a directional heading perpendicular to the predominant wave direction.



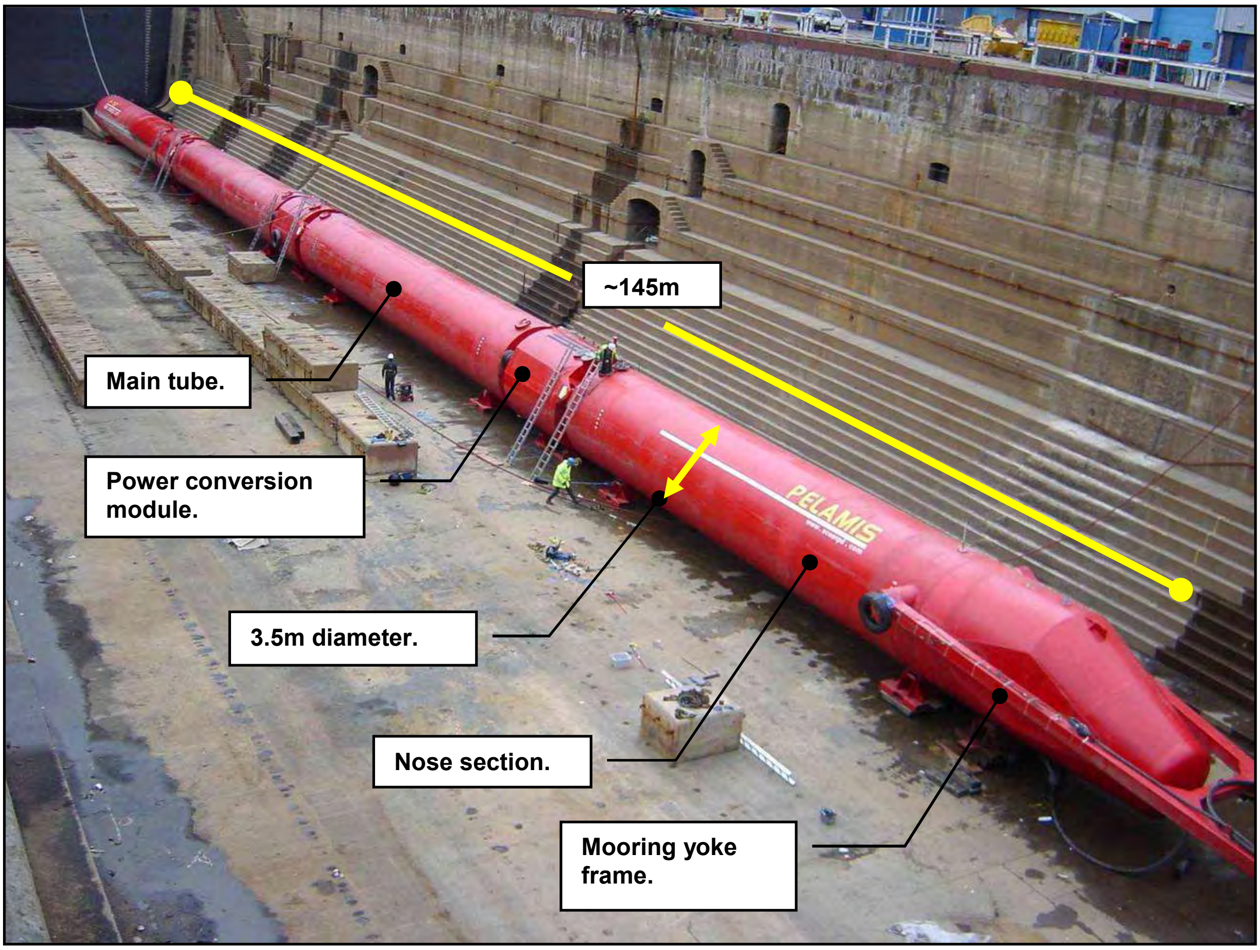
2.2 Structural.

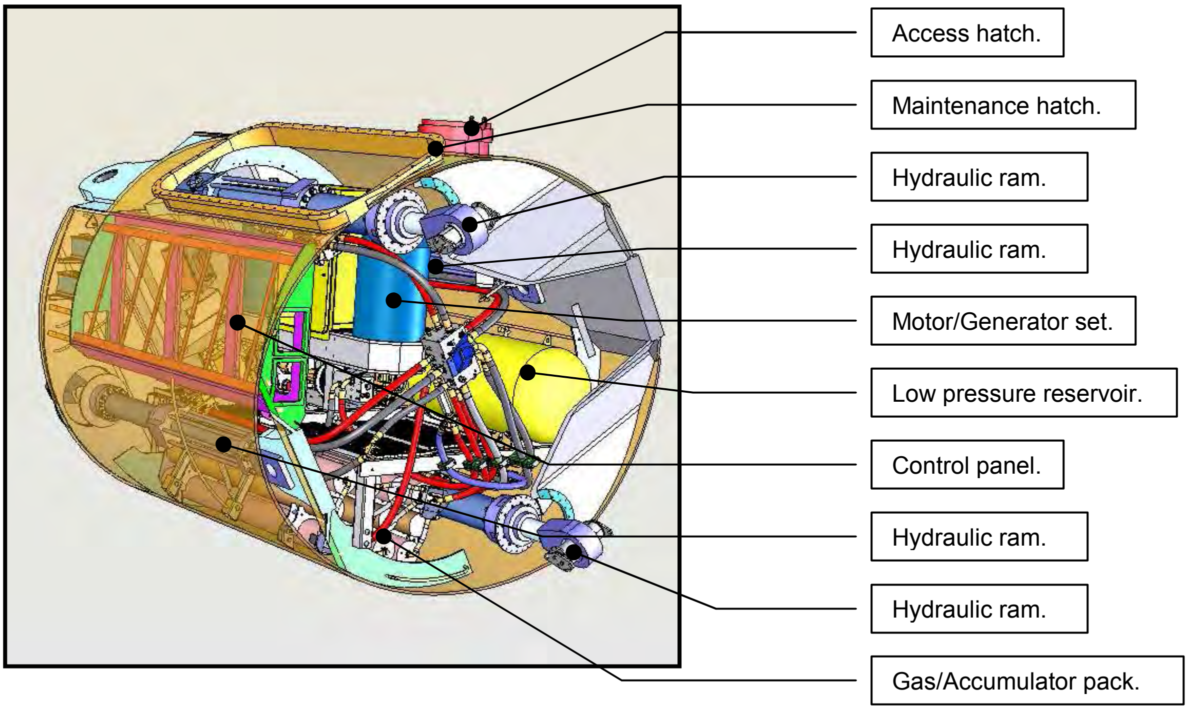
Current Pelamis structures (as shown on the following page) consists of four, steel, longer main-tube sections with steel end-caps and three, shorter, PCM's containing the power conversion equipment, however it is envisioned within the timescales of this project Pelamis designs will have five main-tube sections and four PCM's. The total fabrication weight is approximately 380 tonnes of mild steel. The structure is painted externally using an International paint system. Maintenance free composite marine bearings are used at the hinged joints and at the mooring yoke attachment. The designs for the Pelamis machine, and associated mooring spread, have been independently verified to applicable offshore codes and standards.



14500CM
REAR TUBE ASSEMBLY
MID TUBE ASSEMBLY
MID TUBE ASSEMBLY
SWAY LINE ATTACHMENT POINT
END-CAP ASSEMBLY
JOINT MODULE
FRONT TUBE ASSEMBLY
MOORING ATTACHMENT POINT
NOSE
R1750
OCEAN POWER DELIVERY LTD
PELAMIS GA
DO NOT SCALE DRAWING

The following pictures show the overall dimensions of the Pelamis (although, as mentioned previously; the final dimensions might vary slightly subject to further design considerations) and the component lay-out within a PCM.



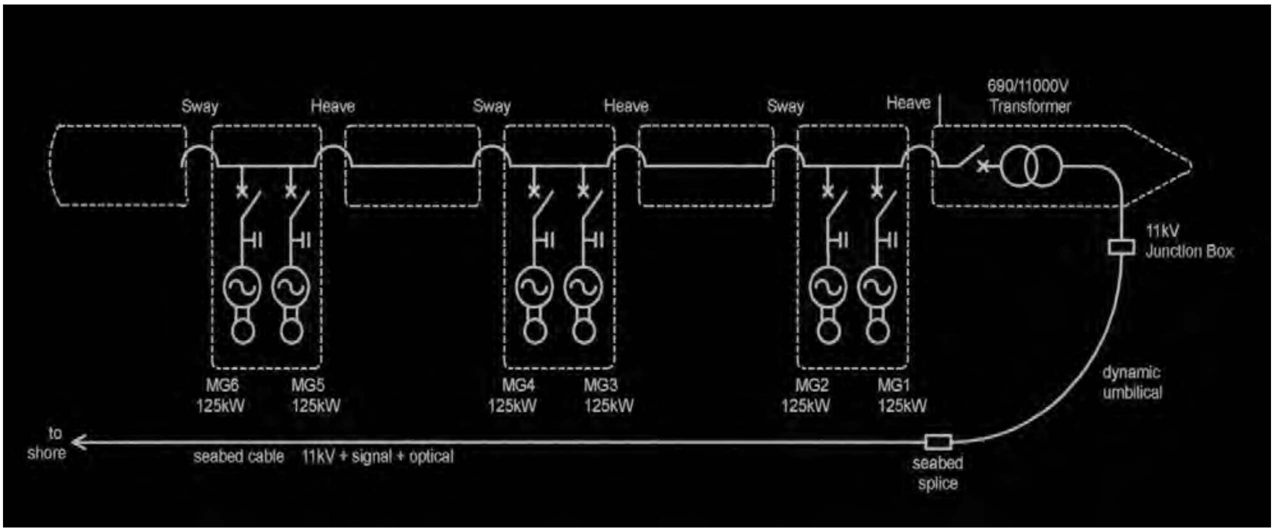


2.3 Electrical System.

Electrical power is produced in the power conversion modules by twin, marine rated, air cooled generators coupled to the hydraulic motors. The generators are each rated at 125kW, run at a constant 1500rpm. 250kW (max) of electricity is generated at 690V (50Hz).

A transformer is located in each nose tube section to step up the transmission voltage to transmission voltage at 50Hz. The transformers are filled with ~680 litres of Midel 7131. It is a synthetic ester - non-flammable and classed as non-hazardous. The transformers are sealed (IP67) units specified to withstand the environments onboard Pelamis and do not require replacement. In the unlikely event of a leakage of coolant from transformer the fluid would be contained within the nose tube where the transformer is located.

Under normal operating conditions; control and data acquisition systems are powered by the grid or power generated by the machine. In the event that the grid connection is compromised a battery backup system is used to power critical systems. Four sealed, 200Ah, lead acid batteries are located in the nose section of the machines and two in each of the PCM's for backup.



2.4 Communications System.

Main communications with the machines is via fibre optic cables embedded in the seabed power cable. Backup communication is made via a radio link from Pelamis machines to the onshore operations unit. The radio modems operate on 458MHz @ 0.5W power and 5.8GHz @ 0.5W giving the link a 4-5km range. There is also a machine only radio modem at 2.4GHz @ 0.5W. At this frequency and power rating, the link is license exempt.

The radio antennas on the Pelamis machines extend approximately 2.5m and 5.0m above water level. There is also a GPS antenna, this is a non-transmitting antenna, used for monitoring the position of a machine, this system is linked to an audible alarm if the position of the machine exceeds its mooring allowance.

The antenna at the onshore operations unit will not extend more than 25m above the sea level. There will be a compact, 12-element Yagi-type antenna (for 458MHz link) and a 305mm^2 flat panel antenna (for 5.8GHz link).There are no health risks of electromagnetic radiation from the base station.

Under normal operating conditions, communication and control systems are powered from the grid. In the event that grid connection is lost a battery backup system is used to maintain function of critical systems. Four, 200Ah, sealed lead acid gel batteries are located in the rear of the nose tube.

2.5 Paints.

The structure surface is shot blasted to SA 2.5 prior to paint application and then painted externally using an International paint system:

External (per machine)

Painted area ~1400m2.

Substance	Quantity
EPIGRIP M922	1200 litres
RESISTEX C137V2	200 litres

Internal (per machine)

Painted area ~200m2

Substance	Quantity
EPIGRIP C400V2	100 litres
RESISTEX C137V2	50 litres

2.6 Bearings.

Maintenance free composite marine bearings are used at the joints and at the mooring yoke attachment. Bearing materials are non toxic and emissions due to material wear are negligible. Main bearing arrangement consists of 12 off journal bearings and 12 off thrust washer.

Main bearing system (per machine)

Item	Manufacturer	Material	Quantity per machine
Journal bearing	Orkot Marine Bearings	Orkot TXM Marine	~10kg
Thrust Washer	Orkot Marine Bearings	Orkot TXM Marine	~10kg

Yoke bearing system (per machine)

Item	Manufacturer	Material	Quantity per machine
Journal bearing at top of yoke	Orkot Marine Bearings	Orkot TXM Marine	~1kg
Thrust Bearing at top of yoke	Orkot Marine Bearings	Orkot TXM Marine	~1kg
Journal bearing sub-sea	Orkot Marine Bearings	Orkot TXM Marine	~27kg
Thrust bearing Sub-sea	Orkot Marine Bearings	Orkot TXM Marine	~16kg

2.7 Hydraulic System.

Each power conversion module contains a complete hydraulic/electrical power conversion system rated at 250kW. A closed loop hydraulic system, with a maximum pressure of 350 bar, powers two hydraulic motors. Each complete system is filled with approximately 1400 litres biodegradable hydraulic oil. BP Biohyd SE-S is a highly biodegradable hydraulic fluid, based on saturated ester base stocks.

The hydraulics system in each power conversion module is split in to two circuits such that if a hydraulic leak should occur only half of the fluid will be lost into the base of the module following automatic detection and isolation of the compromised circuit. Two box oil coolers are located in each power conversion module. Heat is dissipated into the surrounding water as the oil runs through a series of submerged pipes. The coolers are located within the module envelope for protection against accidental damage. Typically, less than 10kW is dissipated per cooler. They are rated such that the machine can dissipate all absorbed energy in the event of grid loss, approximately 250kW each.

With the exception of the box cooler pipe work, no hydraulic components are in contact with the water. Each power conversion module unit has twin seals on all potential water ingress points to minimise risk of water penetration or hydraulic oil leakage. The rods of the hydraulic cylinders are situated behind a single rubber bellows seal. Normal leakage past rod seal on the hydraulic cylinder is very small, typically 1-2 drops per hour. In the event of failure of the bellows seal, oil loss would be small.

An impressed current antifouling system protects each box cooler from biological fouling. The sacrificial anodes disperse copper ions at a rate of approximately 30kg per year.

2.8 Anti-fouling.

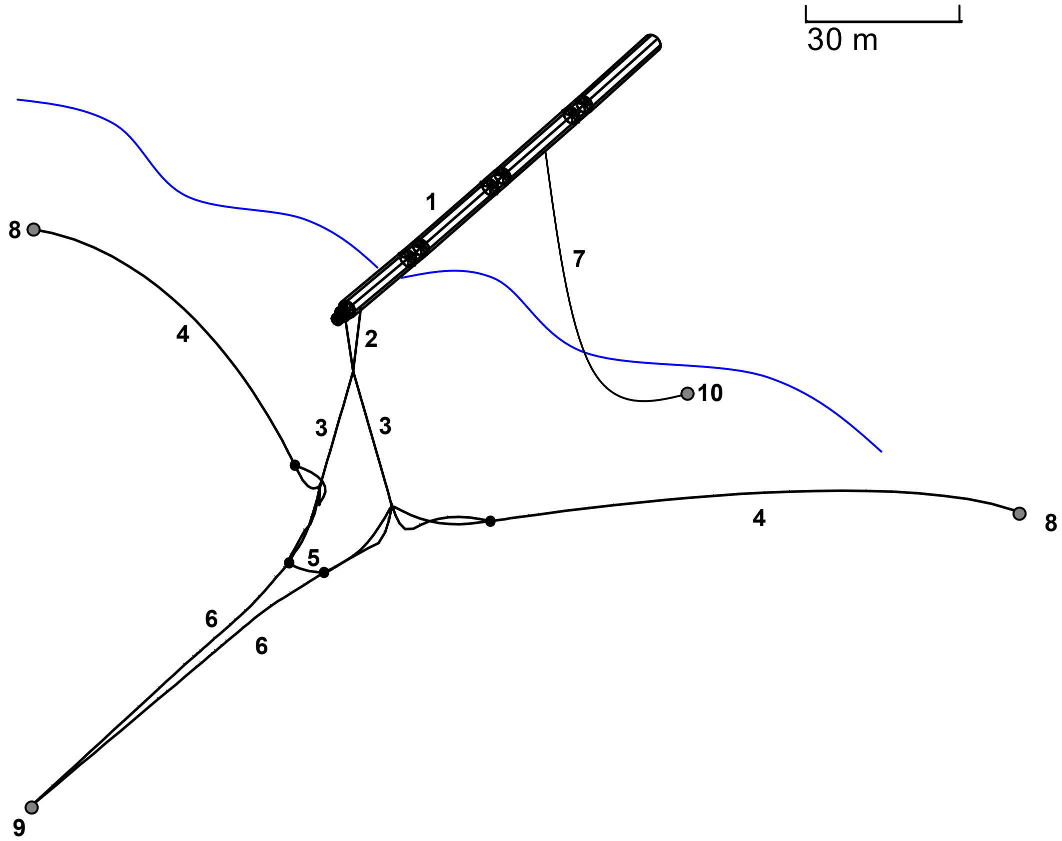
It is anticipated that Copper Coat anti-fouling might be applied in small quantities to local areas of concern. This antifouling system has been granted approval in the UK by the Health and Safety Executive under the Food and Environment Protection Act 1985 and Regulation 5 of the Control of Pesticides Regulations 1986. Key areas potentially requiring anti fouling will include:

- In and around the box cooler vents on the module (~12m^2 per machine).
- Around the main bearing components (~12m^2 per machine).

2.9 Mooring system.

The mooring system is an integral component of the Pelamis technology. The Pelamis is held on station by a compliant mooring system. The general arrangement drawing below details key components and dimensions.

The mooring yoke is a fabricated steel structure painted with an International Protective Coatings paint system identical to that applied to the structure. Orkot Marine bearings systems are used at sub-sea connections. The bearings are non toxic and emissions due to wear are negligible.



REF. NO.	DESCRIPTION
1	Pelamis WEC
2	Yoke – fabricated steel, overall length 15m
3	Tether Line – 96mm Polyester in grommet formation
4	Rear Lines – 3” studlink chain, 130m long
5	Front Connection Line – 3” chain, 8m long
6	Front Lines – 3” studlink chain, 140m long
7	Yaw Restraint Line – 65m of 3” chain with an additional, retractable 80m of 32mm dyneema
8	Rear Embedment Anchors – 4T
9	Front Embedment Anchor – 7.5T
10	20T clump weight Anchor

Mooring clump weight (steel). Embedment anchor (4T).

2.10 Machine ballast.

The four main tubes which make up a Pelamis unit will contain approximately 400 tonnes of washed building sand within the compartments between structural bulkheads to achieve the correct displacement. Additional ballast is not required for PCM's.

2.11 Machine marking.

Lighting- each Pelamis machine will have flashing lights mounted at the ends of the nose and tail sections for visual marking at night. These lights will be yellow flashing lights (flashing once every 5 seconds) and will have a nominal visibility range of 2 nautical miles. The lights are self contained, solar powered units.

Structural marking- as well as the Signal Red structural colouring, following consultation with the Northern Lighthouse Board, the Pelamis machines will have an additional yellow colour scheme similar to that seen in the following picture.

Above the calm water line; the yellow areas of the nose and tail sections account for 50% of the surface area and 25% of the surface area of the main tube sections in between.

2.12 Design verification and standards.

The design of the Pelamis machines and associated moorings to be deployed within the Project will be fully verified by Atkins or similar party (as with previous machines). The design will be verified against applicable and appropriate offshore codes and standards as listed in the table on the following page.

STRUCTURAL	
DNV-OS-C101	*Offshore Standard Design of Offshore Steel Structures.*
DNV-OS-B101	*Offshore Standard Metallic Materials.*
DNV-RP-C202	*Recommended Practice Shell Buckling.*
DNV-RP-C203	*Recommended Practice Fatigue Strength Analysis of Offshore Steel Structures.*
API-RP-2A-LRFD	*Recommended Practice Planning, Designing and Constructing Fixed Offshore Platforms.*
HSE OTH 92390	*New Guidance for Fatigue for Steel Joints and Connections in Offshore Structures.*
API-RP-2SK	*Recommended Practice for Design and Analysis of Station-keeping Systems for Floating Structures.*
DNV-RP-B401	*Recommended Practice Cathodic Protection Design.*
AISC	*Load and Resistance Factor Design (LRFD) Manual of Steel Construction.*
DNV-OS-C401	*Offshore Standard Fabrication and Testing of Offshore Structures.*
BS 3100:1991	*Steel Castings for general engineering purposes.*
MOORINGS	
DNV-OS-C101	*Offshore Standard Design of Offshore Steel Structures.*
DNV-RP-C203	*Recommended Practice Fatigue Strength Analysis of Offshore Steel Structures.*
HSE OTH 92390	*New Guidance for Fatigue for Steel Joints and Connections in Offshore Structures.*
AISC	*Load and Resistance Factor Design (LRFD) Manual of Steel Construction.*
DNV-OS-E301	*Offshore Standard Position Mooring.*
DNV-RP-B401	*Recommended Practice Cathodic Protection Design.*
API-RP-2SK	*Recommended Practice for Design and Analysis of Station-keeping Systems for Floating Structures.*
	DNV Rules for Planning and Execution of Marine Operations.
ELECTRICAL	
BS 7671:2001	*Requirements for Electrical Installations.*
IEE	*Recommendations for the Electrical and Electronic Equipment of Mobile and Fixed Offshore Installations.*

2.13 Material Itinerary.

The table on the following page gives a summary of the approximate material quantities within each current Pelamis machine and mooring spread. Final quantities might vary following machine optimisation and design consultation and given Project machines will have an additional PCM and main tube section.

MATERIAL	APPROXIMATE QUANTITY
(MACHINE)	
Steel (various grades & alloys)	450t
Ballast sand (washed)	400t
Copper (incl. wiring & generator windings)	<3t
Rubber (incl. seals)	<2t
Plastics (assorted components)	<1t
Batteries (200Ah lead batteries)	X10
Transformer fluid (Midel 7131)	<700lt
Hydraulic fluid (Biohyde SE-S)	<5000lt
External paint (EPIGRIP M922 & RESISTEX C173V2)	1400lt
Internal paint (EPIGRIP C400V2 & RESISTEX C173V2)	150lt
Anti-Fouling paint	Currently none
Bearing material (ORKOT TXM)	65kg
(MOORINGS)	
Mooring chain (steel)	50-60t
Anchors (x3) (steel)	15.5t
Clump weight	20t

3.0 OFFSITE ACTIVITIES, OPERATIONS AND DECOMMISSIONING:

3.1 Manufacture and Assembly.

OPD will manage the sub-contract for the main steel fabrication of the Pelamis machines, including: power module fabrication, main tube and end-cap fabrication, internal main tube details and yoke fabrication. Painting of the structure will be done at the fabrication site. Sub-contractors will be selected following a review of responses to invitations to tender, although fabrication is likely to be carried out within Scotland (as per prototype and previous commercial order) to reduce transport costs and time and for ease of management.

