

# ENVIRONMENT

COMPANY PROFILE AND  
STATEMENT OF CAPABILITIES 2024



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# 1 Company Profile

## About TECHNITAL

### *Description*

TECHNITAL is a private joint stock company established more than 50 years ago (in 1964) and is one of the oldest engineering consultancy companies in Italy. Thanks to its high level of expertise, its dynamic nature and versatility, management autonomy and efficiency and its sophisticated hardware equipment and software libraries, the Company has been awarded large scale international and national projects by major public and private entities and by international funding organizations.

TECHNITAL's headquarters are situated in Verona, Italy. The organization abroad includes 15 between branches and subsidiaries in Algeria, Armenia, Bosnia & Herzegovina, Croatia, Djibouti, Georgia, Iraq, Kenya, Kosovo, Qatar, Tanzania, Trinidad & Tobago, Tunisia, Uruguay and Zambia and a number of local offices which is continuously changing according to the on-going international projects (at the moment there are 4 local site offices).

### *Services*

TECHNITAL is a dynamic company working in the fields of transport infrastructure (roads and motorways, railways, inland waterways, urban transport, ports and airports), hydraulics (water treatment and desalination plants, dams, aqueducts, sewerage systems, waste water treatment), marine and coastal engineering, environment, energy (incineration and waste-to-energy plants, hydroelectric plants, solar plants, biogas plants), waste treatment (recycling plants, dump sites), buildings, architecture and urban planning.

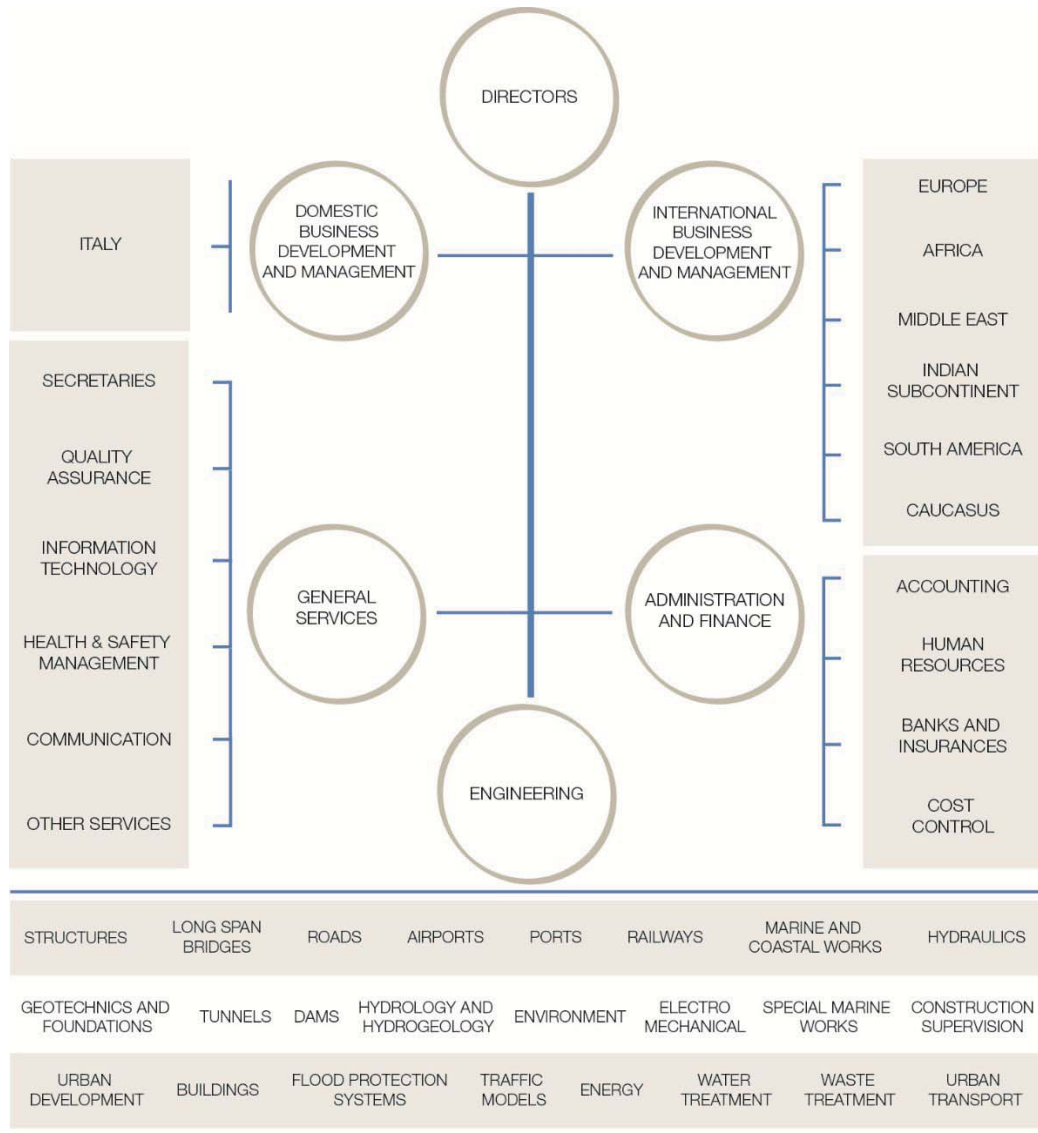
The company covers the full range of services, from planning and feasibility studies through to detailed design, works supervision and technical assistance:

- } project management
- } planning and economic-financial evaluation of investments
- } feasibility studies and technical-economic evaluations
- } all levels of design
- } environmental impact assessment and studies
- } traffic studies
- } procurement and assistance with tenders
- } construction supervision, quality assurance, testing and commissioning
- } co-ordination and supervision of research and laboratory tests
- } development of hydrodynamic and hydrogeological analysis and simulations
- } development and application of analysis methods and computer modelling.

TECHNITAL has worked in several countries world-wide: Afghanistan, Albania, Algeria, Angola, Argentina, Armenia, Australia, Austria, Bahamas, Benin, Bolivia, Bosnia & Herzegovina, Brazil, Bulgaria, Burkina Faso, Burundi, Cayman Islands, Colombia, Croatia, Cuba, Cyprus, Czech Republic, Democratic Republic of the Congo, Denmark, Djibouti, Dominican Republic, Egypt, Ethiopia, Georgia, Germany, Ghana, Greece, Guatemala, Hungary, India, Iraq, Italy, Jordan, Kenya, Kosovo, Libya, Madagascar, Malawi, Malaysia, Mali, Mauritania, Monaco, Montenegro, Mozambique, Nicaragua, Niger, Norway, Panama, Peru, Poland, Qatar, Republic of Haiti, Romania, Russia, Rwanda, Saudi Arabia, Senegal, Slovenia, Somalia, Spain, Sudan, Syria, Tanzania, Togo, Trinidad & Tobago, Turkey, Uganda, Ukraine, U.A.E., United Kingdom, U.S.A., Uruguay, Venezuela, Yemen, Zambia.

*Organization and staffing*

TECHNITAL's multidisciplinary staff is organized according to the following chart:



**TECHNITAL's multidisciplinary staff includes about 250 professional employees covering the various aspects of the engineering services:** Transport, Hydraulics, Geotechnical, Marine & Coastal, Environmental Studies & Territorial Analysis, Structures, Electronic Data Processing & Systems Analysis, Quantity Surveying & Cost Estimation, Electromechanics, BIM/CAD/CAE, Works Supervision, etc.

The above staff is integrated by consultants and specialists, both Italian and foreign. Seeking support and advice from colleagues, scientists, and academics all over the world is part of TECHNITAL's policy of excellence.

Given the firm's considerable international experience, TECHNITAL's staff is proficient in the use of international engineering standards (BS, ASTM, AASHTO, ASME, API and the like) and contract conditions (FIDIC and others).



### *Quality control*

TECHNITAL's activity is ISO 9001:2015 Quality System Management certified. The company is also certified ISO 14001: 2015 Environmental Quality Management, ISO 45001:2018 Occupational Health and Safety Management System and SA 8000:2014 Social Accountability Management System.

TECHNITAL has developed a company policy regarding quality control which is constantly being updated and applied, taking into account the costs to be sustained to achieve the objectives of quality and maximum benefit for both the Company and the Client. Thanks to its Quality Control System, TECHNITAL is capable of guaranteeing the quality of its services and of ensuring the Client that these services satisfy the required quality standards.

### *Code of Ethics*

Ethical and responsible decision making is very important for the company in terms of risk management and in order to keep actions within the ethical and legal boundaries.

For that reason, the company is adopting a Code of Ethics (available from the web site of the company) and conduct for its Executives and Directors and for all the Employees able to fulfil requirements for responsible decision taking. Such code aims at reducing the possibility of stepping outside behavioral limits set by the company.

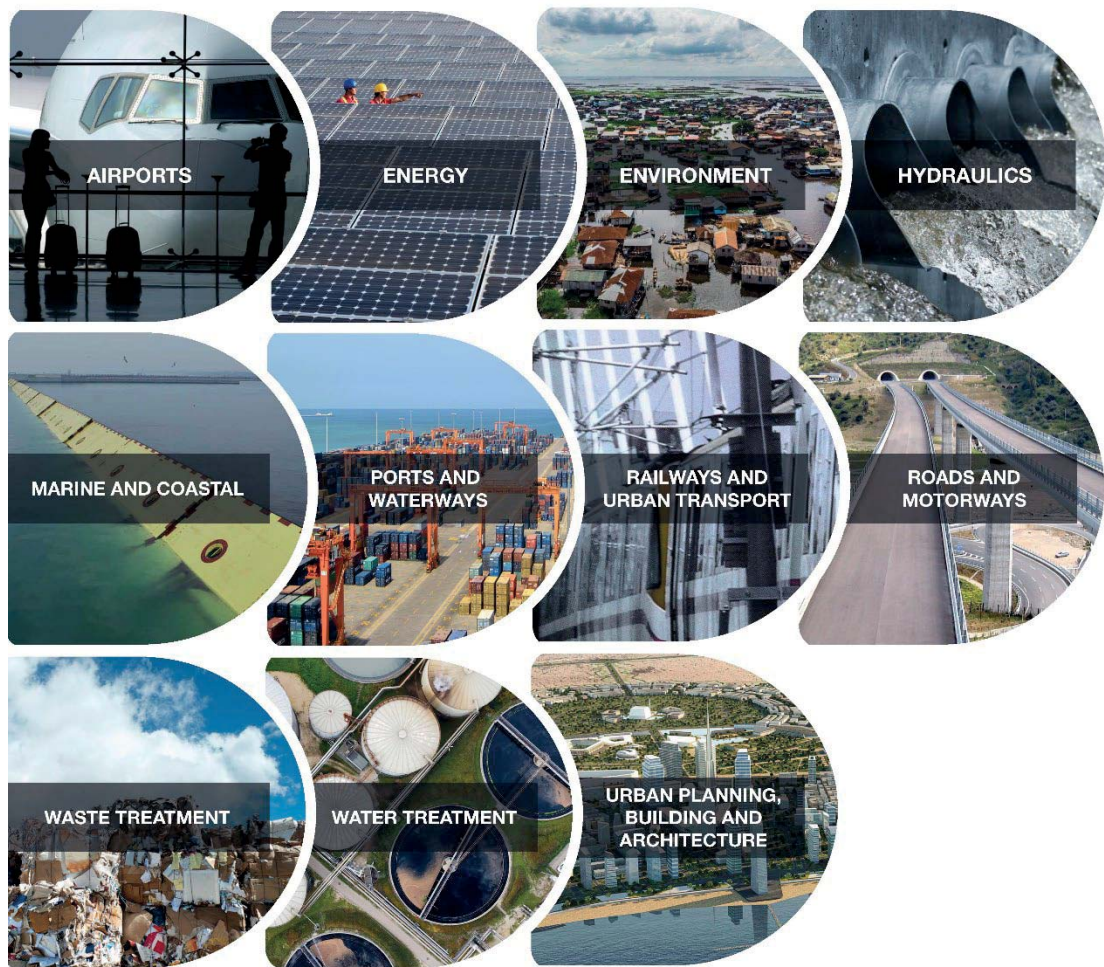
The Code of Ethics the company is adopting also meets the Organization, Management and Control Model pursuant to Italian Legislative Decree n. 231/2001.

*Sectors of Specialization*

TECHNITAL provides high-quality consultancy services in different areas of specialization: Roads and Motorways, Railways and Urban Transport, Airports, Ports and Waterways, Marine and Coastal Engineering, Environmental Engineering, Urban Planning, Buildings and Architecture, Hydraulic Engineering, Water Treatment, Waste Treatment, Energy.

In each of these sectors TECHNITAL provides innovative project solutions to Government Agencies, International Financial Institutions and Private Sector Organizations.

Services provided by TECHNITAL include master plans, feasibility studies, techno-economical evaluations, traffic studies, mathematical and physical modeling, all phases of design from concept to detailed design, environmental impact studies and monitoring plans, tender document preparation and assistance in the procurement of works, construction supervision.



## 2 Our Experience

### Experience in Environment

TECHNITAL has been operating in the field of environment since the early seventies and has therefore been able to acquire a considerable experience which ranges from planning and management to research applications and the design of environmental recovery interventions.

These activities can be summarized under the following headings:

- } territorial planning;
- } territorial and environmental resources management;
- } landscaping;
- } water quality restoration;
- } waste disposal and treatment;
- } landfills and recovery of polluted sites
- } environmental impact evaluation and monitoring.

In recent years TECHNITAL has developed several significant projects concerning the recovery of polluted industrial sites and the disposal of contaminated sediments, e.g. in the port of Marghera (Venice lagoon) and the Port of Naples, and for the recovery and protection of natural environments (lagoon, coastal, river, etc.). Following the latest technical and scientific developments, the firm has extended its sphere of interest to the naturalistic and eco-technological sectors, realizing several avant-garde designs, such as: the transplanting of seagrasses to reduce the coastal erosion phenomena; the morphological reconstruction of lagoon salt-marshes lost by erosion; the creation of artificial wetland areas to reduce pollution loads of diffuse origin.

Besides the design of works and interventions directly related to environmental quality improvement and recovery, the firm's concern for the environment can also be seen in the attention paid to the environmental aspects of "traditional" design work (such as civil, marine, transport and hydraulic engineering). According to this approach, consideration is given in the design to the environmental context of the new work, so that the design choices can be evaluated on a broader basis, including the negative effects which are therefore minimized.

To deal properly with environmental problems a multidisciplinary approach is necessary; for this reason, the firm avails itself of a team of experts in various fields: natural sciences, agronomy, geology, chemistry, biology, town planning, and informatics, who can guarantee the required expertise to manage the various design aspects:

- } planning and organization of the field campaigns;
- } data analysis and processing;
- } description of the present quality of the environment;
- } identification of the problems;
- } choice and design of the remedial interventions;
- } organization of monitoring and management programs.

The various design phases are assisted by advanced computer tools, namely mathematical models and geographical information systems (GIS), which constitute an integrated and articulated system. TECHNITAL uses the best-known software available on the market, and has also developed its own sophisticated ecological and hydro-geological models to study the effects of innovative engineering works particularly in the water environment.

Some of the numerical models usually applied, include:

- } hydrodynamic models, able to reproduce the all the main hydrodynamic phenomena (drying and flooding of tidal flats, density driven flows, wave induced stresses and mass fluxes, flow through hydraulic structures wind driven flows including cyclonic / hurricane / typhoon winds etc.);

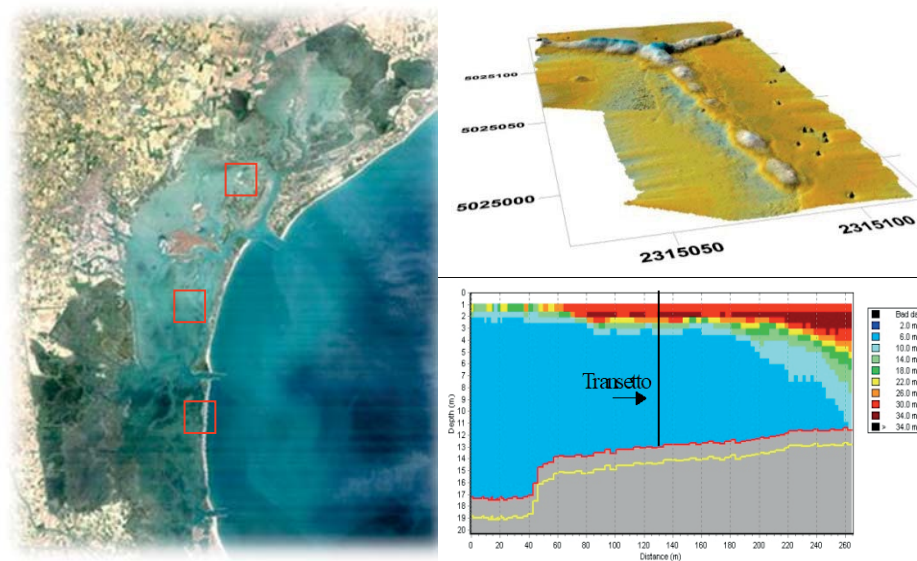


- morphological models, to study the solid transport, the sediment distribution patterns, the erosion /deposition phenomena; shoreline evolution
- water quality and ecological models; able to reproduce the main ecosystem processes (algal blooms, primary production, nutrients uptake etc.) as well as the fate and transport of pollutants in the environment
- air and noise models to study the emission patterns from multiple sources and evaluate the behavior of pollutants under different environmental conditions (temperature, humidity, wind etc.);

Among the recent activities carried out in the field the following are worthy of mention:

Foremost among these is the vast **Project for the protection of Venice and its lagoon from tidal flooding**, for which TECHNITAL has been solely responsible, which has involved numerous projects and studies regarding environmental recovery and protection works and environmental impact studies, including:

- *Environmental studies in relation to the construction of the Venice flood barriers (MOSE Project)*
  - Dry basins at Chioggia and Lido inlets for the prefabrication of giant concrete structures to be floated to location for the construction of the flood barriers
  - Complementary research on the ecosystem of Venice lagoon
  - Monitoring of lagoon and marine biological populations at the port inlets
  - Monitoring of construction of the mobile barriers at the port inlets.



Monitoring of Lagoon and Marine Biological Populations at the Port Inlets of Venice Lagoon

- *Plan of interventions for the protection of Venice and the other centres in the lagoon from tidal flooding ("REA Project" - Rebalancing and Environment).* The project included the selection of the solution for the flood barriers at the lagoon inlets, evaluating not only their efficacy and technical feasibility, but in particular the possibility of their harmonic insertion in the lagoon morphology without significantly affecting the pollution problem or interfering with navigation; the checking out of the effects of each solution considered on the all these factors, by means of comprehensive studies, and physical and mathematical model tests; the identification of the system for managing the closing of the lagoon inlets; a comparative study of the design alternatives, and the definition of the design choices.

- } *Dredging the navigation channels and rebuilding the eroded saltmarshes and the tidal flats using the treated dredged material.* The project aimed to counteract the rapid morphological changes (disappearance of the saltmarshes, filling in of canals and deepening of shoals) by identifying the causes in each area and defining the appropriate remedial measures, including the design of the works for the reconstruction of marshlands and tidal flats, and for the reshaping of the navigation channels.
- } *Sea defences for the ports and lagoon of Venice.* Following a detailed study of the hydrodynamic and morphological system of the coastline, the company developed the design of the interventions for the restoration and protection of some 40 km of coastline between the mouths of the Brenta and Sile rivers, including the littorals of Pellestrina, Cavallino, Lido and Sottomarina, all affected by erosion processes. The design included extensive beach nourishment (with reconstruction of coastal dunes and replanting of the flora), an environmental impact study of the whole project (including borrow areas and dredging activities), and design of a monitoring programme to evaluate the impacts on the aquatic environment.
- } *Improvement and rehabilitation of the Venice Lagoon ecosystem.* To deal with the problem of the increasing pollution of the lagoon water, with its consequences on the physical and biological environment, the project aimed to understand of the causes of environmental deterioration and identify possible interventions to reduce the widespread water pollution and to restore the natural conditions of the ecosystem to acceptable levels in the shortest time possible. The design activities also included the development of the detailed designs of priority interventions and the definition of management scheme to control and monitor the lagoon environment.

Subsequent activities related to the environmental recovery of Venice lagoon include:

- } Design of works to improve the ecological and landscape value of the reconstructed tidal flats and saltmarshes;
- } Analysis of measures to counteract accidental oil spills in the lagoon;
- } Research on the sediments and waters in channels of Porto Marghera and the facing areas of Venice lagoon;
- } Groundwater modelling in the Venice industrial harbor of Porto Marghera;
- } Environmental recovery of various polluted sites in the lagoon.

Other significant environmental projects include:

**Preliminary and Detailed Design of the Wastewater Treatment System of Ganvié (Benin)** The project "Reinventing the Lake City of Ganvié" is part of the Government's action plan as one of the top priority projects of Benin in the tourism sector. Nowadays, the city of Ganvié consists mainly of stilted houses on the lake Nokoué with a population of around 37.000 inhabitants. The human presence together with presence of animal farms has generated serious conditions of pollution of the water of the lake (brackish water as the lake is in communication with the sea) which has led to deplorable hygienic conditions affecting fishing and touristic activities. The project's objective is the identification of a wastewater collection and treatment system with reference to the future scenario with a resident population of 73.000 inhabitants plus the tourist population fluctuating around 11.000 people.



**Studies and investigations relating to the preparation of a regional master plan for the inland waters (especially the lakes) of Lombardia Region** which involved the definition of the environmental framework of the main Lombardy lakes – Garda, Iseo, Como and Maggiore (subsequently extended to include Lake Lugano and the minor lakes of the region) – in relation to water quality, fauna, road and lake traffic, population, existing urban and area plans, etc.

**Extension of the catchment basin of Lake Trasimeno in Umbria Region:** Lake Trasimeno, occupying an area of 120 km<sup>2</sup>, with a maximum depth of 6 m, is a unique swamp environment in central Italy and of great natural and landscape significance. The hydraulic-environmental project aiming at obviating the diminishing water level of the lake, involved the creation of connections to neighboring hydrographic basins, preceded by detailed topographic surveys, geognostic investigations and studies of sediment and water quality.

**Environmental protection of the River Sarca - Lake Garda - River Mincio - Mantuan lakes system:** The study defined an exhaustive framework of knowledge regarding the environmental quality of the area through field surveys and investigations and modelling studies, identifying the interventions needed to improve the quality of the water in the basin, to optimize the water treatment system and the recycling of the treated waste water, define the necessary regulatory measures, and identify the tools required for monitoring the efficacy of the actions.

**Master Plan for the Piave River basin: study of the water resources - Veneto Region.** The project concerned the development of the Master Plan in relation to the Piave River, involving a catchment area of some 4000 km<sup>2</sup>, including the completion of the framework of knowledge regarding the quantity and quality of the water resources, the development of a mathematical model to analyse the capacity of the basin to satisfy the local water demand, and the application of the model to study various intervention schemes for improving water quality and supply.

**Environmental rehabilitation of the coastal wetland of Molentargius and protection and environmental recovery works for the Poetto littoral.** Within the scheme of interventions launched by the Italian Government to rehabilitate the wetland of Molentargius (a very peculiar and fragile ecosystem included in the Ramsar list of areas to be protected), the company was entrusted with the definition of the general plan of the intervention, the environmental impact assessment study and the Detailed Design of coastal works (including beach nourishment with submerged protection works; reconstruction of the natural inshore dune and its protection with marram grass vegetation; protection of sea bottom by planting *Posidonia Oceanica*).

**Master Plan for Livenza, Tagliamento and Lemene river basins.** In the context of the Master Plan of the three river basins (total area of approx. 6,000 km<sup>2</sup>) for the hydrological and hydraulic protection of the soils, the sustainable socio-economic development of the area, the preservation of natural resources, and the depollution of waters and soils, the company carried out preliminary investigations and analyses, mathematical modeling studies, geological surveys, measurements and monitoring.

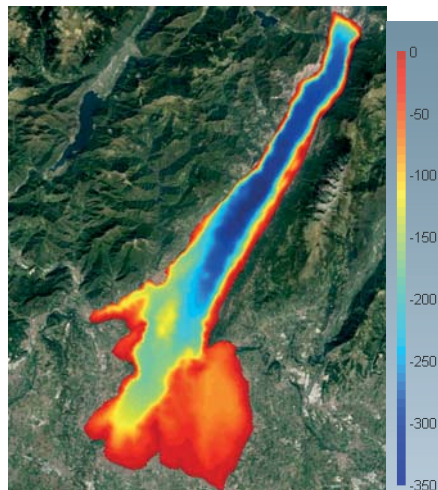
**INTCATCH** is a multi-country research coo-financed by the European Commission aiming at developing efficient, user-friendly water monitoring strategies and systems based on innovative technologies that will provide real time data for important parameters, moving towards SMART



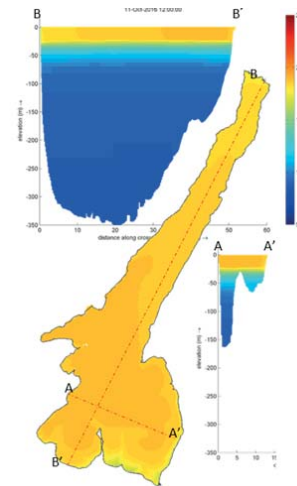
Rivers. The INTCATCH project uses demonstration activities to showcase eco-innovative autonomous and radio controlled boats, sensors, DNA test kits and run-off treatment technologies.

The new INTCATCH products will be tested in four demonstration sites across Europe, which are the Lake Garda (in Italy), the suburban rivers of London (UK), the River Terr in Catalunya (Spain) and the lake Yliliki in Greece.

Garda Lake is definitely the most important site with a surface area of approximately 371 square Km (maximum length of approx. 52 km; maximum width of approx. 17 km), Garda Lake is the largest lake in Italy and one of the largest in Europe. The depth ranges between several tens of meters in the southeast region down to 350m in the middle part. It is a very popular tourist site and is located in northern Italy, between the towns of Brescia and Verona. Its origins date back to the last Ice Age when glaciers formed this alpine region.



Simulated Water Temperature



Depths (m) of Garda Lake

Garda Lake is definitely the most important demonstration site due to the complexity of the physical environment and because it represents one of the most important water resources and attractions for industrial, tourist, agriculture and drinkable uses. Garda Lake is a strategic drinking water basin indeed which contains about 30% of the national surface water which quality must be highly preserved and safeguarded.

The company is in charge of the development of the Development and validation of water quality model and DSS (Decision Support System).

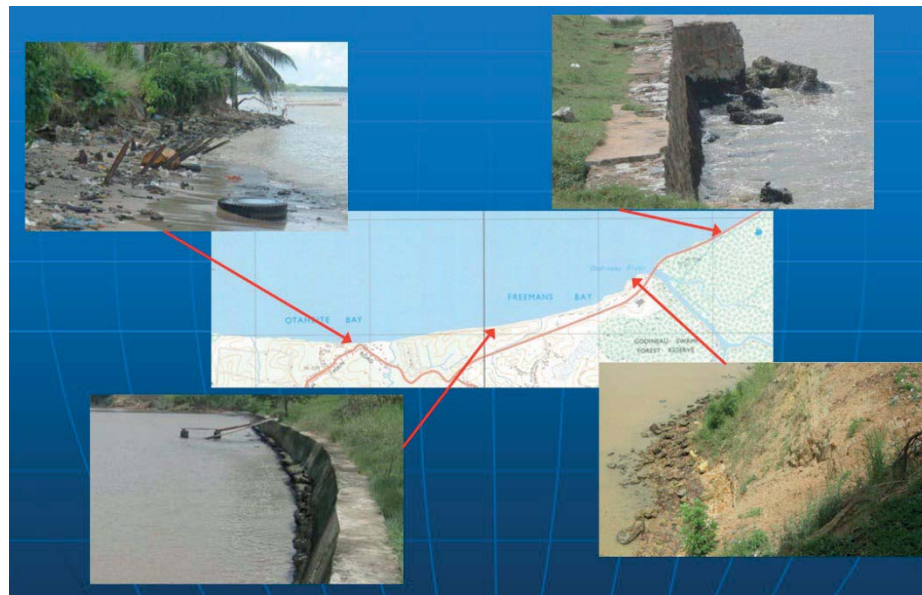
**Karavasta Lagoon Wetland Management Projectin (Albania):** This EU Phare contract involved the supply of Technical Assistance and Consultancy services for the sustainable development of Karavasta Lagoon, (a potential Ramsar Site). The programme will foster social development of the wetland through an optimal and sustainable use of the economic potentials of the area for eco-tourism, fisheries and compatible economic activities involving local inhabitants.

