



**Asia-Pacific
Economic Cooperation**

Advancing Free Trade
for Asia-Pacific **Prosperity**

Sector Study on Environmental Services: Environmental Damage Remediation Services

APEC Policy Support Unit
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The views expressed in this paper are those of the authors and do not necessarily represent those of APEC Member Economies.

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EXECUTIVE SUMMARY

Remediation services encompass the treatment, removal and disposal of contaminated material, typically soil, water and groundwater, building decommissioning and demolition works, and decontamination of workplaces, buildings, vessels or other internal occupied spaces. Goods and services associated with remediation services delivery include technical and scientific consulting, construction and engineering, equipment and chemical manufacture, research and development, and others (treatment and disposal, analytical, litigation, insurance services etc.).

The nexus between development and pollution stems from population growth leading to increased waste generation and the process of industrialisation causing chemicals and other toxic materials to be released to the environment. Environmental incidents, both natural and man-made disasters, also contribute to releases of pollutants to the environment which may adversely affect human health and indirectly impact on the economy. Typically, the demand for remediation services is less immediate in developing economies where higher priority needs such as economic advancement and other basic public services take precedence.

The key drivers for the development of the remediation services sector are the existence of transparent and enforceable regulatory frameworks on contamination management and remediation, as well as enabling factors such as effective enforcement and funding mechanisms. In some of the APEC economies with less developed remediation services sectors, contamination management and remediation regulations are relatively informal or non-existent; even if regulations exist, the effectiveness of enforcement is often low or unclear. Other drivers include commercial reasons, increasing public interest in environmental issues and interest among banks and international financial institutions as lenders to manage risks.

A market research report published in 2016 expects the environmental remediation market to grow. Assessing and remediating contaminated sites is a complex and challenging task, requiring specialised skills and advanced knowledge, especially for larger scale and longer term remediation of brownfield sites or clean-up due to environmental disasters. The vast majority of global leading firms in the sector are United States (US)-based companies with multinational operations. Trade in remediation services is generally limited to the initial site assessment and planning phases of a remediation project, conducted by foreign suppliers (e.g. through cross-border supply of services or foreign subsidiaries), with downstream services usually subcontracted to local firms. With the expected growth in the environmental remediation services market, there is strong business impetus for developing the sector. Work on liberalisation of trade in the sector would need to encompass not just direct remediation goods and services, but also other associated goods and services as described above.

Legacy contamination from past mining and industrial activities as well as ongoing pollution due to rapid industrialisation present opportunities for the development of the remediation services sector in the APEC economies. To tap on the opportunities, APEC economies need to prioritise and develop transparent regulations and standards for contamination management and remediation, and strengthen effective enforcement of the regulations and standards. Availability of funding mechanisms for site assessment and remediation commensurate with the level of effort required for such services is also key in sustaining remediation efforts.

1 INTRODUCTION

One of the key thrusts of the Asia-Pacific Economic Cooperation (APEC) sustainable growth agenda is the APEC Environmental Goods and Services (EGS) Work Programme, which serves to increase utilisation and dissemination of EGS, reduce existing and new barriers to EGS trade and investment and enhance capabilities of the economies to develop their EGS sectors. The Environmental Services Action Plan (ESAP) was endorsed by APEC Senior Officials in September 2015 in Cebu, with key actions identified from 2016 to 2020.

Under Phase 1 of the ESAP, the APEC Policy Support Unit (PSU) has conducted a survey of regulatory and policy measures on services focusing on Central Product Classification 94 (CPC94) in 2016¹. Following that survey, the current sector study on environmental damage remediation services is one of three studies commissioned by the APEC PSU aimed at building and enhancing understanding of the wider range of services in environmental industries/businesses beyond CPC94 among APEC economies with a view to identifying key challenges. The current study on remediation services provides insight into the scope (i.e. sector characteristics including drivers and relevant technical expertise required for service delivery), business models and major trends of the sector, as well as challenges and opportunities related to the sector and supporting businesses.

Based on the progress of Phase 1 of the ESAP, Phase 2 will identify key challenges and provide recommendations on actions for promoting trade liberalization and facilitation as well as cooperation in environmental services. Phase 3 of the ESAP aims to collect and share good practices from case studies, review the implementation of the action plan as well as plan for further actions by the end of 2020.

The current sector study was conducted mainly through desktop literature review of publicly available information for the sector and/or in the 21 APEC member economies as well as Ramboll Environ's practical experience in some of the member economies. Comments / insights from the APEC Workshop on Environmental Services at the 2nd Senior Officials' Meeting (SOM 2) in Ha Noi in May 2017 and inputs from the APEC PSU have also been incorporated.

The report summarises the outcomes of the sector study on environmental damage remediation services. It includes the following:

- Overview of sector study (Chapter 2)
- Details of the environmental damage remediation sector in each APEC member economy (Chapter 3)
- Conclusions and possible next steps for development of the sector (Chapter 4)
- Supporting annexes

¹ APEC Policy Support Unit, *Survey of Regulatory Measures in Environmental Services* (November 2016).

2 OVERVIEW OF SECTOR STUDY IN APEC ECONOMIES

2.1 BACKGROUND

The Industrial Revolution of the nineteenth century revolutionized manufacturing process from manual to mechanized goods production. It also introduced new chemical manufacturing and iron production processes, which have continued to evolve with advancements in science and technology. One of the concerns that arose from the Industrial Revolution in many of the developing or growing economies around the world at that time was the impact a development had on the environment. For example, in the United States (US), there was increasing concern that environmental quality could not be adequately maintained by market-orientated industries or regulating agencies which dealt with only one / some specific aspects of the environment. Although regulations such as pollution control legislation existed, a mechanism was required to ensure that all major development proposals were examined for their potential environmental consequences prior to development.

In order to effectively account for positive and negative environmental externalities, the need to conduct Environmental Impact Assessment (EIA) was first introduced in the US in the late 1960s. EIAs then attained formal status in 1969, with the enactment of the US National Environment Policy Act. EIAs to be conducted prior to project development have since become a key requirement in the regulations of many APEC member economies.

Unlike an EIA, an environmental site assessment (ESA) is typically conducted for property transactions to identify environmental liabilities at the site and site surroundings that are primarily related to land contamination arising from historical and existing operations. The main objective of ESAs is to protect buyers against potential costly liabilities associated with environmental issues that could lead to litigation and remediation expenditure. ESAs are also triggered in situations where there are accidental product releases to assess the extent of contamination and potential liabilities. A Phase I ESA is generally the first stage in the process of environmental due diligence to determine if a site is potentially contaminated and would therefore require further intrusive investigations. If a site is suspected to be potentially contaminated, a Phase II ESA is initiated involving sampling and analysis of soil and groundwater and other impacted media such as air, surface water, building surfaces/ materials to determine the nature and extent of contamination. Once contamination is confirmed and deemed to exceed regulatory levels or acceptable risk levels, thus requiring action, a Phase III ESA is carried out to remediate the contaminated site. This includes both the planning and the execution of the remediation works.

2.2 DEFINITION AND CLASSIFICATION OF REMEDIATION SECTOR

According to the North American Industrial Classification System (NAICS), the remediation services industry comprises establishments primarily engaged in one or more of the following:

- Cleanup of contaminated buildings, mine sites, soil, or groundwater;
- Integrated mine reclamation activities, including demolition, soil remediation, wastewater treatment, hazardous material removal, contouring land, and revegetation; and
- Abatement of asbestos, lead paint, and other toxic material.

The UN Central Product Classification (CPC) constitutes a complete product classification covering all goods and services, providing a framework for international comparison and

promotes harmonization of various types of statistics related to goods and services². The first version was published in 1991. Version 2 released in 2008 already introduced a broader concept of goods and services. Under the CPC Ver.2.1 released in August 2015 which is meant to be more responsive to existing economic and technological reality while maintaining conceptual consistency, remediation services comes under Division: 94 - Sewage and waste collection, treatment and disposal and other environmental protection services, and Group 944 - Remediation services. The UN definition for this group includes remediation services, i.e. services dealing with the effects of contamination caused by operation of facilities or by accidents; these services aim to eliminate or contain any existing contamination of the soil, water or air and have to be performed on site. Group 944 is further divided into 4 classes:

- 9441 - Site remediation and clean-up services (air, surface water, soil and groundwater)
- 9442 - Containment, control and monitoring services and other site remediation services n.e.c.³
- 9443 - Building remediation services
- 9449 - Other remediation services n.e.c. (includes environmental emergency response services)

Besides the UN CPC, the World Trade Organisation (WTO) defines and classifies services under the Services Sectoral Classification List (also known as W/120), which is less detailed compared to the CPC. It classifies environmental services into the following sub-groups:

- Sewage services
- Refuse disposal services
- Sanitation and similar services
- Other

Discussions at the APEC Workshop on Environmental Services at SOM 2 in Ha Noi in May 2017 and on earlier occasions (e.g. Council for Trade in Services meeting S/C/M/100⁴) amongst members within the WTO have indicated the W/120 to be obsolete in its classification of environmental services. The three specific areas of services are considered traditional ‘infrastructure’ activities where public authorities still have a predominant role. However, it neglects the ‘non-infrastructure’ activities which emerged in developed economies in the 1960s and 70s related to pollution prevention and remediation of polluted sites, services which are mainly required by the private sector in order to comply with environmental enforcement.

The Council for Trade in Services meeting S/C/M/100 also noted that developing economies are becoming important actors, both as importers and exporters, in the environmental sector. Liberalisation in the environmental services market could contribute to improve the availability of state-of-the-art technologies, services and raw materials, and spread technical knowledge, in particular through investment.

Besides direct contamination, soil and water are typically the final receptors of various types of pollution, including air pollution and releases of toxic chemicals. As such, this study focuses on land contamination management and remediation of soil and groundwater.

² United Nations Department of Economic and Social Affairs Statistics Division, *Central Product Classification (CPC) Version 2.1* (2015).

³ n.e.c.: not elsewhere classified

⁴ WTO, *Report of the Meeting Held on 30 September 2010* (November 2010).

2.3 SECTOR CHARACTERISTICS

2.3.1 Industrial Development and Environmental Contamination

Contamination of the environment is one of the main negative externalities of industrialisation of an economy. The development-pollution nexus is due to 3 key factors: (a) as the population of an economy increases, waste generation increases, and coupled with a lack of adequate waste management (mostly in developing economies), typically leads to pollution; (b) industrialisation typically leads to pollution due to the lack of appropriate regulations to control pollution (i.e. poor environmental management practices), use of outdated technologies which emit pollutants, spills or releases from industrial facilities and waste disposal / storage sites for toxic industrial waste etc.; and (c) environmental incidents and man-made disasters (e.g. due to industrial mishaps) result in releases to the environment and impacts to health.

Industries which are typically more polluting are primary and secondary industries, while tertiary industries such as the provision of tourism and financial services are typically less polluting. Polluting primary industries include oil and gas extraction and mining of minerals etc. Agriculture is also potentially polluting due to the use of pesticides and chemicals, especially with a lack of careful management. Polluting secondary industries include steel / metal processing, heavy engineering (e.g. shipbuilding, car manufacturing), chemical / petrochemical products, food processing, textiles etc. Heavy metals and petroleum hydrocarbons are common contaminants of these industries. All APEC economies have some form of primary and secondary industries to varying extents, which are potential pollution sources (see **Table 1** for the potentially polluting primary and secondary industries in each member economy).

Table 1: Potentially Polluting Industries in Each Member Economy

APEC Member Economy	Potentially Polluting Primary and Secondary Industries
Australia	<ul style="list-style-type: none"> • Primary: oil and gas extraction, mining, ore processing, and agriculture • Secondary: manufacturing (includes industrial and transportation equipment, metals (steel), chemicals); food processing
Brunei Darussalam	<ul style="list-style-type: none"> • Primary: oil and gas extraction, agriculture, and forestry • Secondary: crude oil refining, natural gas processing, construction
Canada	<ul style="list-style-type: none"> • Primary: mining, quarrying and natural resources (oil and gas) extraction, forestry and pulp and paper, fishing and agriculture • Secondary: manufacturing for automotive, transportation equipment, food, chemicals
Chile	<ul style="list-style-type: none"> • Primary: mining, forestry • Secondary: food processing, textiles, metals (iron, steel), transport equipment, cement
China	<ul style="list-style-type: none"> • Primary: agriculture, mining, ore processing • Secondary: manufacturing of wide range of goods including iron, steel, aluminium, textiles, cement, chemicals, toys, electronics, rail cars, ships and aircraft
Hong Kong, China	<ul style="list-style-type: none"> • Primary: limited • Secondary: mainly electronics, textiles and clothing, watches and clocks, toys and plastics
Indonesia	<ul style="list-style-type: none"> • Primary: agriculture, mining and extraction (petroleum and natural gas, rubber) • Secondary: mainly manufacturing for textiles, automotive, electrical appliances, cement, medical instruments and appliances, chemical fertilizers, food processing
Japan	<ul style="list-style-type: none"> • Primary: limited polluting sectors (agriculture (mainly rice) and fishery are main primary industries but not as polluting as other sectors) • Secondary: manufacturing (mainly automotive, electronics equipment, machine tools, steel and nonferrous metals, ships, chemicals, textiles, processed foods)
Korea	<ul style="list-style-type: none"> • Primary: agriculture, mining • Secondary: major industries include electronics (semiconductors, televisions and smartphones), shipbuilding, automotive, chemicals, steel
Malaysia	<ul style="list-style-type: none"> • Primary: agriculture, mining, petroleum and natural gas extraction, forestry • Secondary: rubber and oil palm processing, wood products, manufacturing (electronics and semiconductors, pharmaceuticals, medical technology)
Mexico	<ul style="list-style-type: none"> • Primary: petroleum, mining • Secondary: chemicals, iron and steel, textiles, clothing, automotive, food and beverages
New Zealand	<ul style="list-style-type: none"> • Primary: agriculture, forestry, fishing, mining, natural resources (oil and gas, minerals)

APEC Member Economy	Potentially Polluting Primary and Secondary Industries
	<ul style="list-style-type: none"> Secondary: processing and manufacturing industries (machinery and equipment, chemicals and plastics, petroleum refining, metal and metal products, textiles, leather, clothing footwear and furniture), construction, production of wood and paper, food and beverage
Papua New Guinea	<ul style="list-style-type: none"> Primary: agriculture, fishery, mining, natural resources (oil and gas), and forestry, palm oil processing, Secondary: plywood production, wood chip production, construction
Peru	<ul style="list-style-type: none"> Primary: mining and refining of minerals, petroleum extraction and refining, natural gas and natural gas liquefaction, fishery Secondary: cement, glass, textiles, clothing, food processing, rubber, machinery, electrical machinery, chemicals, furniture
The Philippines	<ul style="list-style-type: none"> Primary: mainly agriculture and mining Secondary: metal manufacturing and electronic productions, pharmaceuticals and shipbuilding
Russia	<ul style="list-style-type: none"> Primary: natural resources (oil and gas) and mining Secondary: construction, manufacturing for metals, machinery, basic chemicals, shipbuilding, equipment, textiles
Singapore	<ul style="list-style-type: none"> Primary: limited Secondary: electronics, chemicals, oil drilling equipment, petroleum refining, rubber processing and rubber products, processed food and beverages, ship repair
Chinese Taipei	<ul style="list-style-type: none"> Primary: agriculture Secondary: manufacturing for electronics, communications and information technology products, petroleum refining, chemicals, textiles, iron and steel, machinery, cement, food processing, vehicles, consumer products and pharmaceuticals
Thailand	<ul style="list-style-type: none"> Primary: mining, fishing and agriculture Secondary: manufacturing of electric appliances, computers and parts, integrated circuits, furniture, plastics, automobiles and automotive parts, agricultural machinery, air conditioning and refrigeration, etc., petroleum refining, pharmaceuticals
United States	<ul style="list-style-type: none"> Primary: natural resources (oil and gas) and mining Secondary: highly diversified: steel, motor vehicles, aerospace, telecommunications, chemicals, electronics, food processing, consumer goods
Viet Nam	<ul style="list-style-type: none"> Primary: agriculture and mining Secondary: manufacturing of textiles, machinery, food processing, cement, chemical fertilizer, glass, tires, oil, mobile phones

Sources: CIA, Economy Watch, the World Bank.