The procurement of systems components and subsequent population of the power conversion modules will be carried out by OPD at the company's production facilities (Methil, Fife). The wiring and component installation of main tubes (minimal) will be carried out by OPD at the main tube fabrication site.

Final assembly and machine commissioning will be carried out at a suitable location (consideration given to final assembled machine length, facilities and manoeuvring/towing of completed structures). Assembled and commissioned power conversion modules will be mechanically and electrically connected to the completed main tube sections and the yoke system will be attached and wired. There are a variety of methods for final assembly including; dry-dock, ship-lift, at quayside or a combination of these solutions.

3.2 Mooring installation and site preparation.

Since the four static, high voltage grid connection cables have already been laid on the sea bed for the four separate test berths at EMEC, and the sites four cardinal marker buoys are in place, site preparation and construction for the Project will only require the installation of the previously described mooring system and associated flexible electrical umbilical connections for the five machines.

OPD have previously installed a mooring spread and flexible electrical connection at the EMEC site at Billia Croo prior to the testing of the full-scale prototype system (moorings and connectors installed 2003). Through this process OPD carried out cone penetration and vibracore surveys of the installation site to enable accurate mooring component selection (see previous Section **3.9**). Over the past 2.5 years, OPD have carried out regular inspections of the existing mooring system using an ROV, some photo shots from these inspections are shown below, with mooring components settled, at a shallow depth, into the sedimentary cover at site.

Mooring installation is carried out with the use of anchor handling tug (AHT), these vessels have DGPS integrated dynamic positioning capabilities and therefore do not require mooring hardware themselves, but are kept on station by propulsion. All mooring components and electrical connectors are laid on top of the seabed, with only embedment anchors being set into the seabed when they are set to appropriately specified depths. Installation positions are designed and recorded with DGPS accuracy (accurate within <1m). In addition to the mooring spread; electrical connectors will also be installed during this stage of site preparation, this will involve the splicing and splitting of the existing static, seabed cables already installed by EMEC. The Project will use the existing cables for Berth 1 & 2- with 3 machines linked on each cable (this includes 5 machines within the Project and the ongoing testing of the full-scale prototype system). Flexible umbilical cables and machine connectors for the Project will be spliced to the static cables and buoyed off (yellow buoys) ready for machine installation. Mooring connections will also be terminated appropriately and buoyed off (yellow buoys) ready for machine installation.

AHT's are capable of working through day and night and, given suitable sea conditions, the process of mooring and electrical connector installation should take <2 days per spread. Installation activities would be programmed to take place during suitably long weather windows, however if sea states deteriorated beyond safe operating conditions during installation activities; equipment would be buoyed-off for marking, and later retrieval, before the installation vessel returned to sheltered moorings (likely Stromness of Lyness).



3.3 Machine tow and installation.

For control and manoeuvrability Pelamis machines are towed using a lead tug connected to the nose of the machine (providing the pulling force) and a trail tug attached to the tail of the machine (providing positioning control), towing speeds do not exceed 5knts. Large multicat vessels have sufficient capabilities to fulfil the lead tug position and standard, ocean going tugs will be sufficient for trail tug duties.

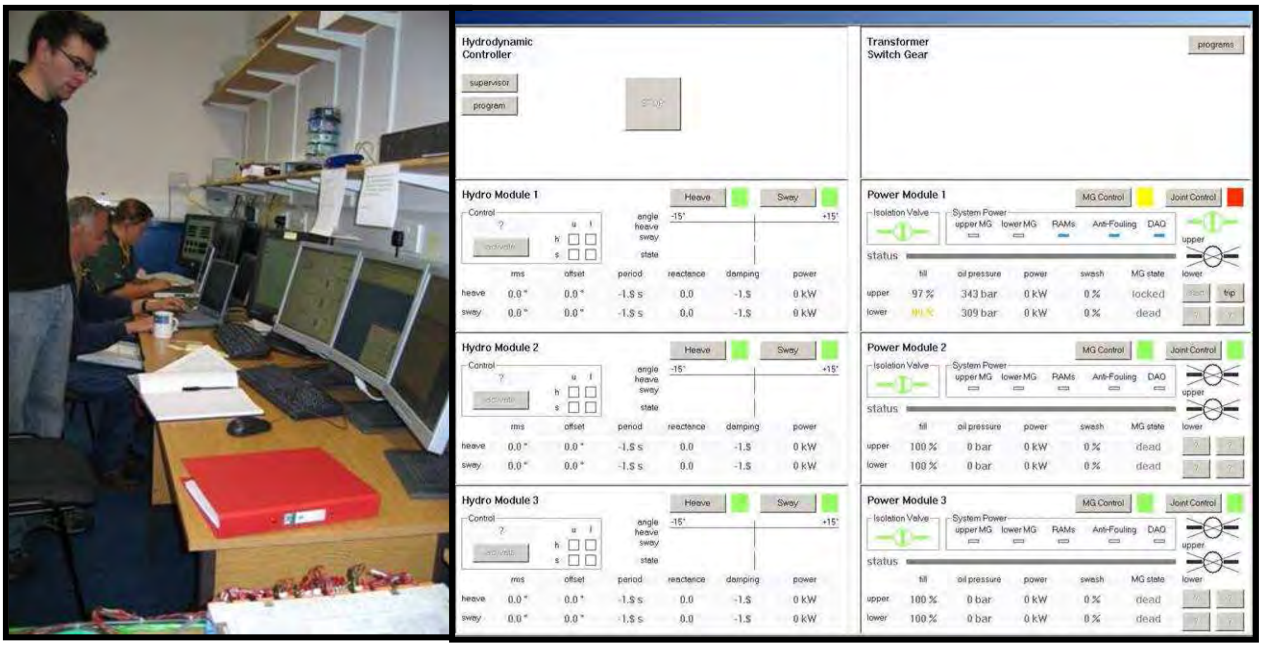


For installation; the mooring and electrical connections are made in one remote winching operation, and the rear yaw restraint line is connected before tugs are disconnected and the machine control is passed to the shoreward control centre. Tow boats are then returned to harbour. Due to the reduced number of connection activities, pre-installed moorings and electrical umbilicals and the pre-commissioning of machines; the installation procedure is rapid, with installation typically taking <4hrs to complete once tow spread is onsite. Similarly for disconnection; after both lead and trail tugs have been attached, the forward mechanical and electrical connections are remotely de-couple with one release mechanism and the yaw line is released (both connection ends are buoyed off for marking and retrieval). The machine is then ready for tow off site, the dis-connection process and tow preparation is due to take <4hrs to complete once tow vessels arrive on site. Both machine installation and recovery procedures will only take place in suitable weather conditions with appropriate weather windows, if weather and/or sea conditions deteriorate beyond safe working conditions during either operations and associated towing; the machine will be made safe to either leave onsite or be returned to safe/sheltered waters (Scapa Flow).

From experience gathered with the prototype system and also proximity to site, it is likely that Lyness harbour will be used as safe water and point for mobilising installation or recovery operations. Lyness is approximately 8 miles from the Project site, towing transit time will be ~1hr depending on weather conditions and tidal flow through the Hoy Mouth.

3.4 Project operation.

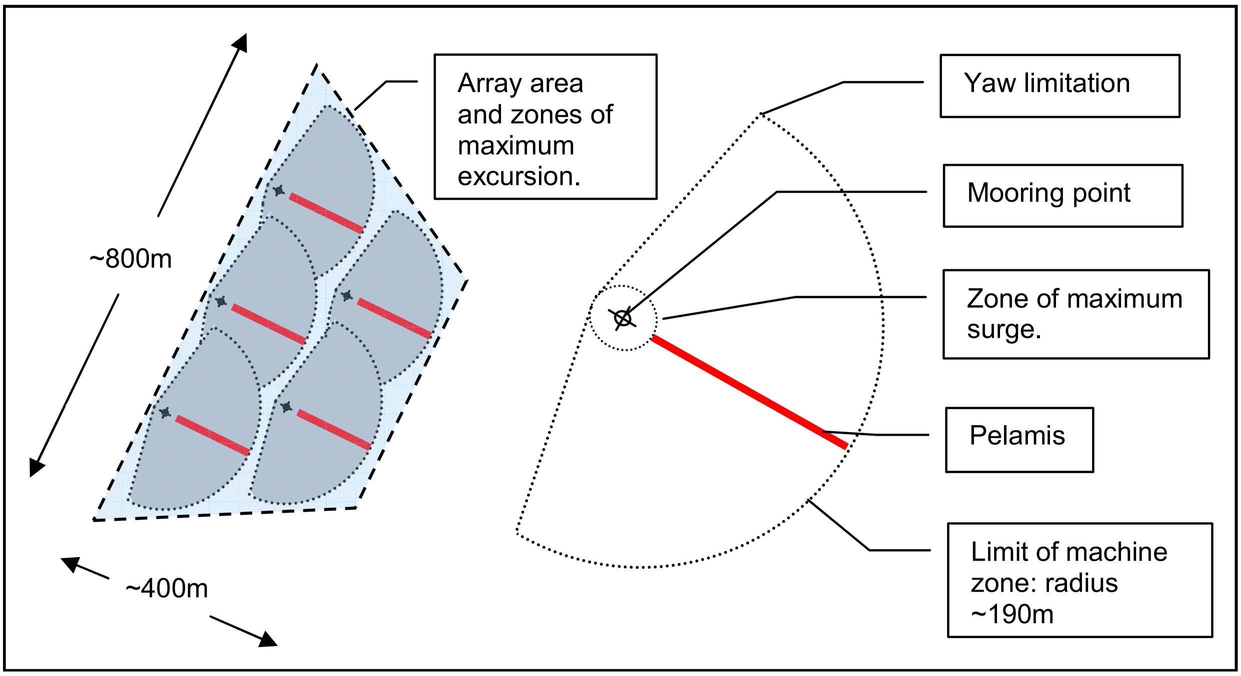
The Project will be monitored and operated from within OPD's existing operating facility in the EMEC office, based in the Old Academy, Stromness. This is carried out via a Graphical User Interface which allows operators to monitor all onboard systems and their conditions. The onboard control system running within Pelamis autonomously controls the functioning of the machine and its power take-off system, and will also respond to detected faults; this includes component isolation in the event of any specific component failure. Any faults detected within the machines will also result in an audible alarm in the operations room to notify operators of the fault and its level. Each Pelamis machine is fitted with a GPS tracker which will trigger an alarm in the control room if the machine in question moves beyond its set mooring limits, this monitoring system is separate to the main machine SCADA system and will continue to function properly in the event of control system failure due to fibre core failure in the main subsea cable.



3.5 Machine operation.

Onsite, with the compliant mooring system, the wave induced loading on the Pelamis machines will cause them to swing and face head-on into the mean incident wave direction (at Billia Croo this is approximately due West). As each machine is experiencing the same local conditions they will all be facing the same approximate direction at any one time. The diagram on the following page shows the zones of influence for the machines taking into account the maximum yaw (rotational) allowance for the mooring system and the maximum surge (forwards and backwards) motion which the mooring system allows.

As described in section **2.1**, as waves travel down the length of the machines they will induce bending movement between the hinged segments. The rotational motion around the hinges is reasonably slow given that typical wave periods are of the order of 8-10 seconds, with maximum hydraulic ram movement at the joints in the region of 10cm/s and typical stroke distances of <1m.



3.6 Project maintenance.

It is envisioned that additional to any reactive maintenance requirements, machines will be taken off-site annually for system checks and annual maintenance procedures. It is OPD maintenance philosophy that no maintenance or repair work is carried out on Pelamis machines whilst they are onsite; machines are removed to safe, sheltered facilities in order for work to be carried out. These works will mainly involve visual checks of internal and external components, and replacing or repairing components which have been identified as faulty or compromised.

From experience gathered with the prototype system, it is planned that project maintenance is based at the harbour facilities at Lyness on the island of Hoy. Lyness is within 1 hours towing time from the Billia Croo site and is also within the sheltered waters of Scapa Flo. Lyness is a former Royal Navy facility with large quay space and length. Lyness has a number of existing users including the main Orkney Ferry terminal for Hoy, a number of fish farm operators, the Lyness Maritime Museum and small charter boats with parties of scuba divers often tie-up at Lyness for divers to visit the museum and have lunch. Access to Lyness quay space for tow spreads, like that described for Pelamis, is excellent. With the prototype system OPD have had presence at Lyness for ~2 years, with OPD personnel being station on the island at rented accommodation nearly permanently for this length of time. Final details of OPD's presence and operations at Lyness have yet to be finalised with ongoing discussions with Orkney Harbour Authority and local Lyness stakeholders.

Machines will be taken on and off site as described in section **3.3** above, once at Lyness maintenance facility requirements are minimal; with 5T cranes capable of removing all system components. All old components and waste materials are disposed of appropriately.

3.6 Project decommissioning.

The overall timescale estimated for the recovery process of the 5 machine project are expected to comprise as follows:

- 1 week - machine removals to appropriate previously designated facility on Scottish mainland.
- 2 week - offshore operations to remove moorings & electrical interconnectors from site.
- 2 months - strip down & sale/scrap of machines.

Of this- the overall site decommissioning time is estimated to be 14 days, excluding any weather related delays.

Decommissioning of the site facilities (mooring components, electrical connectors and machine retrieval) will be carried out by offshore sub-contractors. The full decommissioning of Pelamis units will be carried out by sub-contractor/scrap contractor.

Project de-commissioning will consist of the following operations (independent consultants; Atkins, have previously verified all offshore operational procedures before they are implemented, and also review all offshore HAZID, HAZOP, and HERA activities for OPD offshore operations):

- Removal of the 5 Pelamis 750kW unit (as per standard maintenance routine described in section **3.3**).
- Tow of the 5 Pelamis 750kW to de-commissioning site (recover of re-usable components and scrapping).
- Recovery of dynamic electrical interconnections.
- Lay down of static seabed cable.
- Recovery of primary front moorings.
- Recovery of rear mooring sections.

Following completion of the above activities, the site will be left without any components associated with the 5 Pelamis systems.

Due to the fact that the limited mooring spread associated with the Pelamis consists simply of steel chains, mooring wire and embedment anchors, and all electrical interconnection is carried out mid-water, there is negligible disturbance of the sea bed during installation, operation or complete removal.

It is likely that certain mooring components will be able to be re-used and sold. It is expected that the recovered machines would be sold for scrap, however it may well be that the machines, or certain machine parts, are also able to be refurbished and reused in future projects.

4.0 BACKGROUND TO ENVIRONMENTAL REPORT:

4.1 Overview.

The wave test site at EMEC has already been granted the appropriate consents and licenses for their operation as a test facility for wave energy converters, this process required the completion of a full EIA and review of the environmental statement within the consenting process. Therefore many of the generic impact issues relating to devices installed and operated within the site have previously been assessed. The following section reviews some of the potential impacts arising from the Project which could have device specific attributes.

4.2 Consultation.

In preparation for the consultation with stakeholders, specifically those relevant to the application of the Coast Protection Act (1949) Section 34 consent, a Project Description document was produced and distributed in order to initiate discussion, comment and feedback with the following stakeholders:

- Scottish Natural Heritage.
- Maritime and Coastguard Agency.
- Northern Lighthouse Board.
- Crown Estate.
- Orkney Harbour Authority.
- Scottish Environment Protection Agency.
- RSPB.
- Fisheries Research Services.
- Local Fisheries.

A number of meetings with stakeholders followed the distribution of the Project Description document, comments and suggestions raised within these meetings are incorporated within the following sections.

5.0 ENVIRONMENTAL ASSESSMENT:

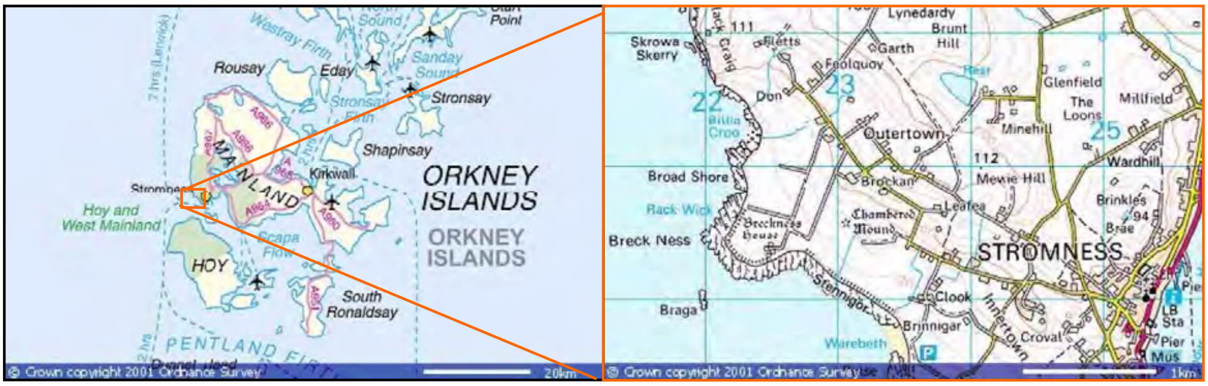
5.1 Seascape.

Baseline:

Most of the Orkney Islands are composed of sedimentary rocks of Devonian age (410-360 million years ago), predominantly Middle and Upper Old Red Sandstone. There are older metamorphic rocks and younger dykes in a few places. The nature of the rock and the glacial features help to determine the present day landscape of the coast.

The geomorphology of the coastline is determined by the energy of the wave system. The west coast of Orkney is regarded as one of the best examples of a high energy coastal environment in the UK. The seascape of this area is an integral part of the National Scenic Area (NSA) designation. The Billia Croo shoreline is composed of a boulder beach above a bedrock shore. The shore area is flanked to the north by the seacliffs of Black Craig and to the south by small cliffs and shelving bedrock.

The location of Billia Croo within the Orkney context is shown below.



View looking northwest with Black Craig in the background.

View looking southwest showing boulder shore and shelving bedrock.

View from the low shore shelving bedrock looking northwest.

Project interactions:

The installation site for the machines is <2 miles from the shoreline at Billia Croo and Pelamis machines are ballasted to lie ~50% submerged therefore there is only ~2m of structure visible above the waterline. The prototype machine was painted Signal Red, however the paint scheme for this Project's machines (outlined in section **2.11**) has changed after consultation with the Northern Lighthouse Authority. The photographs below show the level of visual impact which was seen with the prototype system during onsite deployment, the revised paint scheme is likely to be more visable.

The photographs above are taken from some degree of elevation above sea level (which is more representative for local residencies, which have a view west over Billia Croo, although residencies are set further back from the shoreline than these photographs have been taken from), vision of the machines will increase the higher the level of elevation. The photograph below shows the view out to site, with the prototype on station, from Black Craigs look-out point on top of the cliffs to the north of Billia Croo bay, which is one of the highest local vantage points.

As mentioned in section **3.5** the predominant swell direction at Billia Croo is approximately West, therefore this is the direction which the machines will be facing the majority of the time. The previous photographs were taken with the prototype system during a North-West swell, where the length of the structure is more visible from shoreline; under predominant conditions this would be reduced. As swell conditions become larger it will reduce visibility of machines as they become locally submerged under wave crests and shoreward wave crests obscure visibility.

Pelamis machines are also fitted with flashing yellow lights (one flash every 5 seconds) on the front and rear of the machines. These light come on at night time and are visible to 2 nautical miles, these may be just detectible to local residents at Billia Croo who live at the limit or beyond this range.

During the installation and decommissioning of the moorings and electrical connectors, and when machines are put on site, the installation vessels will be visible from shore. The photograph below shows the anchor handler vessel on site at Billia Croo (view from sea level).

Anchor handler vessels will be used during the installation of moorings, however as described in section **3.3** for machine installation and recovery; smaller multicat type vessels will be used. During installation and decommissioning it is likely operations will continue through the night and day given appropriate weather conditions as the class of vessel allows for this. During darkness the vessels will have deck lights operating to give crew visibility on the rear decks- these lights will be visible from shore.

Mitigation and monitoring:

In order to reduce vessel time on site during construction and decommissioning these operations are planned through the calmer summer months, which should give longer suitable weather windows allowing for operations to be completed as quickly as possible. In addition to this, during summer months daylight hours are at their longest which will require the use of deck lights for shorter periods of time.

5.2 Coastal habitats (littoral).

Baseline:

The shores along the western Orkney coastline comprise predominantly very wave exposed bedrock, with some areas of extremely large boulders (Murray *et al*, 1999). The littoral[2] zone of Billia Croo has been the subject of a number of littoral surveys (OIC, unpublished data; Murray *et al*, 1999). A more recent survey was undertaken in 2002, the results of which are summarised in the EMEC Environmental Statement (Carl Bro, 2002).

The littoral zone in the region of Billia Croo comprises a boulder beach, flanked to the south by a rocky promontory and to the north by steeply shelving bedrock leading to a cliff coastline. The coastal habitats of the Billia Croo site, starting at the top of the shore, are characterised by very exposed littoral rock with mussels (*Mytilus edulis*) and barnacles (*Balanus spp*). The algae *Fucus distichus* Subsp *anceps* and *Fucus spiralis* f *nana* can be found on the extremely exposed upper eulittoral rock, with *Corallina officinalis* on very exposed lower eulittoral rock. The alga *Alaria esculenta*, mussels and coralline crusts can be found on very exposed sublittoral fringe bedrock i.e. at the ELWS (extreme low water springs) mark. The algae species *Fucus distichus* Subsp *anceps* and *Fucus spiralis* f *nana* found during the littoral survey (Carl Bro, 2002) are rare species whose distribution is restricted to the far north and west coasts of Scotland (HIE, 2001; Carl Bro, 2002).

Project interactions:

The infrastructure (subsea cables) to support the Project has already been installed across the littoral section of coastline and there is no further construction or installation of equipment required in this area for the project.

During operation Pelamis machines will be extracting energy from the sea state (and turning it to electricity) which may result in less wave energy reaching the littoral zone. Taking into account factors such as, varying wave directions, number and performance of machines, overall available energy and the relative amounts extracted by machines: it is envisioned that the project will have a negligible effect in terms of downstream effects of energy extraction, especially given that coastal processes are driven by large storm conditions when the relative energy extraction of machines from the system is at the very minimum.