**Design and Environmental Impact Study of the Oropouche Bank reclamation (Trinidad and Tobago):** This large (1,600 ha) reclamation scheme near the West coast of Trinidad was planned by the Government for the development of a new industrial park to be occupied by gas based industries

The contract includes the following studies and determinations:

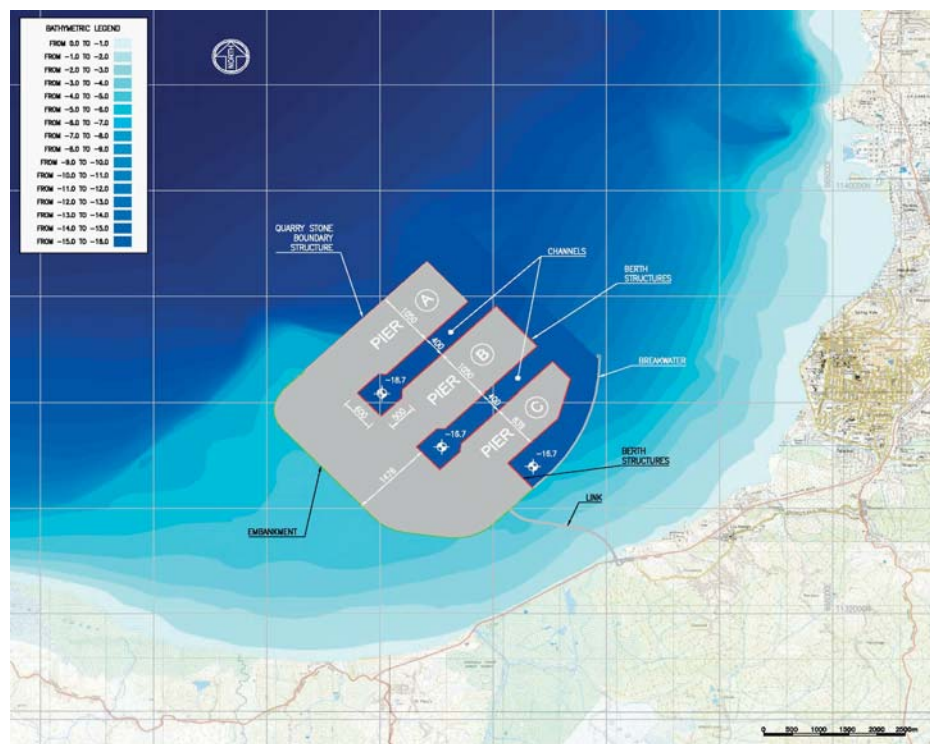
- ↳ location and shape of the new island; this activity involved the performance of several environmental analyses in order to define the most sustainable solution in terms of environmental impact (on the existing sea defences, on littoral currents generated by tides and waves, on relevant river discharges, on the coastline evolution, on the littoral transport, on the swamp area located behind the coastline,

etc.) and social impact (on the fishing activities, on the location of residential areas in terms of noise and air pollution, on the road connections, etc.);



Coastal protection: identification of critical areas

- identification of the most appropriated source of the filling material (roughly 100 million m<sup>3</sup>), analysing the different possibilities offered by Trinidad & Tobago and the neighbouring countries and considering the connected impacts on the sea floor and on the aquatic life;



Completion of the reclamation

- identification of the most appropriate construction methods to be adopted for the reclamation, to minimise the impacts on the local environment as well as on the

local communities and preliminary definition of the environmental monitoring activities to be implemented

**Environmental modelling activities for the new Al Faw Grand Port (Iraq):** The new Grand Port of Al Faw(Iraq) will be located in the most North-Eastern part of the Arabian Gulf, along the in the Khawr 'Abd Allah Channel, dividing the Iraqi coast from the Bubiyan Island (Kuwait). Due to high energy characteristics of this site (tides, waves, winds, etc.), a very detailed study was carried out in order to analyse the evolution trend of the coast in the present situation and modifications the new port might induce in the future. The study focused on hydrodynamic and morphological aspects, with a special care to the evolution of the coast and to settling processes. To achieve these goals, a very detailed measurement campaign was carried out to directly investigate hydrodynamics and sediment transport processes. Specific mathematical models were set-up and calibrated in co-operation with Deltares Foundation (Delft - The Netherlands) and applied to achieve also quantitatively information about these phenomena. The results of the study were taken into account to drive the design of the new port and to identify, if necessary, mitigation measures to minimise negative effects.

**Market Study: Opportunities to Implement Sustainable Strategies in the Maritime Sector:** Maritime transport and ports are essential components of international trade and goods movement. Although international maritime transport is the most energy efficient mode of mass transport, it carries 90% of world trade and it is a major contributor to global CO2 emissions (2.7% in 2007). A global approach for further improvements in energy efficiency and emission reduction is needed as sea transport is predicted to continue to grow significantly in line with world trade. EBRD requested consultancy services for conducting a market review about the current status and prospects of the sustainable strategies in the maritime sector in order to provide recommendations to the Bank with regards to its strategy for investing in the sector in the next years. The project involved the execution of a number of activities including the collection of national and international requirements related to the sustainability in the maritime sector, considering legal requirements, international codes and associations (such as European Sea Ports Association), the collection and analysis of good practices already implemented in ports worldwide, with respect to energy consumption, climate change, waste management, air pollution, water pollution etc., the review of the present conditions in targeted ports within three main areas: Baltic Sea, Black Sea, Adriatic Sea and analysis of the main development trends, a benchmark analysis of the situation of the ports with respect to transport flows, current organization and management development opportunities, the identification of opportunities for investing in sustainable practices in the targeted ports considering cost, benefits, expected paybacks, current applications etc of the most promising sustainable practices and finally the definition of an action plan for the practical implementation by the Bank of the proposed investment opportunities

**Environmental Surveys at the NDIA site, Qatar:** Technital was awarded a project for the production of design and tender documentation for the construction of the reclamation (including the required revetment) of an area located in the North-Western part of the site and previously used as a disposal for building and construction waste. The project is part of the works for the construction of the new International airport of Doha. A large part of the airport is built on site reclaimed from the sea. In the framework of this assignment Technital was required to undertake several environmental investigations in order to comply with requests issued by the Ministry of Environmental, which conditioned its approval to the construction activities to an evaluation of the environmental conditions at the site. The main objects of the investigations were to ascertain the presence of pollution in the area as a consequence of the disposal of waste and to verify the ecological status of the site and the presence of protected or rare marine species. The field surveys included the collection and analysis of water and sediment samples as well as of biological specimens of benthic fauna and flora. After the execution of the surveys, Technital produced an Environmental Management report and an Ecological Survey Report, containing recommendations on the procedures to be followed during the execution of the works and proposals for the environmental mitigation.

**Environmental Impact Study of the development of new roads in the town of Doha – Qatar:** The project scope includes the assessment of the environmental impacts of the construction of



eight packages, with a total area of 30 sq. km. and a total length of roads equal to approximately 385 km. Packages 7, 8, 11, 14 and 17 are empty areas which have been recently sub-divided into residential areas with small commercial outlets, while Packages 9, 12 and 13 are densely populated areas with commercial streets located in the heart of the city and will involve major redevelopment.. A number of environmental studies were undertaken. Several site investigations were performed in order to collect baseline data on present environmental conditions. Site investigations were related to noise levels, soil and groundwater quality, marine water quality and tidal and current and tide measurements. The activities performed also included the definition of the mitigation measures and of the monitoring activities to be performed in the later design stages. In order to comply with the State of Qatar Environmental Protection Legislation

The following table and related project sheets give full details of the main projects executed in this field.

TABLE A – COMPANY’S EXPERIENCE (For titles in bold type see project sheets in Appendix A)

PROJECT	CLIENT	PERIOD		ACTIVITIES	COST OF SERVICES €*	COST OF WORKS €
		FROM	TO			
<b>EIA AND MONITORING PLANS</b>						
<b>Flood control works on the Bozzente River - Italy</b>	Infrastrutture Lombarde SpA (ILSPA)	09/2016	09/2022	Concept Design, Preliminary Design, EIA	155,000	8,860,236
<b>Trieste Port - Strategic and Environmental Impact Assessment of the new Port Master Plan - Italy</b>	Trieste Port Authority	05/2010	01/2014	SIA, EIA	2,217,133	1,864,000,000
<b>Pre-Contract Professional Design and Quantity Surveying Consultancy Services for Design Update of Zone 40 – Qatar</b>	Public Works Authority (PWA)	03/2012	05/2013	Tender Documents, EIA	420,000	53,084,235
<b>Roads and Infrastructure – Phase 2. Packages 7, 8, 9, 11, 12, 13, 14 and 17 – Qatar</b>	Urban Planning And Development General Authority (UPDA)	04/2009	04/2013	EIA	640,000	1,550,000,000
<b>Environmental Impact Assessment of the Hydraulic Interventions on the Arno river drainage channel (Pisa) - Italy</b>	Province of Pisa - Servizio di Difesa del Suolo	10/2012	01/2013	Detailed Design, EIA	24,000	35,044,872
<b>Experimental Morphological Interventions for the Safeguarding of the Venice Lagoon - Italy</b>	VeneziaNuova Consortium for MoPW - Water Board - Venice	05/2008	07/2012	Preliminary Design, Detailed Design	1,116,000	n.a.
<b>Pre-contract consultancy services for beach development at Ras Ushayriq Peninsula (Emiro Beach) - Qatar</b>	Al-Ali Projects Co.	07/2011	05/2012	Preliminary Design, Detailed Design, EIA	400,000	31,400,000
<b>New Port settlement along the “Po di Levante” and safety measures of the navigable section of the river - Italy</b>	Sistemi Territoriali S.p.A	12/2011	03/2012	EIA Environmental Feasibility Study, Landscape Work Design	105,000	40,000,000
<b>New multipurpose platform in Vado Ligure – Italy</b>	Savona Port Authority	12/2008	07/2011	EIA	350,000	335,500,000

PROJECT	CLIENT	PERIOD		ACTIVITIES	COST OF SERVICES €*	COST OF WORKS €
		FROM	TO			
<b>"Gronda" Highway Bypass – Marine Deposit of the Genoa Airport – Italy</b>	Autostrade per l'Italia S.p.A. and Spea Ingegneria Europea S.p.A.	07/2010	04/2011	EIA	120,000	n.a.
<b>Pedemontana Lombarda Motorway connecting Bergamo to Malpensa Airport (80 Km) – Italy</b>	Autostrada Pedemontana Lombarda S.p.A.	05/2008	04/2011	Monitoring Plan, GIS	450,000	3,567,463
<b>Flood Control Works on the Olona River – Italy</b>	Agenzia Regionale per il Fiume Po (A.I.P.O.) – (Interregional Authority for the Po River)	01/2004	12/2011	EIA, Landscape Design	74,666	10,883,200
Environmental Impact Assessment study of the design of coastal protection works in the lagoon of Barbamarco (Po river delta) - Italy	Ferroviana Servizi Srl	11/2007	04/2008	EIA	47,736	n.a.
Monitoring and coordination of morphological reconstruction works - Venice lagoon - Italy	Venezia Nuova Consortium for Ministry of Public Works - Water Board - Venice	03/2005	12/2007	Monitoring, Works Coordination	113,300	434,800
<b>Master Plan for the morphological and environmental rehabilitation of the Venice lagoon - Italy</b>	Venezia Nuova Consortium for MoPW - Water Board - Venice	01/2003	12/2007	Feasibility Study, EIA, Detailed Design	1,210,000	n.a.
<b>Monitoring of lagoon and marine biological populations at the port inlets- Venice lagoon - Italy</b>	Venezia Nuova Consortium for Ministry of Public Works - Water Board - Venice	07/2003	02/2006	Coordination of the biological monitoring activities	380,000	n.a.
Extension of the catchment basin of Lake Trasimeno - Italy	Tiber River Basin Authority	04/1998	06/2000	Feasibility Study, Preliminary Design, Detailed Design, EIA	755,200	43,898,800
Plan of the works to protect Venice lagoon and towns from tidal flooding ("REA" Project) - Italy	Venezia Nuova Consortium for MoPW - Water Board - Venice	04/1987	10/1997	Concept Design, EIA	46,773,698	n.a.



PROJECT	CLIENT	PERIOD		ACTIVITIES	COST OF SERVICES €*	COST OF WORKS €
		FROM	TO			
Environmental protection of the River Sarca - Lake Garda - River Mincio - Mantuan lakes system - Italy	Po River Basin Authority	02/1996	02/1997	Concept Design, EIA	126,000	n.a.
Tourist development of the Fazenda Caeira - Island of Tinharé, Salvador - Brazil	European Union: ECIP 2 Programme	02/1995	06/1996	Feasibility Study, Preliminary Design, Environmental Study.	54,000	5,784,300
Improvement and rehabilitation of the Venice lagoon ecosystem - Italy	Venezia Nuova Consortium for Ministry of Public Works - Water Board - Venice	04/1992	12/1994	Preliminary Design, Detailed Design, EIA	2,644,200	235,504,300
<b>REMEDIATION</b>						
Recovery and upgrading of rural path "Tratturi" for tourism purposes - Italy	Municipality of Campodipietra	08/2023	Ongoing	Detailed Design, Works Supervision	5,422,371	129,000,000
Design of the nature park and regeneration of former Sant'Agostino Area - Italy	Municipality of Salerno	12/2022	Ongoing	Detailed Design, Works Supervision	498,305	22,000,000
Preliminary design for integrated diaphragm and capping of the Malagrotta landfill	Commissario Nazionale per le Bonifiche, Gen. Vadalà	09/2022	Ongoing	Preliminary Design	892,700	96,383,329
Preliminary, detailed design and work supervision for the completion of the landfill in Torretta di Legnago - Italy	LE.SE. LEGNAGO SERVIZI S.p.A.	07/2022	Ongoing	Preliminary design, Detailed design, Works supervision	505,456	26,760,681
Reclamation Project of the "Lo Uttaro" Area in Caserta - Italy	Campania Region	10/2020	Ongoing	Preliminary Design, Detailed Design, EIA	143,000	2,000,000
Reclamation works of the mineral oil polluted sites in Taranto - Italy	Demanio di Stato	12/2017	Ongoing	Feasibility Study, Detailed Design, Works Supervision	177,193	6,700,000

PROJECT	CLIENT	PERIOD		ACTIVITIES	COST OF SERVICES €*	COST OF WORKS €
		FROM	TO			
Construction of a confined dumpsite to be used as new container terminal in the port of Naples, Italy	Naples Port Authority	05/2003	12/2023	Preliminary, Detailed Design, Works Supervision, EIA	18,009,540	424,210,514
Detailed design of the environmental recovery of the dumpsite of Malagrotta (Rome) – Italy	E. Giovi s.r.l.	05/2021	12/2022	Detailed Design	499,500	400,000,000
Final design and construction of a waste route connecting the reactor building and the turbine building of the Caorso nuclear power plant - Italy	SOGIN S.p.A.	09/2020	12/2020	Detailed Design	48,000	1,731,384
Decommissioning of the cooling pool of the Nuclear Power Station of Garigliano in Sessa Aurunca- Italy	SOGIN S.p.A.	09/2017	05/2018	Detailed Design	136,930	1,400,000
Environmental recovery and extension of dumpsite for non-hazardous urban waste at Torretta di Legnago (Province of Verona) - Italy	Legnago Servizi S.p.A.	10/2007	07/2016	EIA, Preliminary Design, Detailed Design, Works Supervision	1,595,800	34,138,800
Environmental recovery of a dumpsite for steelworks near Lake Como (Lombardy Region) - Italy	Infrastrutture Lombarde S.p.A.	07/2012	05/2014	Preliminary Design, Detailed Design, Environmental Feasibility Study, Technical Assistance	79,400	599,400
Upgrading of the Tortona Sanitary Landfill – New Tank F - Italy	SRT S.p.A.	02/2008	10/2013	Preliminary Design, Detailed Design, EIA, Works Supervision, Technical Assistance.	279,940	11,100,000,
Upgrading of the Novi Ligure Sanitary Landfill - New Tank 6 - Italy	SRT S.p.A.	02/2008	03/2013	Preliminary Design, Detailed Design, EIA, Works Supervision, Technical Assistance	304,754	10,200,000

PROJECT	CLIENT	PERIOD		ACTIVITIES	COST OF SERVICES €*	COST OF WORKS €
		FROM	TO			
Biogas migration from closed landfills - Baraccone- Casale Monferrato. Italy	COSMO S.p.A.	05/2012	08/2012	Risk Assessment	20,000	n.a.
Environmental updating and setting of Borsano site - Italy	Infrastrutture Lombarde S.p.A	03/2010	07/2011	Detailed Design	195,845	3,016,833
<b>Oropouche Bank Reclamation Project – Trinidad &amp; Tobago</b>	National Energy Corporation of Trinidad & Tobago Limited (NEC)	08/2008	12/2010	Master Plan, EIA , Detailed Design, Tender Documents	3,070,000	1,870,911,000
Study of the water resources of the Piave river for river basin master plan - Italy	River Basin Authority for Isonzo, Tagliamento, Livenza, Piave, Brenta and Bacchiglione	03/1996	09/1997	Water quality study , Concept Design	80,600	n.a.
<b>Environmental recovery and protection of the coastal wetland of Molentargius and protection of Poetto littoral – Sardinia - Italy</b>	Consortium Ramsar- Molentargius for Ministry of Environment	06/1992	10/1993	General Plan, Preliminary Design, Detailed Design	621,500	61,974,800
<b>LANDSCAPE AND ECOLOGY</b>						
<b>Hydrogeological consolidation works for the north-east slope, downstream of Petacciato</b>	Molise Region	05/2022	Ongoing	Preliminary Design, Detailed Design, Works Supervision	2,024,662	28,531,435
<b>Planning associated with the Landslide Phenomenon in the Northern Sector of the built-up Area of Civitacampomarano</b>	Commissario Straordinario Regione Molise	03/2022	Ongoing	Geology, Geotechnics, Hydrological studies.	724,456	8,191,800
Historical center consolidation project, santo Stefano district. Settlement of the landslide of Caltagirone – Italy	Government Commissioner against hydrogeological instability in the Sicilian Region	07/2021	Ongoing	Detailed Design	144,500	3,350,000

PROJECT	CLIENT	PERIOD		ACTIVITIES	COST OF SERVICES €*	COST OF WORKS €
		FROM	TO			
<b>Consolidation interventions of the rocky walls of Monte Pellegrino overlooking the urban areas of "Vergine Maria e Addaura", Palermo - Italy</b>	Government Commissioner against hydrogeological instability in the Sicilian Region	09/2020	Ongoing	Detailed Design, Works Supervision	1,123,852	22,712,000
Settlement of the landslide of Stigliano, Basilicata region - Italy	Basilicata region	06/2020	Ongoing	Detailed Design, Works Supervision	100,303	2,000,000
<b>Preliminary and Detailed Design of the Wastewater Collection System and Treatment Plant in Ganvié – Benin</b>	Agence Nationale de promotion des Patrimoines et de développement du Tourisme	10/2020	03/2022	Preliminary Design, Detailed Design, ESIA, Tender Documents	1,215,002	27,213,292
<b>Engineering Design Services related to Parks and Urban Landscaping for Phase 1 Konza Techno City – Kenya</b>	KoTDA (Konza Technopolis Development Authority)	08/2018	07/2021	Concept Design, Preliminary Design, Detailed Design	981,450	22,600,000
International Cooperation Activities in The Field of Waste Management and contaminated Sites Reclamation; Water Protection and Integrated Management of Water Resources; Defense of Territory and Coast – Various Countries	Sogesid S.p.A.	09/2018	03/2021	Framework contract for Technical Assistance	1,827,000	n.a.
<b>Syracuse-Gela Motorway (131 km) – Landscape Works - Italy</b>	Sicilian Motorways Consortium	02/1998	06/2018	Landscape design, Environmental Conformity Report, Environmental Monitoring Plan, Works Supervision	800,000	1,700,000
Environmental Engineering Services for Syndial SpA (Massa Marittima, Pieve Vergonte, Ravenna, Crotone, Assets ENI )	SYNDIAL – Servizi Ambientali SpA	10/2014	02/2018	Preliminary Design, Detailed Design, EIA	595,000	39,800,000
<b>New Doha International Airport (NDIA) site Reclamation &amp; Revetment Works - Transplantation of Sea Grass Pinna Nobilis species - Qatar</b>	New Doha International Airport (NDIA)	06/2013	07/2013	Environmental Management Plan	3,507,978	71,425,000



PROJECT	CLIENT	PERIOD		ACTIVITIES	COST OF SERVICES €*	COST OF WORKS €
		FROM	TO			
Experimental interventions to mitigate erosion processes induced by fishing activities -Italy	Venezia Nuova Consortium for MoPW - Water Board - Venice	01/2003	12/2012	Preliminary Design, Detailed, Supervision of the monitoring activities	304,100	1,725,000
Functionality of the Venice lagoon environment by means of surveys on fishery resources, birds and ichthyofaunal	Venezia Nuova Consortium for MoPW - Water Board - Venice	01/2002	12/2011	Coordination of studies	192,805	1,587,425
<b>Works to improve the ecological and landscape value of the reconstructed tidal flats and saltmarshes in Venice lagoon - Italy</b>	Venezia Nuova Consortium for MoPW - Water Board - Venice	06/2001	12/2003	Landscaping Detailed Design, GIS	380,000	n.a.
<b>Karavasta Lagoon Wetland Management Project - Albania</b>	European Commission - Phare programme	03/1995	12/1996	Technical Assistance,	340,000	n.a.
<b>ENVIRONMENTAL MODELLING</b>						
<b>Monitoring of the effects of the construction sites for the mobile barriers at the entrances to Venice lagoon - Italy</b>	Venezia Nuova Consortium for MoPW - Water Board - Venice	07/2003	07/2012	Technical coordination of the environmental investigations and modelling studies	3,365,300	16,410,500
<b>Definition of a monitoring programme of the Venice lagoon - Italy</b>	Venezia Nuova Consortium for MoPW - Water Board - Venice	01/2001	12/2007	Environmental quality studies, analyses and monitoring	425,000	n.a.
Reconstruction of saltmarshes in Venice lagoon - Italy	Venezia Nuova Consortium for MoPW - Water Board - Venice	12/1989	12/2007	Modelling, Preliminary Design, Detailed Design, EIA	20,000,000	400,000,000
<b>ISAP - Research on the sediments and waters in channels of Porto Marghera and the facing areas of Venice lagoon - Italy</b>	Venezia Nuova Consortium for Ministry of Public Works - Water Board - Venice	11/2006	06/2007	Coordination of water and sediment quality study	100,000	n.a.
<b>Modelling the hydrogeological impact of a containment cut-off wall in the Venice industrial harbour of Porto Marghera – Italy</b>	Venezia Nuova Consortium for Italian Ministry of Public Works – Water Board, Venice	12/2003	04/2007	Groundwater Modelling	1,053,130	n.a.

PROJECT	CLIENT	PERIOD		ACTIVITIES	COST OF SERVICES €*	COST OF WORKS €
		FROM	TO			
Verification of effects induced by construction of mobile barriers at the entrances to Venice Lagoon – Italy	Venezia Nuova Consortium for Ministry of Public Works - Water Board - Venice	02/2005	04/2006	Water quality Studies, Modelling , EIA	1,250,000	n.a.
Curved grid hydrodynamic model for the study of the environmental works in the Venice lagoon – Italy	Venezia Nuova Consortium for Ministry of Public Works - Water Board - Venice	09/2001	09/2004	Hydrodynamic Modelling	628,500	1,859,200
Evaluation of the effects of fishing on the Venice lagoon morphology (project no 12.3/II) - Italy	Venezia Nuova Consortium for Ministry of Public Works - Water Board - Venice	02/2002	08/2004	Coordination of studies	79,000	79,000
Works for the protection and environmental recovery of the island of S. Erasmo and the Passaora channel in the Venice lagoon - Italy	Venezia Nuova Consortium for MoPW - Water Board - Venice	01/2002	12/2003	DetailedDesign, Modelling	192,900	4,723,900
<b>Analysis of measures to counteract accidental oil spills in Venice lagoon - Italy</b>	Venezia Nuova Consortium for MoPW - Water Board - Venice	03/2001	03/2002	Coordination of survey, Hydrodynamic Modelling	307,300	n.a.
Development of an ecological model to simulate the effects on the environment of closing the mobile barriers at the entrances to Venice lagoon - Italy	Venezia Nuova Consortium for MoPW - Water Board - Venice	09/1998	11/1999	Water quality studies, modelling , EIA	597,500	n.a.
<b>Decision Support System (DSS) for the granting of concessions for discharging liquid waste into the Venice lagoon - Venice, Italy</b>	Venezia Nuova Consortium for Ministry of Public Works - Water Board - Venice	01/1995	12/1998	DDS development	51,000	n.a.

PROJECT	CLIENT	PERIOD		ACTIVITIES	COST OF SERVICES €*	COST OF WORKS €
		FROM	TO			
Dredging works, land reclamation and disposal of polluted soils for the shaping of the navigation channels of the Venice ports and lagoon – Italy	Venezia Nuova Consortium for Ministry of Public Works - Water Board - Venice	04/1987	09/1997	Modelling Preliminary Design, EIA, Works Supervision	9,259,200	232,405,600
Regimentation of the Alpone river and its affluents - Provinces of Verona and Vicenza - Italy	Ministry of Public Works - Water Board - Venice	09/1994	07/1995	Hydraulic regulation study mathematical models	48,500	n.a.
<b>ENVIRONMENTAL STUDIES</b>						
<b>INTCATCH – Development and application of Novel, Integrated Tools for monitoring and managing Catchments (H2020 EU project N 689341)</b>	Executive Agency for Small and Medium-sized Enterprises (EASME) - European Commission	06/2016	01/2020	Research for the development of a monitoring strategy for Garda Lake, numerical hydrodynamics modelling and water quality.	934,500	n.a.
<b>Market study: Opportunities to implement sustainable strategies in the maritime sector - Croatia, Albania, Slovenia, Montenegro, Ukraine, Romania, Bulgaria, Poland</b>	European Bank for Reconstruction and Development	07/2012	03/2013	Market study	235,000	n.a.
<b>Monitoring programme for fishing activities in Venice lagoon - Italy</b>	Venezia Nuova Consortium for MoPW - Water Board - Venice	01/1997	12/2007	Technical specifications; Environmental Studies	252,000	n.a.
<b>Complementary research on the ecosystem of Venice lagoon (ICSEL Study) - Italy</b>	Venezia Nuova Consortium for Ministry of Public Works - Water Board - Venice	11/2003	07/2006	Study of water and sediment pollution, evaluation of risks to the ecosystem	113,000	n.a.
Monitoring of the fishing activity and the bird fauna in the open Venice lagoon - Italy	Venezia Nuova Consortium for Italian Ministry of Public Works – Water Board, Venice	06/1997	12/2004	Environmental studies	22,464	272,689

PROJECT	CLIENT	PERIOD		ACTIVITIES	COST OF SERVICES €*	COST OF WORKS €
		FROM	TO			
<b>Environmental recovery of the polluted site "I Pili" at Porto Marghera – Venice - Italy</b>	Venezia Nuova Consortium for MoPW - Water Board - Venice	01/2003	06/2004	Environmental Studies, Preliminary Design, Detailed Design	500,000	36,832,000
<b>Regional master plan for the protection and management of the inland waters of Lombardia Region - Italy</b>	Lombardy Regional Government	01/2000	08/2001	Environmental studies on water quality, fauna, road & lake traffic, population, existing urban and area plans, etc.	130,000	n.a.
Study of the water resources of the Brenta-Bacchiglione rivers for the river basin master plan - Italy	River Basin Authority for Isonzo, Tagliamento, Livenza, Piave, Brenta and Bacchiglione	03/1996	09/2000	Water quality study, concept design of remedial works	72,800	n.a.
Study of the environmental impact of the flood barriers at the Venice lagoon inlets - Italy	Venezia Nuova Consortium for MoPW - Water Board - Venice	04/1996	01/1999	Detailed study of the effects on the environment of the planned flood control barriers	1,725,800	n.a.
<b>Adriatic Sea Master Plan - Italy</b>	Palomar s.c.a.r.l. for Ministry of Foreign Affairs and Ministry of the Environment	05/1991	08/1992	Master Plan	150,000	n.a.
Special project for the depollution of the gulf of Naples – Campania - Italy	Cassa per il Mezzogiorno (Authority for the Development of Southern Italy)	07/1984	01/1989	Master Plan	1,153,500	n.a.