The identified polluting industries (**Table 1**) have the potential to generate emissions to air, land, and water media, resulting in environmental pollution. This can result in direct or indirect impact on ecosystems that depend on those same media for growth and survival and/or human health. For all three media, the extent of pollution will be mainly determined by the concentration of the source pollutant from its release point. The dispersal of pollutants from the release point is largely dependent on local factors. As air is the most dynamic media, vaporized and other airborne contaminants will disperse depending on local wind patterns, weather, temperature and climate. For soil and water, liquid will act as the primary media for transporting the contaminants and will propagate it in the direction of the general groundwater flow. The overlying and underlying soil types and structures present (or base rock formation structures if soil is absent) can either retard the spread of the contaminant in water (e.g., in clay soil layers) or facilitate the spreading of the contaminant laterally and vertically (e.g. when natural structures such as joint or fault lines are present). Additionally, the presence of man-made structures such as underground pipelines can act as preferred pathways for contaminant dispersal, while tidal or diurnal influences can spread the contamination vertically above and below the mean underground water level.

Contamination issues not only pose risks to the environment and human health through consumption of contaminated groundwater and/or contaminated crops or direct exposure with contaminated soil or groundwater, but also have indirect economic impacts. Impacts to human health indirectly results in lost labour productivity of an economy, whereas other economic impacts include costs of cleaning up, reputational losses either to companies or the economy in general, as well as decreased property value and loss of natural resources (e.g. contaminated water resource). As such, remediation is not an option but a necessity.

2.3.2 Drivers for Remediation Services

Drivers for the uptake of remediation services (both in terms of demand for and supply of remediation services) range from regulatory and commercial to reputational ones, with demand for remediation services growing with increasing maturity of the economy.

The key driver for contaminated land management and remediation services is regulatory in nature, typically regulated and enforced by the national / local environmental protection agencies and/or agencies in charge of industrial development. All APEC member economies have general environmental laws or regulations which encompass provisions for prevention of pollution, contamination management and / or remediation. However, less than half of the APEC member economies have specific regulations on management of contaminated land management and/ or remediation either at a national level and/or sub-national level, though most of the rest either have regulations under development or related guidelines (see **Table 2** for a summary across the 21 member economies). Whilst strong legislative frameworks boost the development of the remediation sector, weak or inconsistent enforcement and lack of clarity on the responsibility, liability and level of clean-up may prevent investment in remediation services.

Extra-territorial jurisdiction may also impose requirements for contaminated land management and remediation on APEC economies dealing with economies where such jurisdiction exists, e.g. the United Kingdom. In the case of business acquisitions, the regulations in the home economy of the acquirer may require that businesses do not create environmental liabilities elsewhere. As members of the WTO noted in the Council for Trade in Services meeting

S/C/M/100⁵, “regulations could play an important role, both as potential drivers or even prerequisites for the development of environmental industries”. The presence of transparent and enforceable regulatory frameworks for contamination management and/or remediation and clean-up are important drivers for the formation of environmental industries. However, once regulatory frameworks are put in place, effective enforcement by the regulators is equally critical in ensuring that environmental industries can develop and thrive.

Typically, the demand for remediation services has been observed to be less immediate in developing economies where higher priority needs such as economic advancement and other basic public services are more likely to take precedence. Compared to the development of industries supporting basic infrastructure provision (e.g. water supply, wastewater treatment, waste collection and treatment/disposal), environmental damage remediation services have a less immediate or less apparent impact on quality of life or productivity, and are hence typically less prioritised. As such, demand for remediation services is typically higher in developed economies which have addressed the basic and immediate needs of their population, and where the awareness of environmental pollution control and recognition of the impact of a lack of such controls on human health is higher.

Increasing development in other sectors of an economy could also be a driver for development of the remediation services sector. As the population and economic development of an economy increases, more land is required for housing and development purposes. It can become financially viable to clean up brownfield sites with historical contamination for redevelopment as higher value land for residential and commercial purposes. This is becoming apparent not just in developed economies like Singapore; New Zealand; Canada; and Hong Kong, China, but also rapidly developing economies like China. Private sector demand for remediation services thus becomes more pronounced, with developers and construction companies more likely to engage in remediation work and consequently, engage remediation suppliers for site remediation when the return on redevelopment of the site justifies the cost of its clean-up. However, this demand is influenced to a large extent by economic conditions, with an economic downturn dampening demand for such remediation work.

There are also commercial drivers for uptake of remediation services. Private organisations typically conduct remediation in a bid to limit potential liabilities as part of property transactions, prevent financial penalties from fines or convictions due to breach of applicable standards, and prevent reputational losses due to potential public discovery of contamination caused by their activities.

Similarly, there is increased interest among banks and international financial institutions as lenders in determining, assessing and managing environmental and social risks for high-value projects (e.g. pipelines, mining facilities, etc.). Project developers who want to obtain funds from these financial institutions typically have to develop management plans and systems and adhere to stringent standards such as the International Finance Corporation (IFC) Performance Standards⁶ and Environmental, Health and Safety (EHS) Guidelines on contaminated land⁷. Economies which are recipients of development funds from such financial institutions may be subject to these international standards, which could help drive the development of remediation services sector within the economies.

⁵ WTO, *Report of the Meeting Held on 30 September 2010* (November 2010).

⁶ IFC, *Performance Standards*.

⁷ IFC, *Contamination Land*.

Funding mechanisms for remediation work is also a key driver of the development of the remediation sector, since remediation is inherently an expensive process. In most economies, remediation funding typically comes from the national or sub-national governments, but in some economies, private funds also exist either as part of a site sale transaction agreed between the buyer and seller, or as part of a redevelopment agreement between a government or local state agency and developers⁸. This will become a priority as governments recognise the negative socio-economic impacts of pollution on human health and the environment. More than half of the APEC economies have or are developing some form of funding mechanisms for remediating contaminated sites, typically in the more developed economies or in those with a longer history of contamination management (see **Table 2** for a summary across the 21 member economies).

Finally, increasing public awareness and interest in environmental damage and related human health issues have also seen incidences of public litigation against potential and actual pollution/contamination, even in economies where specific or remediation related regulations do not exist (e.g. Formosa Ha Tinh Steel marine spill in Central Viet Nam in 2016, where the government sought \$500 million in compensation from the corporation). This is in part due to rising levels of education amongst member economies and public / media attention arising from large scale industrial and/or environmental disasters such as the Deepwater Horizon oil spill in the Gulf of Mexico (the largest accidental marine oil spill in US waters) in 2010, the Fukushima nuclear disaster in Japan in 2011, Hurricane Sandy in the US in 2012, the Samarco iron ore mine disaster in Brazil in 2015 and the Formosa Ha Tinh marine disaster mentioned above.

⁸ New Jersey EDA, *Brownfields and Contaminated Site Remediation Program*.

Table 2: Regulations and Available of Funding Mechanisms Across APEC Member Economies

APEC Member Economy	General Environmental Law/s or Regulations which encompass Contamination / Remediation	Specific Laws / Regulations for Contamination Management	Funding Mechanisms for Remediation (e.g. dedicated government funding or funding / insurance by other stakeholders)
Australia	●	●	●
Brunei Darussalam	●	●	●
Canada	●	●	●
Chile	●	●	●
China	●	●	●
Hong Kong, China	●	●	●
Indonesia	●	●	●
Japan	●	●	●
Korea	●	●	●
Malaysia	●	●	●
Mexico	●	●	●
New Zealand	●	●	●
Papua New Guinea	●	●	●
Peru	●	●	●
The Philippines	●	●	●
Russia	●	●	●
Singapore	●	●	●
Chinese Taipei	●	●	●
Thailand	●	●	●
United States	●	●	●
Viet Nam	●	●	●

Source: Ramboll Environ

Key

- Available
- Non-legally binding / Under Development / Unclear
- Not Available

2.3.3 Technical Expertise

Assessing and remediating contaminated sites can be a complex and challenging task. Planning, executing and managing a remediation project requires specialised skills and advanced knowledge. In more developed APEC economies such as the US, Canada and Australia which have been conducting remediation work for a longer period due to an earlier history of industrialisation, the necessary spectrum of technical expertise for the remediation sector is more likely to be available within the economy itself. Economies within APEC that are less equipped for remediation services could gain immensely through transfer of knowledge and technologies from APEC economies that are more advanced and experienced. This would also boost demand for such services on both sides.

Remediation begins with delineating the extent of contamination and quantifying what and how much must be remediated. A detailed investigation is required to uncover specific information before remediation work can take place, e.g. volume and lateral/vertical extent of contaminated soil, geophysical soil conditions, groundwater flow and attenuation, presence of natural and man-made structures/underground lines. After the contamination has been characterized and associated impacts have been assessed, an analysis of remedial options best suited to the site is conducted. The specific clean-up goals for the site (e.g. clean-up to industrial standards or to residential standards) are a major consideration and directly influence the selection of remediation approach to be adopted. In some cases, a risk-based environmental remediation strategy is adopted based on the end land-use (e.g. industrial land use or residential land use) rather following prescriptive clean-up standards/levels. Finally, considerations such as cost, timelines, and availability of remediation goods and services are also important in determining the most appropriate strategy for bringing the site into regulatory compliance or to acceptable risk levels.

Remediation services delivery requires a variety of goods and services. Technical expertise for remediation services delivery include consultancy firms with the capabilities to plan and design and validate robust remediation strategies, contractors for ground investigation and performing the site clean-up, suppliers of equipment (e.g. monitoring devices, treatment technologies and products), waste management companies to manage or dispose of the contaminated / remediated materials, and laboratories to provide analytical services of contaminated materials (see **Figure 2.1** and a description of the technical expertise below).

The remediation services industry is a mature yet highly competitive and fragmented sector, as firms providing such services vary markedly in terms of size and degree of specialization. The majority of firms in the industry are small and medium-sized entities operating on a local, regional, or national level. At the transnational or international level, the vast majority of leading firms in the remediation services sector are US-based companies with multinational operations; in most cases, their primary or core business is construction or engineering with remediation services being part of a wider portfolio of the firm's business activities. In fact, US remediation firms account for over one-third of the global market for remediation services. Trade in remediation services is generally low; international trade in remediation services occurs largely during the initial site assessment and planning phases of a remediation project, conducted by foreign suppliers (e.g. through cross-border supply of services or foreign subsidiaries), whereas downstream services (e.g. actual remediation activities) are usually subcontracted to local firms.

In some economies, the regulators have also developed accreditation schemes for approved consultants / qualified personnel for carrying out site assessment and remediation work. Samples may have to be sent to laboratories overseas where the capability of analysing specialised parameters is not available locally.

Figure 2.1 illustrates the types⁹ of associated services and technical expertise with key steps of remediation services delivery, which are also described below.

Technical and Scientific Consulting

- Investigation and identification of remediation objectives: site-specific, to be determined and assessed together with client / regulators.
- Planning and design of remedial action plan: delineation of contamination extent, description of ground conditions (soil, water and air), type, form and scale of contamination to be remediated, methodology of remediation, including contingency measures in case of unsuccessful remediation, necessary licenses/permits, methodology for post-remediation verification monitoring, phasing of work.
- Execution of remedial action plan: work with contractors and supervise implementation of remediation work.
- Post-remediation verification monitoring: ensure effectiveness of remediation and check outcomes of remediation against desired levels to be achieved / regulatory levels.

Construction and Engineering

- Execution of remedial action plan: contractors for demolition (where necessary) and installing / conducting site remediation works.

Equipment, Device, Chemical Manufacture

- Supply of equipment for sampling, testing, monitoring, including personal protective equipment; supply of remediation chemicals and products.

Institutional Research and Development

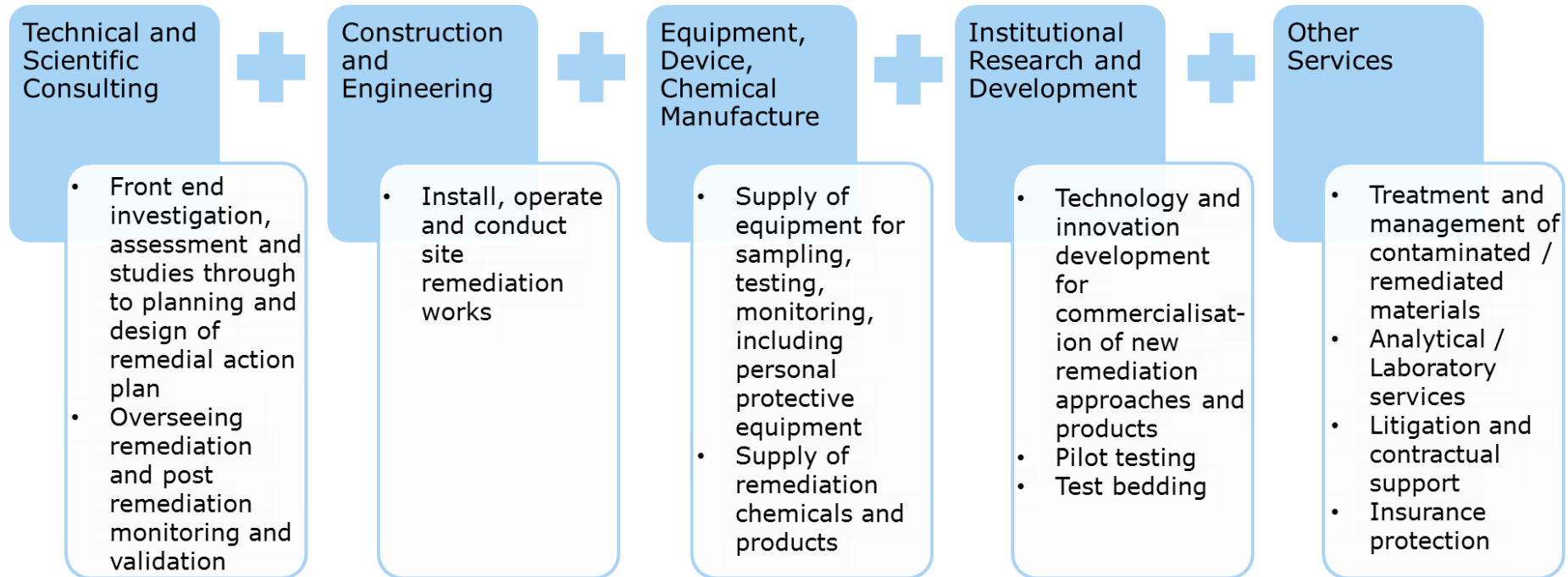
- Technology and innovation development for commercialisation of new remediation approaches and products; pilot testing; test bedding.