Mitigation and monitoring:

Coastal processes and sediment transfer are very hard processes to numerically model, however there are a number of studies (e.g. SuperGen) taking place currently examining the effects of energy extraction from wave energy converters on the overall coastal processes. Given that the energy extracted by the project will be very closely measured (as it is turned into electricity) through all sea conditions, and the sea

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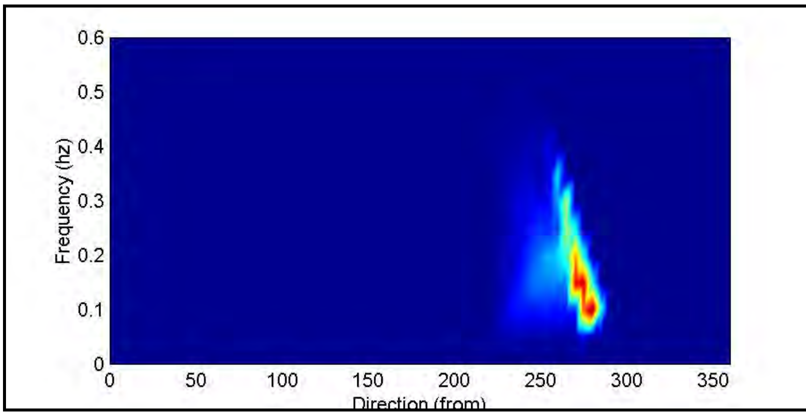
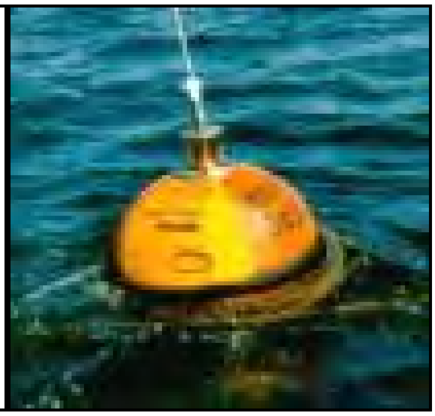
[2] *The word or suffix 'littoral' is used to describe a shore or seabed area. When 'littoral' is prefixed by another word e.g. circa-, sub-, infra-,etc, then this refers to the nature of the zone as defined by the habitat, community type and a number of physical factors e.g. water depth and light amongst others (JNCC, 2004).*

conditions themselves will be recorded the project will provide an excellent opportunity to increase the available input data for further process modelling. Project Parties are willing to cooperate with any EMEC monitoring in relation to effects on coastal ecology and processes.





5.3 Seabed habitats (sublittoral).

Baseline:

5.3.1 Surveys undertaken.

The subsea benthic sediments and communities have been investigated following 2 main studies. These are a cable route survey[3] (ICIT, 2002a) which covers an E-W transect distance of 350m and a sublittoral survey (ICIT, 2002b) which focuses on gathering baseline biological community data and assessing the nature of the seabed sediments at the test site location. Table below shows the locations of dive sites. Analysis of core samples taken from the sediment area has also been undertaken as part of an MPhil student project (unpublished data). These reports, including photographs and video stills of the area, are available from EMEC.

Locations of dive sites from sublittoral survey (ICIT, 2002b)

Dive site	Latitude	Longitude
W1	58º 58.068'	03º 22.148'
W2	58º 58.171'	03º 22.487'
W3	58º 58.190'	03º 22.952'
W4	58º 58.186'	03º 22.927'
W5	58º 58.462'	03º 22.838'
W6	58º 58.452'	03º 22.868'
W7	58º 58.524'	03º 22.171'

5.3.2 Seabed sediments.

Survey results (ICIT, 2002b) indicate that the infralittoral zone is dominated by exposed bedrock. There is a transition area at around 20-25m depth, where the circalittoral zone

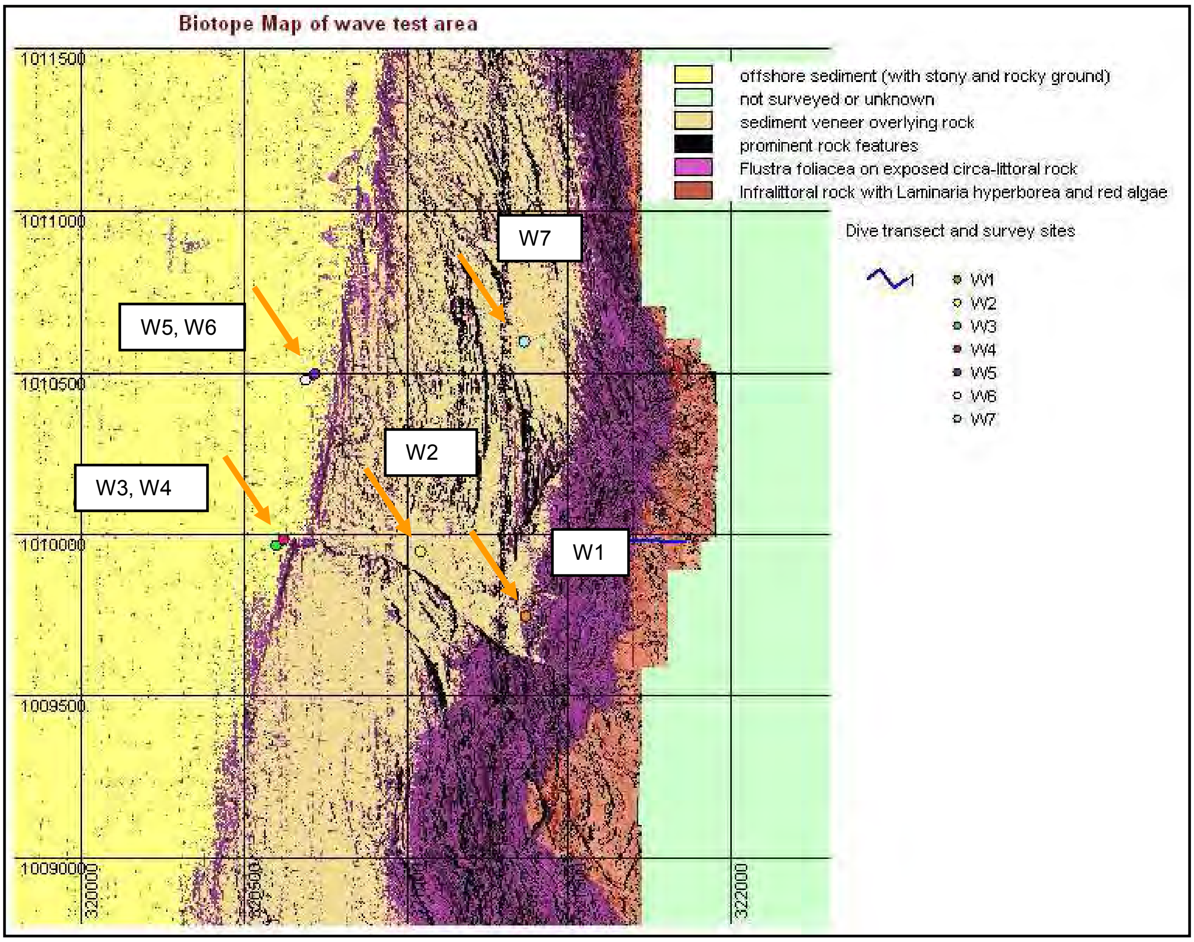
[3] *Position of transect – Seaward 58º 58.20' N 3º 21.64' W, Landward 58º 58.20' N 3º 21.33' W.*

begins and is characterised by exposed bedrock with an overlying sediment veneer[4] in many places. The transition between the infralittoral zone and the circalittoral zone is often not a distinct boundary.

The precise seaward edge of the exposed bedrock of the infra- and circalittoral zones is difficult to determine, although there appears to be a boundary at around 45-47m water depth, where the exposed bedrock is replaced by fine sand in the sublittoral zone. The fine sand is interspersed with boulders and stones. Bedrock outcrops also occur within this area (HIE, 2001; ICIT, 2002b).

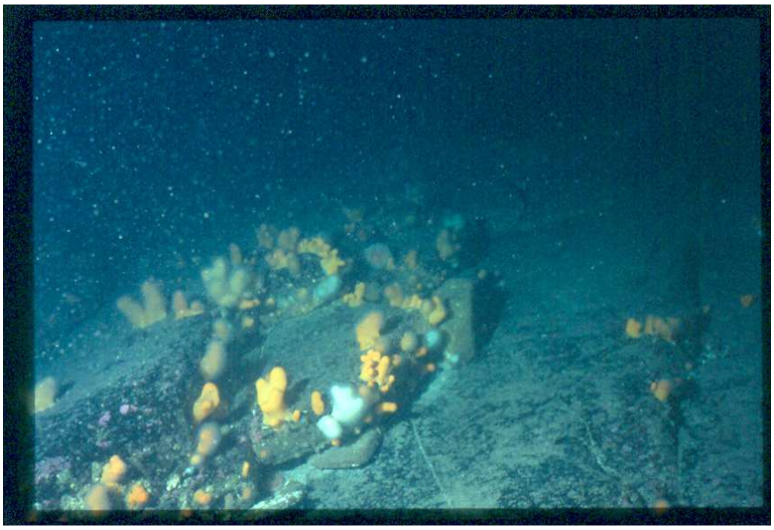
Subsurface sediments have also been investigated via penetration testing and core sampling. Generally, the investigation of the seabed stratigraphy characteristics indicates sandy deposits at the northern area of the site, with glacial till overlying suspected shallow bedrock encountered at the southern area of the site (RJ McLeod (contractors) Limited, 2002). Sediments in the sublittoral zone (≥45m water depth) have been shown to be medium to fine grained (unpublished data).

The sites sampled during the sublittoral survey (ICIT, 2002b) are shown below, followed by a selection of images illustrating the community type and seabed sediments at each dive site location.



[4] *The term veneer is used to distinguish the bedrock from any overlying material e.g. sand or large boulders.*

Site W1, with 'dead men's fingers' (*A. digitatum*) on bedrock.



Site W2, with small bryozoans on sand-scoured rock.

Site W3, large boulder on sand. Grazing on rock surfaces by urchins (*Echinus esculentus*).

Site W5, still image showing sandy seabed with stone/boulder patches.

Site W6, stone/boulder patch, showing urchin (*E. esculentus*) with an anemone, (*Urticina felina*), buried in sand to back right of image.

Site W7, showing dense brittlestar colony among loose stones.

Site W7, area of stones and coarse sediment. Brittlestars and urchins present as well as white calcareous tubes of keelworm (*Pomatocerus lamarki*) fixed to stone surfaces.

5.3.3 Seabed communities.

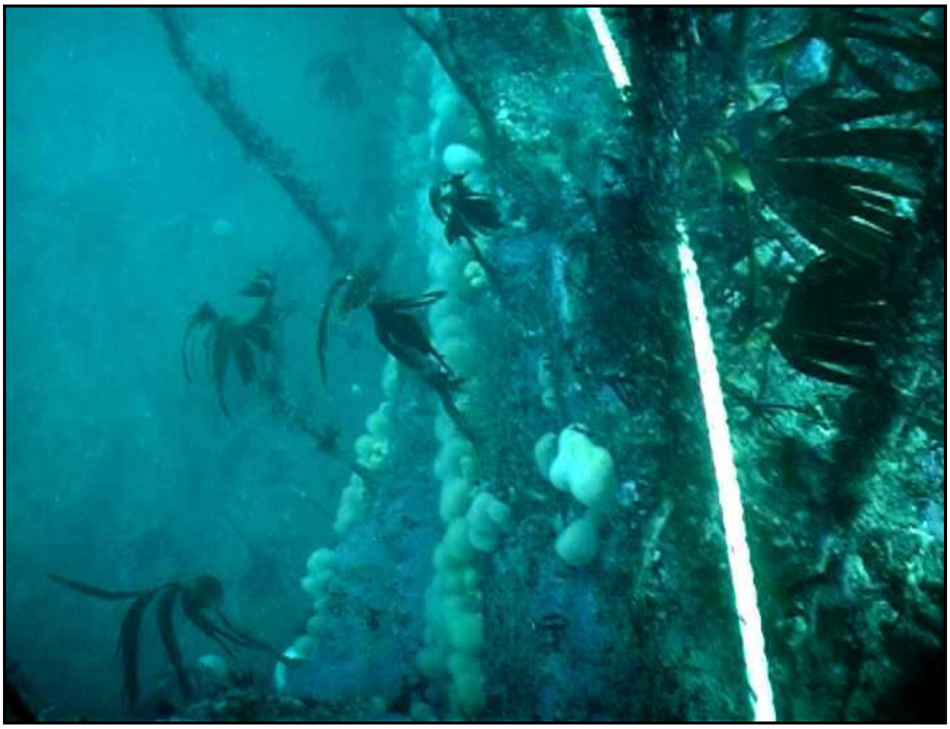
The types of benthic communities present in the Billia Croo area are largely dependent on a number of factors including sediment type, water depth and hydrographic regime. Surveys of the area have indicated that there appears to be a transition from bedrock to a broken boulder/stone seabed, to a sediment dominated seabed, as depth and distance from shore increase (ICIT, 2002a & b). Near-shore areas of the transect survey undertaken in 2002 indicate that dense kelp forests thinning to kelp park exist from the low water mark to a depth of approximately 20-25m (Murray et al, 1999; ICIT, 2002a). At the 20 to 25m mark kelp exist sparsely and are not observed at all at 32m. Fauna typical of hard substrata and exposure to water movement are common on the bedrock, boulder and stone seabed e.g. *Alcyonium digitatum*, *Echinus esculentus* and *Flustra foliacea*. Sites with broken boulder/stone substrata supported more diverse communities, with *F. foliacea* and brittlestar biotopes.

Surveys at the deeper dive sites, i.e., 48-50m depth, were found to lie close to the boundary between the predominantly boulder/stone seabed on the landward side and the sedimentary seabed on the seaward side. Although some hard substrata are available, e.g., scattered boulders, the area predominantly supports sedimentary biotopes and biotopes characteristic of sand scoured rock where hard substrata are available. This area was surveyed visually, (i.e., video and photography) and by taking core samples.

Analysis of core samples taken from the offshore sediment area indicates that the sediments are dominated primarily by polychaete worms followed by nematode worms, although in some samples polychaetes accounted for over 80% of sample species composition (unpublished data).

Examples of the communities present are shown in the following photographs taken during the cable route survey.

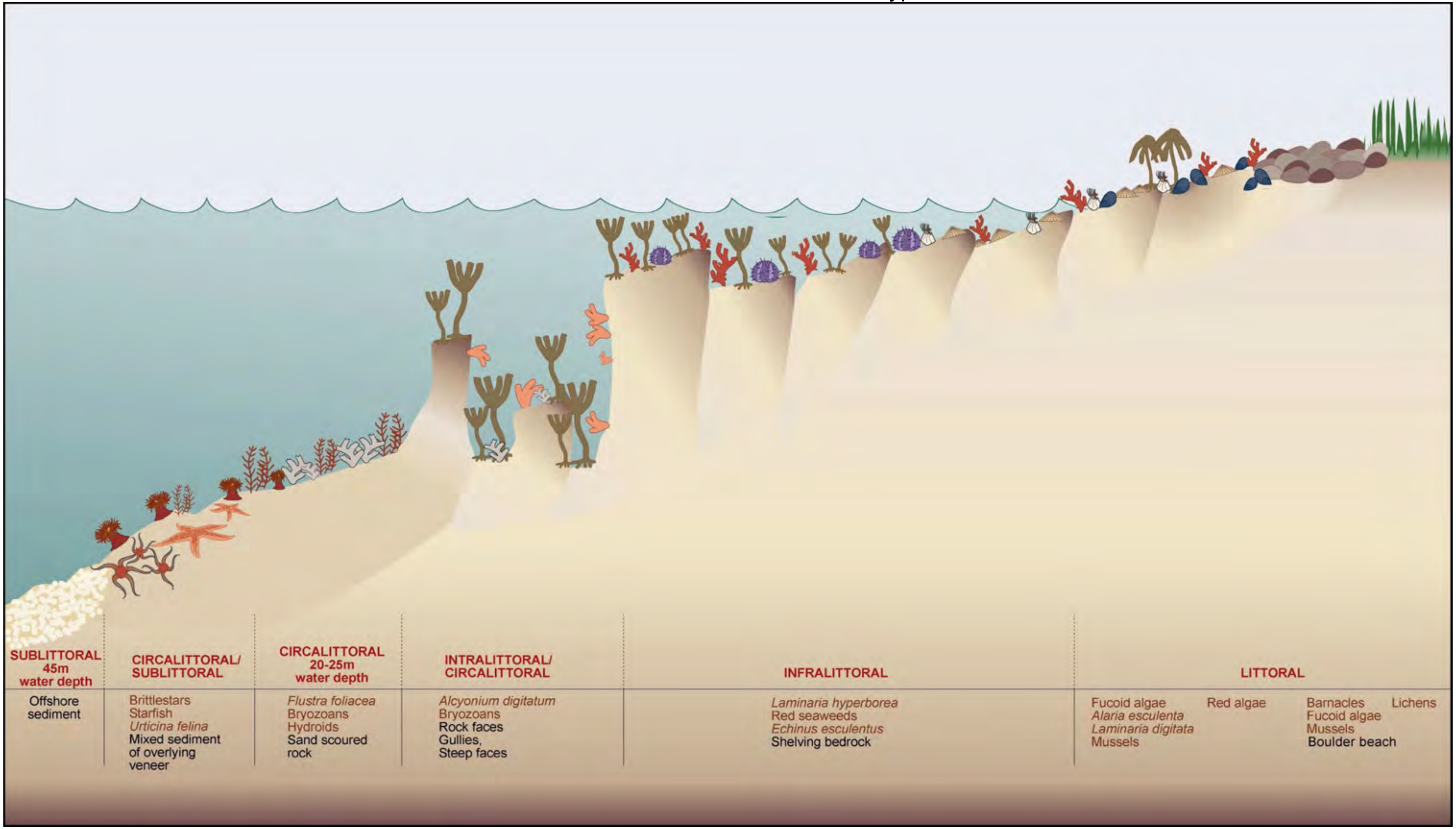
20m marker (seaward)



120m marker (landward)

280m marker (landward)

The littoral and sublittoral habitats and sediment types at Billia Croo[5]



[5] *This simple schematic diagram illustrates community succession at Billia Croo. In reality habitats are more complex than shown and the boundaries between zones less defined.*

Characterisation of the shore and seabed habitats and species at Billia Croo:

Shore/seabed area	Zone classification	Character of zone	Species present
Top of the shore – splash zone	Supralittoral	Bedrock promontory and boulder beach	Dominated by the lichen *Verrucaria maura*. Barnacles present.
	Upper littoral	Bedrock promontory and shelf	Rock pools present with dense coralline algal crusts, fucoids and kelp in deeper pools. Green algae in pools higher up the shore. *Enteromorpha* spp. on the upper shore.
Middle of shore	Mid littoral	Boulder beach and bedrock promontory	Dominated by barnacles and fucoid algae. *Fucus vesiculosus* and *Fucus serratus*. Mussels *(Mytilus edulis)* form a band mid way down the shore.
	Eulittoral	Exposed bedrock shelf	Dominated by mussels with barnacles and barnacles with limpets (*Patella* spp.) and *Fucus vesiculosus* f. *linearis*.
	Lower littoral	Boulder beach	Stands of dulse (*Palmaria palmata*) and other red seaweeds where *Osmundea* (*Laurencia*) and /or *Gelidium* always dominate.
Boundary between shore and low water	Littoral/infralittoral	Bedrock promontory and bedrock shelf	Dense *Himanthalia elongata* with fucoid algae *Fucus distichus*. Closer to infralittoral zone dominated by *Alaria esculenta* with *Laminaria digitata* on bedrock promontory. Mussels on the bedrock shelf.
Below low water	Infralittoral	Bedrock	Dominated by dense *Laminaria hyperborea* forest. Thins to kelp park with depth with sparse understorey of red seaweeds. Sparse fauna and algal crusts. *Echinus esculentus* with sparse dead mans fingers and some grazing tolerant fauna.
	Infralittoral/circalittoral	Rock faces, steep exposed rock features and gullies. High energy, tide and wave swept rock faces.	Dominated by dead mans fingers (*Alcyonium digitatum*) and the bryozoan *Securiflustra securifons*.
Begins 20–25m deep	Circalittoral	Scoured rock and rock surfaces	Dominated by the bryozoan *Flustra foliacea*. Other bryozoans and hydroids present.
	Circalittoral/sublittoral	Mixed sediments of the overlying veneer and at the boundary of sublittoral sediment.	Brittlestar beds characterised by *Ophiothrix fragilis* and *Ophiocomina nigra* but not limited to these. Associated with the starfish *Luidia ciliaris*. *Urticina felina* present.
From 45m	Sublittoral	Sand cover of the offshore zone.	Dominated primarily by infaunal polychaete species. Nematodes, amphipods, bivalves and echinoderms also present.

Project interactions:

As outlined in section **5.3**, the proposed project and associated moorings and equipment will be exclusively installed within the sublittoral zone at EMEC (at depths >50m) as the supporting infrastructure already exists. The mooring components and their installation (sections **2.9** and **3.2**) will require the laying of components on the sea beds sedimentary cover and the setting of embedment anchors into the sedimentary cover, this may cause some slight disturbance to local worm species during installation, however this is expected to be minimum given the small number of components that are installed below the surface of the cover and no excavation is carried out. Components are likely to be covered over slightly through time with the silt/sand top cover, as from experience with prototype mooring components. Although the Billia Croo area lies within 2km (North-West) of the Hoy Mouth, which experiences considerable tidal currents, experience with prototype components has not indicated any issues arising from scour.

Decommissioning of the mooring system will remove all systems components, with the retrieval of chains and cables having minor impact due to their position on top of the sea bed. When anchors are removed (anchors are only set to a depth of 1-2m) there is likely to be localised disturbance of sedimentary cover, although this will re-settle and return to its original condition in a matter of days.

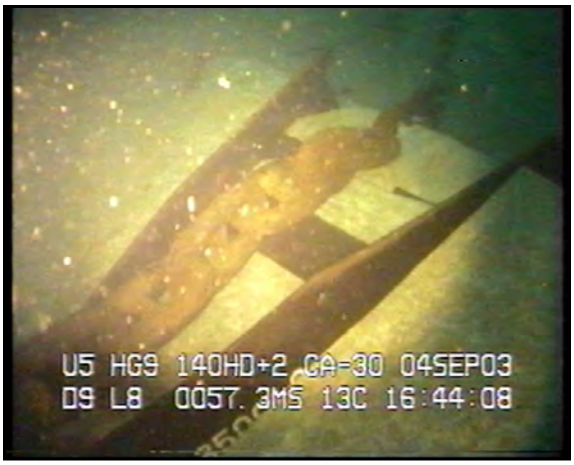
It may be that mooring components attract, or become the focus, for certain species (for example urchins), however due to the minimal surface area of components: numbers would be expected to be few.

Mitigation and monitoring:

OPD have already installed a Pelamis (prototype) mooring spread and electrical interconnector (although electrical interconnectors are held within the water column and not on the sea bed) in this area. The existing prototype equipment has been onsite for >2 years during which there have been a number of ROV scans of the equipment; with no detectable impacts on the local seabed ecology. Mooring systems installed for this project will also be subjected to ROV inspection (1-2 times annually); the results of such inspections will be studied for signs of interactions with the local ecology.

All waste material generated on project vessels during onsite operations will not be disposed of at site, but will be returned to harbour where it will be properly disposed of, this will include recycling of appropriate materials and suitable disposal for hazardous waste. Any lost items during operations will be recovered.

Pelamis machines currently have no anti-fouling paint and only small sacrificial copper anodes; therefore the structure is liable to experience some marine growth. This marine growth does not present performance issues for the machines and it is not planned for it to be removed at any point. If it were to be removed, care and advice would be sought to avoid removed marine growth being disposed of at quayside as this could potentially harm the sublittoral habitats in the shallower waters at Lyness.



5.4 Plankton.

Baseline:

Plankton in the region is characterised by mainly coastal (neritic) and mixed (intermediate) water and is largely influenced by the inflow of Atlantic water (Edwards and John, 1997). The plankton is of fundamental importance in that it is the basis of the entire marine ecosystem, forming a vital link in the food chain of larger organisms such as fish, seabirds and cetaceans (whales and dolphins). The region of Billia Croo is likely to contain a higher proportion of intermediate and northern/boreal species (Adams, 1987), and is fairly typical for north British coastal waters. The spring algal bloom in March–May brings mainly diatoms, followed by dinoflagellates during May–August. A second algal bloom follows during September, thereafter phytoplankton numbers decline to winter levels. The main zooplankton component appears to be copepods. These increase in numbers slightly after the algae blooms to take advantage of the increase in food resource. Other zooplanktoninclude ctenophores, hydromedusea, amphipods and species which have a planktonic life stage.