\* Approx. cost of environmental services only



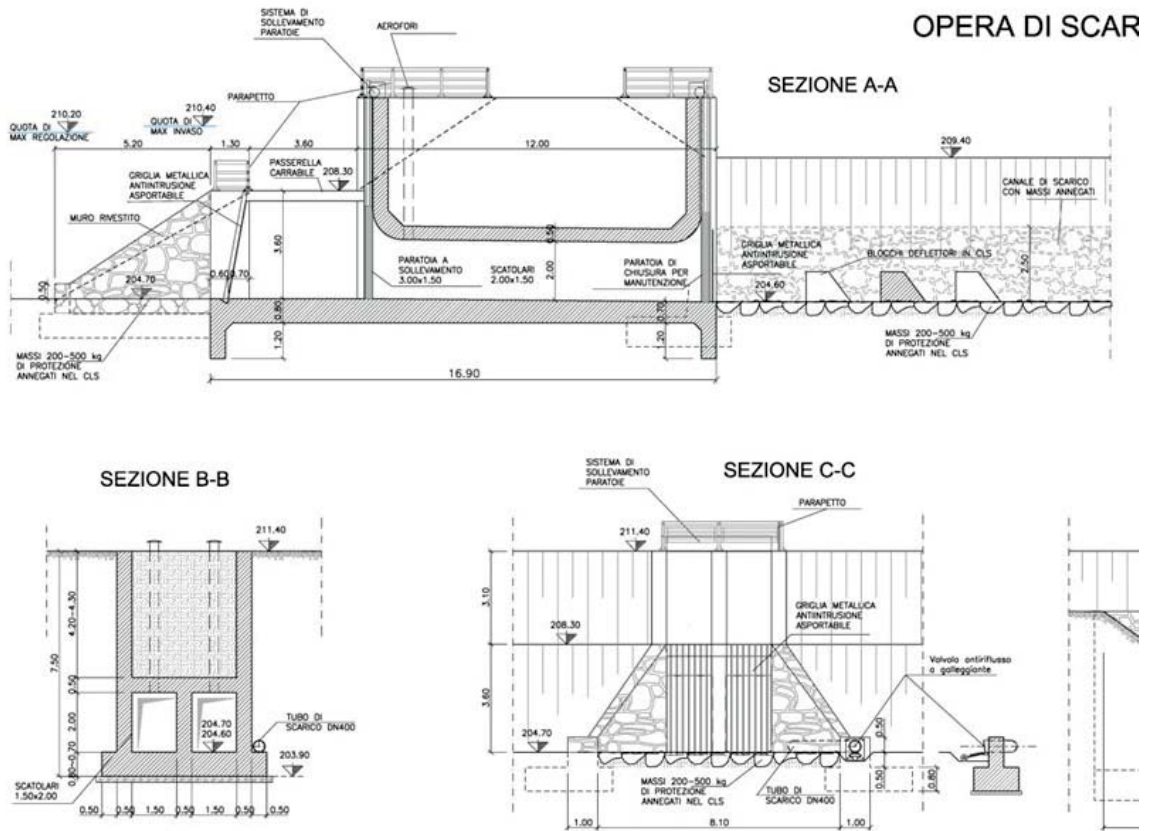
## Appendix A – Company’s Experience

## EIA and Monitoring Plans





Preliminary design – Plan on the interventions



Outfall



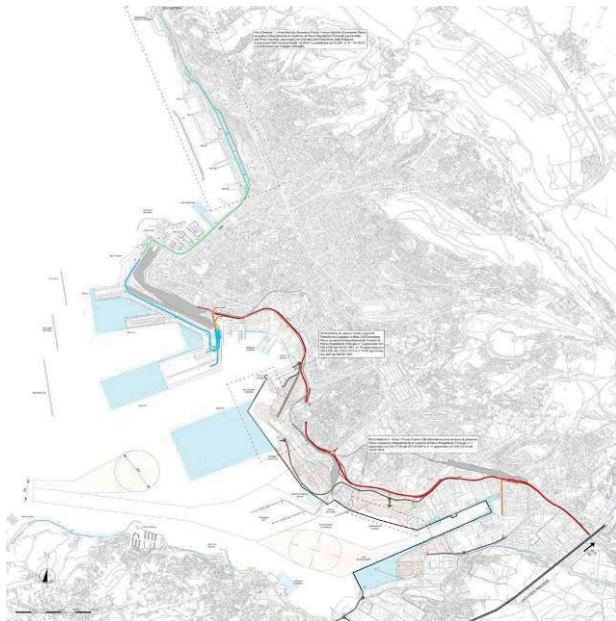
# STRATEGIC AND ENVIRONMENTAL IMPACT ASSESSMENT OF THE NEW PORT MASTER PLAN

Location:	Trieste Port, Italy
Client:	River Po Delta
Services:	Strategic and Environmental Impact assessment report. Appropriate assessment report (Assessment of plans and projects significantly affecting Natura 2000 sites)
Period:	05/2010 – 01/2014
Construction cost:	€ 1,864,000,000

## Project Description:

General objectives of the Port Master Plan are the expansion of port areas, the development of container traffic, the enhancement of reclaimed areas (past industrial activities) and the development of cruise industry.

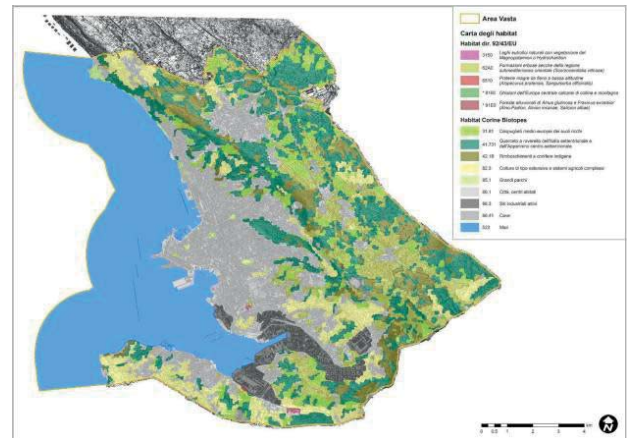
Works construction is divided into two scenarios: short and long term. Short term scenario supplies to immediate needs and priorities and identifies high productivity interventions that allow reaching high functionality with low economic and execution efforts. The long-term scenario represents the final port configuration to be achieved, through various temporal steps on the basis of several factors. Factors include trade evolution, economic dynamic of the country and of the trading partners and actual implementation of national and international infrastructure projects.



Plan actions will lead to a general improvement of the quality of the seabed, due to the planned dredging activities and the preliminary remediation activities necessary where the piers will be built or expanded.

Environmental Impact Study (EIA) identifies, analyzes and quantifies all possible interactions of the anticipated works with the environment and the surrounding territory.

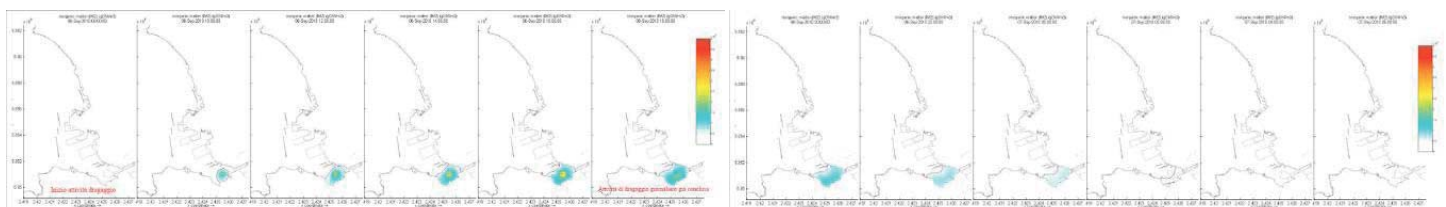
In particular, on the basis of the characterization and analysis of individual environmental components, the EIA Report describes the environmental system of reference and any interference with the work under the new plan.



The Strategic Environmental Assessment (SEA) also verifies if objectives and actions of the Plan are consistent with each other. Furthermore, it shall point out if these objectives are in conflict with local planning and policy instruments and with objectives and sustainability strategies developed at international and national level.

With regards to strategic analysis, the objectives of the Master Plan resulted consistent with each other and/or independent from each other, as the purposes of the Plan is not in conflict with its objectives and the port land uses. With regards to environmental aspects, main issues in the present condition are: sediment and soil contamination of port area, anthropization of the coastline that affects vegetation and wildlife habitats of environmental interest, noise levels in urban areas mainly caused by urban traffic and concentrations of nitrogen oxides (NO<sub>x</sub>) and particulate matter (PM<sub>10</sub>) over legal limits in port and industrial area.

Moreover, contamination of marine coastal waters of the bay harbour is supposed, due to potential release of hazardous substances from the sediments. Model analysis have shown low hydrodynamic activity considering both the residence time and the distribution of flow velocity, thus making the bay harbour a sort of large sedimentary basin.



# PROFESSIONAL DESIGN AND QUANTITY SURVEYING CONSULTANCY SERVICES FOR DESIGN UPDATE OF ZONE 40

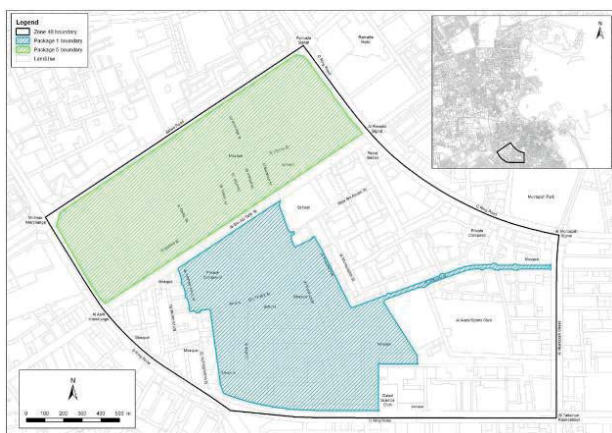
Location:	Qatar
Client:	Public Works Authority (PWA)
Services:	Tender documents, EIA, Monitoring Plan and Construction Environmental Management Plan
Period:	03/2012 – 05/2013
Construction cost:	€ 53,084,235

## Project Description:

The project area is located in Zone 40, close to the centre of Doha. It is about 173 hectares and it is a residential area already constructed. The scope of the project is to review and update the design of the area as per the regulations and design standards. In order to accomplish State of Qatar Environmental Protection Legislation, environmental studies have been undertaken.



The Project includes two Packages in which Zones 40 is divided. The Project comprises the detail design of the upgrade of the existing roads and infrastructures, planned within the Qatar National Master Plan for the urban development in Qatar. The design update includes all the requirements to complete an infrastructure project as per the regulations and design standards, including proposals for landscaping.



The EIA Study has been developed with the aim of describing and analyzing how the project interferes with the present environmental conditions and of suggesting mitigation measures to be introduced in the design or in the specifications for the Contractor in order to reduce or neutralize adverse environmental impacts. The methodology proposed for the assessment of the impacts considers the following criteria: quality of the impact,

magnitude of the impact, type of the impact, duration of the impact.

VIEW A - Major Urban Collector (20m Road Corridor)  
Aasim Bin Thabit St. (coasting the school)



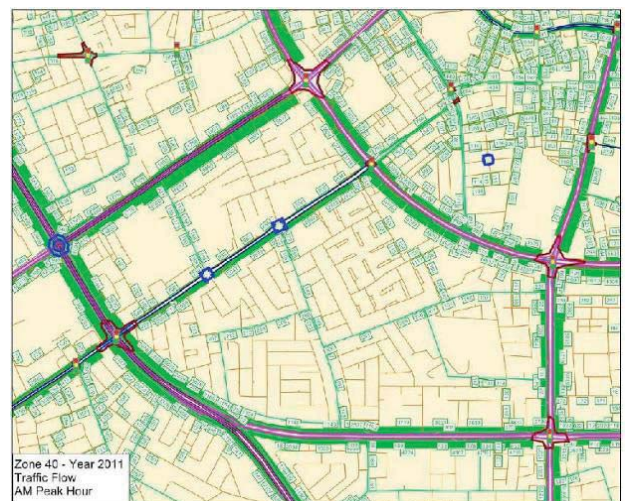
VIEW B - Major Urban Collector (20m Road Corridor)  
Al Mishaal St. (roundabout on Al Maahed St.)



Every impact has been evaluated considering the above mentioned criteria. The single evaluations are then combined in a synthetic joint assessment.

Special attention has been put on the analysis of the noise condition. The design of noise reduction measures allows to significantly reduce the noise level.

Several site investigations were performed in order to collect baseline data on present environmental conditions. Site investigations were related to noise levels, soil and groundwater quality, marine water quality and tidal and current and tide measurements.





# ROADS AND INFRASTRUCTURE – PHASE 2. PACKAGES 7, 8, 9, 11, 12, 13, 14 AND 17

Location:	Qatar
Client:	Urban Planning And Development General Authority (UPDA)
Services:	Environmental Impact Assessment
Period:	04/2009 – 04/2013
Construction cost:	€ 1,550,000,000

## Project Description:

The project is located in 8 different areas across the state of Qatar. The scope of work includes the design of new roads and infrastructures in new district and upgrading of existing ones to new requirements. The Project area comprises 2,932 ha.



Based upon our experience, the Environmental assessment is most effective when preliminary findings are made available early in the project implementation schedule, therefore a close interaction between the staff responsible for the environmental issues and the project issues is an integral part of the method of work.



The evaluation of the environmental impacts is the result of this joint effort of the project and EIA team, aimed at understanding the main relations between the project implementation and the surrounding environment and at tackling the most critical environmental aspects at the earlier stage possible.

This helps in responding to the need of minimising the environmental impacts in the most cost-effective manner, by introducing alternatives or modifications in the project solutions originally chosen (based upon pure technical criteria), before their further implementation in the project.

At the same time this helps in avoiding costly delays and problems during the construction phase of the proposed works.



The EIA has been performed according to the existing Qatari legislation and in close liaison with Ministry of Environment (MoE), Ministry of Municipality & Urban Planning (MMUP) and Qatar Museum Authority. The following environmental aspects have been included in the scope for the case under study: air quality, noise, vibration, soil and subsoil, water and groundwater resources, terrestrial ecology, landscape, cultural heritage, social aspects, waste management.

The nature of the impacts of the project on the environment has been estimated in relation to a list of criteria, based on World Bank, European Union and other guidelines generally utilized at international levels.

The study reflected our previous and present experience in Qatar on this kind of jobs

# EXPERIMENTAL MORPHOLOGICAL INTERVENTIONS FOR THE SAFEGUARDING OF THE VENICE LAGOON

Location:	Venice, Italy
Client:	Venezia Nuova Consortium for Italian Ministry of Public Works – Water Board, Venice
Services:	Preliminary and Final Design
Period:	05/2008 - 07/2012
Construction cost:	n.a.

## Project Description:

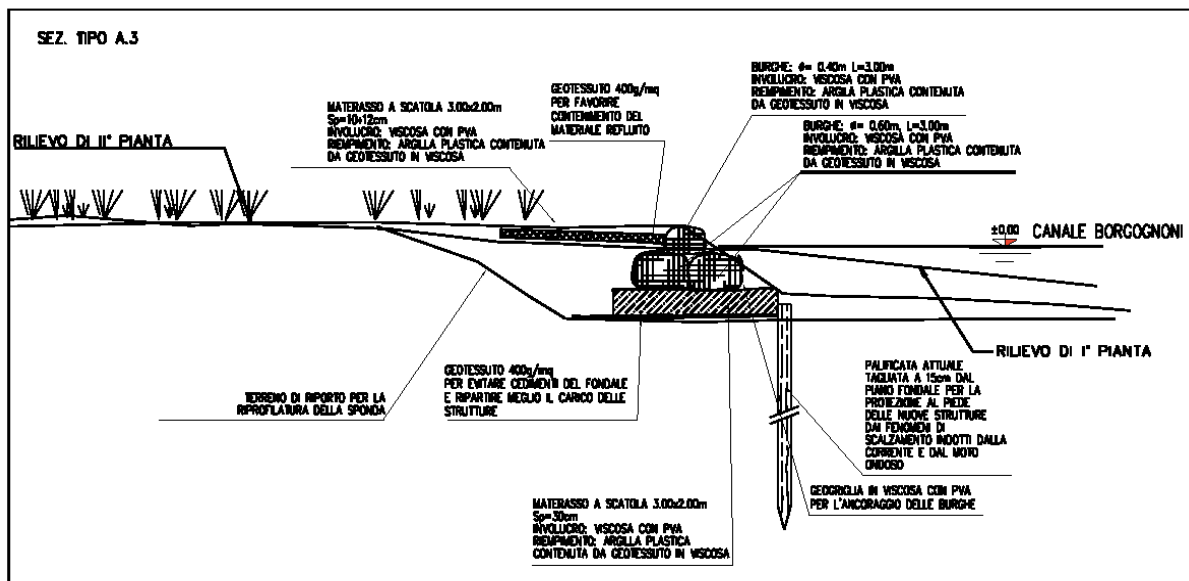
Venice Lagoon has a varied morphology with salt marshes, mudflats and channels which play an important ecological role as areas of reproduction and shelter for many species such as birds, fish and shellfish. However, the current evolutionary tendency of the lagoon towards erosion is clearly evident, with result in the loss of sediments from the lagoon into the Adriatic Sea and the progressive disappearance of salt marshes. Therefore, the protection of marsh habitats is instrumental for the lagoon ecosystem as a whole. New experimental interventions have been designed and experimented in the Venice Lagoon to build new morphological structures able to contrast sediment erosion and to test new biodegradable materials. The experimental interventions were therefore focused on:

- accelerating and/or improving the naturalizing process of salt marsh vegetation after sediment dumping such as increasing nutrient concentrations in sediments, or changing their grain size;
- testing how long as biodegradable materials last in lagoon waters under the effect of wave stress;
- testing how long different wood and synthetic poles last in waters under the attack of marine worms (*Teredo navalis*).
- creating different types of morphological/physical structures capable of act against wave stress and protect marshes/mudflats.

Moreover, as lagoon represents a transitional area between the land and the sea, a new experimental intervention was also focused to promote the development of new transitional habitats from the fresh and saline environment. A controlled fresh water input was diverted from a river into the lagoon, to decrease salinity values and promote the development of *phragmites* habitat important for birds, fishes and benthic fauna.



A detailed Environmental Monitoring Plan (EMP), at a field scale, was designed to define the *ante-operam* state and to monitor experimental intervention results. The EMP was 3 years long, started in spring 2009 and ended at the beginning of summer 2012. Obtained results, after 3 years of monitoring, furnished useful information to design future morphological reconstruction of lagoons and transitional areas and minimize the cost/benefit ratio.





# BEACH DEVELOPMENT AT RAS USHAYRIQ PENINSULA

Location:	Ras Ushayriq Peninsula, Qatar
Client:	AL-ALI PROJECTS CO. (QATAR)
Services:	Preliminary and detailed design, EIA
Period:	07/2011 - 05/2012
Construction cost:	€ 31,400,000

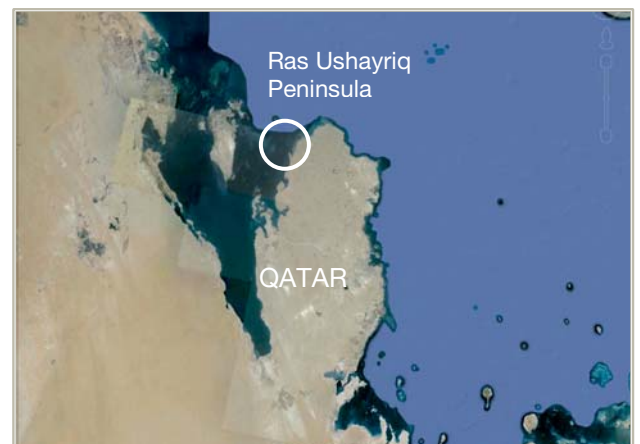
## Project Description:

The engineering consultancy service started from a preliminary study of alternative solutions for the identification of the conformation and location of a new beach for private use along Ras Ushayriq Peninsula. Based on the main requirements affecting quality and technical feasibility of artificial beaches and the due acquaintance of site conditions obtained by data collection, site visits, specialist studies and field investigations, the main dimensions and layout of the beach was defined and the preferable location at the north-western side of Ras Ushayriq peninsula was identified.

Within the concept design, a suitable beach development scheme at the selected location was conceived allowing for the following purposes:

- Fulfilling the engineering design requirements to ensure proper performance as good quality and stable artificial beach: adequate dredging to accommodate a suitable and attractive sandy beach profile and to allow swimming and comfortable access to water; shoreline orientation towards the prevailing waves direction to ensure longshore stability of the beach; provision of protection structures to prevent loss of sand out of the site and shelter the area from meteomarine forcings.
- Developing the engineered beach concept toward an attractive, multifunctional, well landscaped waterfront system, to conceive a prospective overall development allowing the best conditions for living and enjoying the beach as well as its surrounding sea and land environment.

The new coastal development envisages a pleasant artificial beach ("Beach Bay"), delimited at north by a smaller and confined bay ("Laguna Bay") and at south by a rubblemound breakwater which forms a sheltered area which provides docking space to yachts and tenders ("Yacht Basin"). At the northern side of the new beach a "Sea Arena" provides access to the sea and a "Wooden Pier" overhang the water. From the "Laguna Bay" till the "Yacht Basin" a promenade allow to enjoy the seafront and the beach basin design to give a blue water impression. At landside a rest house faces the "Yacht Basin" and green dunes enhance the landscape.



- The new beach development project includes:
- 450,000 m2 of total project area
- 430 m long and 110 m wide beach
- 130,000 m3 of beach sand fill
- 400 m of concrete blocks quay wall
- 600,000 m3 of total dredging (beach up to 3 m deep, yacht basin 3 m deep, lagoon bay around 1 m deep, "Yacht Basin" access channel 4m deep)
- 700 m long promenade
- Sea arena and wooden pier to access the sea
- Landscaping with green dunes



# NEW PORT SETTLEMENT ALONG THE "PO DI LEVANTE" AND SAFETY MEASURES OF THE NAVIGABLE SECTION OF THE RIVER

Location:	Italy
Client:	River Po Delta
Services:	Environmental Impact Assessment (E.I.A.), Appropriate Assessment and Environmental Feasibility Study and Landscape Work Design
Period:	12/2011 – 03/2012
Construction cost:	€ 40,000,000

## Project Description:

The project involves the design of a new port along a branch of the Po river (Northern Italy) and new navigation facilities. The Levante port forms a new strategic point in the port system of the Venice lagoon.

The river Po (about 652 km) is the longest Italian river. It crosses all the North of Italy. The Po Delta is one of the most important wetland in Europe and in the world (UNESCO – World Heritage Site).



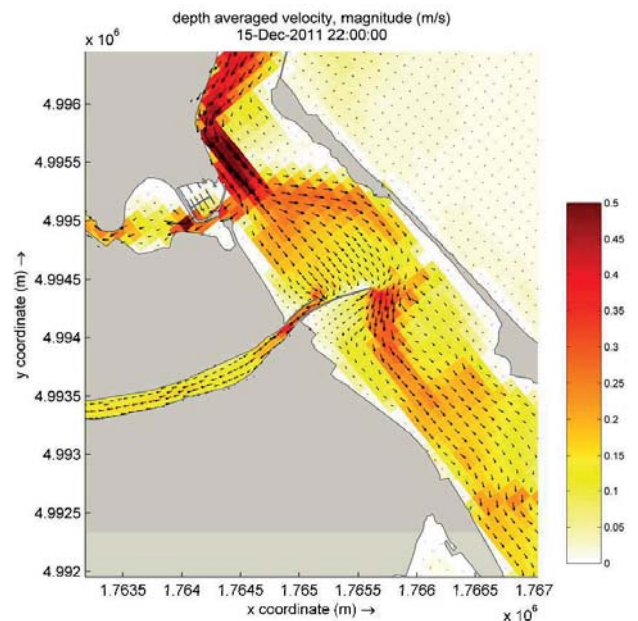
The port area consists of about 360 ha located along the right bank of the river Po, in the delta area. The port area is included within the Regional Park of the Po Delta. Most of the area has a high natural value and it is included in the Nature 2000 Network: Sites of Community Importance (SCI) and Special Protection Areas (SPA). The screening of the potential impacts has been carried out by a matrix that relates the main project activities during construction and operation phase with the environmental elements identified as significant.

The study of the environmental impacts of the port infrastructure includes a detailed investigation of the current hydrodynamic and dispersive characteristics of the area affected by the project.

The hydrodynamic model of the coastal zone is able to reproduce, with sufficient detail, the morphology of the area of study. It is important to emphasize that, in the hydrodynamic study of a delta or coastal marine area, great attention shall be addressed to the aspects concerning the replacement of the water masses in the different weather conditions that may occur.

A key role is carried out by external forcing (tidal waves, wind, coastal currents etc), since even small variations associated with them can induce effects of a certain importance in the coastal system. During the impact assessment,

special attention has been paid to the natural aspect like the wildlife and specially to the bird community. The area, including the Venice lagoon, is a strong element of attraction for birds. The lagoon, in fact, is home to a rich bird community with an average attendance of more than 200,000 waterbirds and over 180 recorded species, constituting the most important Italian wintering site.



Furthermore, the analysis of the impacts include the socio-economic aspects of the entire area affected by the harbour, as the project is part of a Regional Transport Plan that involves the creation of an integrated system for the transport of goods involving ports, dry ports, border crossings and airports.

The project includes the mitigation of the new harbour through the formation of green barriers of native vegetation and recreational areas available for users of the port. An Appropriate Assessment (as for the UE legislation) of the impact of the project on the Natura 2000 network sites has been developed as part of the EIA procedure.





# NEW MULTIPURPOSE PLATFORM IN VADO LIGURE

Location:	Vado Ligure SV, Italy
Client:	Savona Port Authority
Services:	Environmental Impact Assessment
Period:	12/2008 – 07/2011
Construction cost:	€ 335,500,000

## Project Description:

The port area of Vado Ligure is one of the most important Italian port terminals. The new multi-functional platform will rearrange the bulk cargo terminal, the two jetties for unloading of petroleum products and will include the construction of a new container terminal.

The EIA has been divided into three frameworks: Design framework; Planning framework and Environmental framework.

The design framework describes in detail the project. The main project actions have been analyzed for both the construction and operation phases in order to highlight the main interactions between the work and the context. Since the early stages of the drafting of the EIA, agreements with local authorities have been undertaken.

In the planning framework, the possible interferences between the platform and the requirements and constraints contained in the territorial planning programs have been analyzed.

In the environmental framework, an accurate description of the current state of the environment has been performed. In addition, the evaluation of the potential impacts generated during the construction and operation phase has been carried out.

The description of the base conditions includes: air quality and climate weather conditions, coastal waters (waves and currents, hydrodynamics, sediment transport, quality), soil and subsoil (geology and geomorphology, soil quality and sediment quality), flora and fauna, landscape, archaeological, noise and vibration, economy and social aspects.

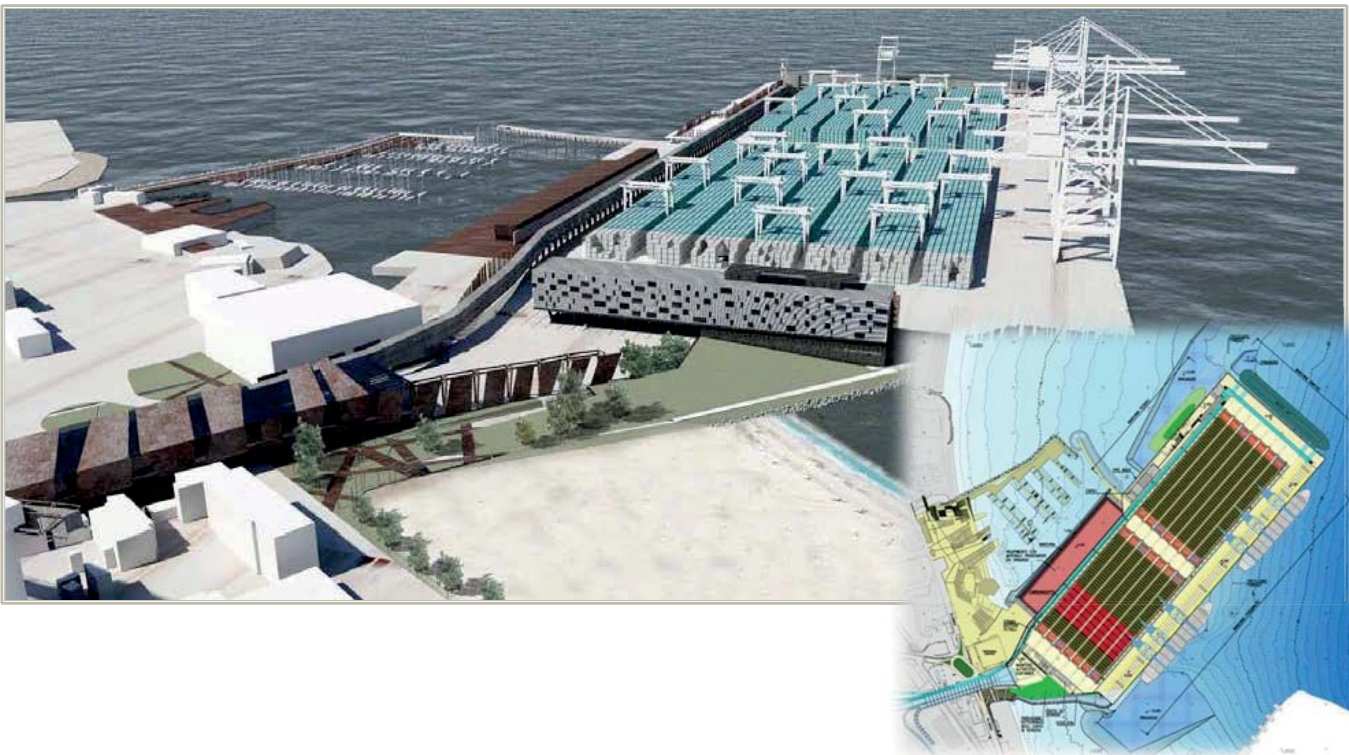
A modelling and numerical approach have been used to study and describe the effects of the new infrastructure. Then, the analysis of the variation of the environmental conditions have been carried out.

Key environmental aspects under study were:

- Detail study of the seabed with quality analysis of the sediments in order to evaluate the risk of the reuse of the dredging material;
- Modelling simulation of the hydrodynamic condition with particular attention to the variation of the coastal circulation and possible effect on the shoreline;
- Inclusion of the new platform into the landscape considering the master plan for the new waterfront.

Field tests have been carried out in order to study the effects of the dredging activities, with particular attention to the resuspension of contaminated sediments. The results have been used to develop a standard operating procedure to be followed during the construction phase, in accordance with the environmental authorities.

Following the evaluation process, the necessity of mitigation measures useful to minimize the effect of the work on the environment has been considered. Special attention has been paid to minimize the impact on nearby beaches so as to avoid repercussions on the local economy and improve the acceptance of the work by the local population.

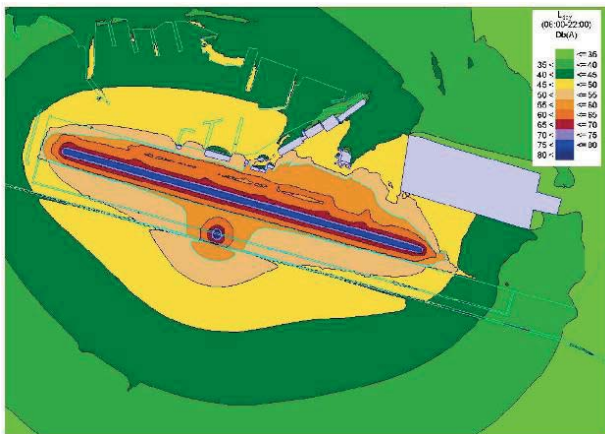


# “GRONDA” HIGHWAY BYPASS – MARINE DEPOSIT OF THE GENOA AIRPORT

Location:	Genoa, Italy
Client:	Autostrade per l'Italia S.p.A. and Spea Ingegneria Europea S.p.A.
Services:	Environmental Impact Assessment
Period:	07/2010 – 04/2011
Construction cost:	N.A.