Other Services

- Treatment and management of contaminated / remediated materials: removal from site and adequate disposal or treatment of materials at approved and/or designated facilities.
- Analytical / laboratory services: conducted by laboratories on contaminated / remediated materials to determine extent of contamination and subsequent effectiveness of remediation against desired levels to be achieved / regulatory levels respectively.
- Litigation and contractual support.
- Insurance protection.

⁹ ENR, *The 2016 Top 200 Environmental Firms 1 – 100* (August 2016).

Figure 2.1: Services associated with Remediation Services Delivery corresponding to the Key Steps of Remediation Work

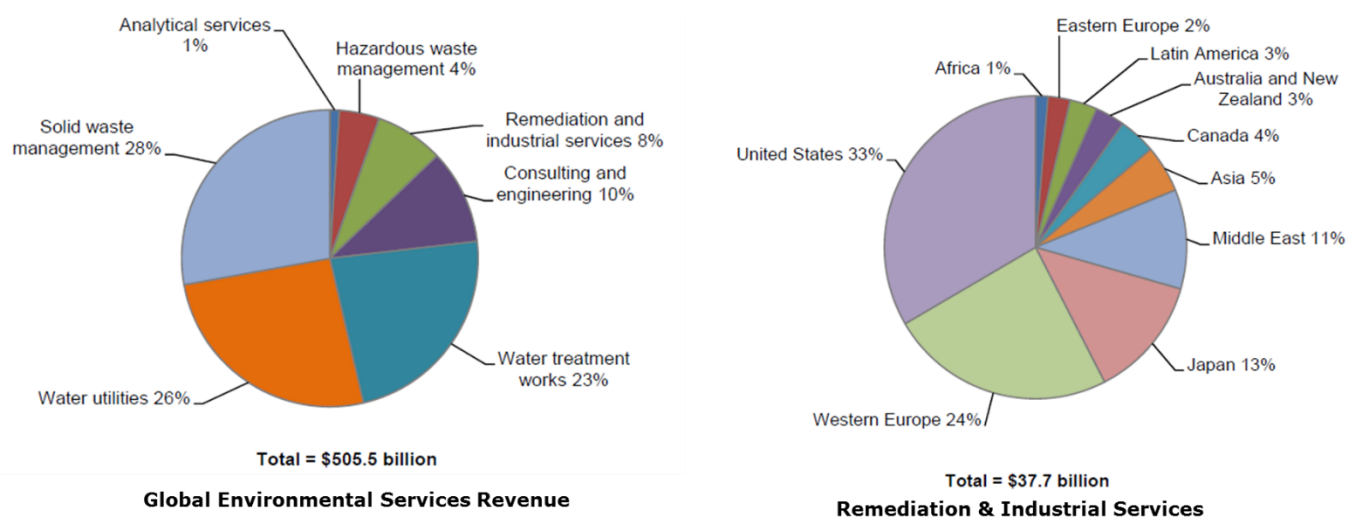


Source: Ramboll Environ

2.4 EXISTING BUSINESS MODEL IN THE SECTOR

In 2010, the remediation sector contributed about 8 percent (i.e. US\$37.7 billion) to the global environmental service market (see **Figure 2.2**), and 10 percent of US environmental services employment. The US is the major contributor to revenues within the sector globally, followed by Western Europe and Japan. A market research report¹⁰ published in 2016 expects the environmental remediation market to be worth USD 123.13 billion by 2022, at a compound annual growth rate (CAGR) of 7.62 percent between 2016 and 2022. The major driver for the growth of the market is the increasing demand for environmental protection, growing pollution, stringent government regulations, and demand from applications such as oil and gas, mining and forestry, automotive etc.

Figure 2.2: Global remediation market scenario in 2010: Per Cent Contribution by Different Nations and Services (Source: US International Trade Commission¹¹)



The value of the sector lies in its complex and highly specialised nature, thus requiring specialised expertise and services. Economies where such expertise and services are available are not only able to provide them within their own economies, but they also have the opportunity of exporting and transferring the knowledge to economies where the remediation services sector is less developed.

Businesses in the sector also derive value from the volume and scale of remediation projects, especially from large government projects for brownfield sites or clean-up due to environmental disasters. In economies where regulations play a strong role in driving remediation work, the volume of projects tend to be higher. Some projects are large scale and long term in nature, thereby creating higher value possibly over a longer period of time. Of note is that overall revenue for the sector could fluctuate drastically over short periods of time, as natural and manmade disasters can affect the sector's activities at any moment.

¹⁰ Cision PR Newswire, *Environmental Remediation Market by Environmental Medium (Soil & Groundwater)* (February 2017).

¹¹ USITC, *Environmental and Related Services*, Investigation No. 332-533 (USITC Publication 4389, March 2013).

2.4.1 Case for Expansion / Liberalisation of CPC94

With the environmental remediation services market expected to grow in the coming years, there is strong business impetus for developing the sector, at the same time bringing about the development of other associated goods and services described in **Section 2.3.4**. The complex and specialised nature of the sector means that there is much scope for technical development, which also underlies the potential for more trade opportunities and greater knowledge sharing. Trade in environmental goods and services brings about the benefit of improving export performance of firms and reducing costs of cleaner practices and technologies in the sector¹². However, trade through foreign participation across APEC member economies have been found to be affected by formal and informal trade restrictions or lack of transparency of regulations¹³.

The CPC is used as a tool to facilitate trade negotiations on services and for defining the sectoral coverage of commitments by member economies; however, more clarity and specificity is needed with regards to the current definition and scope of environmental related services¹⁴. A cluster approach has been proposed to the liberalisation of environmental services, where complementary relationships between “core” environmental services and broader / ancillary environmentally related services are considered¹⁵. Being able to clearly define environmentally related services as part of a cluster serving a clear environmental purpose is a challenge, depending on the degree of interpretation (i.e. till which extent are goods and services included), which varies across member economies, as well as dual-use problems where goods and services used for environmentally related purposes are also used for non-environmental uses.

Work on liberalisation of trade in the sector would require regulatory authorities in the individual economies to recognise the need to not just liberalise and reduce trade barriers in direct remediation goods and services, but also other associated goods and services.

2.5 MAJOR TRENDS

2.5.1 Legacy and Future Contamination

Environmental damage such as historic land and water contamination issues are closely related to under regulated and uncontrolled emissions from industrial activities and disposal / management of wastes, particularly toxic industrial wastes. Many economies have a history of lack of investment in environmental infrastructure (e.g. air pollution control, industrial wastewater discharge control) and/or waste management facilities (e.g. availability of secured landfill sites for hazardous wastes). As such, most of the industrialised APEC economies face existing land and water contamination issues, but significant increase in contamination in future is not expected due to the maturity of industrial operations. If uncontrolled, industrialising APEC economies which are undergoing urbanisation and rapid expansion of primary and secondary industrial activities may also face increased land and water contamination issues in the years to come. Moreover, developing / industrialising economies are also likely to have less

¹² Sauvage, J. and Timiliotis, C., *Trade in Services related to the Environment*, (February 2017).

¹³ APEC Policy Support Unit, *Survey of Regulatory Measures in Environmental Services* (November 2016).

¹⁴ World Trade Organization Economic Research and Statistics Division, *COVERED OR NOT COVERED: THAT IS THE QUESTION - Services Classification and Its Implications for Specific Commitments under the GATS* (December 2015).

¹⁵ Sauvage, J. and Timiliotis, C., *Trade in Services related to the Environment*, (February 2017).

robust environmental damage remediation services (local capabilities, laboratories, etc) which could lead to delayed remediation and higher potential for long term ecological or human health damage to occur.

2.5.2 Regulatory Focus on Remediation

Since one of the strongest drivers for remediation work stems from regulations and enforcement of the regulations, changes / expected changes in regulatory focus is a major factor affecting trends in demand for remediation services. Member economies experiencing an increase in regulatory focus or government spending on contamination management, increase in public awareness / interest in environmental matters and increase in demand for brownfield clean-up due to planned redevelopment are expected to see growth in demand for remediation services.

2.5.3 Remediation Technologies

There are different biological, physical and chemical technologies available for remediating soil and water contaminants with their own unique applicability, advantages, limitations and concerns.

As scientific understanding advances, previous remediation techniques or risk assessment assumptions could become invalid. One area which pose uncertainty to remediation outcomes is climate change, which could result in failure of a remediation project or result in potential future risks from previously ‘safe’ areas due to changing environmental conditions. Changing environmental conditions include fluctuations in water tables, flow rates, changes in temperature or dissolved oxygen, unanticipated geochemical reactions, sea level rises, increased flooding and coastal erosion¹⁶. These potential changing conditions may not have been accounted for in the initial site characterization and remedial design efforts. As such, planning, designing and monitoring for remediation requires the practitioner to account for and adjust accordingly for longer term climate change impacts, particularly for in situ remediation techniques where performance is influenced by ambient oxygen, temperature and hydraulic conditions.

In developed economies such as Australia and the US, environmental protection took on greater importance starting in the late 1970s¹⁷. Correspondingly, it is also mainly in these economies where solutions and technologies to bring contaminated land back to pre-contamination / background quality are designed, implemented and developed. Developing economies would likely import such remediation technologies and products from these developed economies, where they are more readily available.

Contaminants which are resistant to environmental degradation with potential adverse impacts on human health and the environment and/or contaminants of emerging concern or emerging contaminants whose health and environmental risks are not yet fully understood also influence regulatory focus and drive the development of remediation technologies. For example, the Stockholm Convention on Persistent Organic Pollutants (POPs), an international environmental treaty effective from 2004, aims to eliminate or restrict the production and use

¹⁶ Pannett, M, Wilton, M, and Bannon, S, *Future-proofing Contamination Risks. Poster Presentation at Network for Industrially Contaminated Land in Europe (NICOLE) forum* (2016).

¹⁷ Ibid.

of POPs, while emerging contaminants like per- and poly-fluoroalkyl substances (PFASs) and perfluorooctanoic acid (PFOA) are being looked at in economies like Australia and the US.

Treated / remediated materials are typically sent to landfills for final disposal. Rather than viewing the remediated materials as waste, there is ongoing research on the reuse of treated contaminated materials (e.g. treated soil as clean backfill soil for on-site development).

2.6 CHALLENGES AND OPPORTUNITIES

2.6.1 Sector

Industrial development in economies around the world presents opportunities for the growth of the remediation sector. However, the nature of the remediation sector is inherently complex (e.g. complex behaviour of chemicals in the environment and their effects on ecosystems and human health), and there is no single remediation technology or strategy which can be applied to all contamination problems. The selection of appropriate remediation technologies is dependent on many factors including site characteristics, types, concentrations and levels of contaminants, regulatory requirements, costs and time constraints (Khan, Husain and Hejazi, 2004), and the successful treatment of a contaminated site will depend on the proper selection, design, and adjustment of the remediation technique's operation based on the properties of the contaminants and contaminated media and on the performance of the system. Certain contaminants or mixture of contaminants are difficult to be effectively remediated or may require a combination of technologies.

Practitioners in the sector tend to rely on established methodologies, and are less inclined to explore innovative remediation technologies. One of the reasons is the known performance characteristics of conventional methods against the uncertainty of predicting remediation outcomes for innovative technologies. Another reason is the lack of economic drivers, as most companies required to clean up contaminated sites view the high costs of remediation as a liability and thus have no financial interest in the development of new remediation processes. Moreover, the enforcement of regulations related to contaminated land management and remediation is usually inconsistent, so the risk of a major penalty for delaying or not conducting clean-up is low¹⁸.

Remediation work typically incurs high costs and can be of significant duration (months to years) to complete. As such, remedial cost projection can be challenging in complex contaminated sites where the pollutant or media may be difficult to treat. Uncertainties include the cost of labour, energy, analytical testing and consumables required over the life of the remediation works. Changes in regulations and standards can also add to the cost to any clean-up especially if more stringent standards are enforced. In general, it is also difficult to extrapolate costs from other remediated sites due to the different hydrogeological and contaminant characteristics, and technology suppliers may report costs using different metrics which makes comparison challenging. Lack of local expertise (consultants, workers, etc.) would further drive up costs.

¹⁸ NRC, Sciences, Engineering and Medicine, *Market – Based Approaches for Stimulating Remediation Technology Development, Innovations in Ground Water and Soil Cleanup: From Concept to Commercialisation*, National Academies Press (New York, 1997).

2.6.2 Businesses

The level of industrial development provides an indication of the potential of contamination and remediation opportunities. However, a high level of industrial development in an economy may not necessarily translate to actual remediation projects on the ground. This is because the extent of land and water contamination and need for remediation in a member economy is determined by not only the regulations in place, but also the effectiveness of enforcement of those regulations as well as the acceptable threshold contaminant values beyond which sites are considered contaminated and require remediation within individual economies.

There are also challenges for businesses planning to enter the sector. Clear regulations and consistent enforcement of the regulations provide certainty to technology developers and players in determining their potential investment in the sector. However, the complex nature of the sector also means that much specialised expertise is required for providing technical services in the sector, which serves as a barrier to entry, particularly for smaller local firms. Added to this is the fact that member economies have varying degrees of economic advancement, as well as having different economic development priorities.

Rather than relying solely on regulations to drive the remediation services sector, a market-oriented approach tapping on economic self-interest should be encouraged. By developing a market that is quantifiable, with reasonably well-defined risks and commensurate opportunities for financial returns, both the service provider *and* the client would be able to perceive financial benefits from improved remediation of contaminated properties, while still protecting the interest of the affected public in ensuring that sites are cleaned up. Consequently, investment and capital will be channeled to developing remediation technologies when it becomes evident that new technologies can create real value for various stakeholders.