Project interactions:

The deployment of floating Pelamis machines at Billia Croo is not expected to cause any impact to the plankton found in the area.

5.5 Fish and shellfish.

Fish stock baseline data was gathered in consultation with national and local fisheries.

5.5.1 Finfish.

Baseline:

Fish fauna studies are poorly represented for this part of Orkney, however general statements can be made considering the exposed locality and bedrock conditions. Fish species likely to be found include saithe (*Pollachius virens*), pollack (*Pollachius pollachius*) and ling (*Molva molva*). Other gadoids appear seasonally and include cod (*Gadus morhua*), which is widely distributed around Orkney during the summer months. Peak spawning for cod occurs in February. Whiting (*Merlangius merlangus*) and haddock (*Melanogrammus aeglefinus*) tend to appear in larger but often variable shoals, during late summer and autumn. Both species are abundant and present throughout the Orkney area (HIE, 2001; Carl Bro, 2002).

Herring (*Clupea harengus*) and mackerel (*Scomber scombrus*) are also present during their migratory passage past Orkney. Herring spawn in areas to the west and north of Orkney during early summer. Mackerel are present in coastal waters during the summer and autumn months and spawning takes place in summer. Monkfish (*Lophius piscatorius*) spawn in deep water along the edge of the continental shelf, mainly during March and June. However, juveniles and non-spawning adults are present throughout Orkney waters. Conger eels (*Conger conger*) and gurnard (*Triglidae*) would also be expected to be present.

Orkney is located within spawning and nursery areas of a number of commercially important fish species including herring, lemon sole, sandeel and sprat spawning areas and saithe, lemon sole and sandeel nursery areas.

5.5.2 Shellfish.

Baseline:

The nature of the seabed in the vicinity of Billia Croo creates an ideal habitat for lobster (*Homarus gammarus*), brown crab (*Cancer pagurus*), velvet crab (*Necora puber*) and shrimp (*Nephrops norvegicus*).

Project interactions:

Fish and shellfish are known to congregate around objects rising from the seabed, whether they are rock reefs or man-made structures. It is likely that deployed Pelamis devices and the associated mooring array may attract certain fish shoals and through providing shelter from fishing activities the populations of indigenous fish species could increase. It is anticipated that this will have no adverse affect upon the fish themselves.

Mitigation and monitoring:

During ROV inspections of the mooring system behaviour and number of fish and shell fish species will be noted.

5.6 Birds and shore birds.

Baseline:

Much of the Orkney coastline is colonised by seabirds, and some sections of coastline have several contiguous colonies. Of the seabird colonies in Orkney, 23 hold numbers of seabirds at or above 1% of the total European population for that species (Tasker, 1997). However, the RSPB have confirmed that there are no populations of nationally or internationally important species in the region of Billia Croo.

Cliff top habitats at Billia Croo provide nesting areas for many species of bird. The site is locally important for birds, such as a pair of Peregrine falcon which regularly nest on the sea cliffs, and nearby colonies of Guillemot and Kittiwake at Row Head. The site is also home to breeding numbers of Arctic skua, Great skua and a small colony of Arctic tern (OIC, unpublished data). Birds that have breeding colonies elsewhere in Orkney may be present in small numbers, for example Cormorant, Shag and Puffin.

Waders likely to be found in the shallow areas of the shore include relatively large numbers of Oystercatcher, Redshank and Curlew, and smaller numbers of Turnstone, Ringed plover and Purple sandpiper. Sightings of various gull and waterfowl would also be expected in the area (Tay and Orkney Ringing Groups, 1984).

The times of year during which the highest population numbers are expected varies depending on the species. For Orkney the highest numbers of seabirds (i.e., Guillemots, Kittiwake, Arctic skua, Great skua and Arctic tern), occur between April and September. For the aforementioned seabirds Orkney or parts of Orkney represent a main breeding area (Tasker *et al.*, 1987; Thom, 1986). For the waders and wildfowl, i.e., Oystercatcher, Redshank, Curlew, Turnstone, Ringed plover, the highest population numbers in Orkney are expected (based on 2000-01 figures) between August and February, and during November; for the Purple sandpiper, between February and April. Oystercatcher, Redshank, Curlew and Ringed plover are considered widespread in Orkney, and for the Turnstone and Purple sandpiper Orkney is a main wintering area (Pollitt *et al.*, 2003; Thom, 1986).

Seabird vulnerability to oil pollution in the vicinity of Billia Croo is predicted to be moderate between October and March and high between April and September (EMEC OSCP, 2004).

Project interactions:

As outlined in the previous section, the local zone within the project area at EMEC, which is excluded to fishing activities, may see fish numbers increase; which in turn may provide better feeding for local diving birds. In addition to this the tubes of the machines could act as resting rafts for local and transient bird groups (see photograph below of gulls landing on the prototype during sea trials). Birds standing on or floating close to the structures are at minimal risk to the movement of the machine structure as rotational movements between sections are relatively slow and over short distances (outlined in section **3.5**). It is envisioned that as wave conditions become higher (>2m) and the machine starts to submerge below wave crests; birds are unlikely to stand on the sections.

Given the assessment above and taking that machines do not pose great structural objects to flying birds and only very local obstructions to diving birds, the presence of machines installed at EMEC is unlikely to cause significant impacts to the local bird population's behaviour.

Mitigation and monitoring:

Project Parties are willing to cooperate with EMEC monitoring on bird activities and behaviour.

Vessel activity onsite will also be kept to a minimum to minimise potential disturbance to birds in the area through both presence and associated operating noise.

5.7 Marine mammals.

Baseline:

Harbour porpoise are known to regularly feed in the area between April and September. There are also regular sightings of Minke whale and Risso's dolphin and occasional sightings of white beaked dolphin. Records further offshore indicate that white sided dolphin, killer whale and pilot whale use the area for passage. There are no known resident populations of cetaceans in the area (C. Booth *pers. comm.*)

Seals are observed in the area, with the nearest known haul-out being recorded at Warebeth beach where sightings of up to 50 individuals have been recorded.

Project interactions:

Cetaceans and seals travelling through the project will have to navigate around the floating machine structures on the surface and the associated mooring and electrical connection cables in the water column. The floating structures are similar in dimensions to other marine craft with the advantage that they are stationary, and with underwater visibility in the area being good it is unlikely the structures will present navigational problems to marine mammals. Both the mooring and electrical cables are standard offshore oil and gas equipment which are also unlikely to present significant navigational problems, and both the bend radius and tension of the cables are such that entanglement for marine mammals is exceptionally unlikely.

Since the cylindrical sections of the Pelamis machines are wide rolled, smooth, painted steel; both the slope of the surface and its finish will make the machines very hard, if not impossible, for seals to haul out on (there has been no experience of this with the prototype system). For instances when marine mammals are close to tube sections, as discussed earlier; the structure itself poses a minimal risk since the movement between sections is relatively slow and over short distances (outlined in section **3.5**).

Mitigation and monitoring:

Project Parties are willing to cooperate with EMEC monitoring on marine mammals activities and behaviour.

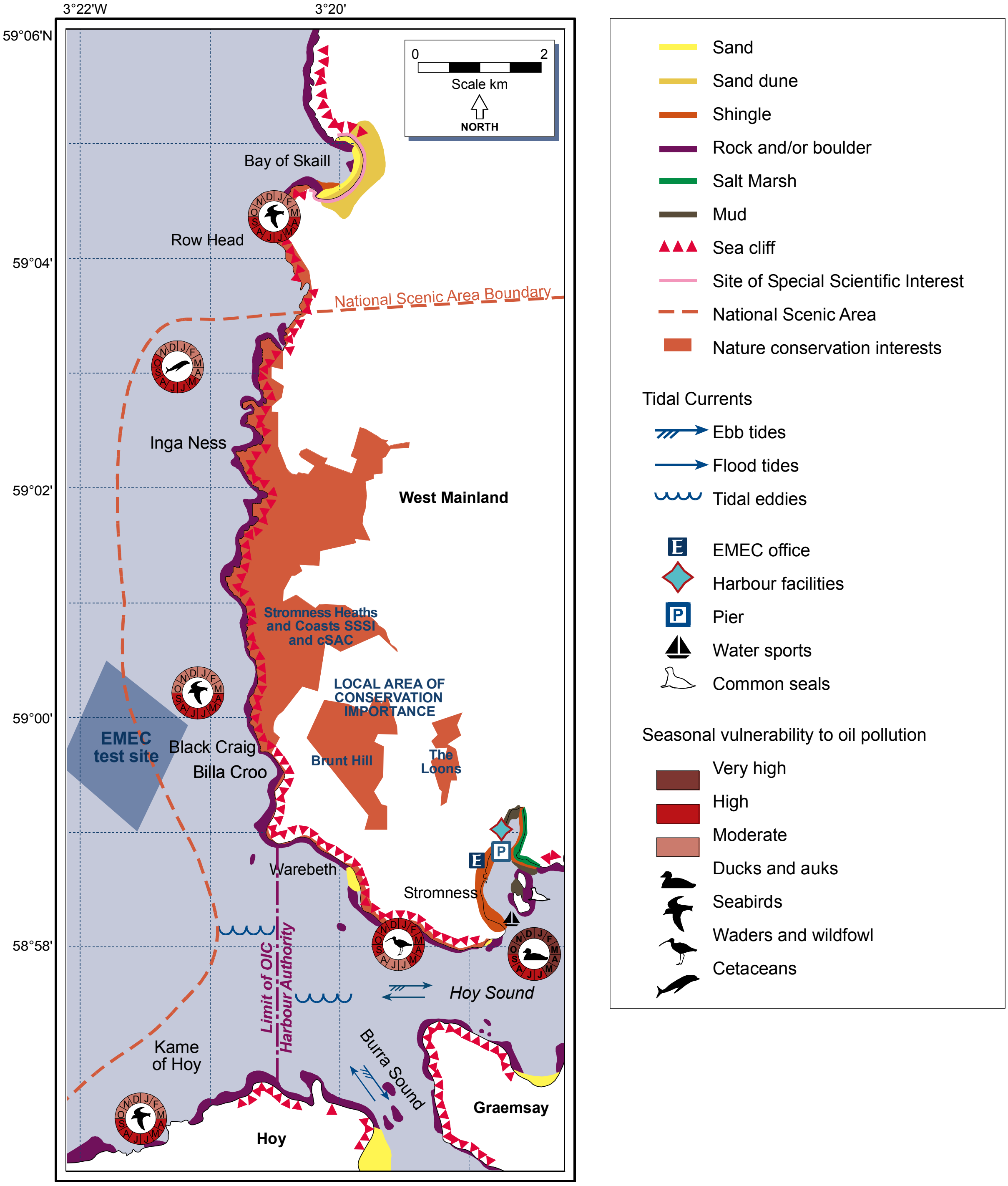
5.8 Conservation.

Baseline:

The area in the vicinity of Billia Croo has a number of conservation designations, noted for their local, national and international importance. National Scenic Areas (NSAs) are Scotland's only national landscape designation, being designated by Scottish Natural Heritage (SNH) as the best of Scotland's landscapes, deserving special protection in the nation's interest. They are designated under Section 262c of the Town and Country Planning Act (Scotland) 1972. Sites of Special Scientific Interest (SSSIs) are notified under the Wildlife and Countryside Act 1981. They are intended to form a national network of areas representing in total the parts of Britain in which the natural features, especially those of greatest value to wildlife and earth science conservation, are most highly concentrated or of highest quality (Plaza & Keddie, 1997).

The designation of Special Areas of Conservation (SAC) is one of the main mechanisms by which the EC Habitats and Species Directive (1992) is implemented. Natura 2000 is the title for the network of areas designated to conserve natural habitats and species of wildlife which are rare, endangered or vulnerable in the European Community. A site cannot be designated an SAC without first being designated a SSSI.

A number of sites have also been identified as being of local importance to wildlife or exhibiting features of local natural heritage interest. These sites of local importance, in addition to the sites of national and international importance, are representative of important Orkney nature conservation areas and also represent the diversity of habitats and nature interests in Orkney. Environment and conservation areas of Billia Croo and surrounds are shown on the following page.


3°22'W
3°20'
59°06'N
59°04'
59°02'
59°00'
58°58'
0
2
Scale km
NORTH
Bay of Skaill
Row Head
National Scenic Area Boundary
Inga Ness
West Mainland
Stromness Heaths and Coasts SSSI and cSAC
LOCAL AREA OF CONSERVATION IMPORTANCE
EMEC test site
Black Craig
Billa Croo
Brunt Hill
The Loons
Warebeth
Stromness
Hoy Sound
Limit of OIC Harbour Authority
Burra Sound
Kame of Hoy
Graemsay
Hoy
Sand
Sand dune
Shingle
Rock and/or boulder
Salt Marsh
Mud
Sea cliff
Site of Special Scientific Interest
National Scenic Area
Nature conservation interests
Tidal Currents
Ebb tides
Flood tides
Tidal eddies
EMEC office
Harbour facilities
Pier
Water sports
Common seals
Seasonal vulnerability to oil pollution
Very high
High
Moderate
Ducks and auks
Seabirds
Waders and wildfowl
Cetaceans

Conservation areas around Billia Croo:

Name of site	Designation	Features of interest
Hoy and West Mainland	National Scenic Area (NSA)	The designation of NSA does not consider any one aspect of an area singly from all other aspects. Rather, it is the enjoyment of the scenery as a whole, which determines how important a site is. With this in mind, the designation of the Hoy and West Mainland NSA recognises the quality of the natural beauty and amenity of the area, in that the area should be safeguarded and enhanced as part of Scotland's natural heritage. It is also recognised that provisions should be made for the socio-economic development of an area without compromising the scenic value of the area.
Stromness Heaths and Coast	SSSI/cSAC	Transition of coastal vegetation from typical maritime communities to a heathland community. Several colonies of the nationally scarce Scottish primrose *Primula scotica,* breeding birds, small numbers of Arctic and Great Skuas and a small Artic tern colony. A pair of peregrine, guillemots and kittiwakes. Cliff-top communities strongly influenced by the sea and associated plant species. Landward transition from more maritime plant communities into areas of wind-pruned acidic heath. Geology and geomorphology of sandstone and flagstone cliffs and other rock coast features including cliffs, caves, arches, geos, stacks, shore platforms and cliff-top scouring. Important site for the study of Lower Old Red Sandstone environments and Middle Old Red Sandstone lake sediments.
Brunt Hill, Stromness	Local ornithological site	A block of heavily grazed heather with small patches of *Juncus* spp., and primrose in damper areas. Breeding birds in the area include Teal, Oystercatcher, Lapwing, Curlew, Common gull, Skylark, Meadow pipit and Wheatear. Also Arctic skuas nest in some years. Other fauna in the area include the Brown hare.
South Stromness Coast	Local geological site	The low coast to the south of Stromness provides one of the most accessible sections through crystalline basement and the overlying Stromness flags. The rocks are seen in cliffs, generally less than 5m in height, and in a wide wave-cut platform, which is readily accessible at low tide. Between Breckness and Ness the Lower Stromness Flags and the Sandwick Fish Bed are repeated by faulting and are well exposed in the extensive rock platform which fringes the low cliffs. The rocks are a complex of schists, gneisses and granites and throughout their crystalline nature and distinctive colour are easily distinguished. The overlying conglomerate consists of sub-rounded pebbles of gneiss and granite in a fine sandy matrix. Basal conglomerates, algal coatings and sedimentary structures associated with sedimentation of flags are well displayed. The site is also of interest for the occurrence of lead mineralization in the lower Stromness Flags.
The Loons, Stromness	Local ornithological site	A large patch of wetland habitat containing rough grassland and in the wetter areas Iris, *Juncus* spp., Meadowsweet, Cotton grass and some Willow scrub can be found. The site has been subjected to drainage in recent years. Breeding birds in the area include Mallard, Teal, Shoveler, Moorhen, Pheasant, Oystercatcher, Lapwing, Snipe, Curlew, Redshank, Common gull, Black headed gull, Skylark, Pied wagtail, Meadow pipit, Wheatear, Linnet and Reed bunting. Hunting birds of prey also use the area. Other fauna in the area include the Brown hare.

Project interactions:

Many potential interactions of the project with the various environmental and conservation areas are discussed in other sections within this chapter, although it is appropriate to mention that waste from offshore activities can have a negative effect on local water quality and result in waste being washed ashore at Billia Croo or else where.

Monitoring and mitigation:

Handling of wastes during marine operations is mostly related to deck wastes from installing and maintaining moorings. The most important factor being that these materials are brought ashore for appropriate disposal. The handling of bilges and sewage from any vessels should follow established maritime regulations. No materials will be disposed of overboard.

5.9 Other sea users.

A criterion within the site selection process for Pelamis deployments is to avoid areas that have high importance and high usage to other sea users (shipping lanes, recreational use etc). This is the same criteria for the selection of Billia Croo for the installation of the EMEC facility also; therefore the proposed site has been the subject of successful consultation with regards to navigational issues with groups such as local and national fisheries representatives.

Baseline:

5.9.1 Fisheries.

The sea area adjacent to Billia Croo is mainly used by trawlers passing through on the way to their preferred fishing grounds (Alan Coghill *pers. comm.*). The preferred fishing grounds tend to be further north and west of the test area, although in bad weather there may be trawling close inshore. Fishing along the west coast of the Orkney mainland takes place in water depths of approximately 58m (Carl Bro, 2002).

The area along the west coast of Hoy and Mainland Orkney experiences a seasonal closure on the use of mobile fishing gear. The fishing closure is made under the Inshore Fishing (Prohibition of Fishing and Fishing Methods) (Scotland) Order 1989. The ban runs between May and September (inclusive) and is designed to protect recognised fish nursery areas.

Inshore fishing takes place around the wave device test area targeting lobster, edible crab, green crab and velvet crabs. These species are fished in water depths of approximately 33-38m, all year round depending on the weather.

5.9.2 Other vessel traffic.

The area off Billia Croo is not an important location for recreational angling compared with other areas to the west of Orkney. The area is used for passage of Orkney Islands Sea Angling Association vessels on the way north to Marwick Head (approximately 13km north of Billia Croo). The area is not a major location for recreational diving, although Orkney Dive Boat Operators Association vessels use the area for passage to diving sites in the north. Sailing vessels are known to pass through the area on passage to and from Stromness marina.

In addition, it should be noted that Scapa Flow experiences vessel traffic movements since the area is important for recreational diving, sailing, fishing and oil terminal traffic.

5.9.3 Miscellaneous.

The wave test site is located within a charted area to be avoided (ATBA), i.e., an area to be avoided by vessels >5,000 grt with oil or other hazardous cargoes in bulk.

Other than the cables associated with the wave test facility, there are no pipelines or other cables charted within the Billia Croo area (Hydrography of the Navy, 1993).

There are no piers or sea access structures at Billia Croo.

Project interactions:

When the Pelamis device is being towed to and from the site, or when it is in a stand-by area (likely within Scapa), there is potential for interactions with small and large vessels using or passing through the same area.

The offshore site lies within the prohibited fishing area in place May to September and therefore fishing vessels are not permitted to be fishing the area. However; throughout the year marine traffic will have to navigate around the EMEC site, this will be an issue mainly for traffic leaving Scapa Flo through the Hoy Mouth and turning north; up the west coast of the main island.

A machine separated from its mooring system would pose a substantial threat to vessels in the area.

Mitigation and monitoring:

Careful selection of sites, routes and timing of activities and good communication with other sea users will avoid any difficulties.

A safe passage zone between the EMEC test site and the Orkney mainland exists to allow the passage of vessels heading north from the Hoy Mouth.

On site the project completely lies within the EMEC test area marked by cardinal markers (IALA standard) with flashing lights and radar reflectors and machines are individually marked as described previously (see Section **2.11**). Navigational interaction of the project will be monitored.

As outlined in section **2.12**, the mooring system and Pelamis are designed to rigorous codes and standards to both survive and keep station during 100 year extreme conditions at Billia Croo. The design verification process reviews many varieties of combinations, and their consequences, of structural and mooring failures to establish appropriate designs that will perform to the survival and station keeping requirements. In addition to completing design verification OPD will carry out the development of emergency response procedures effective for the project machines with EMEC. All machines are fitted with separate GPS systems which alarm when machines are detected outside their excursion zones.

5.10 Offsite activities.

Project interactions:

With the testing of the prototype system OPD have had experience with project operators working at the operational office at EMEC in Stromness and have a permanent rented residency in Stromness for staff. The proposed project would be operated in a similar manner (as described in section **3.4**) using existing facilities. Outside working hours staff will utilise local facilities and amenities, experience so far has indicated that staff presence on the island has had a positive effect on the local community and businesses.

For maintenance activity and temporary berthing of machines at Lyness (see section **3.6**) there will be a requirement for project staff at Lyness. Again, OPD have experience with this having had a permanent presence on the island (housed at rented accommodation close to Lyness) for >1 year with the prototype machine. As with Stromness; staff will utilise local facilities and amenities and join in with local community activities (for example badminton, plays, film screenings and dances/music concerts), experience so far has indicated that staff presence on the island has had a positive effect on the local community and businesses.

Mitigation and monitoring:

Notification to harbour authorities and other concerned stakeholders (including Lyness harbour master, fish farmers, dive boats) should be given in advance to project operations involving the recovery of machines from site, installation of machines/departure from Lyness and the moving of machines or vessels for maintenance activities.

It could be appropriate and beneficial to find mechanisms for communicating effectively with the local community and informing them of the benefits- locally, nationally and globally- that can arise out of offshore Pelamis installations, and give information of the position of the installations and any planned activity. This could be done at Stromness and Lyness through information boards, local liaison groups or distributed information leaflets (via Post Office, local shops, ferry terminals etc). Where appropriate community involvement in the project should be sought to increase local community benefits from the project.

5.11 Noise emissions.

Project interactions:

With particular reference to marine mammals (but also potentially of relevance to birds and fish): there has been progressively greater interest in the effects of underwater noise over recent years as more has become known about the distribution and abundance of sea mammal populations and the scope of sound producing activities has widened and entered into new areas. In relation to the deployment and operation of the Pelamis devices the following points are noted:

- The vessels used for towing the Pelamis machines will be the source of the greatest energy levels.
- The operation of the Pelamis is a relatively slow process, with any sound energy being relatively low at any particular time.
- The more energetic processes associated with the machine, for example the spinning (1500rpm) of motors and generators, produce noises with levels up to approximately 70-80dB (@1m in air), however due to the air surrounding these components within the module, the coupling to the water is poor.
- The device(s) will be located in one position for much of the time allowing sea life to acclimatise to its presence.

Mitigation and monitoring:

A noise review has been carried out by OPD prior to the prototype device installation, this was in addition to, and in reference to, noise monitoring within the full-scale test rig facility. Prior to the installation of the 5 machine Project it is anticipated that during onsite operation of the Prototype system at EMEC underwater acoustic data will be gathered in cooperation with the development of acoustic monitoring methodology as being formulated by the Sea Mammal Research Unit (SMRU) in conjunction with recommendations following the recent Scottish Executive's Strategic Environmental Assessment of marine renewable technologies. Project Parties are willing to cooperate with this monitoring to assess effects of multiple machines.