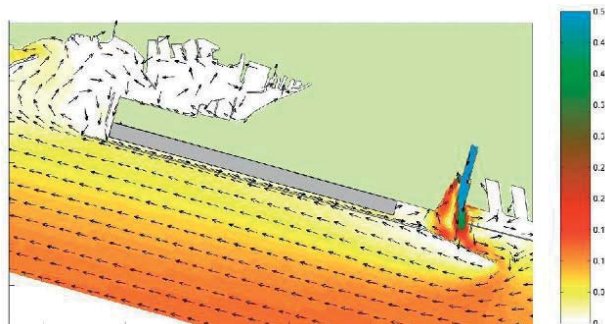
## Project Description:

The construction of the "Gronda" highway bypass involves the planting of about 8.4 million cubic meters of spoils, of which about 5.2 potentially containing asbestos. The area identified for the disposal of the material produced by the excavation of tunnels, is the port area overlooking the Genoa airport "Cristoforo Colombo", and in particular the "Calma" Channel that separates and protects the airport from breakwater's overflowing. The deposit consists of a strip 180 m wide and about 3,600 m long, located in front of the airport, at depths ranging from -14.50 m asl and -10.00 m asl, obtaining a narrowing of the Channel of "Calma" from 240 m to 60 m.



The study of the effects induced by the implementation and the presence of the marine deposit requires the ability to represent the behaviour of the aquatic system in which the deposit is located. The level of detail shall be useful to identify the main changes due to the construction and presence of the work.

To achieve this purpose, an integrated system of mathematical models able to represent not only the area of the project but also a wider part of the coastal strip, which influences the local hydrodynamic and dispersive conditions, is applied.



The hydrodynamic model is the main model which is connected to the dispersive model, the model of sediment transport (which simulates the erosion / sedimentation in the short / medium term), the morphological model (simulating morphological evolution in the long period) and the quality model, with which it is possible to study both the processes related to the oxygen kinetics (primary production, debris cycle, etc.) and the variation of toxic

substances, considering them conservative and also applying a degradation kinetics.

The main activities carried out were:

- Data collection for the definition of the base condition of the main environmental factors (water quality, air quality, noise condition, soil quality, etc.);
- The analysis of the interactions between environment and works.



In addition, micro-simulation of the behaviour of the contaminants was carried out, and in particular: contaminants flow through the deposit barrier and contaminants flow in sediments under the deposit

The results of the simulations were used to evaluate phenomena like: the variation of the spare time and the generation of turbidity plumes.

Special attention has been paid to the impacts associated with the transfer of asbestos materials, considering the potential release of asbestos fibers into the atmosphere and marine waters during both construction and operational phases.





# PEDEMONTANA LOMBARDA MOTORWAY CONNECTING BERGAMO TO MALPENSA AIRPORT (80 km)

Location:	Lombardy, Italy
Client:	Autostrada Pedemontana Lombarda S.p.A.
Services:	Monitoring Plan and Geographic Information System (GIS)
Period:	05/2008 – 04/2011
Construction cost:	€ 3,567,463

## Project Description:

The "Pedemontana-Lombarda" motorway is a great road infrastructure, which crosses one of the most built-up areas in Europe. It consists of 67 km of motorway, 20 km of ring roads and 70 km of road connection, aimed to solve the congestion and saturation of the road network in the North of Milan. The road will be for nearly three-quarters below the ground level, almost invisible in trenches and tunnels.

The main activities carried out were:

- Drafting of the Environmental Monitoring Plan;
- Coordination and execution of the investigations;
- Development of geographic information system (GIS).

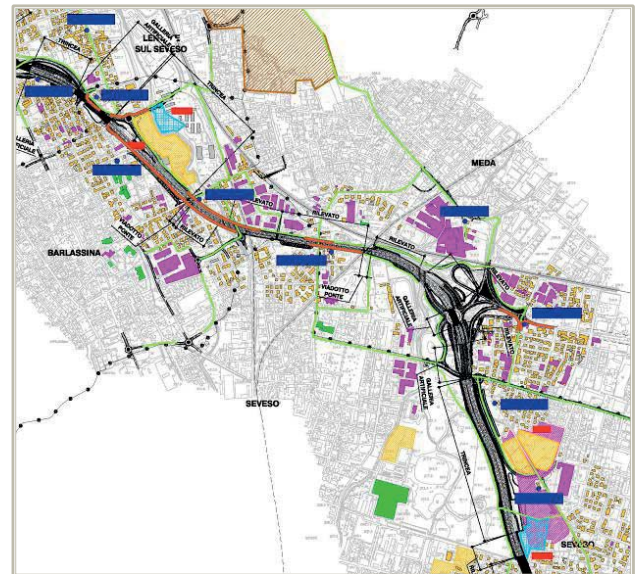
The environmental monitoring allows to quantify the impact of the construction and presence of the infrastructure on the environment by a series of periodic surveys, carried out on chemical, physical and biological parameters. The environmental aspects monitored are: atmosphere, surface water, groundwater, soil, vegetation – wildlife – ecosystems, landscape, noise, vibration, and social aspect.

The plan has been divided in three phases: ante operam, construction phase and post operam.

Correlating the results obtained in the different phases, it is possible to assess the evolution of the environmental conditions and evaluate the impact of the infrastructure.

During the preliminary design, the environmental monitoring plan has been settled in accordance with the Regional Authority for the Protection of the Environmental and in accordance with national and local guidelines and laws.

The environmental surveys have included the execution of field sampling and laboratory analysis as well as ecological surveys.



Special attention has been paid to the interaction between the work and the local population. According to this, the noise and air quality sampling points have been placed in order to survey the effect of the construction activities and the future emission of the road, considering as a priority the safeguarding of the resident population.

The groundwater investigations have been carried out in order to evaluate the possible effects of the tunnel sections of the road.

The Geographic Information System (GIS) has been implemented to support the environmental monitoring activities, with the aim to collect, validate, manage, represent and process the information acquired. The GIS is available on line.





# FLOOD CONTROL WORKS ON THE OLONA RIVER – ENVIRONMENTAL IMPACT ASSESSMENT

Location:	Olona River, Lombardy, Italy
Client:	Agenzia Regionale per il Fiume Po (A.I.P.O.) – (Interregional Authority for the Po River)
Services:	Environmental Impact Assessment, Landscape Design
Period:	01/2004 – 12/2011
Construction cost:	€ 10,883,200.00

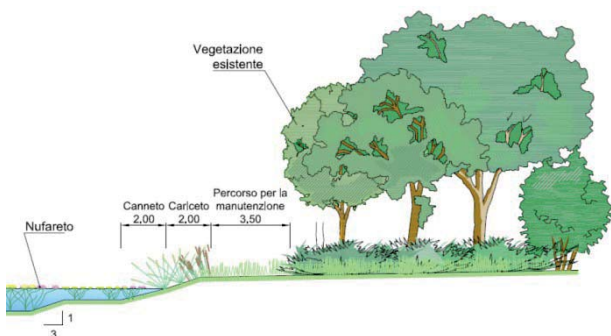
## Project Description:

The project concerns the design of lamination and control works of the Olona river which flow through urbanized areas. The project includes the design and construction of two separate and artificial flood areas, aimed to allow the lateral expansion of the river during flooding events, thereby avoiding the risk of flooding.

The approach that has characterized the project was to maximize the environmental compatibility of the work.

The primary objective was:

- Protection of resident population in case of flooding events;
- Reduction of the impacts on the landscape and on the natural habitats of the Olona River Park;
- Integration of the work in the socio-economic context (agricultural use of the land).

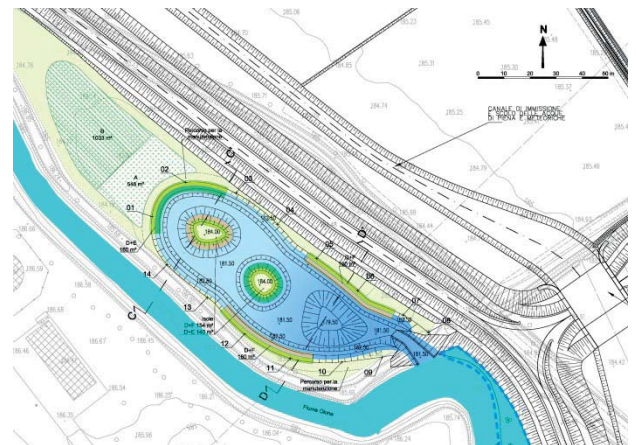


The Environmental Impact Assessment includes:

- Analysis of the current conditions - environmental framework
- Identification of constraints - planning framework
- Study of the project – design framework

Particular attention has been given to the natural value of the project area that is included in the Olona River Park. Particular attention was paid to vulnerable ecosystem units such as watercourses, groundwater and natural habitats. The assessment of the current conditions was based on bibliographic data and on the results of the investigations carried out to support the design such as geological and hydrogeological surveys.

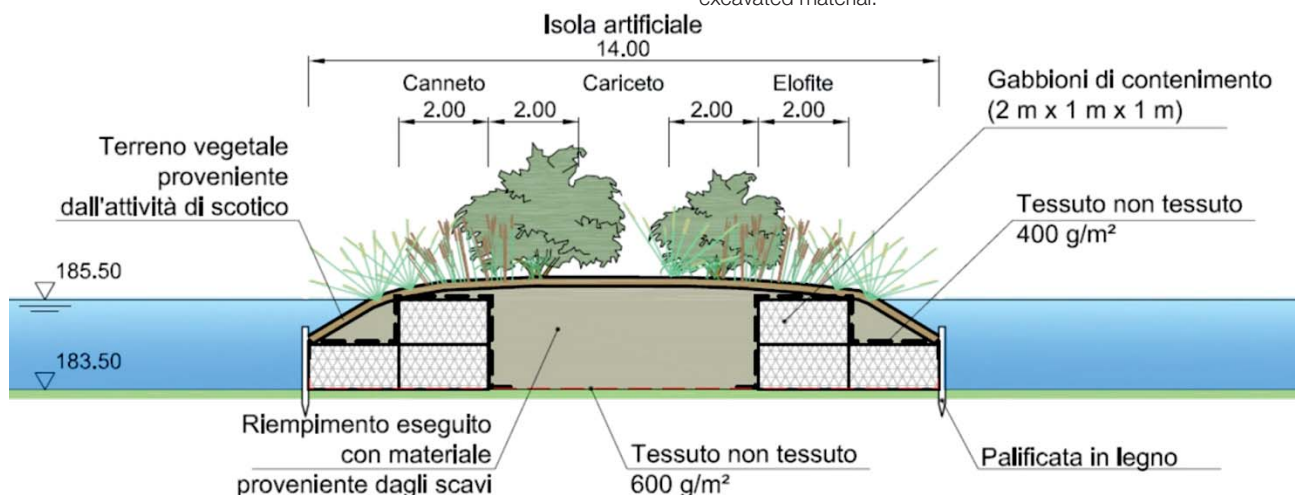
Additional data have been collected from local environmental authorities. Furthermore, the study includes the analysis of the interaction between the works and the requirements of landscaping plans, environmental regulations, territorial and urban planning.



The definition of the impacts is one of the most delicate operations of the entire process, and plays a crucial role in the environment study. An effective checklist of the impacts has been drafted. The analysis identified impacts in the short and long term as well as at various spatial scales.

The socio-economic aspects like the interaction between the works and the agricultural use of the land were analyzed. Furthermore, the possible contribution of cumulative and synergistic effects have been considered. A degree of significance have been associated to each impact.

During the assessment of impacts, sustainable reuse of the affected areas has been proposed. The creation of a public green area and the realization of a bicycle path on the banks of the flooding areas has been designed. The landscape design includes the use of native species of local origin and naturalistic engineering works. The study also includes the management plan of the excavated material.

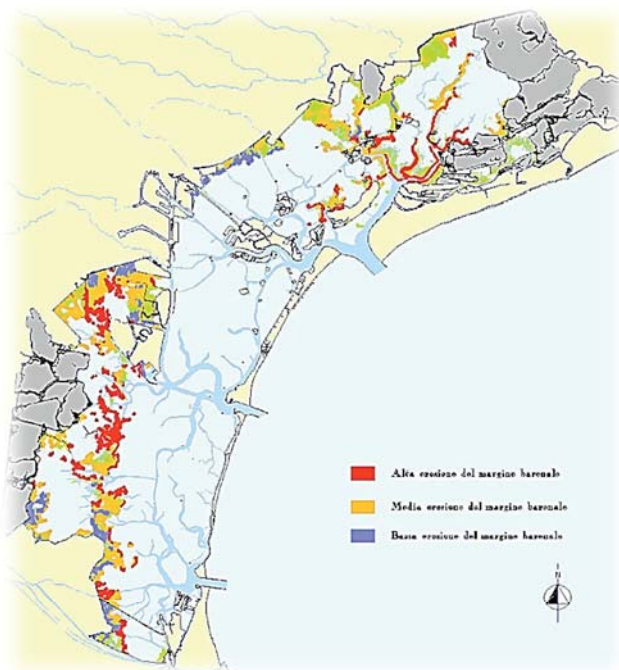


# MASTER PLAN FOR THE MORPHOLOGICAL AND ENVIRONMENTAL REHABILITATION OF THE LAGOON OF VENICE

Location:	Venice, Italy
Client:	Venezia Nuova Consortium for Italian Ministry of Public Works – Water Board, Venice
Services:	Feasibility study, EIA. Support activities included land use and GIS studies for mapping of pollution sources. Detailed design of urgent and pilot interventions
Period:	01/2003 – 12/2007
Construction cost:	N.A.

## Project Description:

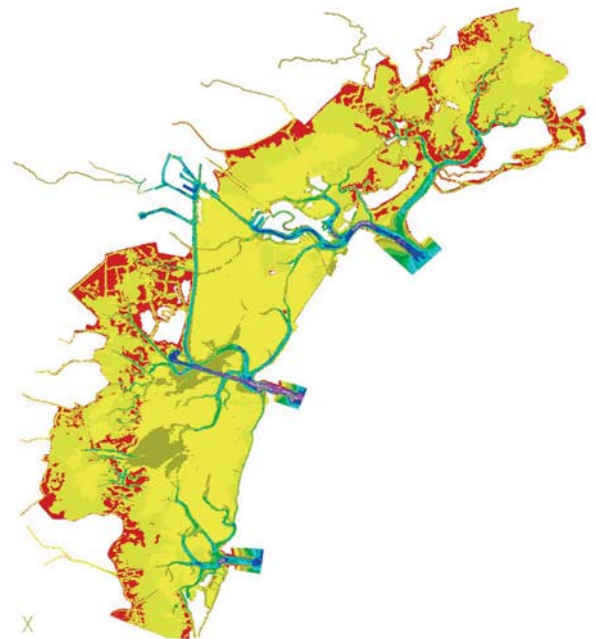
In the context of the Project for the protection of Venice and its Lagoon from the devastating effects of high tides, one of the major problems to be dealt with is that of the conservation of the lagoon ecosystem and its biodiversity, threatened by the human use (fishing, clam harvesting, navigation, urban development) and the present negative environmental conditions (sea level rise, subsidence, erosion).



The Project undertaken by TECHNITAL has as the primary objective the understanding of the causes of morphological and environmental deterioration and the identification of possible interventions to reduce the causes and to preserve and (when possible) restore the natural conditions of the ecosystem to acceptable levels in the shortest time possible.

To this end the following activities were performed:

- creation of a relational data bank and data processing with the aid of GIS for the automatic production of thematic maps
- detailed description of the environmental situation of the lagoon, including aquatic life, vegetation, natural habitats, sediment and water quality, morphological features;
- detailed description of the present human use of the lagoon and their impact on the environment



- preliminary analysis of interventions needed to improve the environmental conditions, by use of mathematical models specifically implemented
- definition of management scheme to control and monitor the lagoon environment.

The main measures proposed to restore and preserve the lagoon environment were:

- Creation of freshwater habitats along the lagoon border to enhance the ecological value.
- Construction of tidal flats and marshlands to restore the lagoon's natural hydrodynamic patterns
- Protection of eelgrass beds for bottom protection
- Preservation and restoration of natural habitats by protecting and planting salt marshes species in areas under stress.
- Definition of guidelines for the practical construction of morphological structures (type of materials, equipment, technical solutions to dispose the dredged material etc.)
- Definition of mitigation measures to reduce the impact of human activities (i.e. clam harvesting)
- Design of pilot interventions.



# MONITORING OF LAGOON AND MARINE BIOLOGICAL POPULATIONS AT THE PORT INLETS OF VENICE LAGOON

Location:	Venice, Italy
Client:	Venezia Nuova Consortium for the Water Board - Venice
Services:	Coordination of the biological monitoring activities
Period:	07/2003 – 02/2006
Construction cost:	N.A.

## Project Description:

The area of the Lagoon of Venice situated in the vicinity of the port inlets will be involved in construction of the tidal flooding defense works (MOSE system).

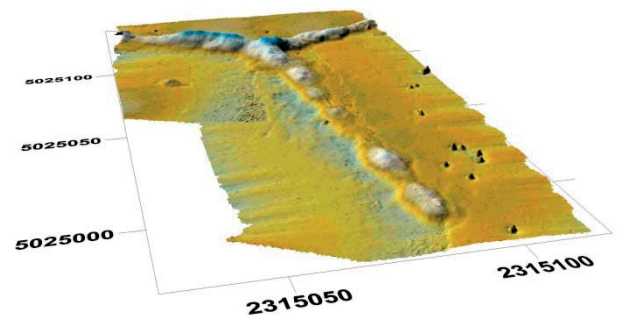
The purpose of this study was to assess, prior to construction of these works, the quality state of the marine and lagoon biocoenoses (with special focus on those of commercial interest) that are found in the areas directly or indirectly involved in the works.



Both test research and modeling activities were performed concerning the various aspects of interest in order to obtain a reliable picture of the state of the biological populations on the sea and lagoon beds involved.

The state of the marine phanerogam and macrozoobenthos populations located in the lagoon in the vicinity of and inside the port inlets was determined by means of a series of direct measurements and underwater investigations.

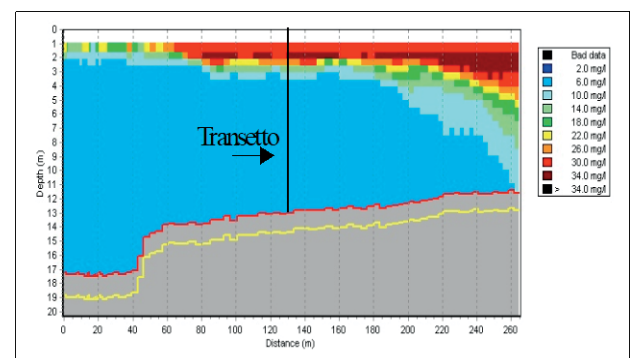
The size of the banks of *Chamelea gallina*, a mollusk of special commercial interest, was determined by sampling performed along transects perpendicular to the coastline and using boats from the local seagoing fleet equipped with commercial hydraulic dredges.



A side scan sonar survey of the seabed also determined the positions of beach rocks present on the seabed along the coastline. These are elements of great environmental and faunistic value which could be indirectly influenced by the works.

Measurements of turbidity in the inlet areas were also performed in addition to these activities. This was done to have a reference for natural variability prior to execution of the works.

This information was used to perform a modeling study to simulate the effect of the dredging works on pre-existing turbidity.



Finally, a social-economic study of lagoon fishing was carried out to give indicators useful in pointing out possible interferences with works. This study also comprised activities for informing and involving the fishermen by setting up "Reference Round Tables" with businessmen in this sector.

# ENVIRONMENTAL PROTECTION OF THE SARCA RIVER - LAKE GARDA - MINCIO RIVER - MANTUAN LAKES SYSTEM

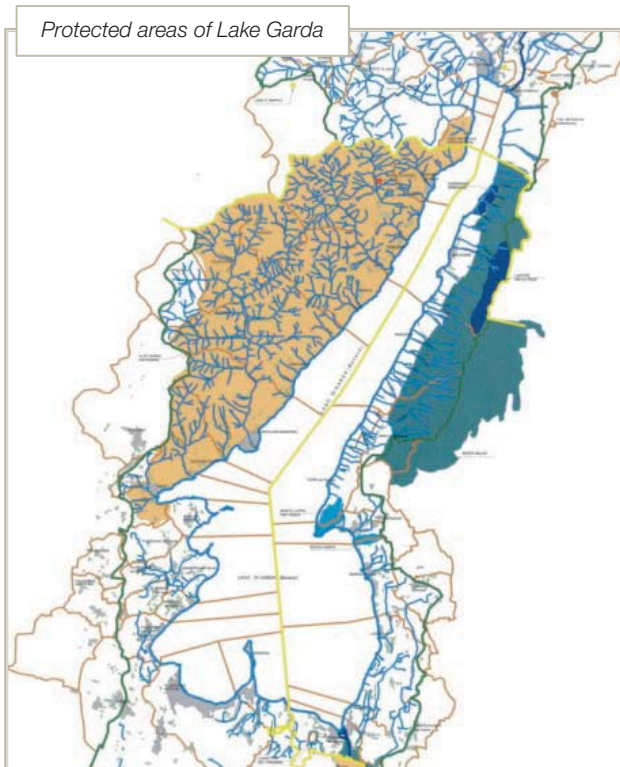
Location:	Italy
Client:	Po' River Basin Authority
Services:	Concept Design, EIA
Period:	02/1996 – 02/1997
Construction cost:	n.a.

## Project Description:

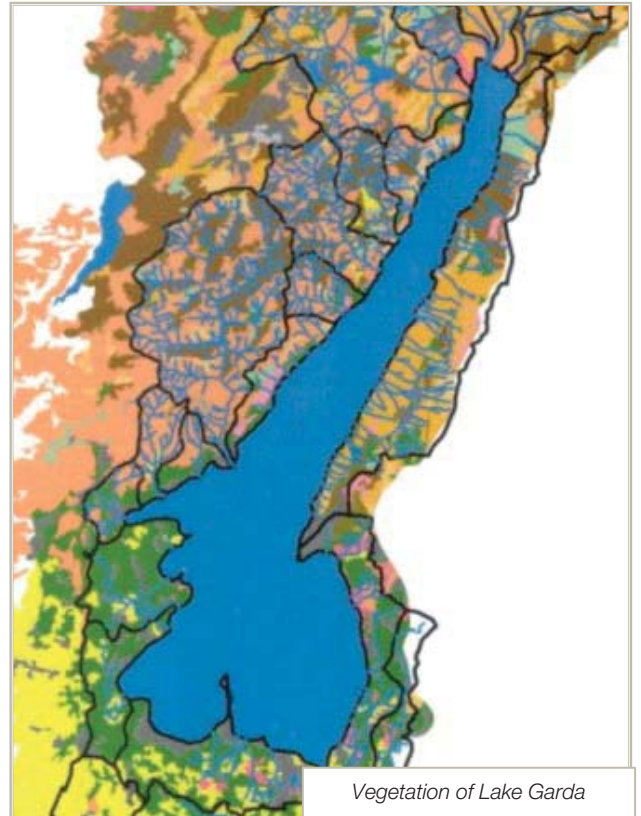


Sarca river

The aim of the study is to define an exhaustive framework of knowledge regarding the environmental quality of the area and to supply the elements needed to:



- improve the quality of the water in the basin in relation the integrated and optimum use of the water resource, taking into consideration the tourist-recreational prerogative of the area;



Vegetation of Lake Garda

- define the principal alternative actions to optimize the water treatment system and the recycling of the treated waste water;
- define the restrictions for using both the water and the land, identifying criteria, standards and regulations to reduce the impact of anthropogenic activities on the territory;
- identify the tools required for monitoring the efficacy of the actions.



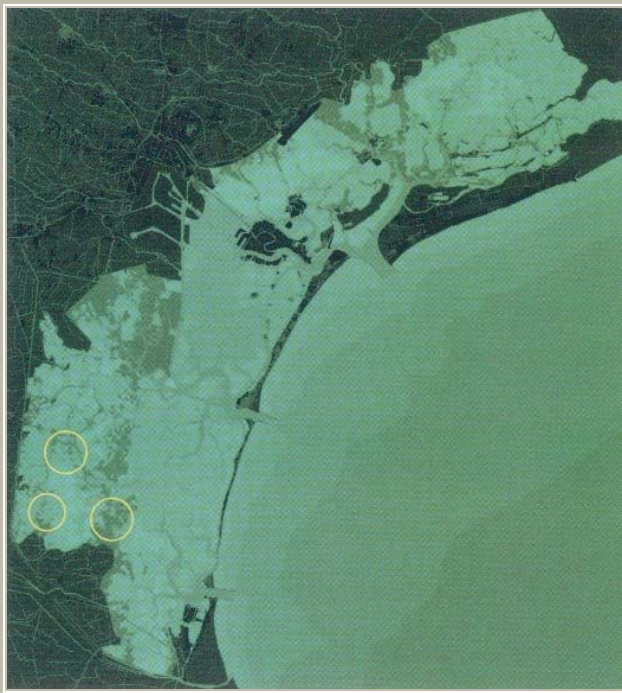
Mantua lakes



# IMPROVEMENT AND REHABILITATION OF THE VENICE LAGOON ECOSYSTEM

Location:	Venice, Italy
Client:	Venezia Nuova Consortium - Ministry of Public Works
Services:	Feasibility study, preliminary design and environmental impact assessment; detailed design of specific remedial works
Period:	04/1992 – 12/1994
Construction cost:	€ 235,504,300

## Project Description:



In the context of the Project for the protection of Venice and its lagoon from the devastating effects of high tides, one of the major problems to be dealt with is that of the increasing pollution of the lagoon water, with its consequences on the physical and biological environment.

The Project undertaken by TECHNITAL has as the primary objective the understanding of the causes of environmental deterioration and the identification of possible interventions to reduce the widespread water pollution and to restore the natural conditions of the ecosystem to acceptable levels in the shortest time possible.

In this regard the following activities were performed:

- detailed description of the environmental situation of the lagoon, including animal and vegetable life, sediment and water quality, morphological features;
- preliminary analysis of interventions needed to improve the environmental conditions;
- preliminary and final design of priority interventions;
- definition of management scheme to control and monitor the lagoon environment.



## Emergency interventions

The recovery plan drawn up by TECHNITAL aims primarily to reduce the eutrophication phenomena by reducing the amount of nutrients discharged in the lagoon. Nevertheless, due to the technical and social difficulties related to the implementation of this program, it is likely that anoxic episodes and related bothersome problems are not to be excluded in the near future. For this reason TECHNITAL defined a series of measures to be used during periods of ecological crisis in the most sensitive areas. These measures do not eliminate the problem but help minimise the negative effects to the environment and the population.

The emergency actions include two kinds of interventions:

- oxygenation of the water column in certain areas and periods.
- harvesting of algal biomasses in certain areas and periods

For both the interventions, the design phase has included not only the choice of the best technical solution (type of equipment etc.), but also the management aspect, i.e. the selection of the most sensitive areas and of the risk periods.



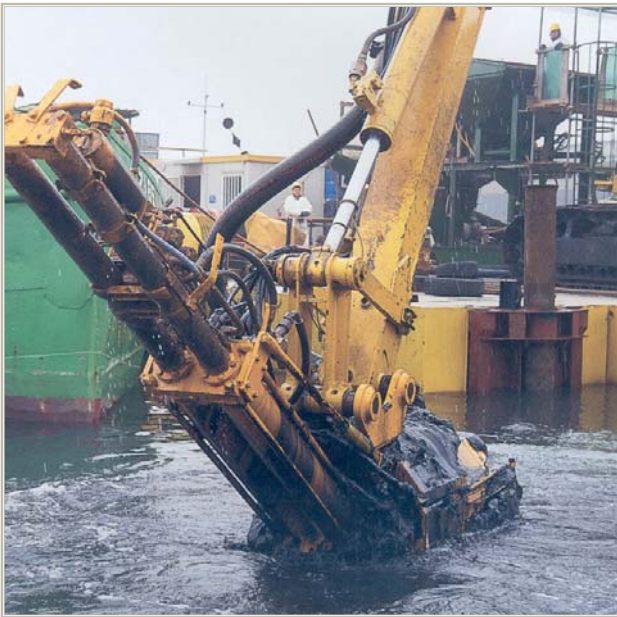
Morphological works



The morphological interventions include the construction of tidal flats and the reduction of the lagoon depth in the area surrounding the town of Venice.

The main objectives of these actions are:

- create morphological and hydrodynamic conditions unfavourable to the growth and accumulation of the macroalgae, whose decay in summer produces anoxic episodes in the water column;
- reduce the risk of release of pollutants from the sediments into the water column and in the trophic chain (using clean sand from offshore deposits in the Adriatic).



#### Use of artificial wetlands to intercept and purify the fresh water input from the drainage basin

One of the main problems of the lagoon of Venice is the huge amount of nutrient discharged into the same from the network of channels and rivers situated in its drainage basin.

The majority of this input, which has been estimated to be 4,800 tons of nitrogen and 500 tons of phosphorus on a yearly basis, is due to agricultural and urban runoff and therefore cannot be dealt with by building sewerage systems and treatment facilities.

In relation to this problem TECHNITAL carried out the Preliminary Design of an extensive belt of artificial wetlands around the lagoon (about 7,000 ha), which should collect both the average and the peak freshwater flow, thus increasing the residence time of the polluted waters and allowing the development of bacterial depuration processes before the final discharge into the lagoon.



In order to acquire more precise information concerning the effectiveness of this kind of system in the context of the Venice lagoon, TECHNITAL also carried out the Detailed Design in relation to two pilot areas at opposite extremes of the lagoon, optimising the final design and the management of the general system.