One good example of market forces creating demand for remediation is the redevelopment of contaminated urban industrial sites. There is high economic incentive to clean up contaminated brownfield sites for redevelopment because many of these properties sit on urban land parcels with extremely high value. To encourage uptake of contaminated sites for reuse and redevelopment by reducing fears of future liability, some US states have developed legal provisions whereby new owners of contaminated property will not be prosecuted as long as the owners have followed state voluntary cleanup program procedures¹⁹. Market incentives driving the redevelopment of brownfields could then lead to development of innovative remediation technologies as property developers have a strong interest to complete the remediation as quickly and effectively as possible so they can sell or lease the rehabilitated land. For example, in the city of Wichita, Kansas in the US, the local government selected an in-situ treatment approach over a conventional pump-and-treat system in part because the innovative method could be more easily modified to improve performance²⁰.

According to the US National Research Council²¹, to achieve this shift in the remediation services sector, regulatory agencies need to pursue five types of initiatives: firstly, create

¹⁹ GAO, *Community Development: Reuse of Urban Industrial Sites* (United States of America, June 1995).

²⁰ NRC, Sciences, Engineering and Medicine, *Market – Based Approaches for Stimulating Remediation Technology Development, Innovations in Ground Water and Soil Cleanup: From Concept to Commercialisation*, National Academies Press (New York, 1997).

²¹ NRC, Sciences, Engineering and Medicine, *Market – Based Approaches for Stimulating Remediation Technology Development, Innovations in Ground Water and Soil Cleanup: From Concept to Commercialisation*, National Academies Press (New York, 1997).

economic incentives for remediation; secondly, ensure consistent enforcement of regulations; thirdly, create a more predictable regulatory process for selecting clean-up goals and remediation technologies; fourthly, where possible, make available complete information about the size and nature of all sectors of the remediation market, public and private; and lastly, create more opportunities to allow testing of innovative remediation technologies and verification of their performance.

3 SECTOR STUDY IN APEC ECONOMIES

This chapter briefly summarises the remediation sector characteristics in terms of industrial development and known contamination issues, drivers for remediation services, availability of local technical expertise, projections / major trends in soil and groundwater pollution and regulatory / policy trends affecting contamination management and remediation, as well as challenges and opportunities for each APEC member economy.

For most economies, a comprehensive review of the effectiveness of enforcement, level of technical expertise in the local market and projections / expected trends in regulatory focus was not possible due to the lack of availability of publicly available information as well as time constraints. A detailed and accurate picture in these areas across the economies would require on ground investigation with regulators, relevant experts and service providers in the economies concerned.

Caution should also be exercised in comparing the extent of development of the remediation services sector among APEC economies, given the differences in level of industrial development, regulatory and legal structures, and specific local contexts such as issues with indigenous communities.

3.1 AUSTRALIA

3.1.1 Industrial Development and Contamination Issues

Australia is a developed and urbanised economy. The Australian economy is dominated by its services sector, and due to the availability of natural resources, it also has a natural resource based economy with minerals, agriculture products, and to a smaller extent, fisheries contributing to about half of the economy's exports. As the mining industry matures, it is currently transitioning into the production phase²². Its top exports are iron ore, coal and natural gas. Australia also has a significant manufacturing sector, with manufactured goods including machinery and equipment, metals, wood, paper and shipbuilding. Operating mines are mainly located in Eastern and Western Australia²³, while the economy's industrial centres are largely located along the east coast in the states of Queensland, New South Wales and Victoria. Petrochemical facilities are mostly found in Western and South-eastern Australia, although some legacy petrochemical facilities were found along the east coast in New South Wales.

Contamination issues in Australia arise from legacy land contamination due to agricultural practices such as the use of pesticides and other chemicals, historical industrial land use and disposal of chemicals, mining activities and burying of wastes. There have also been concerns on radioactive contamination due to uranium and rare earths mining, nuclear testing and the construction of nuclear facilities. Australia has an estimated 160,000 contaminated sites²⁴ with as many as 75,000 different contaminants²⁵.

3.1.2 Drivers for Remediation Services

The Australian Government, state and territory governments, and local governments jointly administer environmental protection. All states and territories have regulations on assessing and remediating contaminated land. Some states and territories also have remediation funds such as the Mining Remediation Fund (Northern Territory) and the Mining Rehabilitation Fund (Western Australia). In recent years, there has been greater emphasis on intergovernmental cooperation and civil society involvement within Australia for environmental matters.

Statutory regulation of contaminated land is usually required where the extent of contamination poses significant risks to the environment or human health. Otherwise, market forces drive the issue of contaminated land, e.g. through redevelopment / change in land use or purchase / leasing of land, leading to due diligence work, site assessments, remediation and audits. Where an assessment indicates remediation would have no net environmental benefit or would have a net adverse environmental effect, implementation of an appropriate site management strategy is required, e.g. capping the site and limiting the uses of the site²⁶.

²² Australian Government, Department of Industry, Innovation and Sciences, *Australian Industry Report* (Australia, Office of the Chief Economist, 2016).

²³ Australian Mining, *Australian Mine Map 2015*, (2016).

²⁴ EPA, South Australia, *Site Contamination Overview Fact Sheet* (Australia, December 2016).

²⁵ Plant, R., Wilmot, K. and Ege, C., *Contaminated Soil Wastes in Australia*, Prepared for the Australian Department of the Environment, Institute for Sustainable Futures, University of Technology (Sydney, June 2014).

²⁶ Ibid.

3.1.3 Technical Expertise

Given the strong regulations and established contamination management and remediation sector, Australia has a high level of technical expertise across the spectrum of remediation and related services. Most states also have accredited contaminated site auditors to independently review investigation, remediation and validation work conducted by contaminated land consultants to ensure the work complies with current regulations and guidelines and meets the standard appropriate for the proposed land use.

3.1.4 Major Trends

3.1.4.1 Soil and Groundwater Pollution Trends

There is no literature indicating a potential shift in Australia's main industry types; hence there are no major changes expected in the potential for future soil and groundwater pollution compared to current status.

3.1.4.2 Regulatory / Policy Trends

In terms of regulatory focus, there were some updates in 2015 to existing guidelines pertaining to the duty to report contamination (New South Wales, Queensland) and liability provisions (Northern Territory). Due to these regulatory developments, there could be some increase in demand for related remediation services (e.g. legal and technical), as owners and occupiers of sites are required to ensure their obligations are met under the revised guidelines²⁷. However, major changes in demand for remediation services due to these changes in land contamination / remediation regulations are not expected.

Due to human health concerns leading to regulatory developments in some states, there is a current push in Australia for more sustainable remediation and in-situ bioremediation / in-situ remediation methods, especially in developing new technologies for PFAS which is being driven by both the public and private sectors. Key drivers include the aim to reduce the time required to complete remediation projects, costs (regulators are increasing landfill costs to encourage more sustainable or innovative solutions than disposal by landfilling) as well as health risks to end users. With increasing complexity of contaminant types and remediation solutions, there is an increasing trend in the import of new remediation technologies mainly from the US, adopted by US multinational companies with local presence.

3.1.5 Challenges and Opportunities

Australia has a mature remediation services sector. The main drivers for soil and water contamination management and remediation in Australia are the existence of state / territorial regulations as well as commercial drivers. Demand for remediation services is not expected to increase significantly, as major changes (growth or decline) to Australia's polluting industries and regulatory focus are not expected, barring discovery of legacy contaminated sites. However, there are indications of development in technical expertise and technologies in certain parts of the sector due to health concerns and regulatory developments. There is scope for import of technical expertise from other economies like the US, and potential export of technical expertise to APEC economies developing their remediation services sector.

²⁷Clayton UTZ, *Environment & Planning National Review 2016* (Australia, 2016).

3.2 BRUNEI DARUSSALAM

3.2.1 Industrial Development and Contamination Issues

Brunei has a small but wealthy economy owing much to its large oil and gas sector, with a lower reliance on manufacturing, and thus imports most of its goods and food. However due to a persistent fall in oil prices, oil and gas revenues have contracted. This reliance on oil and gas as a driver of the economy has prompted the Brunei government to implement several reforms in 2016, such as attracting new foreign direct investment and developing other sectors such as high tech and manufacturing industries. The manufacturing industries include cement production, garment making, production of pre-cast concrete, mineral water, canned food, dairy products, publishing and printing. Development and manufacturing facilities are largely centred near the coast in the Muara District, as well as near the border to Malaysia in the south.

Improper municipal waste disposal is a major cause of soil and groundwater pollution. Areas of particular concern include Anduki Sand Pit, a landfill site near the coast, and Kampung Air, near the city centre of the capital Bandar Seri Begawan. The current techniques of waste disposal which include direct disposal, burying in landfills and injection into abandoned wells in the oil and gas industry present potential avenues for pollution. Offshore exploration and extraction of oil and gas have had also resulted in marine pollution.

3.2.2 Drivers for Remediation Services

There are no specific regulations on contamination management and/or remediation in Brunei, but requirements for contaminated land assessment and remediation are provided under the recently enacted Environmental Protection and Management Order (EPMO) (2016) and Pollution Control Guidelines for Industrial Development²⁸. Under the EPMO, the authority has the power to issue remedial or stop work orders to persons likely to pollute or damage the environment, failing which they would be liable to fines. The authority may also direct the “owner or occupier of premises or a person who appears to be carrying out the activities or having control over the carrying out of such activities in which an environmental incident occurs” to take all reasonable measures to prevent further pollution or damage to the environment. Given that the EPMO is a recent development, the effectiveness of enforcement is currently unclear.

Large industries such as those within the oil and gas industry typically have established protocols and actions plans in the form of an Environmental Management System in place; should large scale pollution occur, it is often followed by remediation. Environmental awareness among the public appears to be low due to a general lack of reporting of environmental pollution cases.

3.2.1 Technical Expertise

Due to the recent development of the EPMO and lack of specific soil and water contamination management regulations, the environmental sector in Brunei is still in its infancy stages, and while technical expertise in the remediation sector is available, the technical capacity is likely to be limited.

²⁸ Energy and Industry Department, *Brunei Law, Environment*.

3.2.2 Major Trends

3.2.2.1 Soil and Groundwater Pollution Trends

Despite the government's push to diversify the economy into high value-added knowledge industries such as life sciences, agri-business, ICT and services industries, Brunei is still hugely dependent on its oil and gas, petrochemical and manufacturing industries, thus land and coastal pollution is likely to increase. In 2015, the government undertook a construction of a bridge linking Pulau Muara Besar to the mainland, along with associated roads and utilities. This was to transform the 955 hectares (ha) island into an industrial site for chemicals, petrochemicals, ship maintenance, repair and overhaul, marine supplies. However, this would likely intensify coastal pollution in the vicinity of the island more than soil and groundwater pollution.

3.2.2.2 Regulatory / Policy Trends

With the recent enactment of the EPMO, it remains to be seen if changes in the demand for remediation services might occur.

3.2.3 Challenges and Opportunities

The government has enacted the EPMO, which could drive the remediation services sector. However, the extent of development also depends on the enforcement of the order as Brunei develops its manufacturing industries, environmental regulations and standards for contaminated land management and remediation need to be developed in tandem with the targeted industrial activities to ensure that adequate regulation is present to govern new industries and their potential polluting waste streams. Local expertise for delivery of remediation services also needs to be developed. However, it should be noted that being a small economy, Brunei's capacity to absorb new remediation service providers would be limited.

3.3 CANADA

3.3.1 Industrial Development and Contamination Issues

Canada is a developed economy, with its primary industries including mining, quarrying and natural resources (oil and gas) extraction, forestry and pulp and paper, fishing and agriculture, and its secondary industries including manufacturing for automobiles, steel, food, chemicals, forest products, minerals and oil. Canada is the US's largest supplier of energy, including oil, gas, uranium and electric power. Canada is the world's largest producer of zinc, uranium, potassium cadmium, sulphur and nickel. Canada's mining and industrial centres are spread across the economy; Ontario for the manufacture of automobile engine and parts, Central Canada such as the prairies are known for agricultural industries and fossil fuels, while the eastern provinces are known for fisheries and seafood production.

Legacy contaminated sites are spread across Canada, with higher density along the western and eastern coasts of British Columbia, Newfoundland and Labrador and the central manufacturing areas in Ontario and Quebec. A 2012 Spring Report of the Commissioner of the Environment and Sustainable Development²⁹ identified four sites as having the highest financial liabilities in the economy due to land contamination arising from heavy metals and radionuclide contamination. The Port Hope and Welcome Waste Management facilities in Ontario are contaminated by low level radioactive waste such as radium 226, uranium and arsenic. Similarly, the Faro Mine in Yukon contributes to an estimated 64,000ha of contaminated soil and groundwater from leached acids and metals. The contaminants include metal, metalloids and organometallics, acid rock drainage and petroleum hydrocarbons. Nearby, in Yellowknife in Northwest Territories, the abandoned Giant Mine site is contaminated with 237,000 tonnes of arsenic trioxide dust stored in 15 underground chambers, 16,000,000 tonnes of tailings which is also arsenic rich, three large tailing ponds and eight open pits with 35 mine openings.

3.3.2 Drivers for Remediation Services

The responsibility for environmental management in Canada is shared between the federal government and provincial/territorial governments. At the federal level, there is the Canadian Environmental Protection Act (1999), with individual Provinces and Territories having their own environmental laws/regulations as well as contamination management or soil and groundwater remediation laws / regulations. In addition, there are designated enforcement provisions within these acts and regulations. There is also a Federal Contaminated Sites Action Plan with government funding and tax relief-based funding schemes at provincial level for brownfield remediation. Some remediation projects funded by the Federal Contaminated Sites Action Plan include soil remediation at Forillon National Park, Colomac Mine remediation, Kitsoo soil remediation, Rock Bay remediation, Oshawa Harbour remediation, Swallowtail Light Station remediation and Cartier-Brebeuf National Historic Site of Canada³⁰.

3.3.3 Technical Expertise

Given the strong regulations and established contamination management and remediation sector, Canada has a high level of technical expertise across the spectrum of remediation and related services. There is also a robust education system and private environmental contracting

²⁹ CBC News, *Canada's four most expensive contaminated sites, contaminated soil, and radioactive waste puts groundwater in jeopardy* (Canada, May 2012).

³⁰ Federal Contaminated Sites Portal, *Federal Contaminated Sites Action Plan (FCSAP)* (Government of Canada, October 2016).

and industry sector in Canada, which facilitates sharing of new technologies for assessment and remediation on a regular basis.

3.3.4 Major Trends

3.3.4.1 Soil and Groundwater Pollution Trends

There is no literature indicating a potential shift in the main types of polluting industries in Canada (such as mining and agriculture); hence there are no major changes expected in the potential for future soil and groundwater pollution compared to current status. A movement by the Canadian Prime Minister in early 2017 to reduce greenhouse emissions by phasing out oil sands production³¹ could reduce contamination from the mining process (e.g. through reduction in liquid tailings).