5.12 Key environmental sensitivities summary.

The table on the following page outlines some of the key environmental sensitivities identified for the project installation site in the Billia Croo area.

J	F	M	A	M	J	J	A	S	O	N	D
Coastal and seabed habitats (littoral and sublittoral)											
Two species of algae identified during the coastal survey, which are considered to be at the southern limit of their distribution; *Fucus distichus* Subsp *anceps* and *Fucus spiralis* f *nana.* Overall there is no information to indicate any particular seasonal sensitivity.											
Plankton											
A spring phytoplankton bloom of diatoms and dinoflagellates occurs between March and May. The main components of the zooplankton are copepods, which form an important link in the food chain.											
Fish and shellfish											
The Billia Croo site (and Orkney as a whole) is located within spawning and nursery areas of a number of commercially important fish species. Sensitivity represents spawning times of these fish.											
Birds											
Billia Croo is a nesting site for a number of birds. There are no internationally or nationally important species or aggregations within the Billia Croo area. Although birds are present throughout the year, the spring and summer breeding months can be considered to be the most sensitive as this is the time when greatest concentrations of birds will be present and may be particularly vulnerable to any pollution (e.g. oil).											
Marine mammals											
Most frequent visitor is the Harbour porpoise. Also regular and occasional sightings of other cetaceans. Nearest harbour seal haul-out is at Warebeth.											
Conservation interest											
The area around Billia Croo has a number of conservation designations including NSA, cSAC, SSSI and local sites of importance. The nationally scarce Scottish primrose can be found at one locality and Harbour porpoise can be spotted in the area (see above).											
Fisheries and shipping											
The Billia Croo area is predominantly used for vessel passage throughout the year, although fishing takes place close by and inshore during bad weather.											
Low sensitivity				**Moderate sensitivity**				**High sensitivity**			

Appendix

The **Potential Impacts** matrix below outlines the possible interactions that could take place with minimal mitigation and management, reflecting **a worst case scenario**.

	Wildlife	*Habitats*	*Energy*	*Sea users*	*Local community*	*Landscape*	*Wider community*	*Wastes*
Tow-out of harbour	-	-	-	-	-	-	-	*Exhausts & bilges, paint drips, debris in dock*
Tow at sea	*noise*	-	-	*Obstacle to shipping*	-	-	-	*Exhausts & bilges*
Testing at sea	*noise*	-	-	*Obstacle to shipping*	-	-	-	*Exhausts & bilges*
Temporary docking	*noise*	*Disturbance to seabed*	-	*Obstacle to dive boats*	*Harbour dues Servicing work*	*Use of pier*	-	*Seepage water*
Near-site preparations	*Noise & antifouling*	-	-		*Local servicing needs*	*level of activity on pier*	-	*Exhausts & bilges*
Sheltered water standby	*Noise*	*Disturbance to seabed*	-	*Interference with creeling*	-	*Boat will attract attention*	-	*Exhausts & bilges*
Exposed water standby	*Noise*	-	-	*Interference with creeling*	-	*Boat will attract attention*	-	*Exhausts & bilges*
Mooring device	-	*Disturbance to seabed*	-	*Debris*	-	-	-	*Waste cable*
Electrical hook-up	*Attraction for fish*	-	-	-	-	-	-	-
Location marking	-	-	-	*Assistance to navigation*	-	*Will enhance visibility*	-	*Waste cable*
Operation of device	*Noise attraction for fish*	-	*Absorption of wave energy*	*Obstacle to shipping& fishing*	*Point of interest, adds to renewables credibility*	*Visibility*	*Validation of important technology*	-
Performance monitoring	-	-	-	-	*Confidence in future for investment and jobs*	-	*Validation of important technology*	-
Environmental monitoring	*Sampling losses*	-	-	-	*Local benefits*	*Demonstration of visibility*	*Validation of important technology*	-
Routine recovery	*Noise*	-	-	*Obstacle to shipping*	*Service opportunity*	*Passing operation*	-	*Exhausts & bilges*
Unplanned recovery	*Noise*	-	-	*Obstacle to shipping*	*Service opportunity*	*Passing operation*		*Exhausts & bilges*
Docking and/or landing	-	*Disturbance to seabed/coast*	-	*Obstacle to shipping*	*Service opportunity*	*Passing operation*	-	*Seepage water*
Maintenance	-	-	-	*May fill berth*	*Service opportunity, noise, odour, reduced access to pier*	*Temporary operation on pier*	-	*Removal of fouling, paints, hydraulic oil, scrap metal*
Re-launching	-	-	-	*Obstacle to shipping*	*Service opportunity*	*Passing operation*	-	-
Mooring maintenance	-	*Seabed disturbance*	-	-	*Service opportunity*	*Passing operation*	-	*Waste cable*
Final recovery	*Noise*	-	-	*Obstacle to shipping*	*Service opportunity*	*Passing operation*	-	*Exhausts & bilges*
Mooring recovery	*Turbidity*	*Seabed disturbance*	-	*Removal of obstacle*	*Service opportunity*	*Passing operation*	-	*Waste cables*
Decommissioning	-	-	-	-	*Service opportunity*	-	*Museum piece*	*Scrap metal, sand, hydraulic oil etc*
Disposal of wastes	*Litter or debris*	*Litter or debris*	--	*Debris*	*Service opportunity, litter*	*Avoid litter*	*Off Orkney disposal ?*	*Reuse, recycle, reduce then licensed disposal*
Delivery of supplies	-	-	-	-	*Service opportunity*	-	*Service opportunity*	*Packaging*
Supply of services	-	-	-	-	*Service opportunity*	-	*Service opportunity*	-
Facilities for visitors	-	*Vegetation damage*	-	*Boat trips*	*Service opportunity, increased visitors to unusual areas*	*Suitability of interpretation*	-	*Litter*
Communication	-	-	-	-	*Service opportunity Need info*	-	*Need info*	*Recycled paper*
Management	-	-	-	-	*Service opportunity*	-	-	*Office efficiency*
Security	-	-	-	*Easy access to site*	*Eyes and ears*	-	-	-

Key	***Negative***			***None***	***Positive***		
	Major	Moderate	Minor		Minor	Moderate	Major
	(red)	(orange)	(yellow)	**-**	(light green)	(green)	(dark green)

The **Residual Impacts** matrix below outlines the possible interactions that could take place with planned mitigation and management successfully applied, reflecting a expected **best case scenario**.

	Wildlife	Habitats	Energy	Sea users	Local community	Landscape	Wider community	Wastes
Tow-out of harbour	-	-	-	-	-	-	-	Exhausts & bilges, paint drips, debris in dock
Tow at sea	-	-	-	- None	-	-	-	Exhausts & bilges
Testing at sea	- insignificant noise	-	-	- None	-	-	-	Exhausts & bilges
Temporary docking	- insignificant noise	- None	-	Obstacle to dive boats	Harbour dues Servicing work	- Not noticed	-	Seepage water
Near-site preparations	- insignificant noise	-	-		Local servicing needs	- Not noticed	-	Exhausts & bilges
Sheltered water standby	- insignificant noise	- None	-	- None	-	- Not noticed	-	Exhausts & bilges
Exposed water standby	- insignificant noise	-	-	- None	-	- Not noticed	-	Exhausts & bilges
Mooring device	-	Disturbance to seabed	-	- None	-	-	-	- Safe disposal
Electrical hook-up	Attraction for fish	-	-	-	-	-	-	-
Location marking	-	-	-	Assistance to navigation	-	Will enhance visibility	-	- Safe disposal
Operation of device	insignificant noise attraction for fish	-	- Determined to be insignificant	Obstacle to shipping& fishing	Point of interest, adds to renewables credibility	Point of interest	Validation of important technology	-
Performance monitoring	-	-	-	-	Confidence in future for investment and jobs	-	Validation of important technology	-
Environmental monitoring	- No harm	-	-	-	Local benefits	Demonstration of visibility	Validation of important technology	-
Routine recovery	- insignificant noise	-	-	- None	Service opportunity	- Not noticed	-	Exhausts & bilges
Unplanned recovery	- insignificant noise	-	-	- None	Service opportunity	- Not noticed		Exhausts & bilges
Docking and/or landing	-	Disturbance to seabed/coast	-	Obstacle to dive boats	Service opportunity	- Not noticed	-	- Safe disposal
Maintenance	-	-	-	Obstacle to dive boats	Service opportunity, noise, odour, reduced access to pier	- Not noticed	-	Safe disposal
Re-launching	-	-	-	- None	Service opportunity	- Not noticed	-	-
Mooring maintenance	-	- None	-	-	Service opportunity	- Not noticed	-	- Safe disposal
Final recovery	- insignificant noise	-	-	- None	Service opportunity	- Not noticed	-	Exhausts & bilges
Mooring recovery	Turbidity	Seabed disturbance	-	Removal of obstacle	Service opportunity	- Not noticed	-	Safe disposal
Decommissioning	-	-		-	Service opportunity	-	Museum piece	- Safe disposal
Disposal of wastes	- None created	- None created	--	- None	Service opportunity, litter	- None	- Safely undertaken	Safe disposal
Delivery of supplies	-	-	-	-	Service opportunity	-	Service opportunity	- Safe disposal
Supply of services	-	-	-	-	Service opportunity	-	Service opportunity	-
Facilities for visitors	-	Visitor facilities on roadside and in town	-	Boat trips	Service opportunity, increased visitors to unusual areas	Suitability of interpretation	-	- None
Communication	-	-	-	-	Service opportunity Need info	-	Need info	Recycled paper
Management	-	-	-	-	Service opportunity	-	-	Best practice
Security	-	-	-	Easy access to site	Eyes and ears	-	-	-

Key	Negative			None	Positive		
	Major	Moderate	Minor		Minor	Moderate	Major
	(red)	(orange)	(yellow)	-	(light green)	(green)	(dark green)

Commitment table:

Issue	Commitment or Action	Responsibility	Target completion date	Completion date	Notes
Hydraulic fluid.	*Use biodegradable fluid.*	*OPD*		*02/2004*	*Fluid used: BP Biohyde SE-S*
Hydraulic fluid leak.	*Two levels of sealing at ingress points.*	*OPD*		*02/2004*	
Antifouling paint.	*Not used.*	*OPD*		*02/2004*	
Mooring components, local sediment, fish and shell fish presence inspections.	*ROV scan of area.*	*OPD/SP*	*08/2007*		*ROV inspection of mooring equipment will be ongoing (1-2 times annually).*
Paint scheme.	*Colour scheme to be finalised.*	*NLB/OPD*	*08/2006*		
Energy attenuation.	*Monitor level of energy extraction from sea states.*	*OPD/SP/EMEC*			*Ongoing study.*
Bird behaviour.	*Coordinate with EMEC.*	*SP*			*Ongoing after project installation.*
Machine under water noise.	*Coordinate with EMEC/SMRU to assess cumulative effects..*	*SP*			*Ongoing after project installation.*
Project waste.	*Establish waste disposal management process.*	*OPD*	*06/2007*		
Maintenance operations.	*Further consultation with Orkney Harbours and local communities.*	*OPD*	*09/2007*		*Preliminary discussions have taken place.*
Radar signature.	*Establish further details of Pelamis radar signature. Coordinate with EMEC & MCA.*	*OPD*			*Ongoing; initial radar signature complete (submitted to MCA).*
Decommissioning.	*Submit plan to EMEC.*	*OPD/SP*		*05/2006*	
Structural and station keeping integrity.	*Independent design verification and project insurance.*	*OPD/SP*	*05/2007*		*Process underway- continuation of prototype verification.*
Marine mammal behaviour.	*Coordinate with EMEC.*	*SP*			*Ongoing after project installation.*
Community information.	*Information leaflet to be distributed to service providers.*	*SP*	*03/2007*		*Ongoing after installation when required.*
Communication process with Harbours Authority and sea users for notification of operations.	*Establish notification guidelines.*	*OPD/OIC*	*04/2007*		*Notification of operations to stakeholders throughout project life.*

B-5. English Translation, *Declaración de Impacto Ambiental* (DIA) for Cultivation of Macroalgae in a Suspended Mariculture System (Sept. 2010)

ENVIRONMENTAL IMPACT STATEMENT "MODIFICATION OF A TECHNICAL PROJECT: CULTIVATION OF *Macrocystis pyrifera* IN A SUSPENDED SYSTEM"

Application No.: 210103056
Center code: 103653

Action Proponent:
Pesquera San José SA

PREPARED BY
PLANCTON ANDINO LTDA.

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2010

Page

Environmental Impact Statement

"MODIFICATION OF AN TECHNICAL PROJECT:
CULTIVATION OF *Macrocystis pyrifera* IN A SUSPENDED SYSTEM"

GENERAL BACKGROUND

1.1 . Action Proponent's Background

Name of Action Proponent	Pesquera San José SA
Tax ID:	96535470-0
Phone:	02-3712711
Fax:	
Address:	Avenida El Bosque Norte N º 440, Piso 10, Las Condes, Santiago.
Legal Representative:	Domingo Jiménez Olmo
Tax ID:	5547596-2
Phone:	02-3712711
Fax:	
Address:	Avenida El Bosque Norte N º 440, Piso 10, Las Condes, Santiago.
Legal Representative E-mail:	domingoj@coloso.cl

1.2. Background of the consulting firm.

Name:	Plancton Andino Ltda
Tax ID:	77137290-2
Legal Representative:	Alejandro Clément Diaz Marine Biologist, M. Sc Oceanography. Oregon State University. alexcle@telsur.cl Fono: +65-235046 Cel:9-847 2643
Responsible Professional:	Jorge Mardones Sanchez. Marine Biologist Universidad Austral de Chile pal@telsur.cl Fono: 65-235046

1.3. Project Background

Name	MODIFICATION OF AN TECHNICAL PROJECT: CULTIVATION OF *Macrocystis pyrifera* IN A SUSPENDED SYSTEM
Location	Southwest Punta Tanecuhe, Quinchao Island, Quinchao Island
Community	Curaco de Velez
Region	De los Lagos

The project corresponds to a modification in cultivation and cultivation units to the Original Technical Project (Appendix1: 400,173,908), which has favorable environmental qualification resolution RCA # 239/2009. The concession was originally classified as Category 3, the aquaculture facility is now actually classified as Category 3 considering that the modules are located in areas shallower than 60 meters deep, are located in soft bottom areas, and have authorized production greater than 1,000 tons.

Then, on June 17, 2010 a Technical Project application was submitted to National Fisheries Service (Sernapesca) De los Lagos Region to modify the production and cultivation species of the Southwest Punta Tanecuhe, Quinchao Island facility; Sernapesca assigned a PERT No. 210103056

See Appendix 1:

- Original Technical Project No. 400173908
- Amended Technical Project No. 210103056, Submitted on 06/17/2010.

Subsequently, with DAC letter No. 1398 dated 8/17/2010 the action proponent was invited to enter the Environmental Impact Evaluation System within a period not exceeding 6 months.

This Environmental Impact Statement is made according to a new Technical Project as indicated below:

Table 1: Comparison of production between Technical Project authorized for Resolution SUBPESCA 1062 of 10.03.2010 (Pert No. 209 103 104) and current application for Production Increase of Technical Project (Pert No. 210103056).

Technical Project	209103104	210 103 056
Area	requested: 40,55 Ha	Autorizada: 40,55 Ha
Location	Southwest Punta Tanecuhe, Quinchao Island	Southwest Punta Tanecuhe, Quinchao Island

Coordinates Without Modification (Source Letter SHOA No. 7370)

Vertices	Latitud S	Longitud W
A	42 28' 54.36"	73° 35’ 46.60’’
B	42° 28’ 39.87”	73° 35’ 32.57’’
C	C42º 28’ 52.26’’	73° 35’ 01.74’’
D	D 42º 29’ 04.69’’	73º 35’ 14.34’’

Species or Species Group	Name	Scientific Name	Cultivation Stage	Name	Scientific Name	Cultivation Stage		
	Mussels	Mitilidos DS 604	Weight Gaining	Mussels	Mitilidos DS 604	Weight Gaining		
	Abalone	Haliotis rufescens	Growth	Abalone	Haliotis rufescens	Growth		
	Huiro	Macrocystis pyrifera	Excessive Growth	Huiro	Macrocystis pyrifera	Excessive Growth		
Technical Structure and Dimension	Mussels: Double -Lines 150 meters in Length Abalone: Single Lines of 150 meters in length Macrocystis: Lines of 100 meters in length, each separated by 2 meters			Mussels: 7 double-lines of 300 meters in length. Abalone: 1 line of 300 meters in length. Macrocystis: 784 lines of 100 meters in length				
Max Project Production	Year	Mussels (kilos)	Max Production (kilos)					
	1	56,000	350,000					
	2	136,000	850,000					
	3	216,000	1,350,000					
	4	376,000	3,000,000					
	5	600,000	3,000,000					
						Average Fish (kg)	Max Production Per Year	Project max production
	Year	Red Abalone (kilos)	Max Production (kilos)		Mussels	0.015	74,724	1,550,000
	1	80	3,750		Red Abalone	0.15	402	402
	2	80	3,750		Macrocystis	11	5,174,400	9,702,000
	3	80	3,750					
	4	80	3,750					
	5	80	3,750					
	Year	Macrocystis (kilos)	Max Production (kilos)					
	1	150	240,000					
	2	150	240,000					
	3	150	240,000					
	4	150	240,000					
	5	150	240,000					

In regards to the current production status of the project, the following are the main aspects concerning the environmental conditions of the concession taken from Appendix 2 (Comparison of preliminary site characterization and environmental information)

- A clear pattern of stability on the composition and abundance of macrofauna was observed.
- There was no observation of alteration of pH or oxidation reduction potential, showing that the activities in the aquaculture have not contributed to generating a negative impact on the oxidation of organic matter in the sediment.
- There is no evidence of differences with respect to the composition of the sediment and the granulometric percentage of organic matter of the concession area, considering the environmental information produced to date.

Considering the current limits of acceptability specified in RES. (SUBPESCA) No. 3612, for evaluating the aquaculture facility in terms of aerobic condition, the content of organic matter (OM), particle size and benthic macrofauna, full compliance is found with these limits through information presented in preliminary site characterization and environmental information filed in 2008, highlighting that no significant changes have been detected to the environmental status of the concession attributable to farming activities.

Therefore, the author is requesting approval of modification to the technical project in a timely manner.

1.4. Project Justification

Contrary to what could be estimated until recently, the sea can be an inexhaustible source of energy as a liquid fuel oil substitute called "Marine biodiesel, or biodiesel from algae."

Currently, the production of biodiesel from marine algae is already a reality. In fact, there is a growing number of countries with extensive algal cultures dedicated to obtaining this precious "green gold" on an industrial scale.

The potential for mass cultivation of brown algae in Chile, as well as consumption of atmospheric CO2 (rather than production of) could be an important link in the start of integrated cultivation in the fjords areas and channels of southern Chile, considering their physiological condition for efficient absorption of metabolic waste products from aquaculture fish facilities

This modification to the technical project, aims at a diversification production opportunity based on technological possibilities to generate biofuel from brown algae cultivation.

Below are the ecological characteristics of marine macroalgae, focusing mainly on the positive and negative aspects of their farming in the open sea. In addition a review is conducted of some examples of these types of facilities located in other countries that support the viability of this technical project:

Use and environmental requirements of marine algae

Marine algae are autotrophic organisms and thus the availability of light and CO_2 are central to their photosynthetic metabolism. Additionally, these organisms require inorganic nutrients (nitrate, ammonium, phosphate, etc.) as well as a range of minerals and vitamins. All these elements naturally present in seawater are captured by algae and transported of the cell interior. As a product of the process of photosynthesis and respiration, algae produce oxygen and organic matter that are integrated into the chain of decomposers. These metabolic processes are modulated by various environmental factors such as temperature, salinity and pH.

The cultivation of algae does not require external energy sources, which explains the minor environmental effects and, additionally, because of the inorganic nutrients that are removed from the water; the algae have a lower impact on the environment. If the number of publications available on environmental impact for the three relevant types of farms in Chile is considered as an indication of impact, it can be noticed that that algae cultivation has received far less attention. In addition, the next section of this document demonstrate that the majority (> 80%) of the scientific publications concerning algal environmental reference positive environmental externalities.

Environmental externalities of algae farming

Depending on their morphology and type of development and reproductive cycle, marine algae are grown on seabeds or on suspended systems (Santelices, 1999). In regions where seabed cultivation of the alge *Eucheuma Kappaphycus* is conducted, these organisms can change sediments impacting on sea grass beds and other species associated with plants (including some commercial importance; Eklöf et al., 2005, 2006). In Chile, the alga

Gracilaria can be grown in back-end systems thanks to its capacity to be restrained in soft seabeds. When buried in the substrate, the algae changes the sedimentation rates, modifying the substrate and the infauna. Additionally *Gracilaria* interacts with invertebrates and other algae which produce different environmental changes, but overall there are no irreversible environmental effects form its cultivation (Buschmann et al., 2001a). A study of large-scale cultivation of *Kappaphycus* in soft substrates in the Philippines showed a reduction in diversity meiofauna (Olafsson et al., 1995). However, other experiments suggest that these effects are not directly caused by the cultivation of algae but rather by the increase of consumer pressure from an increase in the abundance of fish due to the presence of algae.

Despite the success of seabed farming for the species mentioned above, the most cultivated species are grown in floating systems in order to maximize the availability of light for plants (Santelices 1999). The algae *Porphyra* in Japan, Korea, and China are produce on nets on the surface of the sea. Furthermore, brown algae such as *Laminaria* and *Undaria* are grown in floating lines. The intensity and scale of the brown algae farming was high reaching only in China in 2007 at 5,415,885 tons (FAO statistics). Nevertheless, the information collected in the literature shows no adverse environmental effects and indicates that in general, their effects are mainly associated with the consumption of nitrogen and thereby reducing problems related to eutrophication processes (Feng et al. 2004). Several studies have been indicating an increase in eutrophication processes and degradation of coastal ecosystems worldwide (Conley et al., 2009). In response to these phenomena, several authors have indicated the necessity of installing algal cultivation systems specifically to reverse the eutrophication processes (Fei 2004, Fei et al., 1999). Although in the western nations there is no experience of cultivation of algae on a large scale, except in the case of *Gracilaria* in Chile, many studies have emphasized its use associated with fish farming to reduce environmental effects caused from the excretion of nitrogen compounds to the environment by developing a more environmentally friendly approach called Integrated Multi-Trophic Aquaculture (IMTA) (see example: Troell et al., 1999, Buschmann et al., 2001b, Chopin et al., 2001, 2008). Chile has called attention to the potential positive effect the cultivation of *Gracilaria* and *Macrocystis* algae may have on the environment (Buschmann et al. 2009). These studies have shown that both species can capture nitrogen compounds and accumulated in their tissues primarily as protein that can be removed from the medium during the harvest (Buschmann et al., 2008c). Studies in ponds using the algae *Gracilaria* demonstrate that it's possible to remove 85% of nitrogen inputed to the environment from growing salmonids during an annual production cycle of (Buschmann et al., 1996), demonstrating the high potential benefit to the farming of algae from an environmental point of view.