#### Containment of the existing solid waste dumping sites

As a consequence of the development which took place following the end of the second world war, when the number of urban settlements and the size of the industrial area of Marghera increased dramatically, several areas situated along the lagoon border or within the lagoon itself, have been used as dump site for urban and industrial waste. The leaking of pollutants from these areas was observed recently and TECHNITAL was therefore charged with developing a plan for restoring to their former state the existing 17 dumping sites.

For each dump site a specific recovery plan was elaborated, according to the nature of the contaminants (toxicity etc.), the physical environment (many dumping site are partly located below the mean water level) and the available technology. Among the solutions adopted are the containment of the site with a plastic diaphragm or sheet piles to minimise release towards the water column and, when practical, the chemical and thermal treatment of wastes.

TECHNITAL also executed the detailed designs for two of these dump sites.



Remediation





# INTEGRATED DIAPHRAGM AND CAPPING OF THE MALAGROTTA LANDFILL

Location:	Rome, Italy
Client:	Commissario Nazionale per le Bonifiche, Gen. Vadalà
Services:	Preliminary Design
Period:	09/2022 - Ongoing
Construction cost:	€ 96,383,329

## Project Description:

The Malagrotta landfill occupies an area of about 226 ha and includes a series of installations and plants connected to the waste cycle, as well as a series of installations that were, and in part still are, functional to the management of the landfill.

The project is for the construction of a new diaphragm and the capping for the landfill.

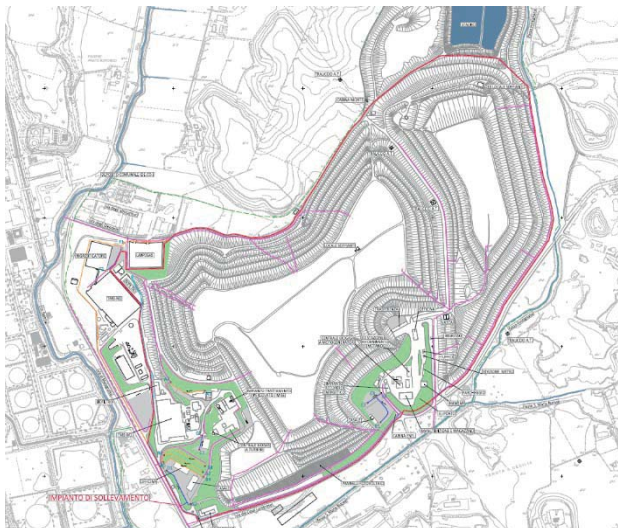
As far as the new waterproof belt diagram is concerned, it will be realized outside the existing diaphragm at a variable distance between a minimum of 7 m and a maximum of about 12 m. This will make it possible:

- Completely overcome the performance deficit of the existing plastic diaphragm;
- Avoid direct exposure to contaminated water from internal leachates to the existing diaphragm, ensuring that performance requirements are maintained over time (absence of alteration products that may increase the permeability of the barrier over time);

Based on the characteristics of the site, its size and the distribution of contamination (deduced from the Environmental Characterization Plan) and the techniques for the containment of polluted sites, the new belt will also consist of a plastic diaphragm.

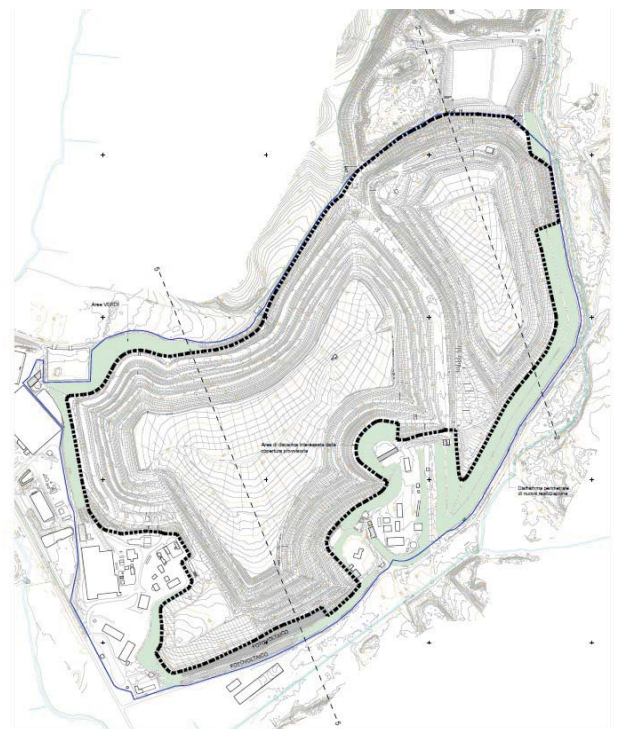
The diaphragm has these characteristics: Thickness: 100cm; Height: variable 16,70÷20,90 m; Height mean = 18,80m

As far as capping is concerned, the project consists in the completion of the stratigraphy of provisional final cover of the landfill.



The realization of the final cover is to be performed only downstream of the development of most of the subsidence due to both the decomposition of organic matter and the extraction of leachate and biogas. A minimum amount of subsidence will still be present for the continuous biodegradation of the organic substance and therefore for the extraction of the corresponding volumes of leachate and biogas.

This means that the landfill must have reached a condition of stability in terms of deformation or must be stable from a point of view of both possible gravitational mechanisms and differential sagging. These phenomena, in fact, are responsible both for the global/local stability of the embankments of the landfill and for the stability of the cover package and/or its deformations, which can cause damage to the cover itself, affecting its sealing characteristics (waterproofing, rainwater drainage, etc.).



The current condition of Malagrotta, is such that the deformations induced by the widespread and systematic extraction of leachate and biogas will determine important morphological changes, that must be properly detected and regularized (think for example to the design of the system of collection and removal of rainwater) before the realization of the Final Coverage.

The object of the project, namely the laying of 30 cm of vegetable soil, does not therefore entail any geotechnical problems whatsoever, because the landfill will be in a final configuration stabilized, thanks to the extraction of leachate, biogas and the necessary morphological regularization works.

From the construction point of view, the following processes are expected on the shell:

1. Removal of the first 30 cm of plant soil of the provisional cover and provisioning of the material;
2. Laying of 30 cm of soil. This volume is expected to be supplied by the accumulation of granular earth material located east of the landfill and now used for landfill disposal/ maintenance (rehabilitation of dirt roads, levelling of the ground where the biogas pipes rest, etc.);
3. Laying of the 30 cm of previously set aside vegetable soil.

A re-distribution and planting of the surface of the landfill, where not already present or not inherited from previous activities, will allow better retention of the cover plant soil and operate a better environmental integration.

The capping will be for an area of Area: 365000m<sup>2</sup>



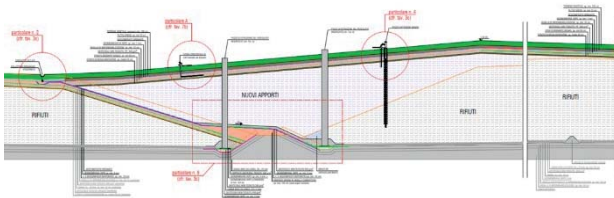
# COMPLETION OF THE LANDFILL IN TORRETTA DI LEGNAGO

Location:	Torretta di Legnago, (Italy)
Client:	Legnago Servizi S.p.A:
Services:	Detailed Design, Works Supervision.
Period:	08/2023 - Ongoing
Construction cost:	€ 26,760,681

## Project Description:

The intervention concerns the detailed design and construction supervision of the remodeling of the existing lots of the expansion of the landfill for non-hazardous waste located in the Municipality of Legnago, Torretta locality, without occupation of new areas, by "filling the valleys" existing between lots A and F on one side and of lots C and D on the other.

The works concern the adjustment of the bottom barrier, the cover, leachate, and biogas plants.



The shaping and waterproofing activities of the different sectors can be summarized as follows:

- Scarification of the perimeter embankment and formation of the "flat" zone in continuity by raising the embankment by 1.00 m, with the laying of several well-contoured layers of natural clay, having permeability not exceeding  $1 \times 10^{-9}$  m/s;
- Removal of the vegetation layer of the former cover of Lot C north side until the mineral sealing layer is reached, regularization and formation of the design slopes of the existing mineral layer, with a minimum thickness of 0.5 m and permeability not exceeding  $1 \times 10^{-9}$  m/s;
- Formation of separation embankments between sectors and the southern perimeter embankment.
- Laying on the flat area and embankments, two bentonite geocomposites, with a minimum thickness of 10 mm each and permeability coefficient not exceeding  $1.5 \times 10^{-11}$  m/s, capable of supplementing the permeability of the clay layer;
- Laying on the flat area and embankments of the waterproofing membrane, consisting of 2 mm thick HDPE Geomembrane sheets, joined by double-track/extrusion heat welding and also carried over to the embankments.
- Laying on the embankment area of an overlapping layer of  $500 \text{ g/m}^2$  nonwoven polypropylene geotextile.
- Laying on the embankment area between lots C-D of a layer of non-calcareous gravel with drainage function at the "flat" part of the bottom, not less than 50 cm thick;
- Construction of the vertical HDPE leachate collection wells, each consisting of: an HDPE backing plate surmounted by a double TNT, an HDPE bottom plate welded to a HDPE D1000 mm vertical base pipe connected to the draining pipe, an HDPE D800 mm well

module inserted inside it, a truncated gravel cone of  $h=1$  m placed above the draining layer with, on the top, a supporting HDPE plate, and an outer liner above the said plate, consisting of a HDPE D1300 mm vertical pipe with HDPE reinforcements. The gap between the liner and the well module is filled with anti-shrinkage mortar, after reinforcing the inner module with reinforcing bars.



Once the maximum heights of the waste constituting the reburial have been reached, the temporary cover of Lot C will be constructed; it will consist of the following system, from the bottom up:

- 20 cm thick regularization layer.
- Woven geotextile separating the regularization layer and the inert material.
- Drainage layer consisting of inert granular material with a total thickness of 50 cm.
- Nonwoven geotextile separating the drainage layer and the clay thickness.
- Compacted clay mineral layer with a total thickness of 50 cm and permeability not exceeding  $1 \times 10^{-8}$  m/s







# RECLAMATION WORKS OF THE MINERAL OIL POLLUTED SITES IN THE MUNICIPALITY OF TARANTO

Location:	Taranto, Italy
Client:	Agenzia del Demanio
Services:	Final design, Detailed design and Construction Supervision
Period:	02/2018 – Ongoing
Construction cost:	€ 6,700,000

## Project Description:

The Agenzia del Demanio, as part of its programme of works on public buildings, awarded the engineering services for the reclamation and securing of large mineral oil tanks formerly used by the Italian Navy, located in the territory of the municipality of Taranto, in the areas called "Toscano", "Manzo" and "Rapillo", where there are other tanks connected by a system of pipelines.



Technical and economic feasibility, final design and executive design services have been entrusted for the works, which mainly consist in emptying the residual material contained inside the tanks and in their reclamation, tightness control and permanent safety with total or partial demolition of the tanks.

A careful characterisation plan of the soil, ground water and materials contained inside the tanks was initially prepared. Geoelectric surveys were carried out to highlight the presence of underground structures that needed to be remediated, as well as videoscopic surveys with a probe. All investigations were carried out from outside the tanks as it was not possible to enter them for safety reasons.

Possible design solutions were studied and the best solution was identified in terms of the best cost-benefit ratio, with particular reference to the following aspects:

1. removal of the material contained inside the tanks;
2. transfer of the material contained in the tanks to a suitable destination on the basis of the results of the supplementary investigations carried out and in compliance with current legislation, or recovery of the same;
3. remediation of the tanks and of the pipelines connecting them, and verification of the tanks' tightness

4. permanent securing of the tanks and of the pipelines connecting them;

5. verification of any pollution due to leakage from the environment surrounding the tanks

6. anything else necessary to achieve the objectives of the previous points and to obtain a certificate of reclamation certifying that the tanks have been regularly reclaimed and that the contents have been disposed of in accordance with the law (Legislative Decree 152/2006).

The project involves the reclamation of 8 cylindrical steel tanks (each 35 m in diameter) that contained naphtha or diesel fuel and 4 concrete tanks, each 1250 m<sup>2</sup> in size that contained naphtha. The decontamination and securing also includes the underground tunnels and the associated pipelines and manoeuvring chambers.

The steel cylinders are enclosed in a stepped cyclopean concrete structure. After decontamination, the steel tanks are selectively demolished, reclaimed and sent for recovery, thus reducing costs for the contracting authority. The steel pipes also undergo the same treatment.

The concrete naphtha storage area consists of a large tank divided into four smaller tanks, which is also underground. The tunnels containing the pipes and the manoeuvring chamber are also underground.

The inside of the tank has concrete columns supporting the vaults.

The project foresees the selective demolition of the vaults in order to allow safe access to the reservoir and to carry out the final cleaning and securing operations.

All the tanks rest on a layer of blue clay with low permeability.

A careful monitoring plan will be in place to ensure that the remediation operations do not lead to impacts on soil and groundwater.



# CONSTRUCTION OF A CONFINED DUMPSITE TO BE USED AS NEW CONTAINER TERMINAL IN THE PORT OF NAPLES

Location:	Naples, Italy
Client:	Naples Port Authority
Services:	Preliminary, Final and Detailed Design, EIA, Works Supervision
Period:	05/2003 – 12/2023
Construction cost:	€ 424,215,000

## Project Description:

The design of the new container terminal at the Levante Dock (Port of Naples) is based upon the closure of the dock with land filling of about 1.3 million cube metres of sediment dredged from the whole Port area. Thanks to the low permeability of the boundaries the site was designed to be used also as a confined disposal facility. The port dredged materials in fact are potentially polluted.

The new quay for container ships is to be built by converting an existing quay with the following features:

- 650 m length, 14 m depth which could be increased to 16 m for future needs;
- capacity to host two 6,000 TEU ships at the same time, or one ship of 11,000 TEU
- storage and handling area for containers including backup area of 230,000 m<sup>2</sup>;
- availability of areas for road and rail connections, port services and workshops for dockers.

The new quay structure consisting of a double wall of steel piles connected with Larssen type joints, with polyurethane waterproof sheathing up to the impermeable tufa layer. Backwards, the boundaries are made by means of cement-bentonite mix diaphragms.

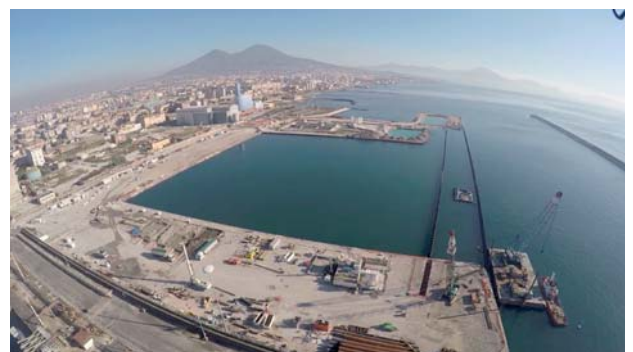


The project comprises the clean-up of bottom sediments (characterization and confinement of hot spot soils to a disposal

site), protection of the area by a cut-off wall in order to prevent polluted groundwater to enter in the CDF, re-design of existent structures, dredging and land reclamation activities.

As far as Environmental Impact Assessment is concerned, noise and air modelling were used to evaluate impacts induced by the construction site. Further to the Environmental Impact Assessment, environmental risk analyses were performed to properly manage polluted material and avoid detrimental effects to environment and human health, due to the vicinity of the port to the city of Naples.

The design of the Terminal has been approved by the Italian Ministry of Infrastructures and Ministry of the Environment. Regarding as far as environmental protection.





# DETAILED DESIGN OF THE ENVIRONMENTAL RECOVERY OF THE DUMPSITE OF MALAGROTTA (ROME)

Location:	Malagrotta (Rome), Italy
Client:	E. Giovi s.r.l.
Services:	Detailed Design of recovery measures
Period:	05/2021 – 12/2022
Construction cost:	€ 400,000,000

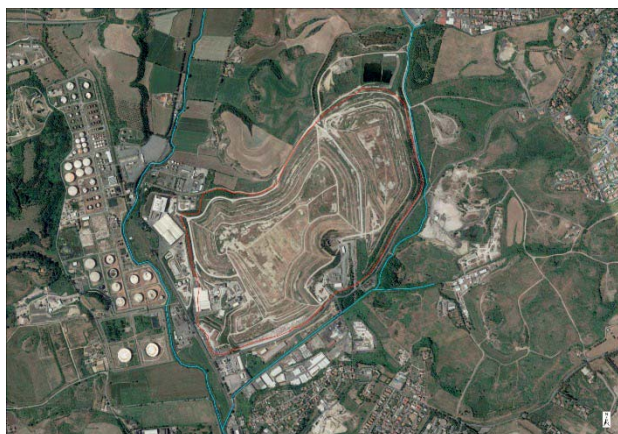
## Project Description:

The dumpsite of Malagrotta (Rome) is the largest in Europe.

It has received the urban waste of Rome and nearby Municipalities from early 1980s to September 2013, when the waste delivery in the site was closed by the public Authority.

The dumpsite has an area of around 140 hectares, in the highest point it is 80 m above sea level, it is delimited by a 5.340 m long cut-off wall and its bed consists in a thick layer of Pliocene clay located around 15 m above sea level.

The maximum height of waste disposed is around 60 m; altogether, the dumpsite has received about 46.000.000 tons of urban waste.



A number of 2.800 biogas wells are present in the dumpsite together with only 12 leachate wells.

In July 2018, the dumpsite was seized by the Italian court due to environmental problems mainly related to the management of the leachate. A Judicial Administrator was named to manage the site. In addition, a pilot procedure by the European Commission was opened too, in 2016.



On 12 May 2021, Technital was commissioned by the Judicial Administrator to perform detail geotechnical investigations (including field supervision activities) to better understand the state of the art of the dumpsite (e.g.: amount of waste, leachate levels and quantities, integrity and continuity of the cut off wall, composition of the perimetral and of the superior embankments, etc.) and to design the intervention for the environmental recovery of the dumpsite (capping and others required), including the final landscaping.



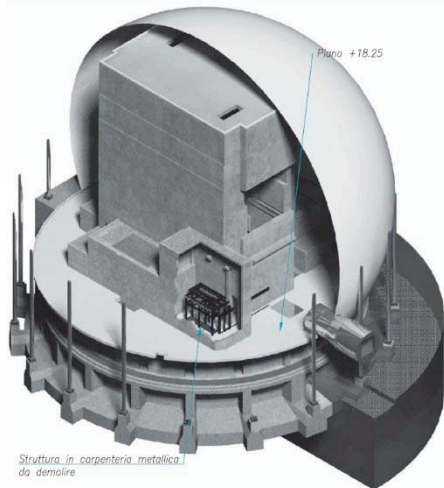
# DECOMMISSIONING OF THE COOLING POOL OF THE NUCLEAR POWER STATION OF GARIGLIANO IN SESSA AURUNCA – CAMPANIA REGION

Location:	Sessa Aurunca, Italy
Client:	SOGIN S.p.A.
Services:	Final design
Period:	09/2017 – 05/2018
Construction cost:	1,400,000 €

## Project Description:

The nuclear power plant "Garigliano" of Sessa Aurunca was built in four years (1959 - 1963) by SENN, National Electronuclear Society, on a project of the engineer Riccardo Morandi, and started the production of electricity in April 1964. The central, model BWR, Boiling Water Reactor, belongs to the first generation of nuclear plants, with an electrical production capacity of 160 MWe.

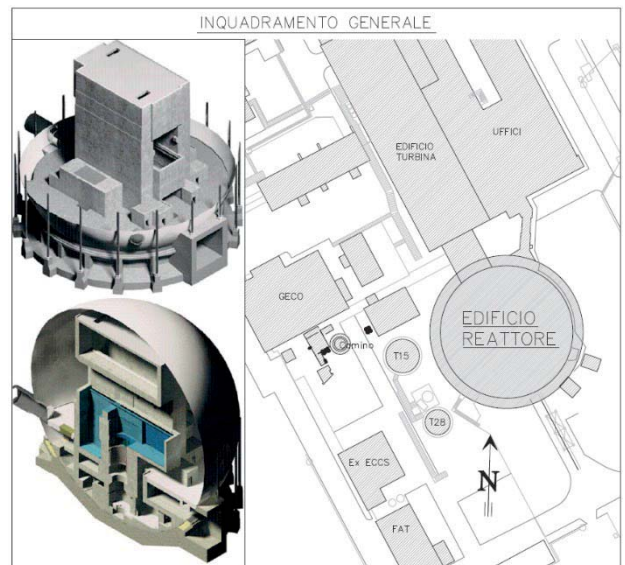
In 1965, the plant was taken over by Enel. The plant was in operation until 1978, when it was stopped for maintenance. In 1982 the power plant was permanently deactivated. Since then it has been guaranteed the safe maintenance of the structures and plants to protect the population and the environment.



The plant produced a total of 12.5 billion kWh of electricity. In 1999 Sogin became the owner of the plant with the aim of carrying out the decommissioning.

The Garigliano power plant was the second of the four Italian nuclear power plants, after that of Trino, to obtain in September 2012 the decommissioning decree approved by the Ministry of Economic Development, the Nuclear Safety Authority (ISPRA) and the other institutions.

The project is aimed at reactivating the pool recirculation system, for the subsequent reuse of the reactor pool for the cutting of components and equipment characterized by high levels of contamination / nuclear activation.



The interventions consisted in: demolition and restoration (demolition of concrete block walls, demolition of reinforced concrete structures, temporary confinement of areas, restoration of the epoxy resin coating, investigations of integrity/tightness of the liner and restoration interventions), component removal (fresh nuclear fuel storage rack, fresh nuclear fuel storage carpentry, electromechanical elements, pool cover elements, press, pool racks), new installations (filtration unit, pumps, softener, valves, regulation and control logics, discharge to the central unit RW, automation and control system), electrical system.

Technital provided the final design of the new piping and fittings, pumps, filters and supports. Moreover, Technital provided structural analyses and verifications on civil structures, both after partial demolitions and as support of provisional equipment.





# ENVIRONMENTAL RECOVERY AND EXTENSION OF DUMPSITE FOR NON-HAZARDOUS URBAN WASTE AT TORRETTA DI LEGNAGO

Location:	Torretta di Legnago, (Italy)
Client:	Legnago Servizi S.p.A:
Services:	EIA, Preliminary and Detailed Design; work supervision
Period:	10/2007 - 10/2016
Construction cost:	€ 34,138,800

## Project Description:

The intervention concerns the permanent sealing and environmental recovery of the areas used as dumpsite in the years 1982-1990. The first section of this dumpsite occupied the former riverbed of the Tartaro river, which dried up after the deviation of the river into the Bianco canal. The riverbed had a natural slow-permeability surface cover which, according to the legislation of the 1980's, was suitable for receiving urban waste. When the first riverbed section was filled, the dumpsite was extended into a second riverbed section and subsequently in the area to the north between the old riverbed and the Bianco canal until the expected exhaustion of this area in Dec. 2008. Moreover, the project is intended to guarantee the dumpsite a further operating life of 8 years to receive the daily collections of urban solid waste. Following the analysis of the existing situation and the comparison of the two alternative solutions allowed by Italian law - the making safe by complete sealing or by the removal of the sources of contamination - the latter alternative was chosen, involving the removal of 595,316 m<sup>3</sup> of waste from the old riverbed and its conveyance to the extended dumpsite area, together with some 87,224 m<sup>3</sup> of cover material.

The removal of the waste material will be carried out cell by cell, each cell bounded on two sides by the river banks and on the other two sides by the excavation front and a closing clay dyke. In this way contamination of the areas by the percolated overflow of the dumpsite is kept to a minimum. The excavation will be carried out in two phases: the first half from above, positioning the digger and the trucks on top of the dumpsite, and the other half from below with the digger inside the cell being excavated and the trucks outside it in the area already recovered. The excavation will therefore be done mechanically using grabbers capable of gathering up the waste material leaving behind most of the water contained in the voids of

the material removed. The waste material will be loaded onto trucks. The new dumpsite must receive approx. 500-600 m<sup>3</sup>/day of recovered material from the first riverbed section plus the daily volume of solid waste from the neighbouring areas.

According to the indications of Le.Se. S.p.A., the normal volumes of USW to be conveyed annually to dump are equivalent to 120,000 t/year, of which 96,000 t/year dry material for dumpsite and 24,000 t/year of organic material to be conveyed to the composting plant and recycled as daily cover material (BD). Assuming the unit weight of the dry USW is 0.75 t/m<sup>3</sup>, the useful volume of the dumpsite annually occupied by ordinary USW can be estimated to be around 128,000 m<sup>3</sup>. The dumpsite therefore needs to be extended for a total of 1,620,000 m<sup>3</sup>, considering the volume deriving from the clearing and recovery of the first section plus the regular waste conveyance. These volumes were defined according to an arrangement approved by the competent authorities. These volumes were defined according to an arrangement approved by the competent authorities.

Technital also designed the monitoring system for checking the environmental parameters before, during and after the recovery and construction works.

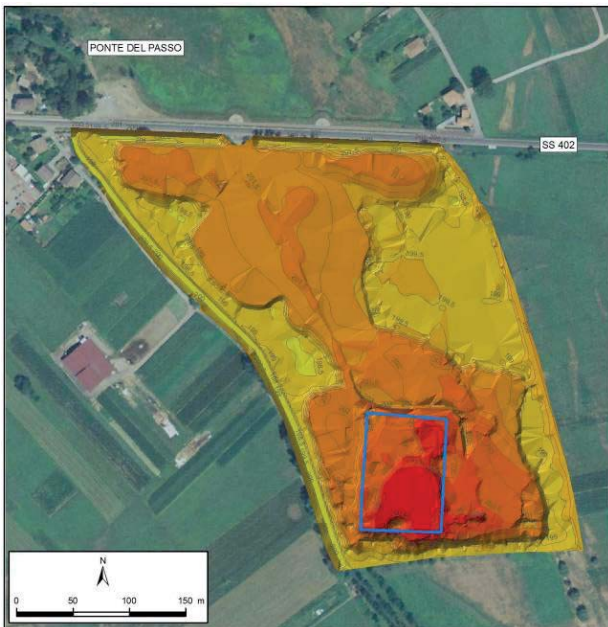


# ENVIRONMENTAL RECOVERY OF A DUMPSITE FOR STEELWORKS CLOSE TO LAKE COMO

Location:	Lombardy Region, Italy
Client:	Infrastrutture Lombarde S. p. A
Services:	Preliminary, final and design, Environmental feasibility study, landscaping design, monitoring plan of underground waters, technical assistance
Period:	07/2012 – 05/2014
Construction cost:	€ 599,400

## Project Description:

The project site is located close to Lake Como (Lombardy region) and it is inside a natural reserve protected by European Regulations (Directive 92/34/CEE and Directive 79/409/CEE). The site is about 7.500 m<sup>2</sup> and from 1972 to 1992 it was filled with wastes from steelworks. The project objective is the environmental recovery of the site through capping and collection of rainwater to prevent infiltration.



The design activities took into consideration the criteria provided in national and international scientific literature (e.g. US EPA) and national laws and regulations, particularly in relation to isolation of the waste, minimization of the rainwater infiltration and of the erosion, prevention of local settlings, and reduction of maintenance activities.

The interventions carried out included removal of the vegetation cover, disposal of the capping and of the drainage network, landscaping (re-vegetation).

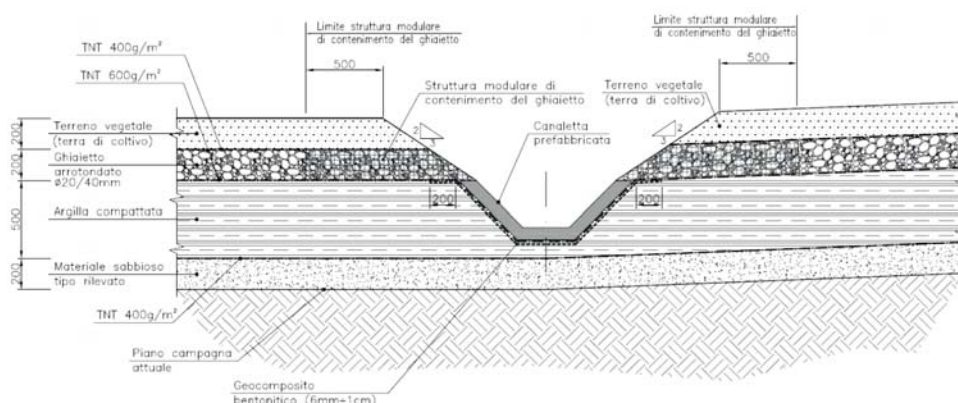
The capping is made of: minimum of 20 cm of sand for regularizing the terrain, geotextile 400 g/m<sup>2</sup>, 50 cm of compacted clay, geotextile 600 g/m<sup>2</sup>, 20 cm of rounded gravel (Ø 40-60 cm) (i.e. the drainage layer), geotextile 400 g/m<sup>2</sup>, and 20 cm of topsoil for the landscaping.

The compacted clay is the waterproofing layer; it permits reaching the permeability of 10<sup>-9</sup> m/s. The layer has been combined with a bentonite geocomposite (permeability of 10<sup>-11</sup> m/s) where the thickness of 50 cm needed to be reduced.



The collection of rain water will be performed through the drainage layer and to the network of prefabricated ducts (486 m length), laid on the clay layer, to deliver the water to a ditch located along the west side of the site.

Given the location of the site, the landscaping activities represented an essential element of the project. Native species were re-introduced in the site, according to local regulations and to the Master Plan of the natural reserve in which the site is located.