3.3.4.2 Regulatory / Policy Trends

There is no indication of major changes in the regulations for contamination management in Canada; hence significant changes in the demand for remediation services due to regulatory changes are not expected. The identification of legacy contaminated sites is an ongoing process; as such, the number of known contaminated sites will increase. This encourages the environmental industry to develop innovative and sustainable technologies and approaches. In addition, the government of Canada will provide over \$1 billion over four years starting 2017 – 2018 to support clean technologies, especially in the forestry, fisheries, mining, energy and agriculture sectors to help Canada transform into a low-carbon economy³². This could have an indirect positive impact on reducing pollution from those industries.

3.3.5 Challenges and Opportunities

The main drivers for contamination management and remediation in Canada are the existence of provincial / territorial regulations, land redevelopment and financial sector requirements, government funding, a robust education system and private environmental contracting and industry sector. Demand for remediation services in the economy is not expected to increase significantly, as major changes (growth or decline) to Canada's polluting industries and regulatory focus are not expected, barring the discovery of legacy contaminated sites. There is scope for the export of technical expertise and remediation technologies to the APEC economies seeking to develop their remediation services sector.

³¹ CBC News, *Trudeau's 'phase out' oilsands comments spark outrage in Alberta* (January 2017).

³² Government of Canada, *2016 Growth Strategy – Canada* (Canada, September 2016).

3.4 CHILE

3.4.1 Industrial Development and Contamination Issues

Chile is one of South America's fastest-growing economies, with the gross domestic product (GDP) having more than doubled in the last 2 decades. In Chile, natural resources are a key driver of growth due to their abundance, with mining, agriculture, forestry and aquaculture contributing significantly to national income and exports. In fact, Chile is the largest copper producer in the world, and also supplies other minerals such as molybdenum, gold, silver and lithium. Commodities make up about 60 percent of exports, whereas the mining sector accounts for about 8 percent of GDP and about 40 percent in export value.

Main polluting activities in Chile include mining, forestry (sawmills), fuel service stations and waste disposal (landfills and dumps)³³. There are many active and abandoned and/or inactive sites across the economy, with most abandoned mining sites concentrated in the north, more active mining sites located in Central Chile and small numbers of active and abandoned sites in southern Chile. As of 2015, the national mining service (*Sernageomin*) has catalogued more than 650³⁴ abandoned and/or inactive sites and storage facilities, some of which are located near to communities and have caused significant environmental and public health concerns. Large volumes of mine tailings have contaminated soil, surface water and groundwater in Chile, and some have been disposed of in the Chilean Pacific Ocean³⁵. Sawmills are mostly located in Central Chile³⁶.

3.4.2 Drivers for Remediation Services

Chile's main statutory environmental framework is given by its Environmental Act (Law No.19,300/94) and other supporting environmental statutes. According to the Environmental Act, anyone who negligently or wilfully causes an environmental damage shall be liable for environmental contamination. However, there are no specific regulations for the remediation of contaminated property and no specific agency responsible for the investigation and clean-up of contaminated land. The National Policy for the Management of Polluted Sites (2009) serves to strengthen the management of polluted sites in Chile by stipulating their identification, risk assessment and mitigation of negative impacts and monitoring, and guidance documents have been issued to support this policy. Environmental projects with areas equal to or greater than 10,000m² related to the redress or recovery of polluted lands shall be assessed within the EIA System³⁷. There are non-legally binding risk evaluation guidelines for soil.

The remediation of abandoned mine sites and the heavy metals content is a government priority, but there is a lack of enforceable legal requirements such as remediation standards, and limited systematic assessments of soil and groundwater contamination from mining activities³⁸. The 2012 Mining Closure Law aims to prevent the creation of abandoned mine sites in the future, requiring all new mines to seek approval for end-of-life closure plans, and

³³ Ministry of Environment, *Management of Contaminated Sites in Chile with Emphasis in Mining Areas: Developing Regulation and Promoting Innovation* (Chile, October 2011).

³⁴ OECD / ECLAC, *Environmental Performance Reviews, Chile 2016*, OECD Publishing (Paris, 2016).

³⁵ Ibid.

³⁶ The Sawmill Database, *Sawmills*, 2007.

³⁷ Latin Lawyer, *Chile* (Environment, April 2017).

³⁸ OECD / ECLAC, *Environmental Performance Reviews, Chile 2016*, OECD Publishing (Paris, 2016).

mining companies are to provide cost estimates and a guarantee for the amount. However, it does not apply to already abandoned mine sites which require decontamination plans to be developed. A catalogue of abandoned mine sites with information on tailings deposits is available; however, it needs to be expanded and updated in a systematic manner for greater transparency. There is limited funding for decontamination activities from the state budget.

There is increasing public awareness in environmental matters. In the last one to two decades, there has been a shift in mind set in the area of waste management. In 1995, all of Chile's waste ends up in unauthorised rubbish dumps known as *vertederos*, while by 2012, about 70 percent of the waste generated in the economy is sent to landfills that meet environmental and sanitation norms³⁹. The establishment of specialised environmental courts whose function is to resolve the environmental disputes in the economy (Law No. 20,600/12) has seen some environment-related court actions, indicating an active civil society / citizenry in environmental matters. There are also certain mechanisms for public participation in developing environmental regulations.

3.4.3 Technical Expertise

Given the lack of enforceable legal requirements relating to remediation of contaminated property, the pool of technical expertise relating to remediation services is expected to be low, e.g. there is a lack of certified testing laboratories and environmental drillers. Mining remediation consultants are mostly international firms with local presence in Chile.

3.4.4 Major Trends

3.4.4.1 Soil and Groundwater Pollution Trends

Chile will continue to depend heavily on its mining industry, with a projected increase in mining production⁴⁰. It currently holds the world's largest known reserves of lithium under exploitation (current world market share about 62 percent) and lithium demand and production is likely to increase due to increased global demand from the battery-powered automotive industry⁴¹. This suggests a possible increase in soil and groundwater pollution.

3.4.4.2 Regulatory / Policy Trends

There is a shift from waste disposal in the form of landfills and garbage dumps towards sanitary landfills and waste-to-energy plants, as well as increased waste separation and recycling efforts from the community. The government aims to increase the proportion of municipalities with sanitary landfills from 30 percent in 2010 to 75 percent by 2020, and expects a doubling in the number of sanitary landfills in the economy⁴².

Sernageomin, together with relevant ministries, have embarked on a process of developing soil quality standards for heavy metals.

³⁹ Amcham Chile, Camara Chilena Norteamericana de Comercio, *Waste management in Chile* (Chile, July 2012).

⁴⁰ OECD / ECLAC, *Environmental Performance Reviews, Chile 2016*, OECD Publishing (Paris, 2016).

⁴¹ Export.Gov, *Chile – Mining Sector* (October 2016).

⁴² OECD / ECLAC, *Environmental Performance Reviews, Chile 2016*, OECD Publishing (Paris, 2016).

3.4.5 Challenges and Opportunities

Given the projected increase in mining production, soil and groundwater pollution issues in Chile are likely to worsen. Moreover, Chile needs to deal with the legacy contamination issues of abandoned mine sites. Moreover, the government and society seem to recognise the need to prioritise environmental and remediation matters, as can be seen in the developments in the area of waste management and public participation in environmental matters. Hence, there is scope for developing the remediation services sector. However, local expertise for delivery of remediation services needs to be developed, and limited financing of decontamination activities from the state budget could also restrict much-needed remediation efforts in Chile.

3.5 CHINA

3.5.1 Industrial Development and Contamination Issues

China has undergone major industrial development in the past three decades to become a major global economy. The recent restructuring of China's economy has made it the world's second largest economy after the US. China's primary industries comprise agriculture, mining and quarrying. The main manufacturing components include iron, steel, aluminium, textiles, cement, toys, chemicals, ships, aircraft and electronics. Exploration for mineral resources is mostly located in the south and southeast parts of China⁴³.

The rate of growth of the economy has had significant impact on the environment. There are thousands of brownfield sites in China, with many being heavily polluted. A soil pollution survey⁴⁴ jointly published by the Ministry of Environmental Protection and the Ministry of Land and Resources in 2014 found that 16.1 percent of China's soil and 19.4 percent of its arable land is contaminated, with cadmium, nickel and arsenic identified as top pollutants; 34.9 percent of brownfield sites exceeded agricultural soil and groundwater quality standards. Pollution is severe in three major industrial zones, the Yangtze River Delta in east China, the Pearl River Delta in south China and the northeast part of China which used to be a major industrial hub⁴⁵. A report released by the Ministry of Land and Resources indicated that close to 60 percent of China's groundwater is deemed to be "very poor" or "relatively poor" and cannot be directly consumed⁴⁶. Pollution scandals and health problems due to soil and groundwater contamination from industrial sites and chemical spills are reported from time to time, from sick children to contaminated agricultural land.

3.5.2 Drivers for Remediation Services

China issued the Interim Measures on Soil Environment for Contaminated Sites in December 2016 which became effective since July 1, 2017. The measures are applicable to suspected contaminated sites (e.g. refinery, chemicals, electroplating and hazardous waste storage, utilization and disposal sites) and known contaminated sites. Land owners are required to conduct soil investigation on suspected contaminated sites and submit the investigation results to a nationwide contaminated site management information database; if soil contamination is confirmed, the site must be registered by the local government in a "Known Contaminated Site Inventory" which will be updated regularly. Further detailed investigation and risk assessment shall be conducted for the known contaminated sites and a risk management plan shall be developed according to the results of the risk assessment. Remediation shall be conducted if the known contaminated site is to be redeveloped into commercial, residential or public buildings (e.g. school, hospital). If the sites will not be redeveloped in the near future, preventive measures shall be taken to prevent contaminant immigration/spread.

China has released a Soil Pollution Prevention and Control Action Plan⁴⁷ in 2016, which aims to decontaminate 90 percent of its polluted farmland and agricultural land by 2020 and improve soil quality across China by 2030. It includes a national online platform for disclosing soil data.

⁴³ China Mining Federation, *Mineral of China* (China July 2006).

⁴⁴ Ministry of Environmental Protection of the People's Republic of China, *Soil Investigation of the situation of Soil Pollution in China* (April 2014).

⁴⁵ BBC News, *Report: One Fifth of China's Soil Contaminated* (April 2014).

⁴⁶ China Daily, *China's Groundwater Plagued by Pollution* (November 2014).

⁴⁷ State Council of the People's Republic of China, *Action Plan for Soil Pollution Prevention and Control* (May 2016).

Under the plan, the central government will set up a special fund to tackle soil pollution, as well as a separate fund to help upgrade technology and equipment in the heavy metal sector⁴⁸. Soil pollution monitoring systems will be strengthened and new clean-up technologies will be promoted. There are draft soil regulations at a national level, and arising from the new action plan, legislation is being fast-tracked to tackle soil pollution in China. Cost estimates for the implementation of the action plan range from 5 to 7 trillion yuan⁴⁹ (approx. USD 0.74 to USD 1.03 trillion⁵⁰).

Local authorities in certain more developed regions of China have also developed local regulations to tackle soil and groundwater pollution⁵¹. Site assessment and remediation projects are driven by central and local governments, which may require developers to conduct site assessments and remediation particularly for sites slated for redevelopment if there are potential health risks, especially for residential developments. The Ministry of Environmental Protection issued a Notice on the Redevelopment of Former Industrial Sites in 2014, which prohibits transfer of industrial properties without environmental assessment, specifies responsibility for remediation and prevention of spread of contamination for contaminated sites, and for industrial properties to be closed down or relocated to take proper environmental protection measures etc.

The 'polluter pays' principle applies in China, but it is usually a challenge to identify soil contamination in the first place, and to track down responsible parties and make them pay for the assessment / remediation. As such, local governments usually end up paying for clean-up, especially in rural areas⁵². Due to the physical size of the economy, it is often a challenge for the government to enforce and ensure that remediation work is adequately conducted.

The government and public attention has in the past been more focused on air and water pollution issues in China, with less awareness and weak legislation in the area of soil and groundwater contamination. There is growing concern and interest both from the government and the public regarding the adverse impact of China's rapid industrialisation on the environment and public health.

3.5.3 Technical Expertise

In general, local governments in China mostly engage local institutes and contractors and do not directly engage international firms, citing confidentiality issues. Local technical expertise in the remediation sector is low, with most expertise imported from overseas or supplied by international firms with local presence in China.

⁴⁸ Reuters, *China Releases New Action Plan to Tackle Soil Pollution* (Environment, May 2016).

⁴⁹ Nature, *China's Soil Plan Needs Strong Support* (International Weekly Journal of Science, August 2016).

⁵⁰ Based on an exchange rate of USD 1 to 6.79 CNY the week of 10 – 16 July 2017.

⁵¹ Wang, et.al., *Development of Soil Environment Management System in China and Some Advices Learned from European Soil Management* (November 2014).

⁵² China Dialogue, *China's Tainted Soil Initiative Lacks Pay Plan* (June 2016).

3.5.4 Major Trends

3.5.4.1 Soil and Groundwater Pollution Trends

As China continues to develop, new contamination is likely to arise from new industrial sites. Agricultural activities such as the usage of pesticides and fertiliser will also continue to contribute to soil and groundwater pollution.

3.5.4.2 Regulatory / Policy Trends

The government recognises the impact of rapid industrialisation on soil quality in the economy, the severity of water and soil pollution and its impact on agricultural products and human health⁵³, and is working to strengthen legislation in tackling pollution. The Law on Prevention and Control of Soil Pollution has been drafted and published for public comments in July 2017. Soil and groundwater screening standards and other supportive technical guidelines are being amended/drafted.

3.5.5 Challenges and Opportunities

China's rapid industrial development over the last three decades has led to serious pollution issues within a short period of time, which is challenging in terms of the large areas and quantities of pollution, as well as many different types and sources of contaminants. On the other hand, this provides much opportunity for holistic contamination management and for the development of the local remediation services sector, especially with the recent regulatory developments in curbing water and soil pollution.

Laws on contaminated land management and remediation supported by regulations, effective enabling mechanisms (e.g. funding and enforcement mechanisms), and a long term systematic approach will facilitate tackling of contamination issues. Other issues hindering public awareness and efforts to tackle the pollution problem include the lack of low-cost and effective new technologies. There is also a general lack of transparent detailed information on locations and pollution levels at specific sites⁵⁴.

The Chinese government's investment in soil remediation in 2016 was around 9 billion yuan⁵⁵ (approx. USD 1.3 billion⁵⁶), which is much lower than the costs estimated to implement the new action plan on soil pollution described above. Given the physical size of the economy and the large number of polluted sites, China needs to consider a range of other funding instruments in order to be able to sustain its efforts, from environmental taxes and clean-up subsidies to loan guarantees and insurance⁵⁷.