Despite the interesting use of algae farming to reduce nutrient loads in coastal areas, a recent study showed that algae farming could promote the formation of green tides which have adverse effects. Green tides are known reactions of coastal environments where the excessive growth of green algae is associated with the process of eutrophication. This proliferation of green algae can produce algae with strong wracks which affects coastal communities including coastal fisheries, tourism activities, landscapes, and create an unwanted odors , and even affected the Beijing Olympics just a couple of years ago. Liu et al. (2009) noted that the probable origin of these masses of green algae was associated with the cultivation of red algae *Porphyra* several hundred kilometers to the south of Qingdao. The detachment of fouling associated with the farming system could be the cause of these enormous green tides affecting the Olympics games. However, Pang et al. (2009) demonstrated that the ultimate origin of the accumulation of green algae is associated with shrimp culture pools and other invertebrates and fish species in coastal areas of China that, by releasing their effluents, released nitrogen together with the inoculums of algae that produces the green tides after being dragged by weeks by the currents. This evidence rules out the effect of farmed red algae produced by of green algae blooms.

The cultivation of the brown algae Macrocystis and environmental externalities

The cultivation of the *Macrocystis* in suspended systems for energy production began during the 70's (Fig. 5; North, 1979). These systems were unsuccessful given the negative effects of El Niño current and their low profitability. However, advances in aquaculture, and a switch to production of higher value biofuels instead of methane gas has allowed the consideration of this technology. The development in China and Japan of aquaculture facilities for kelp similar to *Macrocystis* (such as *Laminaria* and *Undaria* case) provides more attractive system from a storm surges risk standpoint because these systems use multiple anchoring which contrast with the systems developed in California. These systems have been in production for over 30 years in Japan and China and as noted previously, they have positive environmental externalities by reducing effects of coastal eutrophication (Feng et al., 2004). Despite the previous described information, and considering that the literature of culture of *Macrocystis* (North, 1979; Gutierrez et al., 2006, Westermeier et al., 2006, Buschmann et al., 2008b; Macchiavello et al., 2010) does not indicate majors environmental effects from intensive algae cultivation in suspended systems, it is possible to establish the following hypotheses with respect to risk of environmental impact that would have to be resolved for the establishment of a facility for the culture of *Macrocystis*:

1. **Aesthetics of southern Chile**. It has been suggested that the large-scale cultivation of *Macrocystis* affects the aesthetics of the coastal landscape of southern Chile. Figure 5A shows the surrounding *Macrocystis* aquaculture pilot facility on the island of Quinchao. 5B shows in the *Macrocystis* aquaculture facility (circle) and denotes the reduced visual impact of this activity. A second related aesthetic criticism associated to the development aquaculture is the large amount of trash that can be found on the beaches of Chiloé (Hinojosa and Thiel, 2009). While it can be argued that the use of floats and lanyards in the cultivation of algae is significantly lower than in the cultivation of shellfish and salmon, this aspect should be considered in environmental evaluation.

2. **Organic waste.** The removal of organic matter and production of food waste and fecal material under fish and shellfish aquaculture facilities is an important consideration. Algae, however, do not require food and do not produce feces making this concern not relevant.

3. **Escapes.** Captive species may escape or fall off from aquaculture facilities. This is especially relevant in the case of introduced species that could affect local coastal ecosystems. *Macrocystis pyrifera* is a native species that exists along the Chilean coast (Graham et al., 2007) and therefore is not an introduced new species. Also genetically modified plants that could create environmental hazards would not be introduced. When algae fall off they form floating rafts that may move passively by currents for many weeks (Macaya et al., 2008). This indicates that the algae that may fall off would not be deposited on the seabed under the modified aquaculture farm. To mitigate the effects from algae that may fall-off a collection system for drifting algae will be implement like the ones that have been already have installed (see Figure 5B). These drift algae capture systems should be monitored to assess their effectiveness.

4. **Eutrophication effects on coastal areas of southern Chile**. The cultivation of Fish and invertebrate in aquaculture facilities produce nitrogen compounds that promote coastal eutrophication processes (Buschmann et al., 2008a). As indicated in earlier, intensive algae cultivation has the potential to reduce these effects by consuming these compounds and limiting primary production. Additionally, this could result in lower a likelihood of development of harmful algal blooms.
5. **Use of chemical compounds**. No known use of any compound in the process sea farming is contemplated, thus eliminating any associated risk of negative environmental impact..
6. **The cultivation of Macrocystis algae should influence a the decline in pressure to extract of *Macrocystis pyrifera* along the coast of Chile**. These kelp forests are important regulators of the abundance of several species that use them as a source of energy and shelter (e.g. fish and invertebrate herbivores, see Graham et al., 2007) and therefore its farming should help the conservation of a number of hydrobiological resources.
7. The development of *Macrocystis* growing technologies can be used also for the restocking of harvested areas (see examples in North 1979). Consequently, aquaculture practices could help to enhance the sustainable development of Benthic Resources Management Areas in Chile.

Summary of potential positive and negative environmental impacts of algae farming.

Neutral Effects and / or positive Effects

- In general, the environmental effects of cultivating algae are orders of magnitude lower than that the effect from growing consumer species (e.g., salmonids) and ten of time smaller than the impact from mussel aquaculture facilities (Folke & Kautsky 1989, Folke et al., 1998).
- Environmental impacts have been described and proven for aquaculture facility that grow algae on the seabed (Johnstone & Olafsson, 1995, Buschmann et al., 2001a; Eklöf et al., 2006), but there are no negative environmental effects document for algae grown in suspended aquaculture facility.
- Algae systems associated to fish and invertebrate aquaculture facilities may have positive environmental effects by decreasing coastal eutrophication processes (Buschmann et al., 2008c).
- Algae systems associated to fish and invertebrate aquaculture facilities could help attain a balance in environmental nitrogen levels that could reduce the risks of harmful algal blooms while raising the levels of oxygen required for animal production (Chopin et al., 2008).
- The aquaculture of native *Macrocystis pyrifera* kelp in Los Lagos region, does not possess a threat or risk for the introduction of alien species because the specie is widely distributed in along the region and no genetically manipulated species would be use.
- The cultivation of *Macrocystis* does not require the use of chemicals or products exogenous to the environment, thus eliminating associated risks and threats.
- Protocols should be developed for the control of solid waste loadings in coastal systems. Reduction in the use of buoys contributes significantly to minimizing the risk of release of materials that can foul coastal areas adjacent to the aquaculture facilities.

➢ Aesthetics impacts from suspended *Macrocystis* aquaculture facilites are significantly lower than those generated by other aquaculture systems (salmon and mussels) because the cultivation lines are permanently submerged between 3-6 meters below water surface.

NEGATIVE EFFECTS

➢ Fall off of algae can occur with heavy swells, leading to accumulation of bundles of algae on beaches near and far. For this reason, the operational protocols for the cultivation of this algae recommend to management options a) control of fall-off, or b) removal of fall-off material accumulated on beaches.

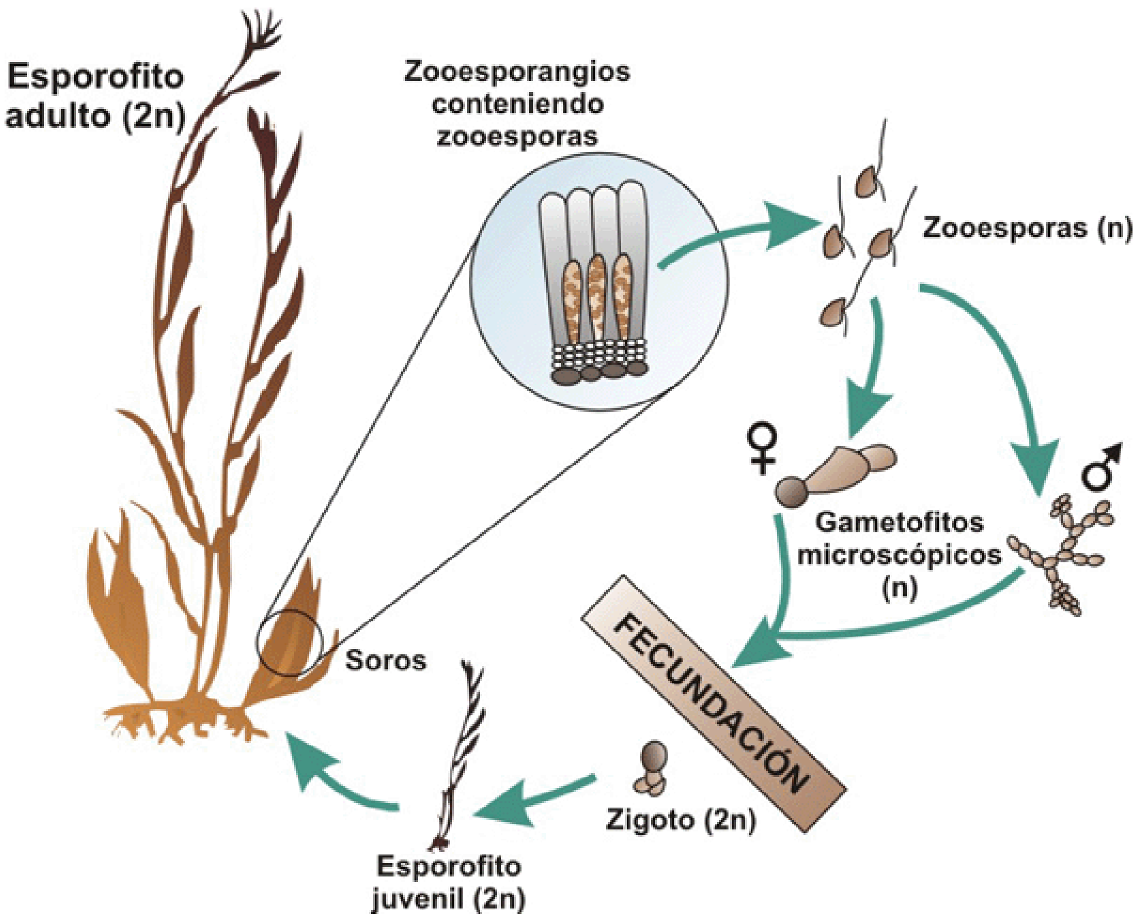


Figure 1. Life Cycle "*Macrocystis pyrifera*".

Considering the cultural, bio-geographical, production, and environmental aspects, among other aspects, the of the project action proponent will consider the following measures:

1) The action proponent shall respect the activities of the fishing trade, both existing and future, as well as tourist activities, considering the preferred use of the area which corresponds to a preferred area for aquaculture facilities according to DS No. 153 of May 20, 2004 (Zoning of the Coastal Area). In the concession area, mooring zones, artisanal fishing docks, artisanal fishing grounds, management zones, re-stoking areas, natural reserves, are marine parks have not been documented CPS DIA 2008).

2) No hydrobiological resources were detected in the concession area

3) The Action Proponent has complied with all existing environmental and aquaculture standards designed for the preservation of environmental quality and hydrobiological resources.

In regards to its touristic potential, the Action Proponent proposes the following voluntary actions to preserve the aesthetic value of the proposed area:

- Do not permit the presence of plastics or other solid waste from the facility on the shoreline along the proposed project, if solid waste from the aquaculture facility is detected, especially plastics, they will be collected and sent for disposal to authorized landfills.
- The facility personnel will be trained on the facility standards that minimizes the release of materials and, if they occur, in handling solid waste.
- There will be no activities that affect environmental resources or aspects related to tourism.
- Wherever they are installed, the aquaculture facility will not impede the transit of small vessels through the granted area.

1.5. Qualification for Registration with Environmental Impact Evaluation System

- The project complies with the requirements set out in Article 10 of Letra n de la Ley 19,300 (n: Proyectos de explotación intensiva; cultivo y Plantas de Recursos Hidrobiológicos) and Article 3 of Letra n.3 of the Regulations of the Environmental Impact: Annual production at or above 35 ton, in the case of echinoderms, crustaceans and non filter-feeder mollusks, fish and other species, through an intensive production system."

- Due to the amount and effluent quality, emissions and waste, and its location, the project presents no human health risk. Is set to record it to CONAMA, with purpose of giving effect to Article 11 paragraph (a) of Law 19,300, Article 5 of D. S. No. 95 of 2001 of MINSEGPRES, history extended in Section 6 of this document.

- The modification of the project will not generate significant adverse effects on the quantity and quality renewable natural resources including land, water and air in any stage, as indicated in Article 11 paragraph (b) of Law 19,300 and Section 6 of D. S. No.95 of 2001 of MINSEGPRES the contrary, the modification is to replace units significantly growing organisms that use more intensively the environment (mussels and abalone) for the cultivation of algae that only subtract inorganic nutrients from the environment. Section 6 of this document provides additional details.

- The modification of the project does not involve resettlement of human communities, or significant alteration lifestyle systems and customs of human groups. This background allows to evaluate compliance as stated in Article 11 paragraph (c) of Law No. 19,300 and Section 8 of D. S. N º 952001 of MINSEGPRE, Section 6 of this document provides additional details.

- The project involves the protection of resources, sensitive areas and environmental value of the territory it is located. It delivers this information in compliance with Article 11 subsection (d) of Law No. 19,300 and Article 9 of the D. S.No. 95 of 2001 of MINSEGPRES, Section 6 of this document provides additional details.

- It would not be located in an areas with aesthetic or tourist value, or areas designated with national touristic value, as provided in D. L. 1294 of 1975. It ill not interfere with areas or sites that depict community culture and folklore, expanded in history, Section 6 of this document provides additional details.

- The project includes the protection of aesthetic beauty and / or tourism, in compliance with the established in Article 11 paragraph (e) of Law No. 19,300 and article 10 of D. S. No. 95 of 2001 of MINSEGPRES. Emphasis will be given to the conservation and use with special care of the concession area. It will implement voluntary actions to conserve the aesthetic beauty of the place of the facility, Section 6 of this document provides additional details.

- Access to the facility will be by sea, mainly from South Beach Punta Tanecuhe sector, Quinchao island or other available locations, which will be used only for loading and unloading of personnel and cargo, and offloading of project supplies.

- The project does not create or submit changes on the cultural heritage, as set in Article 11 paragraph (f) of Law No. 19,300 Section 11 and subsection (d) of D. S. No. 95 of 2001 of MINSEGPRES, history extended in Section 6 of this document.

- The project is not located in any area potentially contaminated or saturated by any pollutant, As required by Law No. 19,300.

- In compliance with the provisions of Article 6 Paragraph (m) of D. S. No. 95 of 2001 of MINSEGPRES, the project does not present a risk for the vulnerable species of flora and fauna, or species at the risk of extinction,. Measures will be implemented for the protection of mammals and birds. The project will not be situated near resources or protected areas that may be adversely affected by presence and activities associated with the cultivation of mussels, abalone and macroalgae; Section 6 of this document provides additional details.

Therefore, the project qualifies for registration with Environmental Impact Evaluation System through an ENVIRONMENTAL IMPACT STATEMENT.

2 LOCATION

2.1 Location

The general location of the project has not changed from the original plan and corresponds to Southwest Punta Tanecuhe, Isla Quinchao, Curaco de Vélez, Región de Los Lagos (Figure 1).

Table 2. Geographic coordinates of the area

Vertices	Concesión Original	
	Latitude	Longitude
A	42° 28' 54.36"	73° 35' 46.60''
B	42° 28' 39.87"	73° 35' 32.57''
C	42° 28' 52.26''	73° 35' 01.74''
D	42° 29' 04.69''	73° 35' 14.34''
SHOA N°	7370	

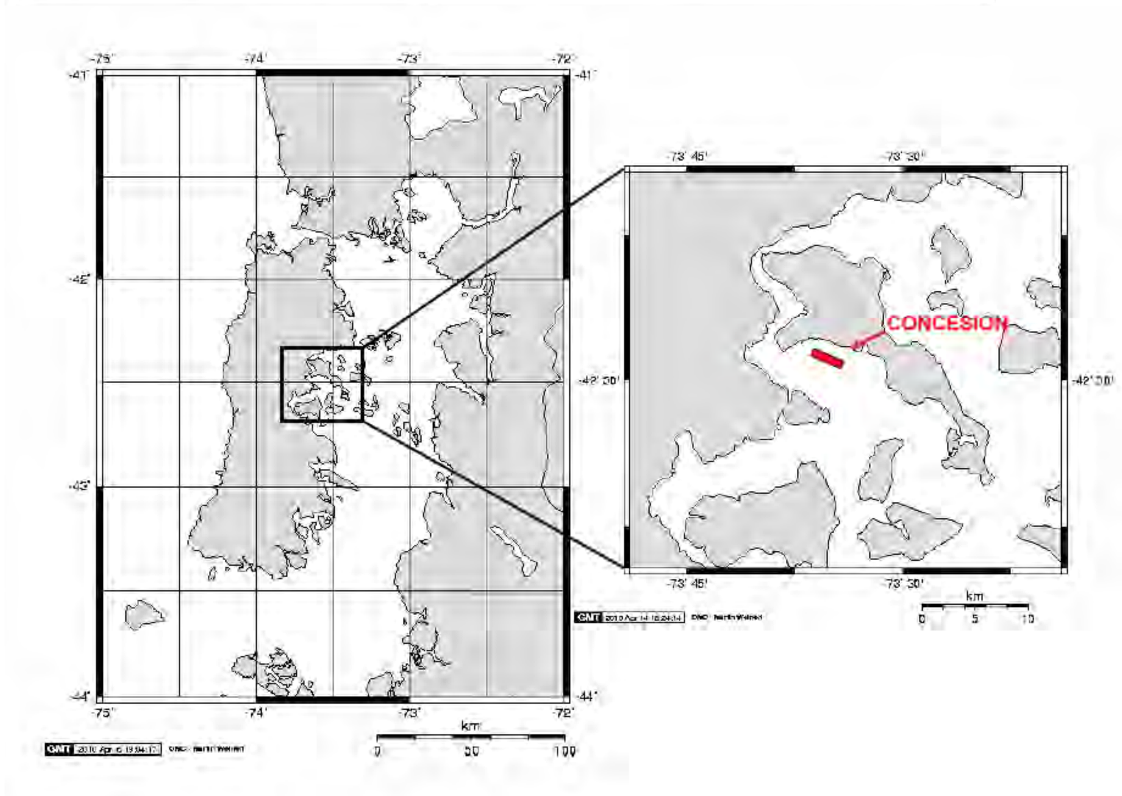


Figure 2: Geographic location of the project site
Source: http://www.aquarius.geomar.de

EIS "Cultivation of *Macrocystis pyrifera* in a suspended system"

2.2. General characteristics of the area of the site

Curaco de Velez is in the province of Chiloé and is the head of the Velez Curaco community. This community shares with the community of Quinchao the island of Quinchao. An island with has a total area of 134.3square km, of which Velez Curaco occupies 59% of the surface, i.e. 80 square km.

The community of Curaco de Velez is located in the western half of the Isla Quinchao of the archipelago of Chiloe, between parallels 42 º 22 º and 42 º 28 º South and meridians 73 º 31 º and 73 º 40 º West.

Topography: The territory of the commune is divided into two parts by the borders that form the high hills of Palqui, Huyar Alto, and Cayumbué.

The first of the territories, located north of the border, at the base of Palqui and Molinos rivers,.

The other part of the territory, home to the village of Curaco de Velez and contains the Curaco de Velez River which reaches a length of 21 km, the an urban area located between 13 to 25 meters above sea level.

Soil: The soils of the community, as in the Isla Grande de Chiloe, have sprung from volcanic ash, which are acidic and have evolved under conditions of excessive moisture. In general, it has well stratified soils, granular surface and sub angular blocks and underground.

These soils are thin to moderately deep, with medium textured, brown in color, and have a very dark to black surface. In general, these soils, which high nutrient limiting conditions associated to the high fixation of phosphorus, as result of the high concentration of aluminum oxide colloid. The total nitrogen, is usually high, but a significant portion is lock in allophonic organic complexes of difficult decomposition. On the other hand, relatively low temperatures slow the mineralization, while and high rainfall induces mobilization of nitrate.

Hydrology: The hydrological system of the area where the community is located is defined by 3 rivers: Rio Los Molinos, Arroyo Palqui and Curaco Estero de Vélez and 37 streams.

Vegetation: The vegetation of the area consist of mix forest vegetation, including evergreen and Ciprés de las Guaitecas. Among the tree species constituting this formation are: Ciprés de la Guaitecas (*Pilgerodendron uviferum*) Coigue of Chiloé (*Nothofagus nitida*), Tepú (*Tepuelia estipularis*) and Tineo (*Weinmnnia trichosperma*).

Fauna: Among the seabirds present stand Penguins (Family Spheniscidae), petrels (Family Procellaridae), ducks (family Anatidae) and gulls (family Laridae), among others. Terrestrial birds include Kingfisher (*Ceryle torcuaca*) Chucao (*Scelorchilus rubecula*) and Thrush (*Turdus flaklandii*) among others. [1]

Climate: The climate in the area is template and rainy, with high humidity, characterized by cool summer and mild winters, highly influenced by the surrounding maritime climate.

Rainfall is abundant, the annual excess of 2,000 mm. There are about 180 to 228 rainy days per year, equivalent to almost 8 months of rain, with a maximum of 6 to 8 rainy days during summer months, which are January and February, and a maximum of 23 rainy days during winter, which are July and August.

1 Source: www.sinia.cl (National System of Enviornmental Information)

The average annual temperature varies between 10.2 ° and 10.6 ° and the average relative humidity of air is 85%, while the maximum average temperature varies between 17.8 ° and 19.4 ° in summer and in winter between 3.2 º and 4.7 º.

In the concession area not detected the presence of fishing grounds, artisanal fishing docks, artisanal fishing, areas, farming areas, management or re-stocking areas, marine reserves and / or marine parks.

Taking in consideration the above described background information the action propones will take the following measures:

⇒The development of the facility activities will be limited to the concession area, i.e., there will be no activities and buildings on land; also the facility will not obstruct access to camp or protection areas for artisanal fishermen.

⇒The action proponent complies with all applicable environmental and fishing regulations designed for the preservation of the environmental quality and aquatic resources.

⇒ Operation and monitoring protocols will be implemented that include specific measures of prevention and mitigation of adverse environmental impacts not covered in this EIS.

2.3. Characteristics of the Marine Environment

The concession was classified as a Category 3 because it is a aquaculture facility with extensive production, with projected maximum annual production exceeding 1,000 tons and presents areas with depths less than 60 meters and soft bottom.

Appendix 2 presents the analysis of the 2008 preliminary site characterization and environmental information developed to date, in compliance with Article 9 paragraph c of Resolution (Subpesca) No. 3612.

As complementary information to characterize the environment where the project is located, the action proponent voluntarily conducted a study of the concentration of nitrates and phosphates in the water column as well as profiles of oceanographic parameters (temperature, salinity and dissolved oxygen), which are presented in Appendix 2 of the EIS.