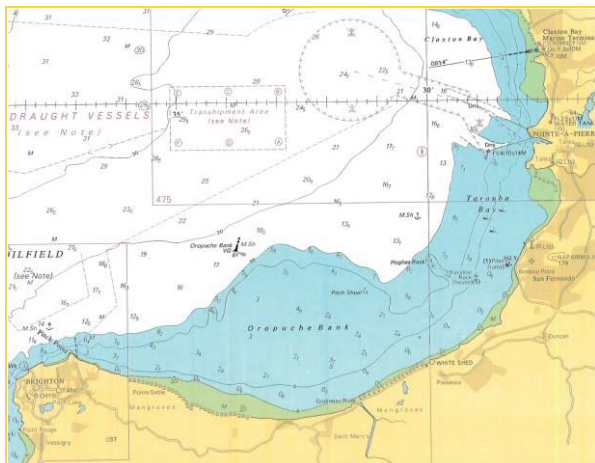




# ORPOUCHE BANK RECLAMATION PROJECT

Location:	Trinidad & Tobago
Client:	National Energy Corporation of Trinidad & Tobago Limited (NEC)
Services:	Master plan, EIA , Detailed Design and Tender Documents
Period:	08/2008 - 12/2010
Construction cost:	€ 1,870,911,000

## Project Description:



In order to accompany the exploitation of the gas resources of Trinidad & Tobago, the Government has charged the National Energy Corporation (NEC) to identify and develop new industrial sites. A series of preliminary studies have been undertaken and as a result of these studies three possible sites seems to give the possibility to allocate new industrial parks as requested by the Government. One of these is the Oropouche Bank, located off the south-west coast of Trinidad, between Pointe a Pierre in the North, and Brighton in the south west, which has been identified as a potential site for locating gas based industries. The idea of creating new industrial sites by building reclaimed areas allows the Government to avoid consuming land side areas, thus reducing the impact on the population.

In the framework of this contract TECHNITAL has developed various activities:

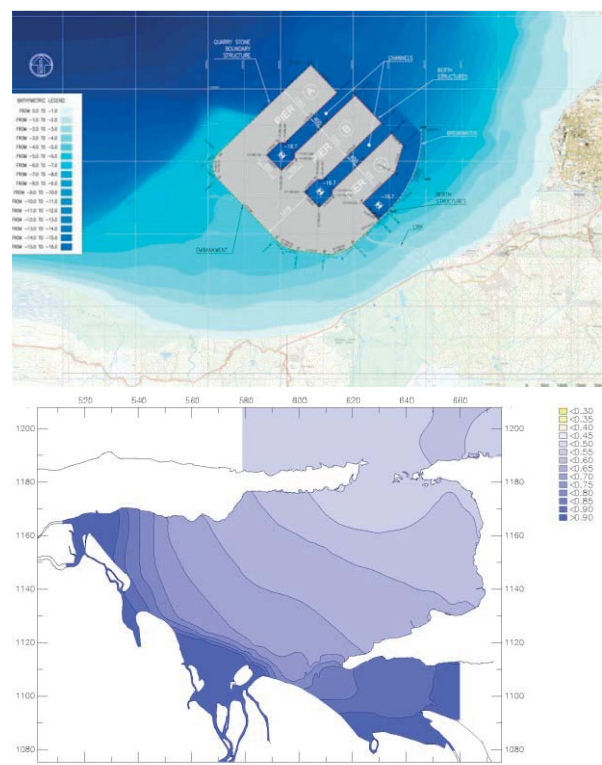
In the first Phase several environmental studies were developed to define location and shape of the new island. The studies included extensive numerical modelling analysis on the local conditions as well as on the general conditions of all the Gulf of Paria in order to highlight possible impacts. The proposed reclamation site is located in a sensitive area, from the morphological and ecological point of view; it is characterised by the presence of the Godineau river mouth, extensive mangrove swamps and is presently a very important fishing ground for shrimps; all these aspects were considered in order to find the more sustainable layout of the new island. Among the aspects studied were: sediment transport, waves, littoral currents , river discharges, coastline evolution, benthic life, fishing activities. As a consequence the final layout of the island with a total surface of 1600 ha was defined

In a second phase a Master Plan of the industrial development on the new island was performed. Industrial planning necessary to define the characteristics and the reciprocal position of the industries that will be installed in the new island and of the relevant port facilities were defined for different development scenarios, considering different combinations of heavy and light industries as well as of tertiary sector

In the third phase it was developed the preliminary design of the new island; the design included

- identification of the most appropriated source of the filling material (roughly 100 million m<sup>3</sup>), analysing the different possibilities offered by Trinidad & Tobago , by the neighbouring countries by offshore marine sites
- definition of construction methods to minimise the environmental and anthropic impacts, the construction time and, as a consequence, the final cost of the work;
- identification of the most appropriated engineering solutions for the quays, the jetties, the boundary protection structures (sheet piles, concrete caissons, rubble mound protections, etc.) as well as for soil compaction and rainfall drainage
- identification of the most appropriated engineering solutions for the link connecting the new island with the mainland (a viaduct approx. 2 km long), including a traffic study of the connection with the existing road network

Finally, a scoping document was prepared, to serve as a guide for the conduct of the future EIA study .



# ENVIRONMENTAL REHABILITATION OF THE COASTAL WETLAND OF MOLENTARGIUS AND PROTECTION OF POETTO LITTORAL

Location:	Cagliari, Sardinia - Italy
Client:	Aeroporto Valerio Catullo di Verona Villafranca S. p. A
Services:	Feasibility study, basic and preliminary design. Environmental impact assessment study; detailed design of the coastal protection works
Period:	06/1992 –10/1993
Construction cost:	€ 61,974,800

## Project Description:

The wetland of Molentargius is considered a very peculiar and fragile ecosystem and therefore is included in the Ramsar list of areas to be protected and conserved. This Project launched by the Italian Government to rehabilitate this area includes: hydraulic rearrangement, phyto-purification plant, redevelopment of the area as a nature reserve, protection of the littoral, surface waters depuration, ecological dredging of the top layer of polluted sediments, coastal protection works.

Within this Project, TECHNITAL was entrusted with the definition of the general plan of the intervention, the environmental impact assessment study, the detailed design of coastal works.



The Poetto littoral is a long strip of beach of some 7 kilometres located close to Cagliari. The closeness to the city, its inclusion in a highly appreciated and unusual environmental context, which also includes Molentargius salt-pans and pools, and the quality of the sand, quartz-bearing and pale coloured, are the principal elements which give the Poetto great appeal, from both touristic and landscape/naturalistic points of view. Since the end of the war, however, successive human interventions carried out without due respect for the delicate morphology of this narrow beach have created problems of widespread erosion and environmental decay.

As part of a broader programme for the environmental rehabilitation of the hydrographic basin behind the littoral, TECHNITAL was commissioned in 1992 to carry out the specialist studies and the designs of the interventions needed to restore conditions of morphological stability and environmental balance throughout the Poetto.



The studies involved the use of mathematical and physical models. Models were used to study the propagation of wave motion, reproduce the current field and calculate sediment transport and coastline evolution. On the basis of the acquired information a balance of the sediments along the littoral was formulated, both reconstructing the recent past and predicting the future trend, for several reference frames corresponding to various intervention proposals. The study with the physical model served to define and check the new interventions.

The works foreseen on the coastal strip in the Preliminary Design included:

- rebuilding the coastal dune and moving the littoral road inland;
- artificial beach nourishment with sand taken from the sea;
- moving a water inlet currently located on the shore-line out to sea;
- removal of some of the illegal buildings present along the littoral and overlooking the shore-line;
- transplanting *Posidonia Oceanica* to restore, in part, the meadows which were once very extensive and which are now greatly reduced due to anthropic action



At the end of the assessment and approval stage of the Preliminary Design, the Detailed Design was developed for the 1st section, consisting of the rebuilding of the first part of the dune belt and a pilot operation for transplanting *Posidonia Oceanica*

Landscape and Ecology



# HYDROGEOLOGICAL CONSOLIDATION WORKS FOR THE NORTH-EAST SLOPE, DOWNSTREAM OF PETACCIATO

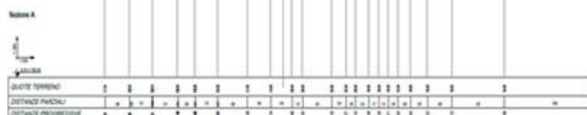
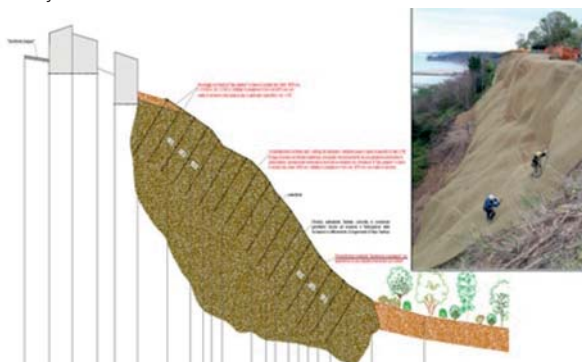
Location:	Molise Region, Italy
Client:	Molise Region
Services:	Preliminary Design, Detailed Design, Works Supervision
Period:	05/2022 - ongoing
Construction cost:	€ 28,531,435.54

## Project Description:

Petacciato is a small town, located in the central Apennine Mountains, in the province of Campobasso at around 150 m above sea level.

The Petacciato landslide has been known since the early 1900s, it's one of the largest landslides in Europe. Between 1906 and 2015, at least 15 landslide events were documented on the slope, in the winter months between January and March, following periods of intense rainfall (landslides in rigid clay slopes along the Adriatic coast; Cotecchia et al. 2008). The landslide is of a "complex type" and can be summarized through the following data:

- surface area of approximately 4 km<sup>2</sup>
- crowning of the head (near the town) approximately 2 km long.
- Depth of the main slip surface approximately 75 m
- The foot of the landslide goes out directly into the sea (a few tens of meters from the coast)
- The difference in height between the crown and the foot is approximately 220 m



At the present the landslide involves, in addition to the town of Petacciato, important transport infrastructures too, including the "Adriatic railway", the "A14 motorway" and the "national road SS16", as well as smaller structures and many local roads.

The Landslide Mitigation Project consists of carrying out geotechnical investigations, checking the stability conditions of the slope and providing for the necessary structural works and non-structural works (deep drainage systems and surface water regulation).

The above elements will be integrated with surface consolidation works (soil nailing) and greening of the slope with planting of vegetable species compatible with the current landscape.

The project will be also completed with a sophisticated deep geotechnical monitoring system (with inclinometers and piezometers) and satellite type (with A-DInSAR technique), to control any residual movements after the completion of the works.

The main cause that generated the large landslide, or rather the multiple landslides of Petacciato, is due to the presence of clayey

rocks alternating with thin sandy levels and a water table, which often comes under pressure (artesian water table) and causes the deterioration of the soil resistance parameters, with the consequent triggering of landslides.

Through historical analyses and studies, as well as through specific geotechnical investigations, we have ascertained that the thickness of the clayey sequence exceeds 120 m and the main sliding surface of the landslide reaches even 70 m, therefore the volume of the landslide soil reaches enormous values (over than 200 million m<sup>3</sup>).

In these conditions, it's very difficult (with acceptable costs) or even impossible to design structural consolidation works necessary to block and stabilize the movements of the landslide. One of the possible solutions that have been analysed and accepted by the Client is the mitigation of the effects of the landslide phenomenon, through the lowering of the piezometric level which causes the improvement of the soil resistance parameters and therefore increase the stabilization effect of the slope.

Due the lack of the enough budget, after the preliminary study, the Client decided to develop the project for a first stage, aimed at safeguarding of Petacciato.

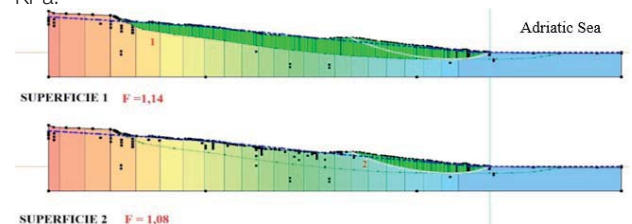
To obtain the soil drainage by lowering the piezometric level with the necessary value to obtain the stabilizing effect a network of drainage shafts, approximately 30 m deep, was designed. The shafts will be connected to each other with a bottom discharge pipe. The entire drainage system discharges all the water collected by gravity towards the Adriatic Sea.

The shafts will be dig after creating a crown of concrete piles to allow excavation in safe conditions. The bottom discharge pipe will be made with T.O.C. (controlled horizontal drilling) technology.

In addition, to the deep drainage network, a surface water disposal system will be created. With these drainage systems will be mitigate the main effects of the landslide phenomenon on the entire slope between the town of Petacciato and the coastline.

For the protection of the town of Petacciato directly affected by the collapse of the vertical cliff, located downstream of the town, and generated by the retrograde effect of the landslide, local consolidation work was planned with the "soil nailing" technique.

The depth and the distance between each shaft was calculated following many checks on the global stability of the slope. Stability analyses were conducted, assuming that the drainage system produces a uniform lowering of the piezometric surfaces around 10 m and a reduction in pore pressures of the order around 100 KPa.



The uniform lowering of the piezometric surfaces of 10 m, gives us a safety coefficient around to  $F=1.14$  and  $F=1.08$  respectively for the deep landslide bodies 1 and 2, which correspond to a hydraulic efficiency of the drainage shafts around 12.5%.

The above values were considered sufficient to establish the depth and distance between the shafts to obtain a mitigation effect of geomorphological instability, in accordance with the budget made available by the Client.



For the protection of the town of Petacciato directly affected by the collapse of the vertical cliff, located downstream of the town, local consolidation work was planned with the "soil nailing" technique. For the protection of the town of Petacciato directly affected by the collapse of the vertical cliff, located downstream of the town, local consolidation work was planned with the "soil nailing" technique.



# CONSOLIDATION INTERVENTIONS OF THE ROCKY WALLS OF MONTE PELLEGRINO OVERLOOKING THE URBAN AREAS OF “VERGINE MARIA E ADDAURA”

Location:	Italy, Sicily
Client:	Commissario di Governo contro il dissesto idrogeologico della Regione Siciliana (Government Commissioner against hydrogeological instability in the Sicilian Region)
Services:	Final and Detailed Design, Construction Supervision
Period:	09/2020 – ongoing
Construction cost:	€ 22,712,000

## Project Description:

The project aims at consolidating the slopes of Monte Pellegrino in the province of Palermo, and at ensuring their safety against the risk of rock falls. The contract has been divided into two lots:

- Lot A: facing north;
- Lot D: southernmost portion of the large east-facing section.



Monte Pellegrino has sub-vertical slopes up to more than 400 m high; in recent years, roads and private houses have been built at a distance too short in respect to rock falling affected area. The project envisages the securing of houses and roads through active systems on the wall such as preventive de-escalation devices, tie-rods, nets and grids of ropes, and passive systems such as high-energy rockfall barriers arranged in several rows.



Lot A extends on a front of more than 1.000 m, while Lot D extends on a front of more than 1.400 m, entirely burdened by conditions of high danger for rock fall. In order to evaluate the typology and the effectiveness of the interventions, surveys on the wall have been carried out with alpine techniques, drone surveys and a 3D model has been realized for the analysis of the rock fall trajectories. Active and passive protection systems have been chosen, positioned and sized according to the model results.



The intervention involved an environmentally dangerous area with a sub-vertical mountainous relief with a height varying from 100 to over 400 m overlooking the sea. In some cases there are houses built close to the slope. The danger is increased by the fact that it is a seismic zone. The design was carried out by a campaign of geognostic surveys, with also nail extraction tests and wall anchors.

The assignment was carried out according to technical standards of construction NTC 2018. Eurocodice 8. ETAG 027.



# PRELIMINARY AND DETAILED DESIGN OF THE WASTEWATER TREATMENT SYSTEM OF GANVIE

Location:	Garvié (Sô-Ava), Benin
Client:	ANPT (Agence Nationale de promotion des Patrimoines et de développement du Tourisme)
Services:	Preliminary Technical Study, Preliminary Design, Detailed Design, Environmental and Social Impact Study (ESIA), preparation of Bidding Documents
Period:	10/2020 – 03/2022
Construction cost:	approx. 27,213,292 €

## Project Description:

The project "Reinventing the Lake City of Garvié" is part of the Government's action plan as one of the top priority projects of Benin in the tourism sector. Nowadays, the city of Garvié consists mainly of stilted houses with a population of around 37.000 inhabitants. The project's objective is the identification of a wastewater treatment system with reference to the future scenario with a resident population of 73.000 inhabitants in 2038, along with a fluctuating tourist population estimated in approximately 11.000 people. The designed works are the following:

Centralised Wastewater Treatment Plant (WWTP): complete treatment system (73.000 PE) with elimination of organic materials and nutrients and final disinfection in compliance with legally binding emission limits. The water line has been designed to minimize the energy consumption and the sludge production. It is structured as follows: Fine screening; Grit removal; Equalisation-homogenization and pumping; Anaerobic treatment UASB; Nitrification, denitrification and dephosphatising with activated sludge; Secondary sedimentation; Chemical disinfection. The sludge line is structured as follows: Pre-thickening; Anaerobic digestion; Post-thickening; Dehydration with belt filter press. The biogas generated through the anaerobic treatment UASB and through the anaerobic digestion of the activated sludge and of the sewage sludge is stored in a gasometer and, after a proper pre-treatment (elimination of humidity, hydrogen sulphide and siloxane), is used for energy recovery (production of electricity and heat) in a co-generation plant.

Collective sanitation system: composed of main collection points (15) equipped with pumping stations which, through successive lifts, are capable to convey the wastewater to the WWTP. The collection points are designed so as to ensure easy construction and adequate integration in the typical local landscape.

Phyto-purification system for individual treatment: including a pre-treatment unit (septic tank) and a treatment unit (phyto-purification with submerged flow, with filter beds or floating beds).



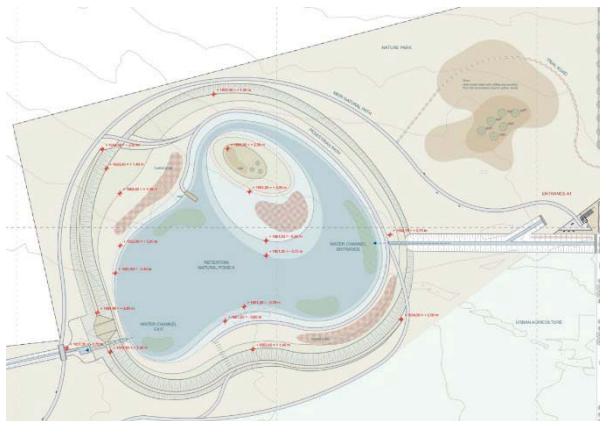


# LANDSCAPING DESIGN SERVICES FOR PHASE 1 KONZA TECHNO CITY

Location:	Kenya, Machakos County
Client:	DELMA UK (ICM Group); final Client: KoTDA (Konza Technopolis Development Authority)
Services:	Concept/Preliminary, Detailed Design (approved for construction)
Period:	08/2018 – 07/2021
Construction cost:	Approx. € 22,600,000

## Project Description:

The Konza Technology City (KTC) is a project of the Government of Kenya (GoK), implemented through EPCF (Engineering, Procurement, Construction and Finance) by the Konza Technopolis Development Authority (KoTDA), under the Ministry of Information and Communication Technology (MOICT). Konza City will be constructed over a 5000-acre land, located approximately 60 Km south of Nairobi Center. The city is designed to allow phased development, and Phase 1 includes various types of land uses and infrastructures that would support future phases of development. The project, implemented through EPCF (FIDIC Silver Book), concerns the development of a new smart technology city of about 28'000 inhabitants.



The landscaping design for KTC covers the following items:

Streetscape (total length of landscaped streets 40 Km)

Softscape and Hardscape for all roads within KTC, which include all landscape/parks features such as lights, seating, shade structures, bike racks, waste receptacles, and wayfinding signage for Parks and Open Space.

City Perimeter Landscape (total surface area 326.867 m<sup>2</sup>)

A system of uneven zig-zag shaped berms surrounding the city preventing unauthorized vehicles and pedestrians from entering KTC and, at the same time, providing visual and sound attenuation.

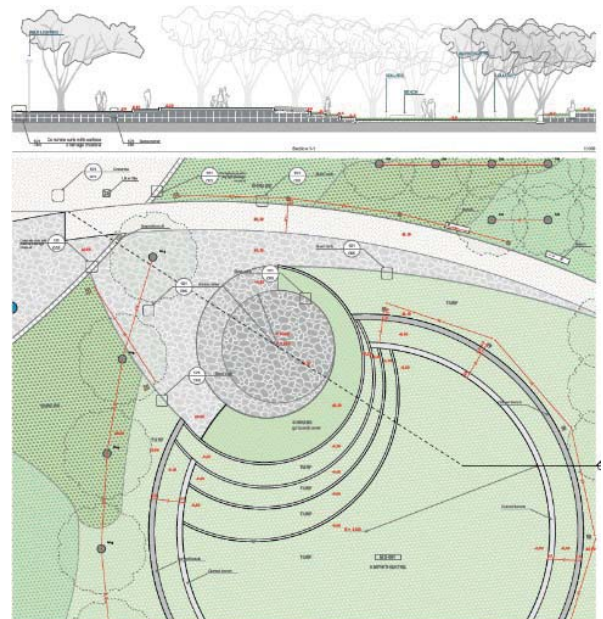
Nature Park (tot. surface area 624.974 m<sup>2</sup>)

An integral element to the city, the Nature Park acts as an urban savanna and nature preserve celebrating the existing native landscape. As a hybrid landscape serving conservation, recreation, education and habitat provision, the Nature Park is the major point of connection between natural and cultural systems for KTC. Also, The Nature Park incorporates a series of retention ponds connected by the natural flow line directing water from northeast to southwest. These ponds are designed to receive stormwater runoff from the KTC for retention, sedimentation, and bioremediation.

Civic Park (tot. surface area 75.854 m<sup>2</sup>)

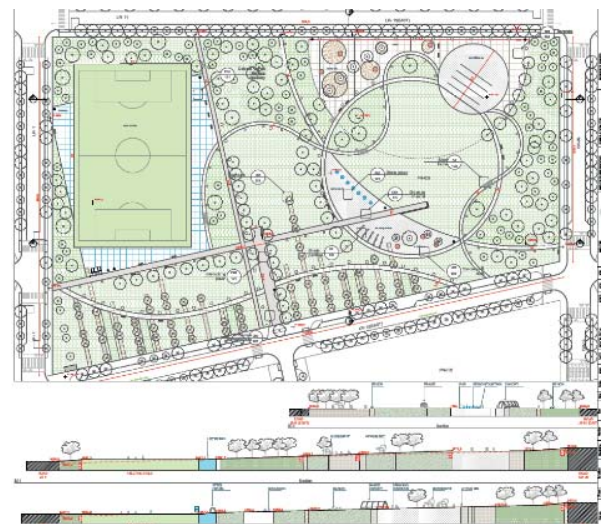
The Civic Park band is comprised of a series of interconnected spaces, linking and extending significant public buildings and institutions. Civic Park is a place for people to share in moments of connection to larger cultural, historical, or political facets of city life. Parks are designed to be inviting, inclusive, and

expressive of the multiple and collective identities of the city and its inhabitants.



Urban Plazas and Squares (tot. surface area 30.912 m<sup>2</sup>)

Urban Plazas and Squares are public spaces in dense urban areas that provide places for leisure, gathering, and respite from bustling city streets. Located near shops, restaurants, cafes, and offices, these spaces are active social nodes within the city. Seating, planting, shaded areas and water features are designed to enhance the comfort of visitors by providing cooling, shading, and aesthetic interest.



Urban Parks and Gardens (tot. surface area 28.675 m<sup>2</sup>)

Urban Parks and Gardens are public outdoor spaces located in high and medium density mixed-use areas and within the Green

Transit Corridor. They provide opportunities for immersion in spaces within the city that are centered on plants and they offer climate regulating benefits by increasing urban biomass to mitigate heat island effects and provide cooling pockets within the city.



Green Transit Corridor (tot. surface area 45.629 m<sup>2</sup>)

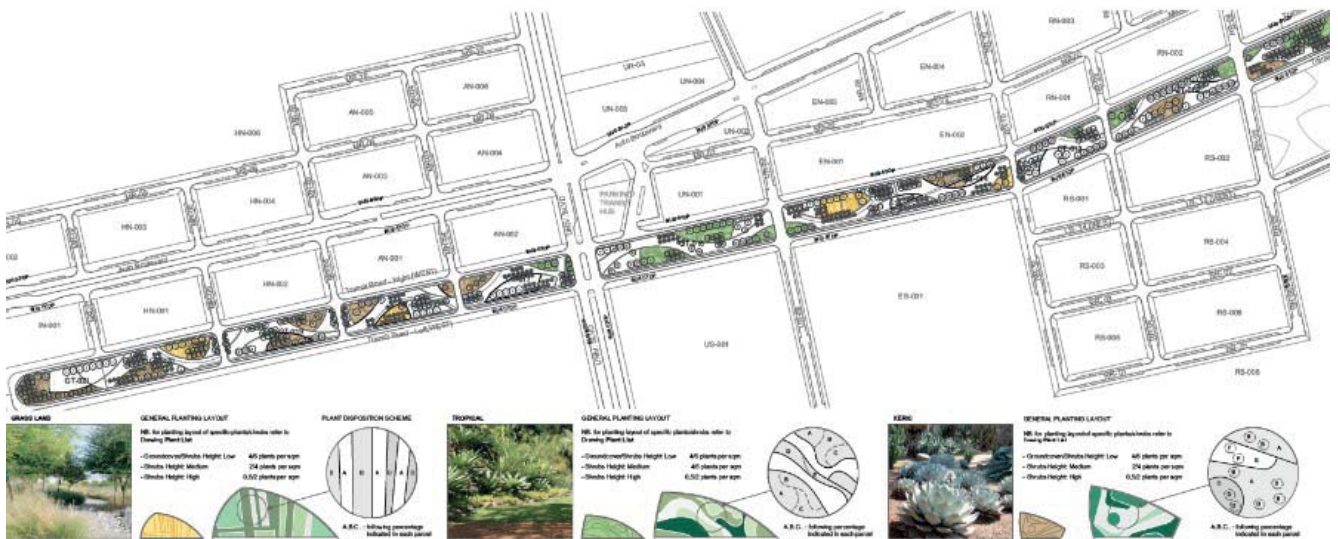
Green Transit Corridor is a major green band oriented along the east-west axis which offers diverse social spaces and mixed-use development connected through multi-modal transportation. It provides a unique and significant type of open space in Konza bridging function, sustainability, placemaking and creating a sense of identity for the city.

Pocket Parks and Playgrounds at Primary Neighborhood Centers (tot. surface area 46.257 m<sup>2</sup>)

Pocket Parks are distributed throughout the city so that every resident may have easy access to them. Each primary school is located adjacent to a playground: a place for children to play, discover and be active.

Athletic Fields at Secondary Community Centers (tot. surface area 79.662 m<sup>2</sup>)

Athletic Fields are located adjacent to Secondary Community Centers, providing organized recreational opportunities for both school and community use.





# SYRACUSE-GELA MOTORWAY (131 KM) LANDSCAPE WORKS

Location:	Sicily, Italy
Client:	Sicilian Motorways Consortium
Services:	Landscape design, Environmental Conformity Report, Environmental Monitoring Plan, Works Supervision
Period:	02/1998 – 06/2018
Construction cost:	€ 1,700,000

## Project Description:

The Syracuse - Gela motorway (133 km) is an important link in the national and regional road network, promoting the economic development of eastern Sicily (tourism, agriculture and the mining industry) as well as offering a rapid outlet for the industrial centres of Syracuse, Ragusa and Gela. All together the motorway will have 15 viaducts for a total length of 6,600 m, as well as 44 overpasses and numerous minor bridges. The motorway alignment also includes 17 double-barrel tunnels for a total length of 16,700 m.

The landscape design activity included the analysis of the plant community of the affected areas through site inspections. This allowed the development of typological models of vegetation well adapted to the ecological characteristics of the area.

with the local natural and traditional landscape. So, the landscape works were finalized to the re-establishment of ecological corridors and the local landscape. The design of the landscape works was based on ecological criteria as for national and international guidelines related to the design of linear infrastructure (e.g. highways).

The mitigation works used native species, local architectural elements (dry stone walls) and the transplant of valuable centuries-old trees (*Ceratonia siliqua*, *Olea europaea*). The project includes also the design of recreational areas characterized by decorative plants. The main plant associations of the area are: garrigue, maquis and evergreen forest (*Pistacio - Quercetum ilicis*).