⁵³ Ministry of Environmental Protection of the People's Republic of China, *The Ministry of Environmental Protection and the Ministry of Land and Resources Issued a National Bulletin on Soil Pollution* (April 2014).

⁵⁴ Nature, *China's Soil Plan Needs Strong Support* (International Weekly Journal of Science, August 2016).

⁵⁵ Ibid.

⁵⁶ Based on an exchange rate of USD1 to 6.79 CNY the week of 10 – 16 July 2017.

⁵⁷ Nature, *China's Soil Plan Needs Strong Support* (International Weekly Journal of Science, August 2016).

3.6 HONG KONG, CHINA

3.6.1 Industrial Development and Contamination Issues

Hong Kong, China is a developed economy mainly dominated by the services sector, including trade and logistics, financial, tourism, retail, high-tech and information technology (IT), as well as other professional services. Agricultural activities are limited due to the lack of arable land owing to their small land area and the British's focus on trade during colonial times. Hong Kong, China relies heavily on agricultural imports, raw materials, food, and water from China. Its manufacturing industries developed rapidly between the 1920s to about 1970, including the textile, clothing, toy and watch industries. Prior to the 1960s, most industrial areas were built along both sides of Victoria Harbour. In the 1980s, a shift of large and labour-intensive manufacturing establishments from Hong Kong, China to China occurred⁵⁸, due in part to land scarcity issues and costs of labour. The industrial sector today is hence mainly focused on re-export of goods produced in China, with some low value-added, light manufacturing activities⁵⁹.

Legacy land contamination issues in Hong Kong, China are mainly due to past industrial or commercial activities such as shipyards, petrol filling stations, vehicle repair workshops and scrap yards, metal or mechanical workshops or oil installations etc.⁶⁰ Many of these sites have been / will be converted into other land uses. A case which raised public interest in the late 1990s / early 2000s is the decommissioning of the Cheoy Lee Shipyard (the largest Hong Kong, China-based shipbuilding company at one time) for the construction of the Disney Theme Park, where significant soil contamination was discovered; this case later became the trigger for the development of Hong Kong, China's Land Contamination Policy. Another high profile remediation project in recent years was the clean-up of the site of the old Kai Tak Airport.

3.6.2 Drivers for Remediation Services

Hong Kong, China has a Land Contamination Policy, and contaminated land assessment and remediation is required under the EIA Ordinance (for designated projects) and Building (Oil Storage Installations) Regulations, and indirectly regulated under the Waste Disposal Ordinance and Water Pollution Control Ordinance. Non-legally binding Guidance Notes are also available: a) Contaminated Land Assessment and Remediation; b) Use of Risk-based Remediation Goals (RBRGs) for Contaminated Land Management; and c) Practice Guide for Investigation and Remediation of Contaminated Land⁶¹. RBRGs were developed as threshold contaminant concentrations using a risk-based approach since 2007 for four types of land uses (urban residential, rural residential, industrial and public parks) in Hong Kong, China⁶².

If Government land is involved, the land lessees or tenants are held responsible for assessment and clean-up of land contamination; the Government will make available public funding if and where necessary. In the case of private land, land owners are required to deal with land

⁵⁸ Nations Encyclopedia, *Hong Kong*, Overview of Economy.

⁵⁹ Government of Hong Kong Special Administrative Region, *Hong Kong Planning Standards and Guidelines*, Chapter 5: Industry (March 2007).

⁶⁰ Environmental Protection Department, *Guidance Manual for Use of Risk – Based Remediation Goals for Contaminated Land Management* (December 2007).

⁶¹ Environmental Protection Department, *FAQ on Contaminated Land Management*.

⁶² Environmental Protection Department, *Guidance Manual for Use of Risk – Based Remediation Goals for Contaminated Land Management* (December 2007).

contamination, including assessment and remediation, if they wish to change the land use⁶³. For decommissioning of facilities, a decommissioning EIA is required to be approved under the EIA Ordinance, and if land contamination is identified, decontamination of the facilities as appropriate to its redevelopment plans to be carried out. When concentrations of soil or groundwater are detected above the RBRGs, clean-up will be required.

3.6.3 Technical Expertise

Most of the technical expertise in the remediation sector in Hong Kong, China is provided by small to medium sized local firms serving the relatively small market.

3.6.4 Major Trends

3.6.4.1 Soil and Groundwater Pollution Trends

Hong Kong, China's economy is dominated by the service industry, with the industrial sector mainly focused on the re-export of goods produced in China and low value-added, light manufacturing activities. This is not expected to change in a major way in the future, hence there are no major changes expected in the potential for future soil and groundwater pollution compared to the current status.

3.6.4.2 Regulatory / Policy Trends

There is currently no indication of regulatory developments which might have an impact on the remediation services sector in Hong Kong, China.

3.6.5 Challenges and Opportunities

As Hong Kong, China has transitioned to a service driven economy in the last decades, without major heavily polluting industries, it is expected that there would not be major increase in new land pollution cases in future. However, the discovery of contaminated sites arising from the redevelopment of past industrial and commercial sites and a more discerning public could result in an increase in the number of known contaminated sites and possibly increased demand for remediation services.

⁶³ Environmental Protection Department, *Information Note on Land Contamination Policy* (December 2008).

3.7 INDONESIA

3.7.1 Industrial Development and Contamination Issues

Indonesia is one of the fastest growing economies in Southeast Asia. It shifted from being an economy that was highly dependent on agriculture in the 1960s to a more balanced economy in which the share of service and industry sectors starting from the 1980s. In 2010, services and industry, at 37 percent and 47 percent of GDP respectively, have outstripped the share of agriculture, which contributed to 15 percent of GDP⁶⁴. Indonesia produces rice, tea, coffee, cocoa, spices, rubber, copra, peanuts, eggs, poultry and palm oil, while its industrial activities include petroleum, textile, leather products and footwear, wood and wood products, paper and printing products, cement and non-metallic quarry, iron and steel industry, transport equipment, machinery and apparatus. Industrial activities are mostly conducted in East Java, West Java and Kalimantan and Sulawesi⁶⁵.

Besides contamination on previous mining sites, due to its shift towards manufacturing industries, Indonesia also faces pollution from motor workshops, petrol stations, oil depots, former transport facilities, abandoned industrial factories and underground storage, as well as landfills in Jakarta and other cities. The textile industry causing severe pollution has also been highlighted in the last few years at the Citarum River Basin in Bandung, West Java. The river is an important source of water supply for Jakarta, irrigation of farms that supply 5 percent of Indonesia's rice, and a source of water for more than 2,000 factories⁶⁶.

3.7.2 Drivers for Remediation Services

There are currently no specific regulations in Indonesia for contamination management and remediation. Law No. 32/2009 on The Management and Protection of the Environment regulates the design, usage, control, management, monitoring of the environment as well as law enforcement. Law No. 33/2009 stipulates the recovery procedure for land contaminated with hazardous and toxic waste, and Regulation No. 85/1999 regulates the management of hazardous waste based on toxicity characteristic leaching procedure (TCLP) (i.e. soil sampling results which exceed the TCLP values indicating the presence of hazardous waste would trigger clean up actions). The Dutch target values (DTVs)⁶⁷ and Dutch intervention values (DIVs)⁶⁸ are adopted as guidelines for allowable concentrations in soil and groundwater.

Other circumstances that drive contaminated land remediation in Indonesia include property value depreciation, public awareness and requirement from third parties such as potential buyers of the site. Large scale contaminated land remediation is primarily conducted on a voluntary basis and not regulatory driven, although some organisations conduct remediation for commercial reasons in order to fulfil property lease or purchasing requirements.

⁶⁴ Indonesia Investments, *General Economic Outline of Indonesia* (January 2016).

⁶⁵ Industry About, *Indonesia Industrial Map*.

⁶⁶ Pure Earth (Blacksmith Institute) & Green Cross Switzerland, *The World's Worst 2013: The Top Ten Toxic Threats, Cleanup, Progress and Ongoing Challenges* (2013).

⁶⁷ The Dutch Target Values (DTVs) for soil have been rescinded in the 2009 Soil Remediation Circular.

⁶⁸ Rijkswaterstaat Environment, *Soil Remediation Circular 2013* (July 2013), Ministry of Infrastructure and the Environment.

3.7.3 Technical Expertise

Given the lack of specific regulations on contamination management and remediation, the level of technical expertise in the remediation services sector is low. Soil remediation by excavation and bioremediation appears to be a common practice in Indonesia. The monitoring requirement for contaminated soil treated by biological treatment is specified in the Ministry of Environment's Decree No. 128 (2003).

3.7.4 Major Trends

3.7.4.1 Soil and Groundwater Pollution Trends

As Indonesia is developing its strategic areas of agriculture, mining, energy, industry, marine, tourism and telecommunication, it aims to develop economic corridors based on the potential and advantages inherent to each region of the economy⁶⁹. Sumatra would be the centre for production and processing of natural resources, Java the centre for national industry and service provision, Kalimantan the centre for production and processing of national mining and energy reserves, Sulawesi the centre for production and processing of national agricultural, plantation, fishery, oil and gas, and mining resources, while Papua Moleccas would be the centre for development of food, fisheries, energy and national mining. These areas would likely see larger extent of industrial development and increased soil and groundwater pollution.

3.7.4.2 Regulatory / Policy Trends

There is no indication of major regulatory developments for contamination management in Indonesia; hence significant changes in the demand for remediation services due to regulatory changes are not expected.

3.7.5 Challenges and Opportunities

As an industrialising economy with a potential for increased soil and groundwater pollution, there are opportunities for holistic soil and groundwater contamination management in Indonesia. Moreover, the presence of polluting industries in Indonesia located in close proximity to agricultural land demands a greater push towards sustainable manufacturing which does not affect national food security. However, current environmental regulations do not obligate polluters to prevent pollution or treat contamination. As such, laws and regulations in this area should be strengthened and/or developed in order to safeguard public health and environment and create opportunities to develop the remediation services sector.

⁶⁹ Indonesia Investments, *Masterplan for Acceleration and Expansion of Indonesia's Economic Development*.

3.8 JAPAN

3.8.1 Industrial Development and Contamination Issues

Japan is an industrialised economy which has undergone major industrial development from one which is heavily dependent on manufacturing to one dominated by the tertiary industry⁷⁰. The manufacturing industry was responsible for 90 percent of Japan's exports in the early 2000s. Japan's industrial activities included mining, manufacturing of automotive, electronic appliances, chemical facilities, machineries, textiles and processed food.⁷¹ Recent rebound in international trade could potentially increase Japan's export growth. However, due to competition with the Republic of Korea and China, Japanese companies have accelerated the relocation of their operations overseas, reducing manufacturing activities locally. Development and manufacturing industries are largely located in western, central and northern Japan.

Due to its early industrialisation years, there are many sites with legacy contamination in Japan. These are due to its past industrial activities such as metal mining, port and ship building works, automotive manufacturing, oil refineries and petrochemical plants after World War II, as well as high technology cutting edge industrial processes and nuclear plants located across Japan. There have been many environmental accidents on military sites in Okinawa, many of which have gone unreported until the early 2000s⁷². The nuclear power plant disaster in Fukushima in 2015 has resulted in massive soil and groundwater radioactive contamination of the Japanese mainland⁷³.

3.8.2 Drivers for Remediation Services

Japan's environmental laws were borne from a range of environmental contamination incidents which occurred or were discovered from the mid-1970s. These incidents, along with many heavily contaminated sites caused by chemical and electroplating industries, have resulted in political pressure to legislate on site contamination⁷⁴. Today, Japan's progress has been driven mainly by the adoption of very strict standards and the use of best available technologies to solve environmental problems. The emphasis put by Japan on a technology-forcing regulatory approach led the Government to invest heavily in environment-related R&D, and to provide some subsidy for pollution control investment. Nationwide standards such as the Environment Law and Guidelines for Investigation and Countermeasures for Soil and Groundwater Pollution⁷⁵ are often supplemented by stricter local ordinances and guidelines from prefectural or municipal governments⁷⁶. The standards are in addition to agreements with industries on the creation of a system of pollution control managers and controllers for larger companies.

In Japan, the Soil Contamination Countermeasures Law (SCCL) requires landowners to perform soil investigation under three scenarios: (i) When a "Specified Facility", as defined

⁷⁰ Ministry of Internal Affairs and Communications, *Statistical Handbook of Japan 2015* (Statistics Bureau, September 2015).

⁷¹ Facts and Details, *Environmental Issues and Pollution in Japan: Asbestos, Minamata Bay and Pollution from China* (2009).

⁷² The Japan Times, *Contamination: Documents Reveal Hundreds of Unreported Environmental Accidents at Three U.S. Marine Corps Bases on Okinawa* (November 2016).

⁷³ Physicians for Social Responsibility (PSR), *Costs and Consequences of the Fukushima Daiichi Disaster* (Environmental Health Policy Institute, October 2012).

⁷⁴ Brandon E., *Global Approaches to Site Contamination Law* (November 2012).

⁷⁵ Ministry of Environment, *Japan's Regulations and Environment Law*.

⁷⁶ Organisation for Economic Co-operation and Development (OECD), *Japan*.

under the Water Pollution Control Law, that produces, uses, and treats harmful materials (25 identified substances, including heavy metals, volatile organic compounds, agricultural chemicals and PCBs) terminates its operations; (ii) when a land more than 3,000 square metres (m²) of area is developed; and (iii) when the prefectural governor identifies soil and groundwater contamination that poses a threat to human health. When human health damage caused by soil and groundwater contamination is suspected, a countermeasure order is enforced on the landowner.

When soil contamination is confirmed by an investigation in accordance with the SCCL, a site is registered by the prefectural governor as a “Designated Area”, which is divided into two sub-classifications: (i) measures required areas; and (ii) notification required areas when the area is developed. When human health damage caused by soil and groundwater contamination is suspected, the site is registered as “measures required area” and a countermeasure order is enforced on the landowner. If it is apparent that the landowner is not the polluter, the landowner can pursue the polluter for payment of the countermeasure.

3.8.3 Technical Expertise

Given the enactment of the SCCL since 2002⁷⁷, technical expertise in Japan is likely to be moderate to high. Environmental consultancy firms specialised in remediation appear to be mostly local firms.

3.8.4 Major Trends

3.8.4.1 Soil and Groundwater Pollution Trends

Japan is undergoing a transformation and shifting its manufacturing centres overseas to emerging economies, focusing on research and product development and manufacturing of high-level components and products within Japan. These high level products include vehicles, aircraft and robots and high-level components include fine chemicals and carbon fibre.

3.8.4.2 Regulatory / Policy Trends

There is no indication of major changes in the regulations for contamination management in Japan; hence significant changes in the demand for remediation services due to regulatory changes are not expected. The discovery of legacy contaminated sites will increase the number of known contaminated sites.