3. CHRONOLOGICAL DESCRIPTION

3.1 Schedule of Project Activities

Table 3. Program Schedule of activities for the Project

Stage	Start Date	End Date
Oceanographic Studies	3/30/2010	
Installation (Aquaculture floating system)	2nd half of 2010	
Planting	2nd half of 2010	
Harvesting	2nd half of 2010 or 1st half of 2011 (depending on obtaining authorization)	

3.2 Area covered by the project or activity

Table 4: Area covered by the project or activity, versus actual current situation

Stage	Surface Area (In Hectares)	
Information gathering	40.55 Ha	
Construction	40.55 Ha	
Operation (Actual)	Available: 40.55 Hectares	20% utilized
Operation (Modified)	Available: 40.55 Hectares	Utilized: 5.93% Mussels 0.37% Abalon 93.7% Macrocystis

3.3- Estimated amount of investment: $250,000,000

3.4 – Life of the Project: Indefinite

Regarding the life of the project, the action proponent states that the project will last indefinitely, depending on environmental conditions of the farm, and the respective environmental information, considering that the Environmental Regulation for Aquaculture (DS 320/01)) and the RES . EXE. No. 3612 provides measures to the aquaculture farms maintaining the ecological balance and operates in accordance with the capacity of the body of water in the location of the area granted, the PI will comply during all stages of the project

3.5 Direct labor utilized by the project not including service labor

Table 5: Direct labor Utilized on the Project

Stage	# of people
Technical Staff	2
Studies and installation of cultivation system	10
Planting	6
Harvesting	6

It is generally estimated that the facility will operate with 4 full time employees, one of them a technically trained professional. In addition staff would be hired sporadically, according to the requirements of each stage of the project. The project would require security monitoring of land and maritime facilities 24 hours a day with 2 people per shift of 8 hours each.

4. DEFINITION OF THE PARTS, ACTIONS, AND PHYSICAL WORK

4.1 Information Collection

This stage consist in the preparation and generate the necessary information required for input into the Environmental Impact Evaluation System, maintaining use of the concession area within existing agreements. Once the EIS is approved and authorization of the concession finalized the, the occupation of the subject area can proceed.

4.2. Construction

a. Anchor and aquaculture (lattice) systems construction

The construction of an anchoring system and aquaculture system (grid) would be made by a company hired for this operation at facilities located in Puerto Montt, afterwards the system will be transferred to the aquaculture facility for installation.

The anchoring and culture system was chosen according to information obtained from oceanographic survey and consists of metal anchors, chains and polypropylene lines for anchoring All polypropylene lines including those of the aquaculture facility have ends connected by galvanized iron fitting. 500 and 1,500 liters polyethylene buoys provide flotation.

b. Installation of anchoring systems, cross-linked and floating:

The design of the cultivation system consist of a grid made of square sub-unit, each of a 1 of hectare in area (Appendix 4). The grid has in all sides 1500 liter buoys that demark de area with a red St. Andrew cross and warning light. 500 liters buoys demark each quadrant within the grid, inside the grid there are no buoys, just aquaculture lines

The anchoring system is installed connecting the cultivation system and forming squares of 1 hectare, each connection vertex has buoy with a 4 meters line that ensures a 4 meter depth for the growing system.

c. Installation of Lines (Long - Lines):

This stage of the process begins after installation of the cultivation system as a whole.

Polypropylene lines, 12 mm in diameter will be cut in 100 and 300 meters segments. These lines will be tied to rings on the grid , extend in the quadrants, and then tied at opposite ends to following rings with the help a 7 meters long High Density Polyethylene boat equipped with a 50 hp outboard engine.

Installation will include:

- 1470 lines for the farming of *Macrocystis* (100 meters each) with a total length of 147,000 meters occupying a total area of 38 hectares (93.7% of the concession area).

- 1 line for the cultivation of red abalone (300 meters each) with a total length of 300 meters and occupying a total area of 0.15 Ha (0.37% of the concession).
- 7 double lines for the cultivation of mussels (300 meters each) with a total length of 9300 meters and occupying a total area of 2.4 ha (5.93% of the concession).

The action proponent broadens the information presented, indicating that in the event it is necessary to provide concrete elements for the anchoring of floating structures such material would be provide only from authorized and certified sources.

4.3. Operation

Only work with licensed providers and those with RCA where appropriate.
The following stages are identified and described for the production cycle :

Macroalgae "Huiro" (*Macrocystis Piryfera*)

Planting: Seeds obtained from authorized hatcheries and will be transferred to the farm in plastic containers (bins) with sea water; in the hatchery the seeds will be settle on lines with a diameter of 3 mm. Once received at the facility, the seeds will be planted according to the following steps:

Receiving the seeds. Once they have arrived at the farm, the water in the container will be changed prior to planting. Lines with seeds will be placed in breeding lines, which remained under the surface for growth. The installation procedure will take place on a 12 x 6 meters metal platform raises the lines to plant the seedlings along the long lines.

Best management practice will be promptly implement to prevent possible setbacks that could affect both the development and farming of plants as result of failure and deterioration of floating structures .

Harvest: during the harvesting process, the cultivation lines will be lifted onto platforms, and using a rolling system the algae will be separated from the growing lines. The platforms are 12 x 6 meters metal barges. After this procedure, which will be held in the same place where the alge growth, the algae will be packaged, weighed and delivered to customers to be transported by land or sea.

Mussels

Once the construction and installation phase of the long-lines from the aquaculture is complete, then the installation of growth strings mainly of mussel seeds in long-line for growing and harvesting will proceed. Eventually the facility may grow the ribbed mussel (*Aulaconmya ater*) or choro mussel (*Choromytilus chorus*).

The technology of cultures consist of double long-lines with a length of 300 m, from which 8 meters long growing lines would be hung, with a final measured weight between 35 to 40 kilos, depending on the diameter of the system. A total of 7 long-lines of mussel cultures will be planted.

Seed Collection. Initially, this phase will involve purchasing seed from authorized cultures facilities and/ or hiring a contractor to the install collection system. According to the biological cycle of mussels, the seed collection season runs from October to February. During this period, the contractors will install collection systems that will be in place until they mussels reach a suitable size for transfer.

Growing. After reaching the optimal seed size, which can occur starting in February and after, depending on the location of the collection facility and environmental conditions, they shall be transferred to the aquaculture growing facility. Once admitted to the culture, the seed will be selected by size or "gauge" for subsequent strings, using the Chilean planting system (also called French--modification). In addition, the Spanish system will be used, in which the seed is connected in strings made webs, using a hydraulic stringing machine, which is installed on the company barge. The planting period will begin once seeds are selected and classified in the aquaculture facility, which is estimated to begin in March and may extend until the end of November. At this stage, particular care will be taken in selecting and adequately distributing seeds in the growing lines to ensure optimal growth and production while minimizing mortality.

The production system of the company requires additional handling between planting and growing because the strings are seeded to reach the harvest without further thinning or unfolding. This was done to optimize growth and prevent seed separation inherent in any task of manipulating the strings.

Harvest. This activity will be undertaken by the vessel that the company has selected for harvesting, which has a hydraulic crane to lift the long-lines. The hanging mussels will be placed on the surface of the barge where the mussels will be separated from the hanging lines, for subsequent transfer to ”bins” to the processing plant in the same vessel or another vessel intended for these purposes. Depending on the planting date and seed size used, these commercially sized mussels can be obtained (> 5 cm.) approximately eighth months after planting. harvesting will occurr according to the planting period, and will begin in October and continue until July of next year or so. The harvesting operation is performed once that the growth-fat string reaches a weight of approximately 35 and 40 kg (depending on and food availability and season).

Red Abalone (*Haliotis rufescens*)

Once the construction and installation phase of the long-lines in the aquaculture facility has occurred, the process to seedling, growing, and subsequent harvesting of abalone will occur.

The technology of cultures consists of double long-lines with a length of 300 m. A double line will be installed, with 125 drums of 220 liters, with a final content of 200 abalone per drum (ie, 25,000 abalones on long-lines). The production will be directed to an abalone weighing an average of 150 g, ie 6 to 7 abalones per kilo. Therefore, each long-line will yield around 3.75 tons over a cultivation cycle of about 36 months to abalones of 80 mm in length.

Seed Collection. Seed will be purchased from the hatcheries. Abalone seed producers exist in production centers in the and Regions III and IV (San Cristobal SA Live Seafood SA etc). The seed size range is between 15 and 20 mm in length.

Growing. After receiving the seeds, they will be placed in 220 liters plastic drums. These drums have 4 windows of about 20 square centimeters in the outline of the drum. The surfaces are covered with plastic mesh which in turn are attached to the drum with fishing line (0.90mm). The bottom of the drum is tied to a weight of about 10 kg, to maintain vertical suspension. In each drum, about 500 abalone is initially deposited, which will be maintained from the initial size of about 20 mm until the reach a size 55 to 60 mm, then later their density will be reduced to 200 abalone per drum. Growing mainly consists of artificial feeding the Abalones until satiation using, *Macrocystis*, or *Gracilaria*, keeping a record of the weekly consumed food and mortalities.

The food supplied to the abalone corresponds to *Macrocystis* (huiro) and Gracilaria (pelillo) algae, which are purchased from collectors from the area and eventually from the *Macrosystis* culture lines.

Harvest. Once the abalone have reached a suitable size and output, i.e., 6-7 abalones per kilo, they will be harvested by lifting the long-lines. The abalones will be placed in bins for bulk shipment by boat to approved processing plants.

Other operations of the center:

Refloating Lines and System Repairs. This activity consists of periodic surveys to identify and refloat those systems and long-lines which arecompletely or partially sunk due to the loss of floats caused by storms that move product lines, overgrowth of the hanging cultures, or stolen floats. In case of one any of these failures, the float should be restored/ or the hanging cultures should be redistributed evenly. The load capacity of structures and systems will be checked periodically.

These are actions to be implemented under situations of risk or accident in compliance with Articles Nº 4, 5, 6, 9 y 12 of D.S Nº320 from 2001.

Periodic cleaning. Every day a person (preferably living in the vicinity of the cultures), will collect all materials or elements that constitute waste, that cause pollution, or adversely impact the environment where the project is located. A drum type plastic container with a 500 liter capacity will be provided for depositing all the elements that constitute waste. The waste will be removed twice a week depending on quantity and will be collected by companies in charge of industrial solid waste removal, for example by the company “CORCOVADO AGRICOLA S.A.” or another company, which will provide a location for waste disposal.

4.4 Abandonment Stage

The project is of an indefinite nature. However, if there is good reason to do so, it is estimated that the time of abandoning the project will be about 8 months, long enough to dispose of the facilities and products that were generated during operation of the project.

5. Major emissions, Waste and Discharges of the Project or Activity

5.1 .- " Will the project or activity, including the works and / or associated actions generate emissions into the atmosphere?

The only air emissions that are considered are:

- Gas Emission will be produce from the combustion of outboard engines and electrical generators during the operation stage.

  Special care will be taken during the maintenance of engines and generators to optimize their use and reduce their emissions, producing the least amount of gas and residue.

- Emission of noise: The main source of noise emissions would be the outboard engines. During the production process will be complied with Article 74 of D. S. No. 594/99, for noise emissions and workers will have hearing protection. No homes are located near the processing area, as this facility is located in the concession area, and therefore there are not population at risk

5.2 .- "Will the project or activity, including the work and / or associated actions generate liquid effluent discharges?
Due to the work regimen, the operators and facility staff can use their own home sanitary facilities, since these can be found near the aquaculture facility. Due to the harsh weather conditions of Region X, chemical bath would not be installed, furthermore people of the area culturally are not accustomed to these kinds of systems

5.3 .- "Will the project or activity, including the works and / or actions generate solid waste?
Yes, the following types:

5.3.1 Construction Stage

a. Debris: The remains of polyethylene floats and other debris, generated during the construction phase, will be removed by the contractor that will install the facility to be disposed at the nearest authorized landfill.

Table 6: Generated Debris

Volume of Debris		Waste Management Implementation	Disposal of generated waste
Current Year 5	Modification of year 5	Remove by boat	sent to an approved landfill
0.5 M^3	1.5 M^3		

For maintaining strict control of this issue, everyday a person (preferably a resident in the vicinity of the cultures), will collect all materials or elements that constitutes waste, causes pollution, or adversely impacts the environment where the project is located. A plastic container with a 500-Liter capacity will be available on the barge for depositing all elements that constitute waste.

5.3.2 Growing phase

a. Fall-off

- **Fall-off of the organisms in the culture.** In case of an accidental separation of mussels, they shall be recollected by divers along seabeds at permissible depths, or by a Remotely Operated underwater Vehicle (ROV), and will be restrung in stronger lines with cotton sock thread, that should last in the water for at least 15 days. Separated abalone will be collected in a storage drum.

  In the case of macroalgae cultures, which corresponds to almost all of the concession area, the fall off organisms will be collected daily and transferred to abalone culture facilities to be used as feed material. These fall off are estimated at 200 kg / day, depending on weather conditions, but it is worth noting that the presence of air sacs will also facilitate the collection of leaves, preventing them from submerging.

- **Sinking culture units.** In case of collapse of structures, they shall be refloated and reinforced in the culturing system. If necessary, the resistance of the lines and anchor ropes will be increased.

- **Fall-off or breakage of culture units**. In case of structural fall-off or breakage of attachment systems due to tides and or waves, the anchoring system will be immediately repaired and reinforced.

b. **Solid waste originating from homes**.
The waste that generated routine operations (basic materials) shall be deposited in garbage containers to be collected and disposed every week by an authorized company

Table 7: Summary of Solids

Solid Waste	Type of waste management	Disposal of waste
3000 Kg per year	Stored in containers	Removed and disposed of in approved landfill.

6. Background for Evaluating the Project Activities not Requiring a Statement of Impact

The action proponent, in general terms, states that the project:

6.1. The project or activity, including the works and / or associated actions, will not include the removal, destruction, excavation, damage or extension of National Monuments as defined by the Law 17,288, or the expansion or deterioration of buildings, places, or sites that because of their construction characteristics, antiquity, constructin, scientific value, historical context, or uniqueness are part of the national certified cultural heritage.

A background analysis was performed in order to determine the presence of national monuments and other relevant entities of the cultural value. In addition, we have visited the area several times and there were no national monuments.

6.2. The project or activity, including the work and / or actions associated, will not involve the extraction, exploitation, alteration or management of species of flora and fauna that are in one of the conservation categories: endangered, vulnerable, and poorly known.

The project will not alter the flora and fauna of the area.

6.3. The project or activity, including the works and / or associated actions with the movement will not relocate or displace people living in proposed action location

It is estimated that the project will have a positive social impact, both during the construction as well as the operation stages, as it will generate employment opportunities for nearby communities.

6.4. The project or activity, including work and / or associated actions will not affect the performance of religious ceremonies and other cultural or heritage events of the people, communities, or groups of the area.

Project activities will not affect cultural aspects.

6.5. The project or activity, including work and / or associated actions will not negatively affect the production of, or access to natural resources by the people, communities, or groups of the area.
6.6. The project or activity, including work and / or associated actions will not adversely access to basic services and equipment by the people, communities, or groups of the area

6.7. Due to the nature of the project, the project will not at any stage affect the presence of people, communities, or groups of the area protected by special laws, furthermore, the project will be located on the property of the action proponent.

6.8. The project or activity, including work and / or actions associated will not include areas with aesthetic and / or tourism value and / or an area location designated as national touristic interest according to Legislative Decree No. 1224 of 1975.

Even though no element in the proposed action locations is declared with a special landscape aesthetic value, the project plans to use of materials and colors harmonious with the landscape. This is discussed in the project with Environmental Qualification Resolution No. 239/2009.

Appendix 4: *Attached pictures show the low visual impact of the project.*

6.9. Throughout the project or activity, included work and / or actions associated will not create significant adverse effects due to the relationship between emissions of pollutants generated and environmental quality of renewable resources.

The investment project will emphasize the proper handling and disposal of waste,
emissions and effluents.

The project in its various stages will not cause significant changes in renewable natural resource quality and thereby avoid effects on biota, soil and air, since in this case, as indicated by the action proponent at EIS with favorable RCA No. 239, includes making the following voluntary environmental commitments:

- *Training of operators in all aspects of crop management of macroalgae, mussels and Abalone and its interaction with the environment.*
- *Implement new technologies to significantly reduce the potential environmental impact of the project.*

6.10. Throughout the project or activity, included work and / or actions associated will not generate significant adverse effects on the quality of renewable natural resources.

There will be full and proper control on all issues associated with the project, and it to be constructed in an appropriate area for this.

The project does not use chemicals that endanger the natural renewable resources.

6.11. Throughout the project or activity, included work and / or actions associated will not intervene or exploit native vegetation.

6.12. Throughout the project or activity, included work and / or actions associated will not intervene or exploit water resources in wetland areas or areas that may be affected by the rising or diminishing levels of groundwater and surface water or underground bodies of water that may contain fossils, and / or lakes or lagoons with fluctuating water levels.

6.13. Throughout the project or activity, included work and / or associated actions will not operate or intervene in water resources in a basin or sub-basin transfer to another.

6.14. Throughout the project or activity, included work and / or associated actions will not introduce flora or fauna, or other similar genetically modified organisms, to the national lands.

6.15. Throughout the project or activity, included work and / or associated actions will not generate increases or significant changes in levels of total population; of the rural urban distribution; of economic activity; and / or age and sex distribution.

The project includes a small number of workers (maximum of 10 people.).

6.16. Throughout the project or activity, included works and / or associated actions will not obstruct the view of areas with natural beauty.

The project will not cause obstruction to visibility in areas with aesthetic value, since its facilities consist of sub-surface buoys.

Appendix 4: Includes installation photographs and sounding diagrams.

6.17. Throughout the project or activity, no resources or elements of environmental areas of aesthetic or touristic value will be altered.

6.18. Throughout the project or activity, there will be no obstruction of access to resources or elements of the environment in areas with aesthetic or tourist value.

6.1. EXPANDED BACKGROUND TO EVALUATE THE PROJECT OR ACTIVITY IS NOT REQUIRED TO SUBMIT AN ENVIRONMENTAL IMPACT STUDY

The action proponent expanded the information by conducting the analysis required to assess the project does not generate effects, characteristics and / or circumstances that indicate the letters a, b, c, d, e and f of Article 11 of Law 19,300. and respect of the provisions of Article 6 of the DS 95/01 MINSEGPRES, as specific paragraphs d), e), i), j) and p).

Evaluation criteria required by the authority:

6.1.1. Letters a, b, c, d, e and f. of Article 11 of Law 19,300

a) Risk to the health of the population, due to the amount and quality of effluents, emissions or waste.

The nearest village to the project area is located about 3 km distance from the aquaculture facility, in the town of Velez Curaco. To assess whether the project will generate and submit any risk to the health of people close to the project, due to the amount and quality of effluents, emissions, or waste generated or produced, the following has been considered:

Table 8. Summary of Generated Waste, referenced in the EIS

Waste type	Document Details
Emissions.	Section 5.1
Noise emissions.	Section 5.1
Liquid waste.	Section 5.2
Solid waste, debris, household.	Section 5.3

Considering the facts presented with respect to generated waste, and the importance of maintaining the sustainability of the concession area, the action proponent expands the information presented indicating that under all circumstances, work will be conducted under a preventive approach will consider the current environmental regulations (DS 320/01; RAMA and its amendments).

Conclusion 1: The project does not generate or present a risk to the health of the population due to the amount and quality of effluents, emissions or waste.

b) Significant adverse effects on the quantity and quality of renewable natural resources, including soil, water and air

According to comparative analyses between 2008 preliminary site characterization and environmental information, to date they conclude:

- The center has maintained a stable pattern with respect to the composition and abundance of macrofauna at monitored stations, since it began and prior to its operation. No significant changes were detected that were attributable to farming activities.

- There have been no observed alterations of pH and redox potential, or evidence showing that farming activities developed in the center have helped to generate a negative impact on the oxidation of organic matter in the sediment.

- The obtained results showed no differences with respect to the granulometric composition of sediment and percentage of organic matter. Considering the environmental information made to date, it was concluded that cropping activities developed in the center, according to production levels reported to the authorities, have had no impact on the granulometric composition of the sediment. Similarly, the CPS 2008 showed a clear homogeneity of particle size in all sampling stations, which shows a low impact on the substrate of the concession area.

- The results did not show significant differences between the INFAS and the CPS 2008, and the percentage of organic matter in the sediment, so it is clear that farming activities developed in the center, considering the production levels reported to the authority have had no impact on the percentage of organic matter in sediment.

Finally with the environmental information presented, regarding the current condition of the grant, it is concluded that:

⇒ The concession area provides optimal conditions for environmentally sustainable production of 9,702 tons of *Macrocystis*, 0.4 tons of red abalone, and 1,550 tons of mussel biomass considering the maximum requested in the technical project.

⇒ Considering the size of the project, the site features industry and operating under a **preventive** concept does not generate significant adverse effects on the quantity and quality of renewable natural resources, including soil, water and air.

⇒ The site has aerobic conditions, complying with requirements of article. 17 and 3 of D.S. (MINECON) No. 320/2001. According to 2008 preliminary site characterization submitted promptly to the authority in the 2008 EIS .

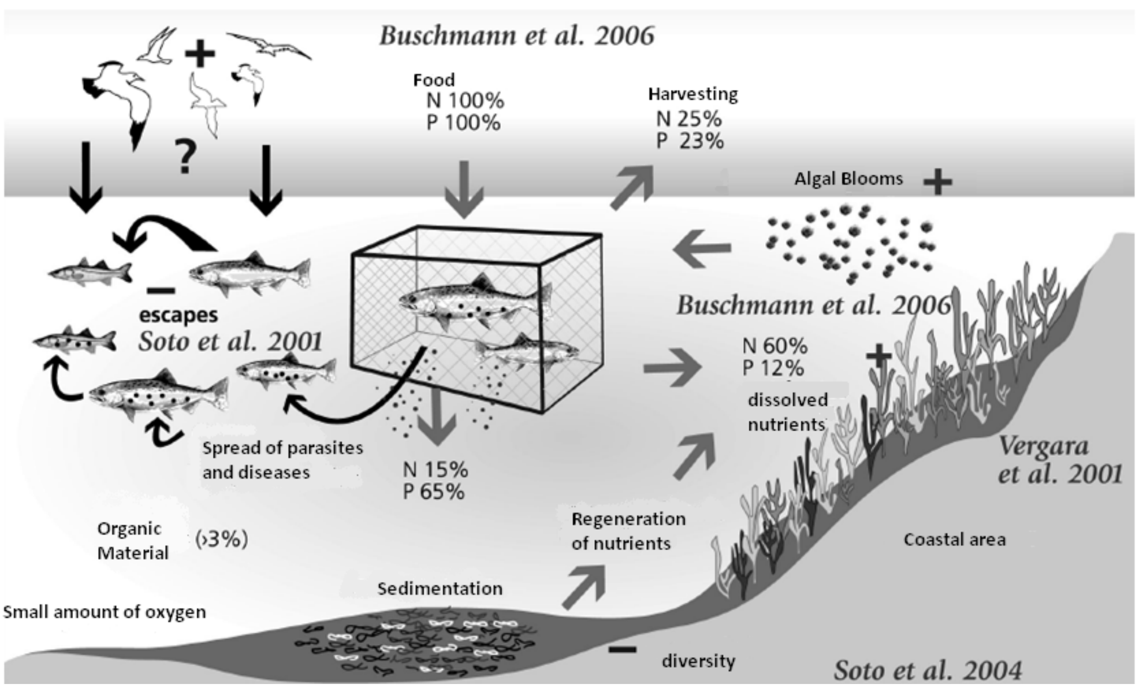
⇒ Complying with the request in the art. 15 of D.S. (MINECON) N ° 320/2001, the CPS 2008, gave all the elements that should be considered by the fishing authority to environmentally assess the project.

⇒ **Based on the above background it is possible to establish that the requested production of 9,702 tons of *Macrocystis*s, 0.4 tons of red abalone and 1,550 tons of mussels does not exceed the dispersion capacity of the environment** and does not create anaerobic conditions, considering that 93.87% of the concession are Macrocystis, which does not generate metabolic digestive waste products, but rather contributes to the conversion of inorganic carbon to organic carbon and reduction of atmospheric CO_2.