The design of the motorway requires the crossing of primarily agricultural areas with high historical and landscape value and areas with a good degree of naturalness. In particular, the road corridor crosses several rivers with high environmental value (ecological corridors). For these reasons, the landscape works had been developed as mitigation measures as required by the EIA study, in order to promote the integration of the road



Landscape mitigation works  
3D VIEW









# ENVIRONMENTAL SURVEYS AT THE NDIA SITE

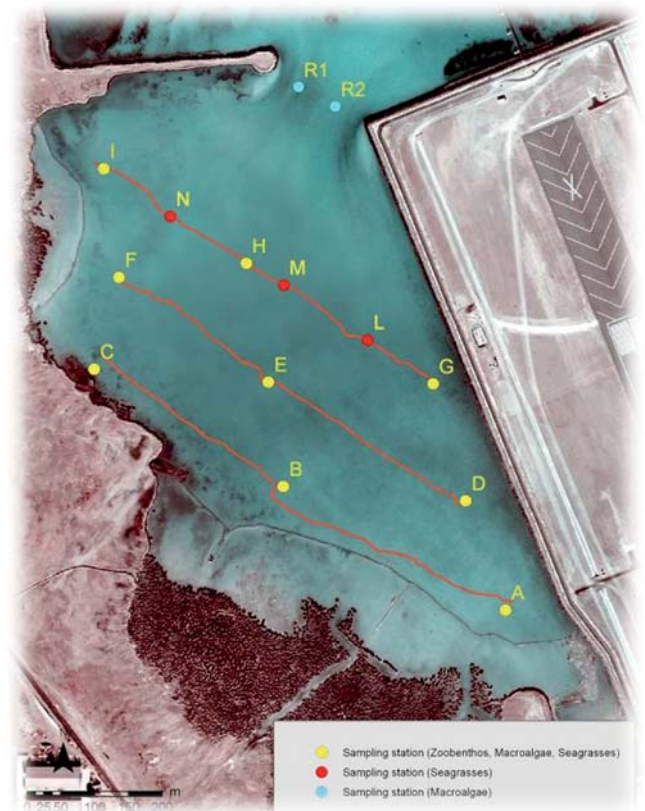
Location:	Doha, Qatar
Client:	New Doha International Airport (NDIA)
Services:	Terms of reference, Scope of Work, Environmental Surveys, Environmental Management Plan
Period:	07/2014 – 05/2018
Construction cost:	€ 71,425,000

## Project Description:

Technital was awarded a project for the production of design and tender documentation for the construction of the reclamation (including the required revetment) of an area located in the north western part of the site and previously used as a disposal for building and construction waste. The project is part of the works for the construction of the new International airport of Doha. A large part of the airport is built on site reclaimed from the sea.

In the framework of this assignment TCH performed was required by to undertake several environmental investigations in order to comply with requests issued by the Ministry of Environmental, which conditioned its approval to the construction activities to an evaluation of the environmental conditions at the site

- to verify the ecological status of the site and the presence of protected or rare marine species



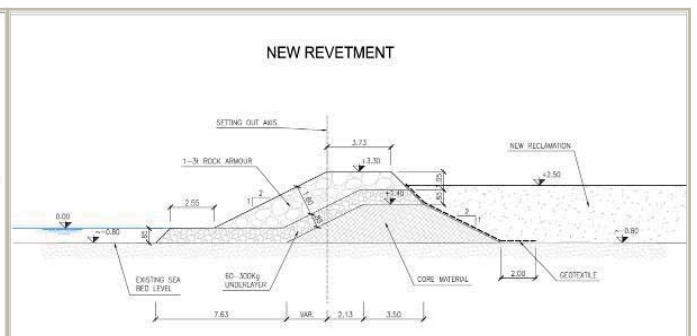
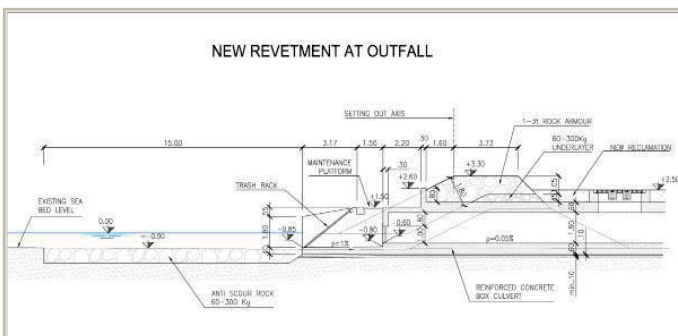
The field surveys included the collection and analysis of water and sediment samples as well as of biological specimens of benthic fauna and flora.

Technital produced the ToRs for the investigations which were approved by the ministry and coordinate their execution

After the execution of the surveys, Technital produced an Environmental Management report and an Ecological Survey Report, containing recommendations on the procedures to be followed during the execution of the works and proposals for the environmental mitigation.

The main objects of the investigations were:

- to ascertain the presence of pollution in the area as a consequence of the disposal of waste





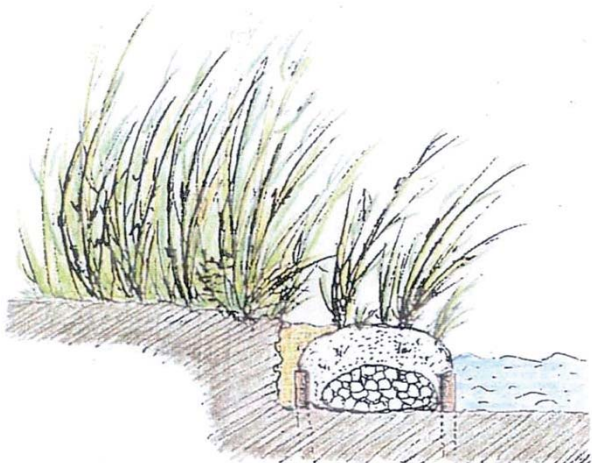
# WORKS TO IMPROVE THE ECOLOGICAL AND LANDSCAPE VALUE OF THE RECONSTRUCTED TIDAL FLATS AND SALTMARSHES IN THE VENICE LAGOON

Location:	Venice lagoon, Italy
Client:	Venezia Nuova Consortium for Italian Ministry of Public Works – Water Board, Venice
Services:	Landscaping detailed design; Support activities included GIS studies for mapping of single structures, environmental and engineering data collection and analysis, database creation
Period:	06/2001 - 12/2003
Construction cost:	N.A.

## Project Description:

In 1985 The Italian Government has launched an ambitious plan to preserve the town of Venice and its lagoon.

In the framework of this plan, many activities have been undertaken, including the reconstruction of some of the habitats of natural importance, lost due to natural causes and human activities, among which are: a reduced sediment input from the rivers, an unfavourable modification of the network of natural channels for navigation purposes, the urban and industrial development along the lagoon borders and in reclaimed area.



In order to study the stability of the new morphological structures (tidal flats, salt marshes, channels etc.) and to monitor their effects on the ecosystem, Technital was awarded the task to:

- collect, analyse and evaluate the present state of the morphological structures and to define when deemed necessary, additional interventions.
- design the necessary interventions to improve the ecological value of the structures

The activities performed included the organisation of a database of more than 50 structures and the preparation of fiches of each structure containing the necessary information on important issues among which: surface, volume discharged, height evolution, surface covered by vegetation, state of containment structures, presence of tidal creeks.

Following this phase, followed the design of specific interventions on some of the structures in order to improve their ecological value, which included: creation of tidal creeks and ponds to attract birds, planting of halophilous species to stabilise the slopes, spreading of organic enriched sediments to help colonization process by the vegetation etc.



# KARAVASTA LAGOON WETLAND MANAGEMENT PROJECT

Location:	Albania
Client:	European Commission - PHARE Programme
Services:	Environmental studies and evaluations, hydrological and morphological studies, surveys, design and construction of observation tower; technical assistance; management consultancy services
Period:	03/1995 – 12/1996
Construction cost:	N.A.

## Project Description:

The project aims at the provision of support to wetland management in the Karavasta Lagoon, along the Albanian coast, which covers 4,330 hectares and borders the southern part of the Divjaka National Park. Immediate and strict protective measures have to be taken, notably to safeguard the existing colony of *Pelicanus Crispus* and other endangered bird species.

The programme will foster social development of the wetland making an optimal but sustainable use of the economic potentials of the area for the eco-tourism, fisheries and compatible economic activities involving local inhabitants.



*TECHNITAL*, in association with *Station Biologique de la Tour du Valat* of France and *Ecotourism Ltd.* of UK, was entrusted by the European Commission, PHARE Programme, to perform, the following activities:

- propose a management plan for the area (future Ramsar site);
- organise and equip the monitoring and enforcement of the rules of the Ramsar site;
- propose a plan for the development of international eco-tourism;
- develop a model of the key hydrological process influencing the lagoon environment and a propose a plan for remedial actions;
- propose a plan for the improved management and exploitation of the fisheries resources in the lagoon;
- produce a holistic picture of the value of the lagoon system for breeding aquatic birds.

To understand the functioning of the ecosystem as well as the dynamics of the socio-economic system, the project tasks aimed to

- describe the trends of the socio-economic system through a Participatory Rural Appraisal
- analyse the legal and institutional context
- evaluate the potential of the site for ecotourism development and assess the carrying capacity of the site
- evaluate the hydrobiological importance of the channels which connect the lagoon with the sea.
- define measures to improve fishery in the lagoon
- assess the natural value of the site by mapping the flora and fauna habitats and conducting a field survey of the water bird communities.



## Environmental Modelling



# MONITORING ACTIVITIES ON THE EFFECTS PRODUCED BY THE CONSTRUCTION SITES OF THE WORKS AT THE PORT ENTRANCES TO THE LAGOON OF VENICE

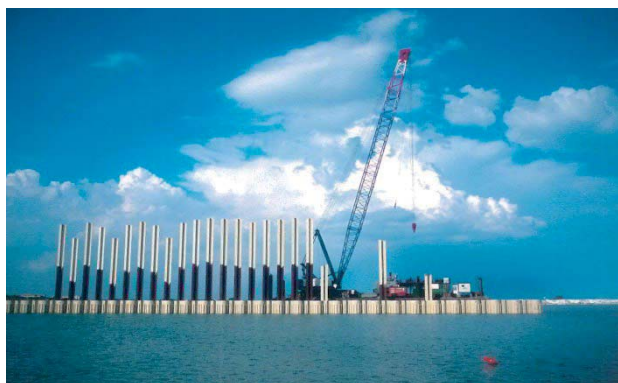
Location:	Venice, Italy
Client:	Consorzio Venezia Nuova for the Italian Water Authority (Venice)
Services:	Technical coordination of the environmental investigations and modelling studies
Period:	07/2003 - 07/2012
Construction cost:	€ 16,410,500

## Project Description:

The construction of the mobile gates at the three port entrances for safeguarding Venice and its lagoon from flooding, and of the complementary works against medium - high flooding and preventing losses of sediments from the lagoon, will require the opening of construction sites for about eight years. The present project is aiming at the evaluation of the effects the construction sites and the principal processing activities may produce.

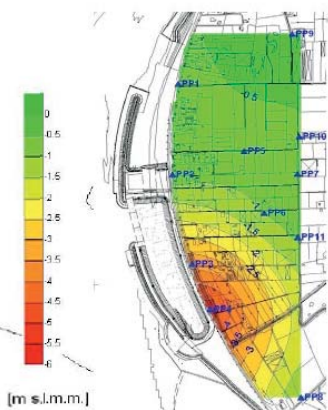
The first phase of the project consisted in an analysis of the actual environmental state, that is "ante operam", in the absence of the construction sites.

Investigations for determining the environmental conditions before construction have been oriented towards defining the actual state, including the identification of spatial and temporal variability expected for the parameters in question, defining their threshold values, measurement campaigns for obtaining data for calibration of mathematical models and the necessary simulation activities.



This was followed by activities to monitor eventual effects produced by the construction sites. To this end turbidity, as generated by the operation of the dredging machines, was measured inside and outside of the lagoon and in vicinity of the site, also with the scope to calibrate and validate models. Currents and turbidity campaigns are being conducted in the three inlets since 2005.

A dispersion model made it possible to spatialize the data of the first year of monitoring and to evaluate the entity of turbidity against other ecosystems of high value.



A monitoring network has been created to measure the level of the ground water table in areas close to the construction sites.

Furthermore a noise detection system has been established with instruments positioned in relation to the source of the noise. Also, mathematical models have been set up for noise dispersion and the dispersion of particles in the air. An existent ecological model has been updated in collaboration with Delft Hydraulics Institute.



In addition air quality is being measured: atmospheric deposition, PM10, nitrogen oxides, heavy metals, polycyclic aromatic hydrocarbons (IPA), in gaseous as well as in aqueous phase.

Ecosystems of high value are being monitored: terrestrial vegetation, eel grass meadows, avifauna, benthos, terrestrial and aquatic insects and benthos of "Tegnue" (underwater rocks).

Socio-economic activities are being monitored (port sector, tourism, fishing) through direct and indirect data. The impact of the construction site on fishing activities is also evaluated monitoring coastal fish resources and the banks of "*Chamelea gallina*".

The monitoring activities are correctly planned through bimonthly visits to construction sites.

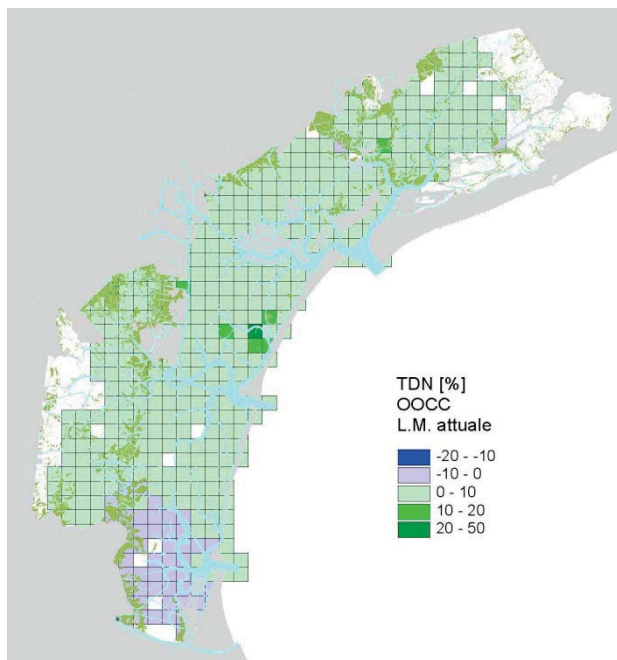
# DEFINITION OF A MONITORING PROGRAMME OF THE LAGOON OF VENICE

Location:	Venice, Italy
Client:	Venezia Nuova Consortium for Italian Ministry of Public Works – Water Board, Venice
Services:	Environmental quality studies, analyses and monitoring
Period:	01/2001 – 12/2007
Construction cost:	N.A.

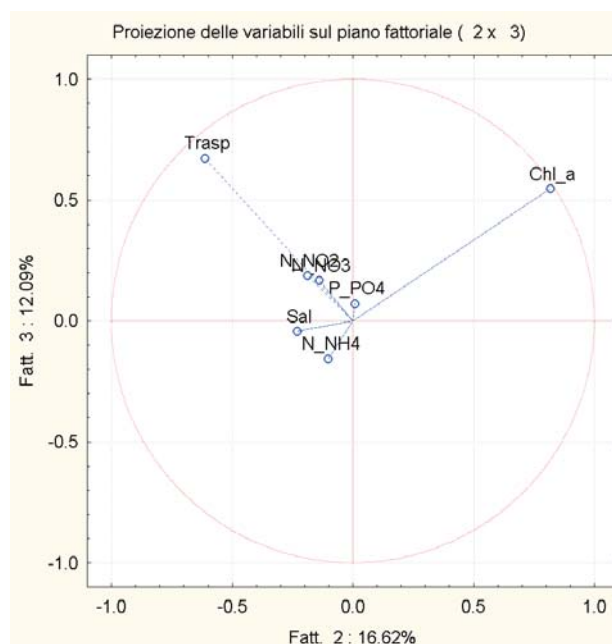
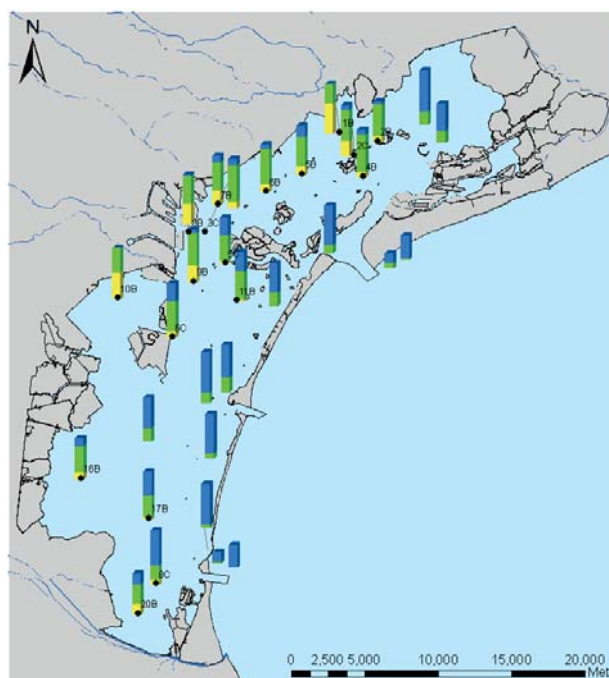
## Project Description:

The Venice Water Authority has organised a monitoring programme of the Venice lagoon in order to assess its ecological state. The programme was issued in compliance with the new water directive 2000/60 of the EU, which fixes new goals for the restoration and protection of European water bodies.

The programme has included the execution of field surveys and of desk studies concerning the following aspects: water quality, sediment quality, pollution loads, benthic fauna, fishes, eelgrass and macroalgae, avifuna, mammals, saltmarsh vegetation.



In the framework of this large programme, TECHNITAL has been awarded the task to advice on the definition of the several investigation activities, to review the technical reports produced by the various research groups and to produce a series of reports commenting the major results achieved during the programme and their importance with respect to the interventions aimed at the environmental recovery of the lagoon.



The activities have also included the coordination of the quality's monitoring programme of the channels of the city of Venice.



# ISAP PROJECT: RESEARCH ON THE SEDIMENTS AND WATERS IN THE CHANNELS OF PORTO MARGHERA AND THE FACING AREAS OF VENICE LAGOON

Location:	Venice, Italy
Client:	Venezia Nuova Consortium for Italian Ministry of Public Works – Water Board, Venice
Services:	Coordination of water and sediment quality study
Period:	11/2006 – 06/2007
Construction cost:	N.A.

## Project Description:

Modeling activities were commissioned as part of the ISAP project to assess the congruency between industrial discharges monitored in the area of Porto Marghera in the lagoon of Venice and the concentrations of pollutants in port waters determined by measurements performed during measurement surveys specifically performed as part of the study.



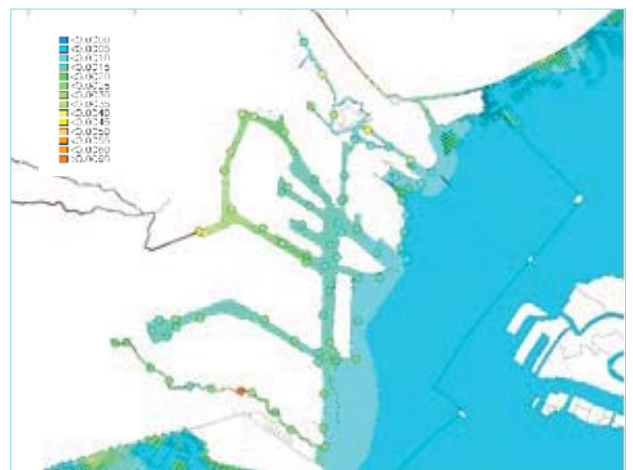
The study took place in three phases:

1. analysis of water column quality data in the industrial channels of Porto Marghera and determination of the analyses that could be considered as conservative tracers or with decay in the first order;
2. design and testing of the dispersion model which, considering the pollutants coming both from industrial waste and from rivers that discharge in the area of interest reproduces the fields of concentration of the tracers being considered which were then compared with those measured.
3. parametric analysis to determine the expected range of variability of concentration of pollutants considered in relation with various marine-weather scenarios and to assess the “exchange” between the industrial area and the surrounding lagoon areas.

A detailed model of the area under examination, dynamically connected with the overall model of the Lagoon of Venice, was developed to carry out this analysis.



A check of the ability of the model to represent dispersion of the area under examination compared the measured and the calculated salinity values. A test of congruency between measured concentrations and monitored discharges compared calculated and measured concentrations of arsenic, lead and copper.



The model showed a good ability to represent dispersion in the area under examination, both in 2-D and in 3-D layouts. It was possible to check that measured concentrations are substantially congruent with declared discharges.

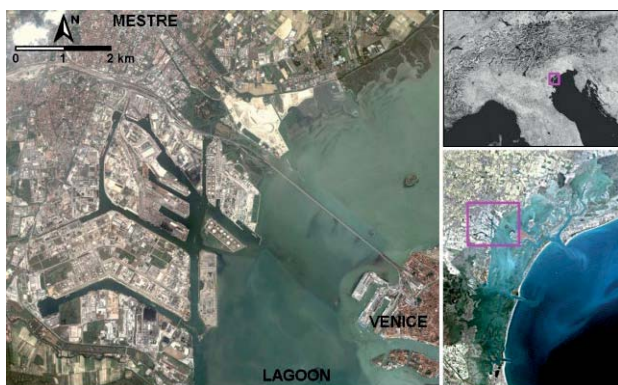


# MODELLING THE HYDROGEOLOGICAL IMPACT OF A CONTAINMENT CUT-OFF WALL IN THE VENICE INDUSTRIAL HARBOUR OF PORTO MARGHERA

Location:	Porto Marghera Venice, Italy
Client:	Venezia Nuova Consortium for Italian Ministry of Public Works – Water Board, Venice
Services:	Groundwater modelling study of the Venice industrial harbour.
Period:	12/2003 - 04/2007
Construction cost:	N.A.

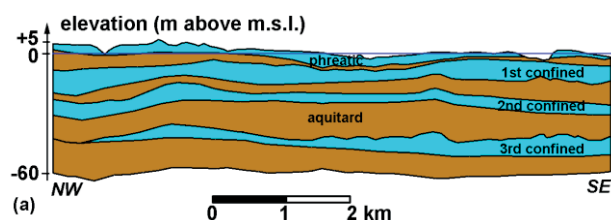
## Project Description:

A major source of non biodegradable organic and inorganic pollutants is represented by Porto Marghera, a port and petrochemical complex on the central-west side of the Venice lagoon. Porto Marghera is classified as "Site of National Interest" (SIN). Within the general project of decontamination activities called MISE, the Italian Ministry of Environment asked the Italian Water Authority (Magistrato alle Acque MAV) to limit the water exchange between the contaminated soils and the lagoon waters within the SIN. MAV, through its concessionary Consorzio Venezia Nuova (CVN), has planned construction of a continuous 56.8 km long cut-off wall made of steel sheet piles along the entire harbour channel banks. The diaphragms are driven into the lagoon bottom down to a depth ranging between 15 and 25 m below sea level. Since such a cut-off wall constitutes an impermeable barrier to groundwater flow from the mainland toward the lagoon a study has been commissioned by CVN to Technital on expected impact of the cut-off wall on the natural flow regime of the shallowest aquifers.

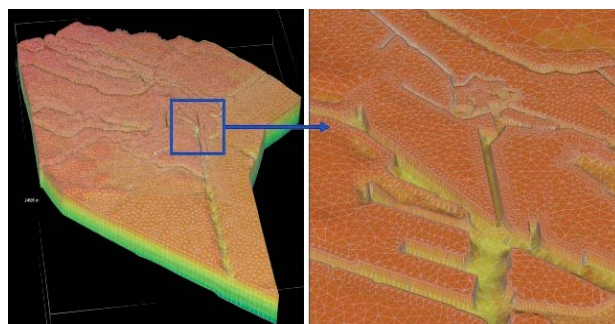


A modelling study based on the geological and hydrological information available to date has been developed to verify the efficiency of a continuous cut-off wall planned along the channels of the Venice industrial harbour to reduce the groundwater discharge into the lagoon. The diaphragm is intended to create an impermeable barrier to the flow of polluted groundwater from the harbour subsurface to the lagoon area.

A detailed reconstruction of the harbour litho stratigraphy is available from more than 1300 boreholes and geotechnical tests, and a number of electrical resistivity sections have been integrated and used to reconstruct 12 detailed litho stratification sections.



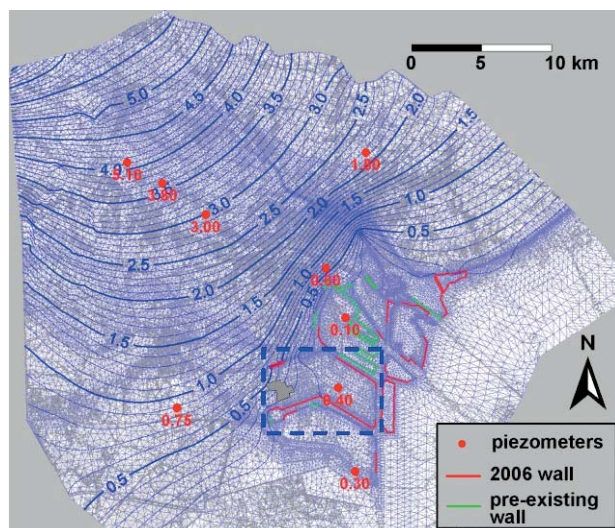
Maps of the depth and the thickness of the geological layers have been created and the spatial variability of the layer geometry has been investigated.



A number of pumping tests along with about 350 Lefranc tests have somewhat allowed for the characterization of the hydraulic conductivity  $k$  in the various aquifers:  $k$  ranges between  $10^{-4}$  and  $10^{-5}$  m/s.

Pumping test interpretation by the traditional Theis-Jacob method provides a specific elastic storage between  $10^{-3}$  and  $10^{-4}$ .

Groundwater flow modelling has been performed by the FEFLOW 5.3 code (Diersch, 2005). FEFLOW solves the classical groundwater flow equation by linear finite elements (triangular prisms) in space and a finite different scheme in time.



The hydrological simulations accurately reproduce the heterogeneous litho stratigraphy in the Venice coastland down to 50-70 m depth below m.s.l.

The model has been calibrated using the piezometric levels recorded in 2006 in a number of wells scattered across the study area.

# ANALYSIS OF THE MEASURES TO COUNTERACT THE EFFECTS OF ACCIDENTAL OIL SPILLS IN VENICE LAGOON

Location:	Venice Lagoon , Italy
Client:	Venezia Nuova Consortium for Italian Ministry of Public Works – Water Board, Venice
Services:	Coordination of the preliminary studies: <ul style="list-style-type: none"><li>- investigations and surveys in relation to shipping, navigation conditions, climate, etc.</li><li>- preliminary definition of the equipment and instrumentation required</li></ul> Execution of hydrodynamic model studies to evaluate the risk of propagation in the lagoon of various types of spills
Period:	03/2001 - 03/2002
Construction cost:	N.A.

## Project Description:

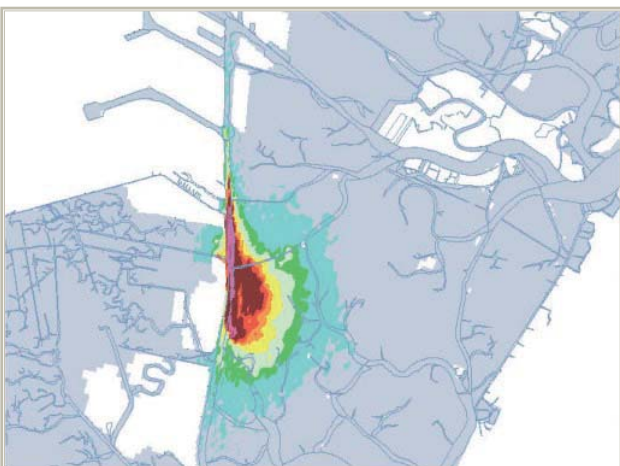
The number of ships entering Venice lagoon average some 5,000 per year and almost half of the total traffic (12 million t/yr out of 25 million t/yr) consists of oil and derivatives, petrochemical and chemical products. Most of the oil traffic (crude oil and diesel oil) is in-bound, destined for the refineries and petrochemical plants of Marghera industrial port, and some transits in the lagoon en route to the refinery of Mantua. Over 60 tankers cross the lagoon to discharge 80,000 t at the San Leonardo oil terminal; the rest is taken in smaller ships to Marghera. This considerable oil traffic in the lagoon represents a very serious environmental risk.



The existing equipment for coping with accidental spills operate in the ports of Marghera and San Leonardo but there is no efficient means of dealing with such accidents in the long navigation channels where any spill would be almost impossible to contain given the very limited depth (not more than 1 m) and therefore inaccessibility of most of the lagoon.

The aim of the present study was that of identifying the best system of urgent intervention in the event of accidental oil spills in the lagoon. The tasks involved were:

- the examination and definition of the various types of accidents possible in all the navigation channels and canals affected by oil traffic



- the identification and classification of the different oil products transported, in terms of statistical probability of spillage and in terms of potential risk to the environment (evaluated using a mathematical simulation model)
- the study and evaluation of systems used in other international ports to deal with similar emergencies
- the identification of systems suitable for the Venice situation and the critical evaluation of their efficacy, limitations and costs
- detailed study and development of the optimum solution for the critical area affected by the so-called «oil channel» between the Malamocco inlet and the port of Marghera.
- Identification of the type of craft capable of guaranteeing rapid remedial action throughout the lagoon and the location and equipment of the related emergency command bases.

The study also involved the analysis of the required resources and organization and the evaluation of the impacts on port operation.





# DECISION SUPPORT SYSTEM (DSS) FOR THE GRANTING OF CONCESSIONS FOR THE DISCHARGE OF LIQUID WASTE IN THE VENICE LAGOON

Location:	Venice, Italy
Client:	Venezia Nuova Consortium for Ministry of Public Works - Water Board – Venice
Services:	Studies, surveys, investigations, development of information system; technical assistance and training
Period:	01/1995 - 12/1998
Construction cost:	N.A.

## Project Description:

The assignment was awarded to TECHNITAL in the context of the vast programme of works (for which TECHNITAL is the sole designer) to save Venice from flooding and restore the natural environment of the Venice lagoon. The objective was to develop a computerised support system for the Venice Water Board in the management of its governmental procedures regarding the granting of permits for the discharging of industrial, craft, commercial and other wastes in the territory of the Venetian lagoon.