3.8.5 Challenges and Opportunities

Japan has a law for management of soil contamination, a database of contaminated land register as well as stringent enforcement. Numerous legacy contaminated sites require treatment, which presents an opportunity for remediation services. In addition, Japan has made a conscious move from a strictly ecological model of sustainable development to a more encompassing approach that identifies the connections between ecological protection, economic growth and social values. These connections were emphasized in the 2006 Third Basic Environment Plan and the 2009 New Growth Strategy. Japan's official Strategy for a Sustainable Society also described the support for a sustainable Japanese society: low-carbon economy, smart material-cycle measures and maintaining equilibrium with respect to the use of natural resources. There is

⁷⁷Petts J., *Handbook of Environmental Impact Assessment: Volume 2: Impact and Limitations* (Technology & Engineering, April 2009).

hence greater awareness by the government and the public towards the link between environmental protection, economic development and societal health and wellbeing. As such, demand for remediation services for the improvement of the quality of land for future generation is likely to continue to increase in the future. Moreover, there is a high level of local technical expertise in the remediation sector; hence Japan could potentially export its technical expertise to APEC economies developing their remediation services sector.

3.9 KOREA

3.9.1 Industrial Development and Contamination Issues

The main sectors in the Korean economy are mining, agriculture and manufacturing. Its exports are mostly semiconductors, wireless telecommunications equipment, motor vehicles, computers, steel, ships and petrochemicals. Korea has benefitted greatly from industrialisation and urbanisation due to its reliance on its large export-orientated manufacturing sector. In recent times, Korea's exports have faced strong competition from emerging economies, notably China, and from advanced economies in high-end markets, while domestic demand has been constrained by structural problems.

Past mining activities have resulted in legacy contaminated sites due to abandoned mines. As of 2013, Korea has 2,428 abandoned metal mines, 423 abandoned coal mines, and 38 abandoned asbestos mine, most of which were developed before the 1940s⁷⁸. Surveys conducted on agricultural land near the abandoned mines found that heavy metals contamination was present. Coal mining is a substantial contribution to energy generation, while mineral resources are mainly coal, iron ore and tungsten.

The Ministry of Environment of Korea carries out annual surveys to establish contamination inventory and to measure the degree of soil and groundwater contamination. The results of the 2012 nationwide soil contamination survey⁷⁹ indicated that Gangwon Province, Jeju Island and Seoul to be the most contaminated areas in the Republic of Korea, while Seoul-Gyeonggi region was found to have the highest groundwater contamination rate.

3.9.2 Drivers for Remediation Services

Under the Soil Environment Conservation Act (1995), facilities that may contaminate soil during the process of the conduct of its activities are termed and managed as 'specific facilities subject to soil contamination control'. Among these, petroleum (20,000L or more) and toxic product production and storage facilities and oil pipeline facilities are designated and specially controlled as specific facilities subject to soil contamination control in order to prevent soil contamination in advance. Once a facility is designated as a "specific facility subject to soil contamination control", it must carry out soil contamination tests and leakage tests on a regular basis. In the event that it has exceeded soil contamination warning limits (describing the degree of soil contamination that may undermine human health, property, and animal and plant growth and development, depending on land use) or is deemed to be noncompliant in the leakage tests, the facility must carry out soil remediation and facility improvements. Gas stations and their underground oil storage facilities account for more than 60 percent of specified facilities subject to soil contamination control.

Soil contamination investigations are carried out by local governments in at least 2,000 locations each year such as industrial complexes and factory areas, factory wastewater inflow areas, areas where ores and scrap metals are stored or used and other areas where soil contamination is a concern. Any area whose results exceed soil contamination warning limits is required to undergo a detailed soil investigation, and identified polluters are required to clean

⁷⁸ Ministry of Environment, *Soil Contamination Prevention and Restoration* (November 2016)

⁷⁹ Ministry of Environment, *Country Report of Korea (ROK), Soil and Groundwater* (Korea Environment Industry Technical Institute, December 2015).

up the contaminated soil. The soil contamination investigation aims to actively identify and remediate contaminated areas and is carried out at different locations each year.

The soil remediation market developed significantly since the enforcement of the Soil Environment Conservation Act in 1996. Relatively small scale projects dominated the market initially, until the District Moonhyun remediation project in Busan in 2000, after which large-scale investigation and remediation projects started to get commissioned regularly by the government (e.g. Ministry of National Defence, Korea Railroad Corporation, local governments) and the private sector (i.e. oil & gas industry). In 2011, almost 60 percent of the market involved remediation of Korean and US army bases⁸⁰. Ongoing/past remediation projects include those at closed metal mines, fuel storage facilities (via voluntary agreements between the government and major oil companies to carry out detailed surveys and conduct remediation where necessary), military bases with detailed surveys and remediation, and old landfill sites⁸¹.

3.9.3 Technical Expertise

Korea has a high level of local technical expertise with regards to soil remediation and research and development in the sector. The Korean remediation market consists of large-sized engineering and construction companies, subsidiary of engineering companies, companies from heavy industry, and companies specialized in contamination remediation (i.e. specialized companies). 228 soil-related specialized agencies (i.e. companies) and 156 groundwater-related specialized agencies are registered in Soil & Groundwater Information System (March 2014). Among them, 47 soil-related specialized agencies also work on groundwater remediation; these agencies represent 50 percent of the total soil and groundwater market share. A majority of soil remediation agencies are small-and-medium sized. Large-sized companies support national environmental industry policies or deal with the soil and groundwater contamination caused by the construction industry, while remediation specialised companies mostly access the market as a consortium with major companies⁸². Korea also benefits from cooperation with the US Environmental Protection Agency (US EPA) via an Environmental Cooperation Agreement to strengthen environmental governance, improve air and water quality, and reduce exposure to toxic chemicals.

3.9.4 Major Trends

3.9.4.1 Soil and Groundwater Pollution Trends

As Korea is transforming into a creative economy, there is an anticipated shift away from production and manufacturing towards high tech industries, which would likely reduce the extent of future soil and groundwater pollution. Coal mining remains the main form of energy generation, and coupled with low and regulated electricity prices, reduce the need to conserve energy and act as a barrier to renewable energy. This could have the effect of increasing pollution from mining.

⁸⁰ Ministry of Environment, *Country Report of Korea (ROK), Soil and Groundwater* (Korea Environment Industry Technical Institute, December 2015).

⁸¹ OECD, *Environmental Performance Reviews – Korea*, 2006.

⁸² Ministry of Environment, *Country Report of Korea (ROK), Soil and Groundwater* (Korea Environment Industry Technical Institute, December 2015).

3.9.4.2 Regulatory / Policy Trends

The Korean Ministry of Environment plans to survey 1,300 abandoned metal mines over the period of 2014 to 2023, in addition to soil contamination improvement projects for asbestos mines as well as coal mines⁸³. Demand for remediation services driven by regulation is expected to continue to increase. With a greater awareness of the Korean public towards environmental and health standards, there could be increased demand for remediation of abandoned mines and their surrounding areas in the future.

3.9.5 Challenges and Opportunities

Korea has regulations in place for the management of contamination. There is an expected increase in demand for remediation services due to the plans by the Korean Ministry of Environment plans as described above. In addition, based on a December 2015 report⁸⁴ by the Ministry of Environment and the Korean Environment Industry Technical Institute, potential institutional developments in the area of contaminated land management and remediation include the following, which could provide more impetus to develop the remediation services sector:

- a. Improving the guidelines for assessing ecological hazards;
- b. Exploring the guidelines' applicability to differentiate natural background levels and remediated levels;
- c. Making available more information on contamination sources, contaminated sites, and remediated sites to the public;
- d. Enhancing the system to control the quality of groundwater under agricultural sites; and,
- e. Adoption of the system to monitor natural radioactive materials in soil.

⁸³ Ministry of Environment, *Country Report of Korea (ROK), Soil and Groundwater* (Korea Environment Industry Technical Institute, December 2015).

⁸⁴ Ibid.

3.10 MALAYSIA

3.10.1 Industrial Development and Contamination Issues

As of 2015, the service sector in Malaysia accounted for 53.5 percent of GDP, manufacturing, mining and construction contributed to 23 percent, 9 percent and 4.4 percent respectively, while agriculture accounted for 8.9 percent of GDP⁸⁵. Export-oriented manufacturing industries include the manufacture of electrical and electronic products, chemicals and chemical products, petroleum products, rubber products and off-estate processing. Domestic manufacturing industries include construction related products, fabricated metal products, transport equipment, food and beverages and tobacco products. Industrial centres are mainly focused on Peninsula Malaysia, in Johor, Kuala Lumpur, Kuantan, Penang, Sabah and Sarawak⁸⁶.

Industries contributing to pollution in Malaysia include manufacturing, petroleum and petrochemical facilities, waste management facilities, mining and agricultural activities. Sites such as motor workshops, petrol stations, fuel depots, railway yards, landfills, industrial sites and ex-mining land can be potentially contaminated sites.

3.10.2 Drivers for Remediation Services

The main legislative environmental framework in Malaysia is the Environmental Quality Act (1974), which provides for the protection of soil and indirectly groundwater. It broadly states that “no person shall, unless licensed, pollute or cause or permit to be polluted any soil or surface of any land and inland water in contravention of the acceptable conditions specified under Section 21”, though “acceptable conditions” have not been defined. This Act stipulates follow-up corrective mitigates measures to be taken by the polluters, and it also applies to cases pertaining to illegal disposal of toxic and hazardous substances as well as contaminated land. There are currently no specific regulations in Malaysia for the protection of soil whereas, groundwater quality status was determined based on the ‘National Guidelines for Raw Drinking Water Quality’ established by the Ministry of Health (Revised December 2000).

The Department of Environment (DoE) of Malaysia is one of the technical and enforcement agencies in Malaysia empowered to carry out investigations and issue notices to polluters or any licensed premises contravening any of the licensed conditions or regulations under the Environmental Quality Act. In early 2011, the DoE disseminated three (3) series of Contaminated Land Management and Control Guidelines 2009, which outlines the site screening levels for contaminated land and requirements for assessing, reporting and remediating of contaminated sites. At present, the site screening levels are for screening purposes only and are not enforceable. The DoE encourages the adoption of this guideline and to report contamination; however, the efforts are fully voluntary, and no one is compelled to do any investigation, or under any legal obligation to report results of any investigations to the authorities.

The industry that frequently initiates contaminated land remediation in Malaysia is the petroleum-based industry (including retail station, oil depots, refineries, etc.) as well as other multi-national corporations due to their more robust environmental management policies and internal corporate policies on contamination related liabilities, especially from a litigation and reputational risk perspective. On the other hand, other industries such as metal plating, paper

⁸⁵ BNM, *Developments in the Malaysian Economy* (2016).

⁸⁶ Industry About, *Malaysia Industrial Map*.

and textile in Malaysia are generally managed by small and medium enterprises (SMEs), which are less inclined to deal with contamination issues within their premises due to the relative high costs of remediation against their earnings⁸⁷. When there are closures of premises, changes in ownership or land use, there is a requirement for the owner/operator to submit an abandonment plan according to the Contaminated Land Management and Control Guidelines 2009.

Other circumstances that drive the remediation services sector in Malaysia include property value depreciation and requirement from third parties such as potential buyers of the site. There is also increased public awareness on this issue in Malaysia, especially due to contamination moving off-site and impacting off-site receptors.

3.10.3 Technical Expertise

Despite the lack of regulatory drivers, remediation in Malaysia is primarily conducted on a voluntary basis due to commercial drivers. As such, the level of technical expertise in the remediation services sector is moderate. Most of the consultancy companies are foreign environmental companies with local presence in Malaysia, as well as local firms providing equipment and services for specialised areas.

3.10.4 Major Trends

3.10.4.1 Soil and Groundwater Pollution Trends

Construction was one of the best performing sectors in the first half of 2016 due to the 11th Malaysia Plan. The Malaysian government has singled out three subsectors - chemicals, electrical and electronic and machinery and equipment under the 11th Malaysia Plan to drive the transition into a high value, high technology production manufacturing sector. Medical devices and aerospace have been identified as segments with potential growth⁸⁸. Thus, it is expected to result in a larger extent of soil and groundwater pollution in the future, which consequently means a greater need for remediation services.

3.10.4.2 Regulatory / Policy Trends

The DoE introduced Guided Self- Regulation (GSR) in late 2016 to all industries regulated under the Environmental Quality Act⁸⁹. The GSR is expected to be an effective environment management system in assisting industrial players to become more competent in managing their environmental performance through the use of environmental mainstreaming tools. The main elements of GSR include performance monitoring and the deployment of continuous emission monitoring systems (CEMs) which impose on the industry operators to monitor and record data on pollutant emissions, and to submit the data to an online reporting system managed by the DoE. The DoE will conduct inspections on factories and industrial premises to verify the data and ensure that regulations are adhered to.

The Contaminated Land Management and Control Guidelines 2009 are expected to be adopted into draft regulations, and regulations concerning contaminated land are expected to be passed and gazetted in the coming years. At present, however, there is no clear indication of the timeline for this to occur.

⁸⁷ Yin C.Y., Assoc. Prof. Ir. Dr. Abdul-Talib. S., Ir. Dr. G. Balamurugan and Ir. Khew S.L., *Contaminated Land Remediation Technologies: Current Usage and Applicability in Malaysia* (The Ingenieur, 2009).

⁸⁸ Oxford Business Group, *Malaysia Manufacturing Sector Expanding But Faces Challenges* (2017).

⁸⁹ Department of Environment, *Environmental Mainstreaming Directive* (2016).

3.10.5 Challenges and Opportunities

The new and potentially upcoming regulations for contaminated land management by the DoE provide opportunities for investors, technology providers and subject matter experts in the sector. Therefore, the contaminated land assessment, management, and remediation sector in Malaysia is expected to grow in the near future.

3.11 MEXICO

3.11.1 Industrial Development and Contamination Issues

The oil industry is the largest industry in Mexico, with the economy being one of the biggest oil producers in the world. The Mexican economy shifted from an oil-dependent one up to the 1990s, to a manufacturing-focused one from the mid-1990s and an export-oriented, international trade hub today. The focus on trade today is thanks to the North American Free Trade Agreement (NAFTA) it has inked with the US and Canada, and (free) trade agreements it has signed with other economies and/or economies over the past 2 decades. Important or increasingly important manufacturing activities include automotive, aircrafts / aerospace, electronics, and food. Mexico's agricultural sector as a proportion of GDP has declined over the past 40 years⁹⁰.