⇒ The action proponent assumes responsibility that the center operates within compatible standards with the capacity of the specific water body and will work towards always maintaining aerobic conditions in the surface area of sedimentation.

Note: As background to the low environmental impact that would produce a massive crop of macroalgae in the area of fjords and channels of southern Chile, if not rather have a positive effect on the system, there is in Figure 3, a diagram that depict the environmental impacts are identified and linked to the organic matter inputs from a plant that grows carnivorous organisms that require an outside source of food as it is in the case of salmon. It shows the relative fluxes of nitrogen and phosphorous from their introduction in the food, and depicts the deposition of organic matter in the bottom, the effect of the inputs of organic matter to the water column, and the effects from fish that escapes and propagation of parasites. Positive effects (+) and negative (-) on different components of the flora and fauna are identified. This does not including effects associated with the entry of chemicals into the system.

Figure 3. Source: Buschman 2007



c) Resettlement of human communities, or significant changes in living systems and habits of human groups;

As background, it is mentioned that the population of Curaco Velez, increased from 3,021 to 3,403 inhabitants between 1992 and 2002. In 1992, 100.00% of the population was rural, remain unaffected in 2002 (Fig. 4).

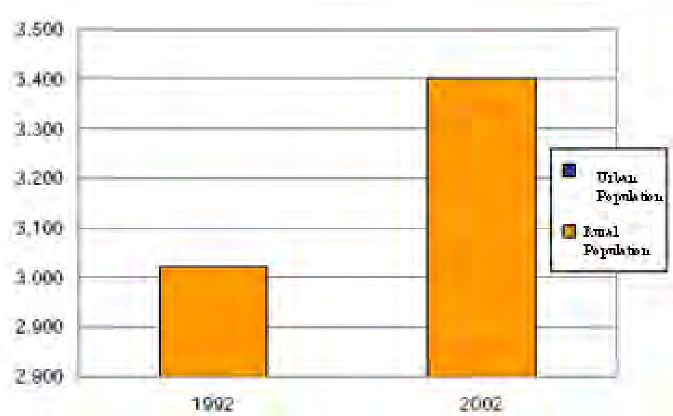


Figure 4. Population of town of Velez Curaco as 1992 and 2002 Census.

Table 9. Curaco Velez. Estimated Population in the year 2020.

YEAR	Population						
	Total	Men	Women	YEAR	Total	Men	Women
1990	2.957	1.407	1.55	2005	3.692	1.827	1.865
1991	3.017	1.44	1.577	2006	3.742	1.861	1.881
1992	3.065	1.468	1.597	2007	3.785	1.891	1.894
1993	3.134	1.501	1.633	2008	3.839	1.928	1.911
1994	3.193	1.532	1.661	2009	3.891	1.963	1.928
1995	3.245	1.564	1.681	2010	8.937	1.992	1.945
1996	3.29	1.585	1.705	2011	3.987	2.025	1.962
1997	3.334	1.606	1.728	2012	4.044	2.063	1.981
1998	3.365	1.625	1.74	2013	4.088	2.089	1.999
1999	3.408	1.648	1.76	2014	4.138	2.125	2.013
2000	3.44	1.665	1.775	2015	4.187	2.161	2.026
2001	3.495	1.701	1.794	2016	4.227	2.187	2.04
2002	3.54	1.733	1.807	2017	4279	2.218	2.061
2003	3.593	1.763	1.83	2018	4.332	2.249	2.083
2004	3.634	1.789	1.845	2019	4.371	2.276	2.095
2005	3.692	1.827	1.865	2020	4.417	2.304	2.113

Source: www.ine.cl

According to Table 9, we can see that compared to 1990, men in the area in 2005, experienced an increase of 2.68%. In 1990 the male population was 47.58%, which increased to 49.48% in 2005. It is estimated that by 2020 to reach 52.16%, therefore, there will be an increase by 2.68% in the male population, compared to 2005. However, this did not happen in the female population as of 1990 (52.42%) to 2005

(50,51%), there has been a decline of 1.91% in this population. With these figures, it is estimated that by 2020 befall an equal decrease in the percentage would be 50.51% (2005) to 47.83% (2020), ie a decrease of 2.68%.

With the above background, it is noted that the project will not generate a resettlement of human communities, because of the low number of workers and because the physical facilities of the project shall be located only in the sea. It is worth taking into consideration that the project is located within an area suitable for aquaculture enterprises, which aims to precisely delineate the areas appropriate for development of this activity.

With respect to significant changes in living systems and practices of human groups, the action proponent knows the cultural and ethnic composition of the area (Table 10) and believes that aquaculture activities do not interfere with the daily life of the population.

Table 10. Membership of ethnic group in Curaco Velez and Lakes Region by Ethnicity (Census 2002).

Region			
	SEX		TOTAL
	MEN	WOMEN	
1. Alacalufe (Kawashkar)	258	186	444
2. Atacameño	59	31	90
3. Aymará	86	95	181
4. Colla	33	29	62
5. Mapuche	51.838	48.826	100.664
6. Quechua	141	173	314
7. Rapa - Nui	76	82	158
8. Yámana (Yagán)	103	77	180
9. Ninguno de los anteriores	486.641	484.401	971.042
Total	539.235	533.900	1.073.135

Source: www.ine.cl

The 2002 census showed that the indigenous population is said to belong to any ethnic group originating in Curaco de Vélez, reaches 6% of the population (3.38% percent lower that of the region), ie 215 people. This places this community in the 91 percentile of the country according to the proportion of indigenous population.

Conclusion 3: "According to the above, it can be concluded that the project will not generate resettlement of human communities or significant changes in living systems and practices of human groups coming to the area of study"

d) Proximity to the population, resources and protected areas may be affected, as well as the environmental value of land it is proposed to deploy

To assess whether the project will be located close to population, resources or protected areas may be affected, the following has been considered:

In the area where the project will be located there are communities or groups protected by special laws, nor develop religious ceremonies or other events specific to the culture or folklore. Proposed project does not include land based installations

Conclusion 4: Based on the foregoing analysis, the area where the project will be located, including the works and associated actions in all its phases, not be located close to population, resources and protected areas may be affected as well as the environmental value the territory in which it is intended
deploy.

e) Significant alterations in terms of magnitude or duration of aesthetic or touristic value of an area.

Considering the analysis of landscape and tourism conducted, it was concluded that the landscape of the area is fairly common to the one it occurs in the southern part of the country, characterized by islands of rocky coast and abundant vegetation, mixed forest formations, typical of areas with high humidity. The project is located in an area that includes islands with mountains covered with abundant and thick vegetation that make an harmonious visual effect of the project. This is mainly because a significant percentage of the structures to be installed below the sea level (submerged lines and buoys), will occupy a small area when contrasted to the surrounding hills and mountains .

The project site has specific characteristics, creating a minimal visual impact, because its structure is composed of a small platform from 12 square meters and a group of buoys to be located in the middle of a homogeneous matrix as is the sea.

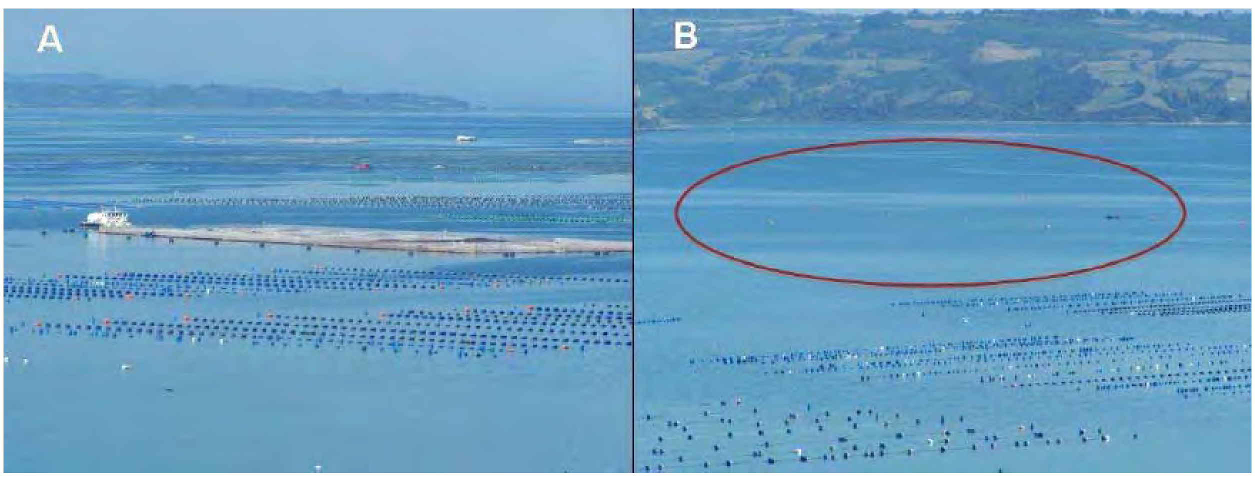


Figure 5. **A)** Area of cultivation of salmon and mussels in the south of the island of Chiloe Quinchao; **B)** site *Macrocystis* alga growing Quinchao island (red circle) showing significantly lower levels of landscape modification.

- The action proponent agrees to maintain the minimum impact on the landscape in the area of project site, implementing the actions detailed in the section of voluntary environmental commitment.

In addition, the action proponent is informed of the initiatives presented in the community based on the Community Development Plan (PLADECO), which are

- Perfect tourism land use planning.
- Perfect role as linking agent between the island territory of the archipelago and the island territory corresponding to the Big Island.
- To collaborate in the protection of cultural heritage tourism, increase technical assistance to tour operators.
- Assessing the environmental impact of tourism projects and addressing the existing symptoms of environmental degradation affecting the sector.
- Propose and ensure the implementation of a public works program and the provision of basic services for rural and urban facilities, which support appropriate private investment.

Conclusion 5: The analysis and evidence presented indicates that the project will not generate a significant change in terms of magnitude or duration of scenic or tourist value of an area, as in the original situation.

f) Alteration of monuments, sites with anthropological, archaeological, historical and, in general, of cultural heritage

Based on the analysis presented the project does not generate or present disturbances in monuments, sites, anthropological, archaeological, historical and cultural heritage pertaining to general.

However, the action proponent reiterates the following background:

- In the area where the project will be located in no sites with anthropological archaeological and / historical exist.
- The project does not include the use of infrastructure or support systems in places outside the area.
- The project does not include the removal, destruction, removal, damage or modification of National Monument those defined in Law 17,288, or alteration or deterioration of buildings, places sites of construction, that are valued for their antiquity, scientific value, historical context, uniqueness, or cultural heritage.

Conclusion 6: Based on the analysis presented the project will not create or submit changes of monuments, sites with anthropological, archaeological, historical and cultural heritage

6.2.2. With regard to the provisions of Article 6 of the DS 95/01 MINSEGPRES, in particular paragraphs d), e), i), j), p)

Considering the facts presented in this document, Section 3, we conclude that:

1. Regarding the composition and quantity of hazardous solid waste, it is shown that the project will not generate or have significant adverse effects on the quantity and quality of renewable natural resources, including soil, water and air satisfactorily complied with the provisions of article 6, 95/01 MINSEGPRES DS, in particular paragraphs d).

2. Regarding the frequency, duration and location of solid waste management, it is shown that the project will not generate or have significant adverse effects on the quantity and quality of renewable natural resources, including soil, water and air as provided satisfactorily fulfilled Article 6 of the DS 95/01 MINSEGPRES, in the literal and specific.)

3. On the relationship between emissions of pollutants generated in the project or activity, it is shown that the project will not generate or have significant adverse effects on the quantity and quality of renewable natural resources, including soil, water and air and have successfully completed the provisions of Article 6 of the DS 95/01 MINSEGPRES, in particular theparagraph i).

4. Regarding the possibility of dilution, dispersion, self-cleansing, assimilation and regeneration, it is shown that the project will not generate or have significant adverse effects on the quantity and quality of renewable natural resources, including soil, water and air, complying satisfactorily with the laid down in Article 6 of the DS 95/01 MINSEGPRES, in particular the literal j).

5. Regarding the biological diversity present in the area of influence of the project or activity and its capacity for regeneration, it is shown that the project will not generate or have significant adverse effects on the quantity and quality of renewable natural resources, including soil, water and air ; complying satisfactorily with the provisions of Article 6 of the DS 95/01 MINSEGPRES, in particular the literal p). Finally with the environmental information presented, regarding the current condition of the grant, concludes that:

- ⇒ The concession area provides optimal conditions for environmentally sustainable production of 9,702, tons. to flee 0.4 tons. red abalone and 1,550 tons. Mussel biomass considering the maximum required in the technical project.

- ⇒ Considering the size of the project, the site features industry and operating under a **preventive** concept does not generate significant adverse effects on the quantity and quality of renewable natural resources, including soil, water and air.

- ⇒ The site aerobic conditions, provided as requested in the art. 17 and 3 of D.S. (MINECON) No. 320/2001. According to 2008 preliminary site characterization, submitted promptly to the authority in the EIS submitted in 2008.

- ⇒ Complying with the request in the art. 15 of D.S. (MINECON) N ° 320/2001, the CPS 2008, gave all the elements that should be considered environmentally fishing authority to evaluate the project.

7. BACKGROUND TO ASSESS COMPLIANCE WITH ENVIORNMENTAL STANDARDS

7.1 Environmental regulations applicable to the project:

Table 11: Enviornmental regulations applicable to the project and how to comply

Policy	Legal Body	Stage of Project	Form of compliance
Law No. 19,300 MINSEGPRES 1/01/94	Basic General Law on the Enviornment	Complete	Present an EIS to CONAMA Region X
Law No. 20417 MINSEGPRES 1/26/2010	"Crea el Ministerio," The Enviornmental testing service and the Supervision of the Environment. "	Complete	Present an EIS to CONAMA Region X under specific provisions
D. S. No. 95/01 MINSEGPRES	System Regulation Impact Assessment. Consolidated, Coordinated and Systematized. Under Article 2 of D. S. No. 95/01, of MINSEGPRES, amending Regulation System Assessment of Environmental Impact, published in the Official Journal, 7-Dec-2002.	Information Gathering	Present an EIS to CONAMA Region X
D.S. No. 430/1991 MINECON	General Law on Fisheries and Aquaculture and its Modifications, Text Revisions, consolidated and standardized.	Complete	Reference the articles specific to environmental regulation such as Articles 1, 67-90, 122, and 136
Law No 20.434	Modification of the General Law	Complete	Reference the articles specific to environmental regulation such as Articles 1, 67-90, 122, and 136 and their modifications
D.S. No. 320/01 MINECON	Environmental Regulation Aquaculture (RAMA) and modifications.	Operating	The aquaculture activities, are subject to compliance with environmental protection measures, through measuring instruments of bodies of water, the operational regulations under the general and specific rules of the Preliminary Site and Environmental Information.

D.S. No 319/2001 and its modifications (MINECOM)	Regulation of protective measures, control and eradication of diseases that are a high risk to aquatic species.	Whole Project	The action proponent shall comply with this decree, mainly to the referenced Title 3 on health programs
D.S. No 345 of 2005 (MINECOM)	Hydrobiological pest regulation	Operating	Do not cultivate or introduce living modified organisms without express permission of the SubPesca
D.Ex. Nº 1892 of 2009 (MINECOM)	extractive resources for sea lions in the area and time period indicated	Construction and operation	The action proponent will not allow the use of firearms and establishes the policy for the protection of flora and fauna.
Res. No 3612/2009 Subsection on Fish	Adopted resolution that fixes the Methodologies for Developing the Preliminary Site Characterization (CPS) and the Environmental Information (INFA).	Whole Project	The owner shall comply with the provisions of this resolution, especially those in reference to the methodologies applicable. to the Environmental Report submitted to the authority in the operation and production stages.
D. S. Nº 225/1995 MINECON, modified for D. Ex. MINECON N ° 135/2005	Establishes restrictions that protect birds, mammals reptiles and penguins.	Operation	Both decrees apply in the construction and operation stages. Further actions to protect and conserve and protect wildlife will be considered.
Res. No 765/2004 Subsection on Fish	Protection of Sea Lions	Operation	Consider appropriate actions that correspond with protect Sea Lions
D. S. No 1/1992 Ministry of National Defense	Regulations for controlling water pollution	Completion	Compliance with the regulations, particularly in Articles 108 and 109.

8. Environmental Sector Permits

The project discussed in this Environmental Impact Statement (EIS) involves the following environmental sector permits:

Table 12: Environmental Sector Permits

SEIA	Legal Body	Background for granting PAS
Article No 74 of D. S. No 95/01	Permission to make work and activities of aquacultures refers to Title VI of Law No. 18,892, Law on Fisheries and Aquaculture and its amendments, the text of the consolidated, coordinated and is contained in D. S. No. 430, 1991, the Ministry of Economy, Development and Reconstruction.	The attached appendices are contingent plans that establish all measures to minimize the potential and possible impacts that could result in the project in its operational phase.

This EIS indicates the appropriate environmental measures necessary for the optimal cultivation and production of aquatic resources, in compliance with current environmental regulations.

9. Project and its relationship to Policies, Plans and Programs of Regional and Community Development.

1. Regional Urban Development plan din the Lake Region.

The economy of the Lake Region is based on agriculture, livestock, forestry and fishing. The industry processes that occur in this region include: cattle milking, preserves, primarily shellfish, extensive grain agriculture, forestry and tourism. Gross Domestic Product of the Lakes Region reached 284,920 millions of pesos, according to figures from the National Statistics Institute (INE) 2000. The main economic activities are agriculture, which includes the cultivation of grains, the top livestock breeds of cattle for milk and meat, forestry, production and exportation of lumber (woodchips), and fishing, with a strong development in types of shellfish, salmon, trout and oysters, among other species. Although aquaculture has impacted all areas, this impact has occurred particularly in the Chiloé Islands,

The mass cultivation of macroaglae is within the concession area and constitutes a promising method of clean production that can lead to a new direction in local aquaculture and is directly tied to projects, policies, regional plans and programs, and community development.

Within the Regional Government Plan 2006-2010 (www.regiondeloslagos.cl), the project is part of the strategic guidelines for economic development, as it is a productive activity of regional importance, which seeks to diversify the aquaculture sector, complying with policies regarding the use of the coastline, creating technology support and development of markets, leveraging both companies and the fishing trade.

For the year 2020 the area around the coastline diversify their production activities by incorporating small-scale aquaculture, special interest tourism, and trade and recreational fishing, protecting the environmental sustainability of the territory.

Within the strategic guidelines, is the development of aquaculture technologies that safeguard the environment, in order to obtain a sustainable resource management in aquaculture.

The implementation of this type of aquaculture project encourages high commercial prospects (in the local community) and low environmental impact in mass production due to the beneficial contribution it generates in reducing atmospheric CO_2 levels .

2. Community Development Plan of Curaco de Velez.

Traditionally the people of Curaco spend time planting potatoes, wheat, and oats. Migration to Patagonia is not necessary, as another important source of income is the activities such as aquaculture, tourism, forestry and the harvesting and planting of *Gracilaria*.

The fishing activity is concentrated over 40% of the active labor force in the district, being one of the main forms of labor. These are, however, temporary jobs and are considered unskilled labor similar to salmon harvesting and fishing in the surrounding the creek.

The strategic economic- production matrix projected for the community of Curaco de Velez will develop policies that promote the association between economics, innovation, product diversification, and access to new markets. Thus, the aquaculture industry is one of the main economic activities on the community and regional levels. At this point the importance of such activities should be recognized since it is designated "an area of significant growth for the next 10 years."

In this case, the project emerges within the community as an economic and employment opportunity for Curaco de Velez and its surroundings, developing services and supplies for community-based support to the project activities, and boosting economic growth within the community.

10 . Voluntary environmental commitments.

Regarding its potential for tourist use, the action proponent suggests the following voluntary actions to conserve the aesthetic beauty of the area around the facility:

⇒ Will train and instruct the personnel with operational measures that can prevent the release of the cultures, as well as, loss of cultivation materials (ropes, buoys, etc). This initiative will reduce the presence of plastic or other solid waste in the coastal edge of the activity. In case of the existence of waste, especially plastics, items will be collected and sent to recycling centers.

⇒ There will be no activities that alter resources or elements related to the environment and to tourism. The cultivation rafts will be restricted solely to the space designated for this work.

11. Signature of the Enviornmental Impact Statement.

Under oath, I state that, based on the facts presented in technical project 210103056 complies with environmental regulations associated with the execution of the project activities.

Domingo Jimenez Olmo

5.547.596-2

12. Appendices

Appendix	Content
1	**Antecedentes del Proyecto** 1. Proyecto Técnico según R. EX. N° 1062 N° PERT 209103104 2. Proyecto Técnico Modificado N° 210103056 3. Carta DAC N° 1398
2	**Análisis CPS e INFAs**
3	**Antecedentes de instalaciones en mar** 1. Plano de Fondeo 2. Esquema de Instalaciones
4	**Antecedentes Legales del Titular** 1. Rut Representante Legal 2. Rol Único Tributario de la empresa 3. Conservador de Bienes Raíces (Poder a Representante Legal) 4. Conservador de Bienes Raíces (Vigencia de la Sociedad) 5. Escritura de la Sociedad

District of Columbia :

:

Washington :

AFFIDAVIT OF TRANSLATION

RE: Declaración de Impacto Ambiental, "Modificacion de proyecto technico: Cultivo de *Macrocystis pyrifera* en sistema suspendido" (2010)

TO WHOM IT MAY CONCERN:

I, **Norman Kaufmann,** being duly sworn, hereby affirm that the following is true and correct to the best of my knowledge, information and belief:

I am thoroughly fluent in the Spanish and English languages, and I have carefully made the attached English translation from the attached Chilean Environmental Impact Statement document written in the Spanish language. The attached translation is a true and correct English version of the attached document.

Norman James Kaufmann
1647 Fuller Street NW, Apt 3. Washington DC 2009

SWORN AND SUBSCRIBED TO

BEFORE ME THIS 10th DAY

OF November, 2010.

Notary Public

YVONNE R. STEWART
NOTARY PUBLIC DISTRICT OF COLUMBIA
My Commission Expires May 31, 2013

STATE OF VIRGINIA

CITY OF ARLINGTON

AFFIDAVIT OF TRANSLATION

RE: Declaración de Impacto Ambiental, "Modificación de proyecto técnico: Cultivo de *Macrocystis pyrifera* en sistema suspendido" (2010)

TO WHOM IT MAY CONCERN:

I, Rafael Arnaldo Olivieri, being duly sworn, hereby affirm that the following is true and correct to the best of my knowledge, information and belief:

I am thoroughly fluent in the Spanish and English languages, and I have carefully made the attached English translation from the attached Chilean Environmental Impact Statement document written in the Spanish language. The attached translation is a true and correct English version of the attached document.

Rafael Arnaldo Olivieri, Ph.D.
5108 Claytonia Ct
Annandale, VA 22003

SWORN AND SUBSCRIBED TO

BEFORE ME THIS

12TH OF NOVEMBER, 2010.

Notary Public

CLARISSA AYENSU
NOTARY PUBLIC
COMMONWEALTH OF VIRGINIA
MY COMMISSION EXPIRES 12/31/2011
COMMISSION #7127754

12TH NOV 10 Notary Public
County Arlington
Notary Public
12/3 2011