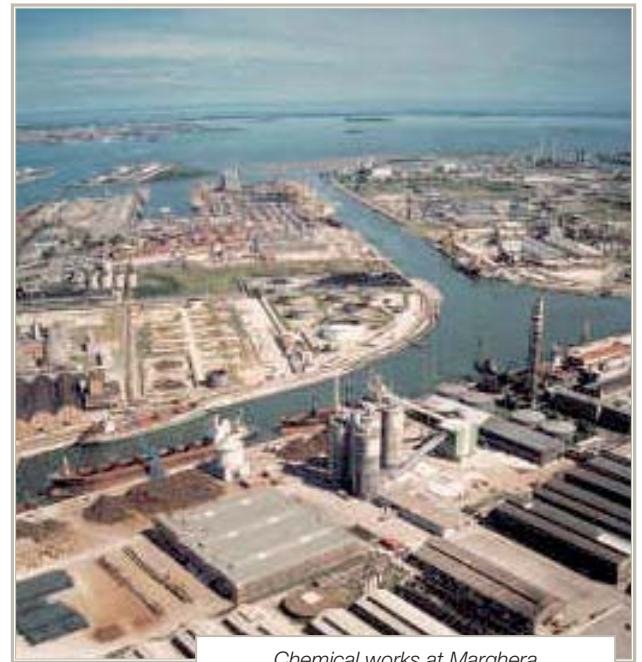
The System was developed in two parts:

- the first part consists of a series of procedures allowing the permit granting formalities to be done by computer (input of case in the data bank, and automatic selection of the information required by the government regulations to be forwarded to the competent authorities). Through other procedures the opinions put forward by the public authorities can be analysed and a report issued for the granting (or denial) of the permit.
- the second part provides access to the geographically located information about the discharges which have already been authorised and those for which the procedure is under way. These data are contained in special data bank used within the GIS and integrated by *ad hoc* analysis procedures to relate the discharges to the quality of the environment. Diffusive mathematical models are used to evaluate the contribution to the pollution of those discharges being considered for permits.



*Lagoon pollution due waste seepage*

The system is entirely “user-friendly” and is used through interactive dialogue windows (of the “WINDOWS” type).



*Chemical works at Marghera*

The delivery of the System to the Client was accompanied by the necessary training of the personnel and assistance in the definition of the operative and administrative procedures.



Environmental Studies

# INTCATCH – DEVELOPMENT AND APPLICATION OF NOVEL, INTEGRATED TOOLS FOR MONITORING AND MANAGING CATCHMENTS (H2020 EU project NO. 689341)

Location:	Europe (UK, Italy, Greece, Spain, Norway, Germany, Austria)
Client:	Executive Agency for Small and Medium-sized Enterprises (EASME) - European Commission
Services:	Autonomous radio controlled boats, Innovative Sensors, Next generation DNA test kits, Innovative treatment systems for combined sewer outflows, Decision Support System, cloud based geo referenced solution; Garda lake water quality model
Period:	06/2016 – 01/2020
Construction cost:	€ 8,770,935.00 (INTCATCH Consortium)

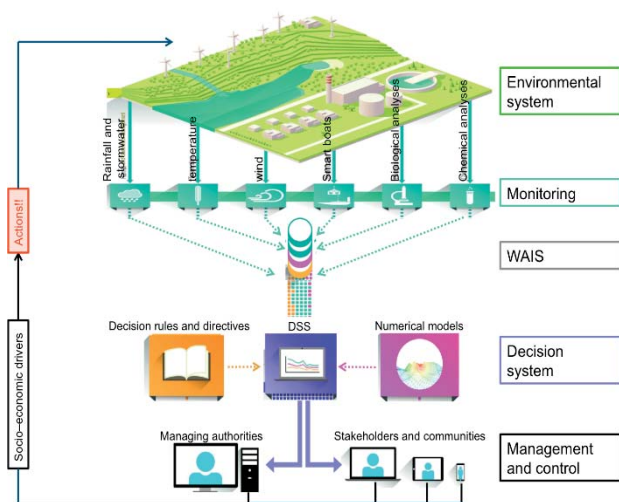
## Project Description:

INTCATCH project instigates a paradigm shift in the monitoring and management of surface water quality that is fit for global waters in the period 2020-2050. INTCATCH does this by developing efficient, user-friendly water monitoring strategies and systems based on innovative technologies that will provide real time data for important parameters, moving towards SMART Rivers. The business model will transform water governance by facilitating sustainable water quality management by community groups and NGOs using a clouds data linked to a decision support system and eco-innovative technologies.

INTCATCH project is financed under the H2020 programme the biggest EU Research and Innovation programme ever with nearly €80 billion of funding available over 7 years (2014 to 2020). The INTCATCH Consortium is led by the University of Brunel (London) and composed by 20 partners including public institutions, Universities and private firms coming from the whole Europe.



The INTCATCH project uses demonstration activities to showcase eco-innovative autonomous and radio controlled boats, sensors, DNA test kits and run-off treatment technologies. Such actions performed in a range of catchments will address the important innovation barriers to uptake, notably, a lack of knowledge of new technologies and their capabilities, identified by the European Innovation Plan (EIP) on water. By conceptually moving the laboratory to the 'field', the monitoring techniques that are developed aim at superseding the inefficient, time dependent, costly and labour-intensive routine sampling and analysis procedures currently deployed to understand the quality of receiving waters. It will compliment routine monitoring that is required for baseline

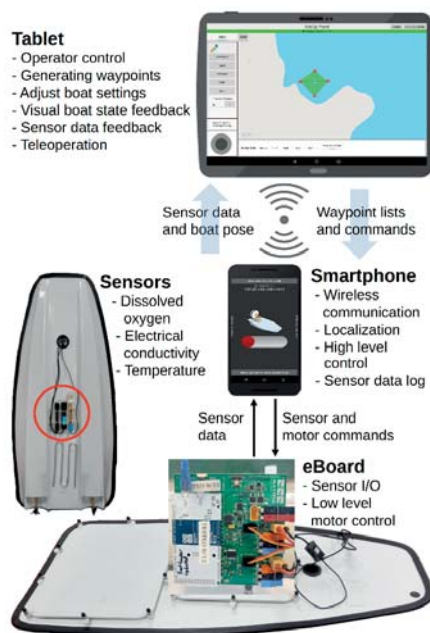


The INTCATCH paradigm.

datasets, but also enable cost-effective impact and management investigations.

INTCATCH will deliver technological innovation in water quality monitoring to take on the challenges highlighted:

- **Autonomous and radio controlled boats** to provide better access and coverage of waterbodies;
- **Innovative Sensors** make monitoring easier and cheaper for 'non-experts' to do, and do 'more effective monitoring for less';
- **Next Generation DNA test kits** provide faster, better results;
- **Innovative Treatment systems** – for combined sewer outflows;
- **Decision Support System** optimizes the water quality monitoring strategies and, ultimately, the management of the water bodies via measures in River Basin Plans;
- **Cloud based geo referenced data management solutions (WAter Information System)** to support sharing with whole community and raising alerts in time to take action to protect end users/uses.



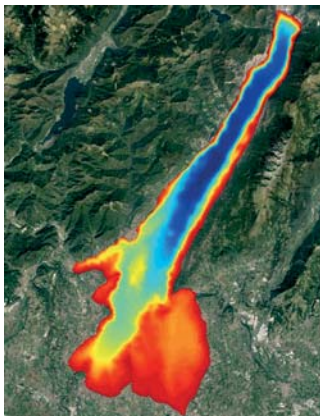
Overall scheme of the INTCATCH autonomous boat for water quality monitoring.

The new INTCATCH products will be tested in four demonstration sites across Europe, which are the **Lake Garda** (in Italy), the suburban rivers of London (UK), the River Terr in Catalunya (Spain) and the lake Yiliki in Greece. Garda Lake is definitely the most important demonstration site due to the complexity of the physical environment and because it represents one of the most important water resources and attractions for industrial, tourist, agriculture and drinkable uses. Garda Lake is a strategic drinking water basin indeed which contains about 30% of the national surface water which quality must be highly preserved and safeguarded.

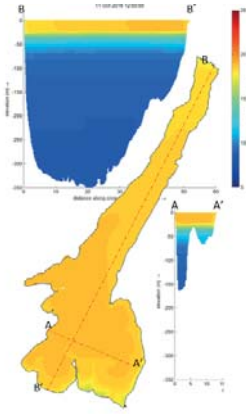
INTCATCH project is structured in 12 work packages, each of them dedicated to specific tasks. TECHNITAL is leader and coordinator of the Work Package 6 “Development and validation of water quality model and DSS (Decision Support System)”.

Activities in WP6 have two objectives:

- A) The development of the Decision Support System (DSS), a software application aimed at improving strategies for the investigative monitoring of water quality and to provide valuable information to be used in the management of catchments. It includes also the validation of the water quality numerical model of Garda Lake for the simulation of the hydrodynamic circulation and processes affecting water quality. This model is to be used as a tool for the analyses of water quality status and to predict the response to selected catchment management measures. It will inform on how to use the monitoring tools and test their effectiveness and describes how the system may react to a potential pollution event and allow identification of potential rules to monitor impacts on water quality. The monitoring strategy based on modelling and water quality indicators will be integrated alongside our other strategy based on boats/sensors into the DSS designed in Work Package 2. With the use of the numerical models and the aquatic drones it will be possible to get valuable environmental information for the study of the limnology of the lake, including the whole inner recirculation system and water quality status.

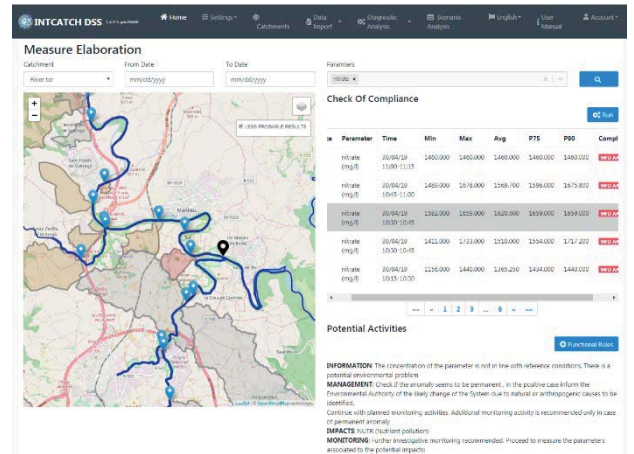


Depths (m) of Garda Lake



Simulated Water Temperature

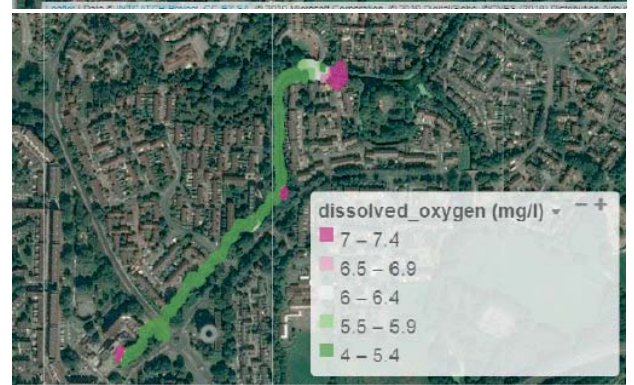
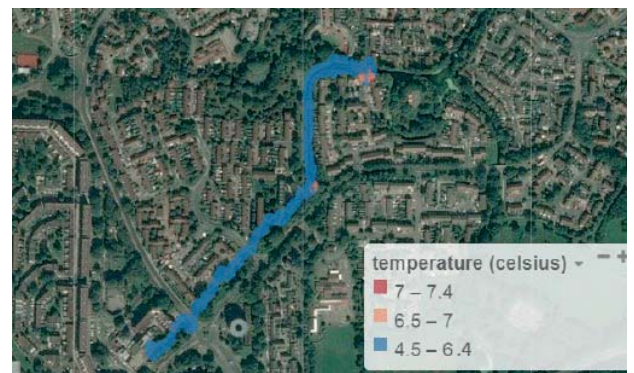
- B) Adaptation and optimization of the integrated DSS software tool, to a general aquatic environment in order to provide valuable information to the decision-makers for the improvement of the monitoring techniques and the management of the water bodies. The flexible configuration of DSS tested at Garda Lake has been transported to different sites by means of an adaptation of external configuration files.



INTCATCH main GUI interface – application at River Ter demonstration site.



INTCATCH water drones powered by a propeller (on the left) or a fan (on the right).



Water quality monitoring with water drones – outputs from the WAIS application.



# MARKET STUDY: OPPORTUNITIES TO IMPLEMENT SUSTAINABLE STRATEGIES IN THE MARITIME SECTOR

Location:	Croatia, Albania, Slovenia, Montenegro, Ukraine, Rumania, Bulgaria, Poland
Client:	European bank for Reconstruction and Development
Services:	Market study
Period:	07/2012 – 03/2013
Construction cost:	N.A.

## Project Description:

Maritime transport and ports are essential components of international trade and goods movement. A global approach for further improvements in energy efficiency and emission reduction is needed as sea transport is predicted to continue to grow significantly in line with world trade.

The study focused on the current status and prospects of the sustainable strategies in the maritime sector in order to provide recommendations to the European Bank for Reconstruction and Development with regards to investment in selected European ports located in three main areas: The Baltic Sea, The Black Sea, and the Adriatic Sea.

The following ports were included in the study:

Adriatic Sea: Koper (Slovenia), Rijeka (Croatia), Split (Croatia), Zadar (Croatia), Ploče (Croatia), Dubrovnik (Croatia), Bar (Montenegro), Durres (Albania).

Black Sea: Odessa (Ukraine), Illichivsk (Ukraine), Mariupol, Constanza (Rumania), Bourgas (Bulgaria), Varna (Bulgaria).

Baltic Sea: Gdansk (Poland), Gdynia (Poland), Szczecin and Swinoujscie (Poland).

Targeted ports were reviewed in term of present capabilities and future trends. Benchmark analysis of the situation of the ports with respect to transport flows, current organization and management development opportunities was performed

National and international requirements related to the sustainability in the maritime sector, considering legal requirements, international codes and associations (such as European Sea Ports Association, Green Ports etc.) were collected

Strategies and best practices to achieve sustainability were grouped in 5 categories:

**Port management:** environmental procedures and certifications (ENV), which include mostly policy or regulating measures, which may support the overall improvement deriving from the behavior of a multiplicity of actors. An example is the port policy with respect to climate change the implementation of a Port Environmental Management System, the establishment of environmental management responsibilities within the port organization.

**Air and noise emissions control (AIR)**, which includes the measures that have as a primary objective the reduction and the control of air and noise emissions. Dust control system based on physical process (e.g. barriers, water cannons and sheltered handling of bulk goods) used in port handling areas are a notable example of these kind of measures. The use of low sulphur fuel or the use of Onshore Power Supply (OPS) technologies also contribute to reduce air emissions.

**Energy management and energy efficiency (NRG)**, are amongst the key issues addressed by the study. The main strategies rely on the adoption of more efficient technologies to reduce energy consumption, such as the refurbishment of buildings, the retrofitting of vehicles, equipment and cranes, the substitution of lighting fixtures and the lighting management, the use of alternative fuels.

**Waste and water management (WWM)**, mainly providing solutions for the compliance with national and international regulations, which is particularly strict in Europe. Waste water collection, storage and treatment, storm water collection and treatment, ballast water management dry-docks operations to avoid spills and uncontrolled release of wastewater are all technical solutions which fall in this broad category.

**Port expansion (PRT):** the need to modify the configuration of the existing ports as well as the need to create new ones leads often to conflicts with other uses of the coastal areas and with the need to guarantee an adequate level of protection of coastal ecosystems. Among the key aspects that define the level of sustainability of port expansion schemes are: the ability to manage properly dredging operations and dredged sediments, the inclusion of mitigation and/or compensation measures in the development plans, the way in which new infrastructures are designed and located in the local context.

Opportunities for investing in sustainable practices in the targeted ports were identified, considering cost, benefits, expected paybacks, current applications etc. of the most promising sustainable practices.

An action plan for the practical implementation by the Bank of the proposed investment opportunities in each port was defined, based upon identified priorities on a cost effectiveness basis.

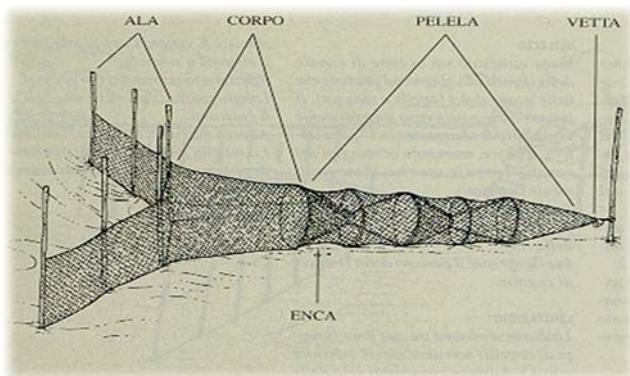
# MONITORING PROGRAMME FOR FISHING ACTIVITIES IN THE VENICE LAGOON

Location:	Venice, Italy
Client:	Venezia Nuova Consortium for Italian Ministry of Public Works – Water Board, Venice
Services:	Technical specification; environmental studies
Period:	01/1997 – 12/2007
Construction cost:	N.A.

## Project Description:

Fishing is traditionally one of the most important activities in the Venice lagoon and has a strong economic importance on the local populations.

Recently a new form of fishing, namely clam harvesting, has become the main activity. Unfortunately, this form of fishing, unlike from the traditional one, causes the erosion of the shallow areas and saltmarshes of the lagoon thus causing a serious negative impact on the environment.



The Venice Water Authority has organised a monitoring program of the Venice Lagoon in order to assess the present state of both traditional fishing and clam fishing activities.

A second objective is to experimentally evaluate the negative impacts on the environment of some of the more commonly used fishing equipment and to define possible countermeasures

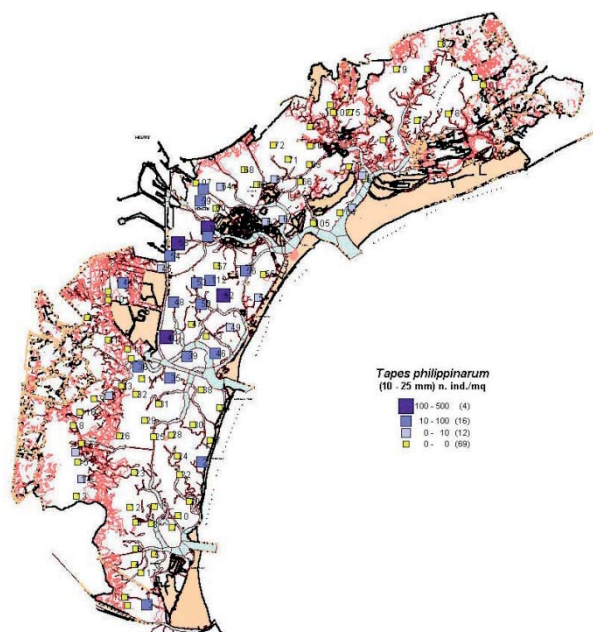
Moreover ichthyophagist bird species has been analyzed as an important environmental quality target and as an element that controls the quantity and the quality of fishes in Lagoon.

In the framework of this large program, Technital has been awarded the task to

- define the investigation programme which included: extensive monitoring of the fishing practices (areas interested, number of vessels utilised, catch analysis etc.), monitoring of areas heavily impacted by fishing practices (sediment quality, design of experiments to evaluate sediment re-suspension and transport during clam fishing operations



- coordinate the researchers activities
- review the technical reports produced by the various research groups
- produce final reports, commenting the major results achieved during the programme and their importance with respects to the interventions aimed at the environmental recovery of lagoon.



# COMPLEMENTARY RESEARCH ON THE ECOSYSTEM OF THE LAGOON OF VENICE (ICSEL Study)

Location:	Venice, Italy
Client:	Venezia Nuova Consortium for Italian Ministry of Public Works – Water Board, Venice
Services:	Study of water and sediment pollution, evaluation of risks to the ecosystem
Period:	11/2003 - 07/2006
Construction cost:	N.A.

## Project Description:

The scope of this project is to further increase the knowledge of contamination levels in the sediments of the lagoon of Venice and of the quality of the lagoon bottom. Studies and analysis have been carried out to assess the state of sediment pollution, the state of the phyto- and zooplankton population, and, through experiments, evaluate the ecological risk caused by water and sediments pollution.

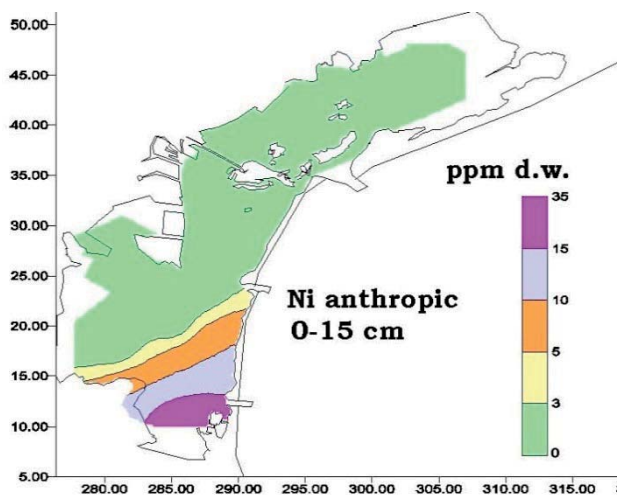
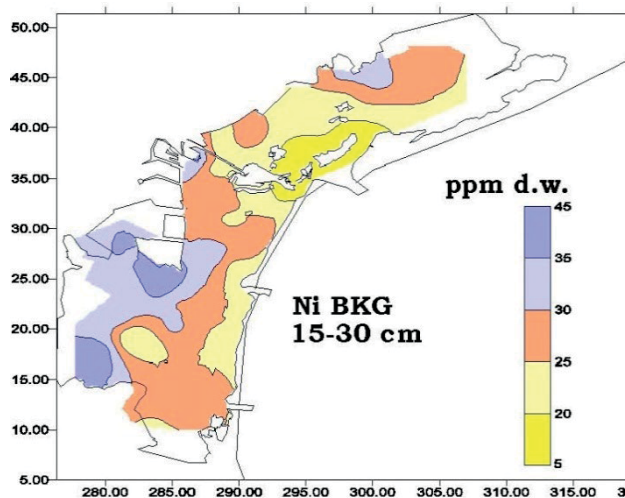
### Description of activities:

The level of contamination has been determined and the period of pollutants enrichment and dynamics in the sediments; background values have been elaborated, as well as dynamics and critical situation of contaminants level.

(Arsenic, nickel, mercury, PCDD, PCCF, IPA, PCB and others). The experimental control tests on biota in the laboratory to verify the absence of impact on the ecosystem of sediments at medium and low contamination, has delivered, on the basis of methods like "SQG census based" and "normalized hazard quotient", an integrated judgement derived from chemical and toxicological data, which made possible a comparison with the Decree for Lagoon Sludge Disposal ("Protocollo Fanghi"). As a result, most part of the lagoon sediments do not show toxicity and only the canals in the industrial area of Porto Marghera some toxic hot spots could be identified.

Data on phyto- and zooplankton has been updated and a database created containing also hydrological and hydrodynamic data. A new set of data has been collected on the biodiversity of plankton and its trophic role.

In order to be able to confirm that in most areas of the lagoon there are no environmental risks connected to the quality of the waters and the sediments, further tests of sediments and biota (mussels and fish) has been done, measuring principal contaminants in sediment and water, their transfer to organisms (bioaccumulation) and the effects of contamination on the biota through toxicological and stress assays.



The investigations (chemical analysis, toxicological assays, biomarkers, genetic damage) made evident that metals present in the lagoon sediments do not give generally any reason for toxicity (ratio SEM/AVS). The test for embryo toxicity however showed toxicity in 50% of the samples, mainly in the north lagoon. Results obtained with stress indexes on mussels and clams showed that in springtime in general individuals are more sensible to the applied biomarkers.

With the data available a preliminary method has been developed which allows to assign a quality judgment on the tested samples (very good, good, poor, bad). As a result 8% of the samples could be classified as "very good", 48% as "good", 28% as "poor" and 15% as "bad". Compared to the classification of the "Protocollo Fanghi" 71% of the sediment samples of "A" type would be considered as "very good" or "good" and only 27% "poor". The sediments of the "B" type would show 66% to be "good", 29% "poor" and 3% "bad". The sediments of the "C" type are always "bad" with this approach. For a complete quality index results from bioaccumulation and stress index have to be introduced into this approach.



# ENVIRONMENTAL RECOVERY OF THE POLLUTED SITE "I PILI"

Location:	Porto Marghera Venice - Italy
Client:	Venezia Nuova Consortium for Italian Ministry of Public Works – Water Board, Venice
Services:	Environmental studies, preliminary and detailed design
Period:	01/2003 – 06/2004
Construction cost:	€ 36,832,000

## Project Description:

The "Pili" site is part of the industrial area of Porto Marghera, one of the main industrial areas in Italy. In the post war period this area, originally a part of the Venice lagoon, has been reclaimed by dumping of industrial waste, mainly phosphogypsum stacks.

The Ministry of the Environment in 1998 has included all the area of Porto Marghera in the list of areas of special interest because of their level of pollution, as a consequence a Master plan for the recovery of Porto Marghera was issued, which identified the Pili



area as one of the priority areas for clean-up.

The main environmental problems can be summarised as:

- Emission of radon gas to the atmosphere
- Emission of radiation
- Transport of polluted material to the lagoon

The recovery intervention strategy was aimed at intercepting the transport of material to the lagoon, reorganising the present drainage system and blocking the public access to the area.



The intervention consists in the:

- Construction of an impermeable barrier made up of a cut off wall and of a mechanical barrier made up of sheet-piles along the border thus isolating the site from the lagoon
- Collection and treatment of rainwater and of groundwater in a package treatment plant to be positioned on site
- Dredging of polluted sediment accumulated in the lagoon bottoms around the site and re
- Storage of polluted sediments in temporary storage areas to be constructed on site, where the sediments are dehydrated in "sandbags"
- Fencing of the whole (40ha) area to avoid public access



# REGIONAL MASTER PLAN FOR THE PROTECTION AND MANAGEMENT OF THE INLAND WATERS OF LOMBARDIA REGION

Location:	Lombardy Region , Italy
Client:	Lombardy Regional Authority
Services:	Environmental studies on water quality, fauna, road & lake traffic, population, existing urban and area plans, etc.
Period:	01/2000 – 08/2001
Construction cost:	N.A.

## Project Description:

One of the key aspects of the study was the identification of the orientations and criteria for evaluating the designs for new port structures or the restructuring of existing ones. The study made it possible to define the guidelines for drawing up the master plan of the works needed in relation to lake infrastructures and to draw attention, in relation to each project, to the difficulties which are likely to be encountered.

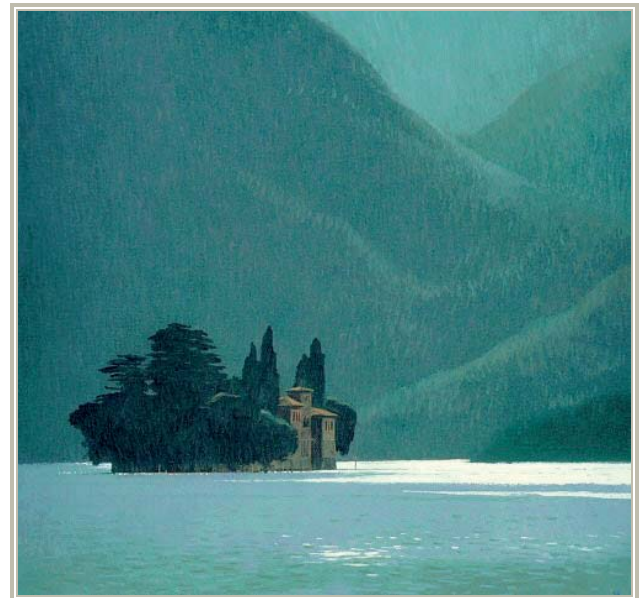


The study consists of three phases:

- *Investigation phase:* Through data acquisition, site surveys and document preparation an environmental and infrastructural framework of reference was defined. On the one hand, those environmental components which can supply representative indications regarding the environmental features pertinent to pleasure boating (climate, water quality, fish life, road traffic, air quality, resident population) were examined. On the other hand, the analysis covered the existing plans of the region in relation to the coastal area affected by the port development, pointing out any relevant local constraints. The final part of this phase was a thorough investigation of the existing public port infrastructures (almost 200) resulting in the creation of a database of the present situation of each port : number of boat spaces, layout of the existing facilities, present water depths at the port entrances and at the berths, available mooring and onshore facilities, and the connections with the road network.



- *Forecast phase:* Analysis of the present demand level and the evolutionary trend to identify the potential demand for boat spaces for each lake and definition of the need for port facilities for different development hypotheses and for different temporal horizons. This part of the study included a census of the boat space requirements for each location and of the proposals for new ports, by means of a specific questionnaire which was distributed in all the lakeside communities.



- *Proposal phase:* Definition of the criteria for the evaluation of the projects and, on the basis of these criteria, examination of the requests put forward by the various municipalities and establishment of an order of priority for the works.



# ADRIATIC SEA MASTER PLAN

Location:	Adriatic Sea, Italy
Client:	Palomar S.c.a.r.l., on behalf of Ministry of Foreign Affairs and Ministry of Environment
Services:	Master Plan
Period:	05/1991 – 08/1992
Construction cost:	N.A.

## Project Description:

The Adriatic Sea represents a very peculiar and fragile ecosystem: it is a closed basin with shallow waters, at least in its northern part, very limited circulation and a considerable influx of pollutants and nutrients from the draining basins.



For the restoration and preservation of its natural resources the Italian government has constituted a special Authority and is providing for the elaboration of a Master Plan, which will constitute the guideline for all interventions in both the sea basin and the catchment area.



TECHNITAL was commissioned to:

- evaluate the consistency and efficiency of all intervention (water treatment plants, littoral protection works, parks and natural reserves, etc.) realised within the Italian part of the catchment basin as consequence of existing Plans and Programmes;
- participate in the elaboration of the Master Plan.







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