Mexico has a long mining history of almost 500 years, and is still a top global producer of metals like silver, gold, copper, zinc, and other minerals, receiving substantial foreign investments. Mines are scattered all over Mexico, with most concentrated in northern and southern Mexico. Due to its long mining history, Mexico faces a huge issue of legacy contamination. Several incidents of toxic spills from mining activities affecting local communities in 2014 made news across Mexico, with the spill of copper sulphate, sulphuric acid and heavy metals from a mine into the Sonora River in Sonora State being called “the worst ecological disaster in Mexican history”⁹¹. Legacy contamination from thousands of abandoned mine sites across the economy continue to affect communities. For example, past mining activities in the Zacatecas state in central Mexico has led to deposits of heavy metals in the Zacatecan valley now used for agricultural activity⁹². Maize plants in those agricultural zones were found to be highly contaminated with arsenic, lead and mercury. It was found that new mine tailings in the state are not managed in a responsible manner, and there is a lack of enforcement mechanisms to oblige the mining companies to obey the environmental laws and regulations. This has major implications for food security and land productivity.

3.11.2 Drivers for Remediation Services

There are no specific regulations on contaminated land management / soil remediation, but these subjects are regulated under the primary environmental law in Mexico, the General Law on Ecological Equilibrium and Environmental Protection 1988, as well as the General Law on the Prevention and Comprehensive Management of Waste and its Regulations. Remediation standards and procedures are beginning to be implemented through binding technical standards called Mexican Official Norms (NOMs) (including NOMs on soils contaminated with total petroleum hydrocarbons and with heavy metals – NOM-147)⁹³. These NOMs were developed based on health risks.

The Secretariat of the Environment and Natural Resources (*Secretaría de Medio Ambiente y Recursos Naturales*) is the main governmental agency in charge of enacting and enforcing environmental regulation at the federal level, and with the Office of the Federal Prosecutor for

⁹⁰ Economy Watch, *Mexico Industry Sectors* (Mexico, March 2010).

⁹¹ Greenpeace, *Toxic Spill in Sonora: The Tip of the Iceberg* (September 2014).

⁹² Dávila, O.G., Gómez-Bernal, J.M. and Ruíz-Huerta E.A., *Plants and Soil Contamination with Heavy Metals in Agricultural Areas of Guadalupe, Zacatecas, Mexico*, Environmental Contamination, Dr. Jatin Srivastava (Ed.) (2012).

⁹³ Aneiros, C, Pasquel, A. C., Palacios, M. W., Creel, Garcia-Cuellar, Enriquez A., *Environmental Law and Practice in Mexico: Overview* (Mexico, November 2015).

Environmental Protection (*Procuraduría Federal de Protección al Ambiente*), they can require a soil investigation and remediation as part of an administrative proceeding related to soil contamination. Mining companies are required to obtain environmental impact permits from the Secretariat of the Environment and Natural Resources prior to any mining and exploration activities, and subsequently other environmental permits including water extraction, wastewater discharge and tailings disposal. There is no law or norm that requires mining companies to carry out mine closure plans in a manner that is adequate, complete and entirely financed⁹⁴.

Mexican environmental regulations have become increasingly stringent over the last decade as a result of international agreements that Mexico has ratified, including the North American Agreement on Environmental Cooperation (parallel to NAFTA), the United Nations Framework Convention on Climate Change and the Convention on Biological Diversity⁹⁵. Enforcement practices have also seen a trend of improvement over the past 10 years. However, enforcement for remediation programmes is still at relatively early stages. As such, there is a certain degree of uncertainty as to the scope of many remediation programmes and how they are enforced⁹⁶. Moreover, enforcement agencies often face the problem of limited resources, both in terms of budget and personnel.

3.11.3 Technical Expertise

Given the lack of specific regulations on contaminated land management / soil remediation, and the early stages of implementation of the NOMs and enforcement of remediation programmes, the pool of technical expertise relating to remediation services is expected to be low. Remediation service providers are mainly foreign engineering and consulting firms serving Mexico / with local presence in Mexico. Due to the proximity to the US, the common practice is to make use of US expertise and resources; in fact, environmental technologies in Mexico are mostly imported from the US⁹⁷.

3.11.4 Major Trends

3.11.4.1 Soil and Groundwater Pollution Trends

The mining potential was expected to grow in 2012, with national and foreign companies starting new production projects mainly in the northern states (Sonora, Zacatecas and Chihuahua)⁹⁸. With the current price increases in metals such as silver, gold and zinc, Mexico's mining industry is expected to continue to grow; in fact, the sector is forecasted to reach \$17.8bn by 2020. Fresnillo LLC, one of Mexico's main producers, has announced that its \$515 million San Julian silver-gold project will continue to ramp up production through 2017. Mining related activities are also an important component of the local job market.

⁹⁴ New Internationalist Magazine, *Mexico's 'Worst Environmental Disaster in Modern Times'* (January 2015).

⁹⁵ Fresnillo, *Mining in Mexico*.

⁹⁶ Aneiros, C, Pasquel, A. C., Palacios, M. W., Creel, Garcia-Cuellar, Enriquez A., *Environmental Law and Practice in Mexico: Overview* (Mexico, November 2015).

⁹⁷ Export.Gov, *Mexico – Environmental Technologies and Water* (Prepared by U.S. Embassies abroad, October 2016).

⁹⁸ Deloitte, *Mining Industry in Mexico* (Vancouver, Canada, May 2012).

3.11.4.2 Regulatory / Policy Trends

There is no indication of any major changes to contamination management, remediation or mining related regulations. However, remediation standards and procedures are beginning to be implemented through the NOMs.

3.11.5 Challenges and Opportunities

Given the projected increase in mining activities, land contamination issues in Mexico are likely to worsen. Moreover, Mexico needs to deal with the existing issue of abandoned mine sites and the health issues brought along by these sites. Hence, there is scope for holistic contamination management and development of the remediation services sector. There seems to be gradual implementation of remediation standards and procedures through the NOMs, and early enforcement of remediation programmes. However, the effectiveness of enforcement is currently unclear. Greater clarity on the scope of remediation programmes and how they are enforced are needed, and local expertise for delivery of remediation services needs to be developed. Limited resources of enforcement agencies also restrict much-needed remediation efforts in Mexico.

3.12 NEW ZEALAND

3.12.1 Industrial Development and Contamination Issues

New Zealand is a developed economy with sizeable manufacturing and service sectors complementing an efficient agricultural sector. Exports of goods and services account for around one third of GDP⁹⁹. The primary industries include agriculture, forestry and fishing, while the manufacturing industry includes production of wood and paper, food and beverage manufacturing and processing of raw materials into ingredients, machinery and equipment, chemicals and plastics, petroleum refining, metal and metal products, textiles, leather, clothing footwear and furniture¹⁰⁰. The economy has recently undergone a functional transition from supplying northern hemisphere markets to supplying the Asia-Pacific region. The main manufacturing areas are located in Auckland and South Taranaki in North Island and Timaru and Waitaki in South Island, while mining activities are mainly located in Buller in South Island¹⁰¹.

Storage and disposal of hazardous substances / chemicals and mining, industry, agriculture and horticulture has resulted in legacy land contamination at numerous sites across New Zealand¹⁰². Soil contamination issues arising from industrial activities gained prominence in the 1990s due to an investigation of historical contamination of pentachlorophenol (PCP) from a major sawmill facility near Rotorua, North Island. A study by the Ministry for the Environment in 2008¹⁰³ investigated sawmill sites around New Zealand, revealing dioxin and PCP soil contamination. Many of these sites were eventually zoned for residential, commercial or industrial use¹⁰⁴.

3.12.2 Drivers for Remediation Services

The Resource Management Act 1991 is the main legislation regulating contaminated land management in New Zealand and when it was passed, made New Zealand the first economy in the world to adopt an environmental management system based explicitly on sustainability¹⁰⁵. The Ministry of Environment has created a National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health as well as guideline values and methodologies for establishing acceptable contaminant levels, while the roles of regional councils and territorial authorities are to ensure compliance to the National Environmental Standard. Derivation of acceptable clean-up levels for contaminated soil and groundwater are assessed on a case-by-case basis. There is a Contaminated Sites Remediation Fund which provides NZD 2.63 million (approx. USD 1.90 million¹⁰⁶) in annual funding to regional councils and unitary authorities for the remediation of contaminated sites that pose a risk to human health and the environment¹⁰⁷. This supports regional councils, unitary authorities and territorial authorities to fulfil their obligations for contaminated land management. However, current uptake of funds for remediation is slow.

⁹⁹ The Treasury, *Overview of the New Zealand Economy* (April 2016).

¹⁰⁰ Ministry of Business, Innovation & Employment, *The New Zealand Sectors Report 2014: Main Report* (December 2016).

¹⁰¹ Stats NZ, *New Zealand Business Demography Statistics: At February 2013* (February 2013).

¹⁰² Whangarei District Council, *Contaminants in Soil*.

¹⁰³ Tokin & Taylor Ltd and SPHERE, *Assessment of Dioxin Contamination at Sawmill Sites* (October 2008).

¹⁰⁴ Stuff, *Soil Contamination Worse than First Thought* (September 2008).

¹⁰⁵ Bret C. Birdsong, *Adjudicating Sustainability: New Zealand's Environmental Court* (March 2002).

¹⁰⁶ Based on an exchange rate of USD 1 to NZD 1.38 the week of 10 – 16 July 2017.

¹⁰⁷ Ministry for the Environment, *About the Contaminated Sites Remediation Fund* (November 2016).

Other drivers for contaminated land management and remediation in New Zealand include redevelopment / change in land use, commercial drivers from property transactions, New Zealand's desire to uphold its 'clean, green' reputation¹⁰⁸, and public awareness of environmental issues which have increased considerably. As such, there is an expectation of continued action by both industry and the government to ensure successful remediation of contaminated sites¹⁰⁹.

3.12.3 Technical Expertise

The implementation of remediation strategies and actions, including uptake of funds from the Contaminated Sites Remediation Fund, is an area under development in New Zealand, and there is a moderate level of local technical expertise in the sector. Technical expertise includes due diligence, site assessment and remediation planning, risk assessment, remedial design and construction, site management and compliance monitoring.

3.12.4 Major Trends

3.12.4.1 Soil and Groundwater Pollution Trends

There is no literature indicating a potential shift in the main types of polluting industries in New Zealand; hence there are no major changes expected in the potential for future soil and groundwater pollution compared to current status.

3.12.4.2 Regulatory / Policy Trends

There is no indication of any major changes to contamination management and remediation related regulations. As such, significant changes in demand for remediation services due to regulatory developments are not expected.

3.12.5 Challenges and Opportunities

There is general interest from the government and the public for management of contaminated sites in New Zealand, as continued environmental degradation and discovery of legacy contaminated sites threaten New Zealand's 'clean, green' image¹¹⁰. There is hence scope for further strengthening and development of contaminated management and remediation services in the economy. Moreover, government funding available through the Contaminated Sites Remediation Fund could be tapped on.

¹⁰⁸ Phys Org, *New Zealand's 'Green' Image under Threat: OECD* (March 2017), Environment.

¹⁰⁹ A. H. C. Roberts, K. C. Cameron, N. S. Bolan, H. K. Ellis, S. Hunt, *Contaminants and the soil environment in New Zealand* (1996).

¹¹⁰ Phys Org, *New Zealand's 'Green' Image under Threat: OECD* (March 2017), Environment.

3.13 PAPUA NEW GUINEA

3.13.1 Industrial Development and Contamination Issues

Papua New Guinea is an economy in its early stages of development, being rich in minerals, agricultural, forestry, petroleum and fisheries resources. Its economic development was hindered by the recent volatile prices for agricultural and mineral exports. Its major economic activities are mining and oil and gas production which significantly contribute to its GDP and account for nearly two-thirds of export earnings. The economy has a small formal sector, focused mainly on the export of those natural resources, and an informal sector, employing the majority of the population. Agriculture provides a subsistence livelihood for 85 percent of the people¹¹¹.

The economy experiences difficulty in managing the extractive industry sector, which has led to grievances and conflicts for local communities living near mine sites. Improper management of mining waste has led to the release of contaminants into the nearby rivers and arable agricultural land¹¹². An example was Rio Tinto's mining facilities in Panguna mine on Bougainville Island, a key copper producing site, where millions of tonnes of acid mine tailings were released nearby Jaba and Kawerong rivers and damaged adjacent agricultural land, which used to be a resource of water and food for thousands of people, but is unusable today¹¹³.

3.13.2 Drivers for Remediation Services

There are currently no specific regulations in Papua New Guinea for land contamination management and remediation. Contamination management is generally regulated under the Environment Act (2000) and an Environmental Contaminants Act (1978). The Environment Act and its regulations are administered by the Conservation and Environment Protection Authority, while the Environment Protection Division ensures that proposed and ongoing development projects in mining, oil & gas, manufacturing, infrastructure, agriculture and forestry are pursued in an environment friendly and sustainable manner.

The government is starting to recognise the importance of environmental protection for tourism development. However institutional weakness in environmental management at national and local levels contributes to land contamination and soil degradation. Early agreements between mining companies and the government also did not contain effective clauses for addressing environmental damages arising from the mining activities¹¹⁴. Moreover, as there is an absence of well-developed commercial and employment sectors, the government has to rely on taxes and royalties from the exploitation of its natural resources as a principal source of revenue¹¹⁵.

3.13.3 Technical Expertise

Given the lack of regulations relating to management and remediation of contamination, the pool of technical expertise relating to remediation services is expected to be low to none.

¹¹¹ The Commonwealth, *Papua New Guinea: Economy*.

¹¹² State of the Planet, *Uncovering Impacts of Gold Mining in Papua New Guinea* (February 2016).

¹¹³ The Sydney Morning Herald, *Rio Tinto's Billion – Dollar Mess: 'Unprincipled, Shamful and Evil'* (August 2016).

¹¹⁴ Mongabay, *Rio Tinto Walks Away from Environmental Responsibility for Bougainville's Panguna Mine* (April 2017).

¹¹⁵ SPREP, *Papua New Guinea*.

3.13.4 Major Trends

3.13.4.1 Soil and Groundwater Pollution Trends

Papua New Guinea is a developing economy, with the main industries being mining, oil and gas production and agriculture. As the government is seeking to promote investment in crop production and diversification to better meet market needs¹¹⁶, Loi Bakani, governor of the Bank of Papua New Guinea, announced plans in 2016 to increase spending on infrastructure and logistics. As these spending facilitate its major exports of mining and agricultural produce, it could increase mining and agricultural activities, indirectly increasing pollution and affecting communities living in the vicinity of these industries.

3.13.4.2 Regulatory / Policy Trends

There is no indication of any major regulatory developments in the areas of contamination management and remediation. As such, significant changes in demand for remediation services due to regulatory developments are not expected.

3.13.5 Challenges and Opportunities

Despite being signatory to a very large number of multilateral environmental agreements, governance issues has led to overexploitation of resources and pollution in Papua New Guinea. Although the government has signalled interest in conserving the natural environment, they face challenges as approximately 97 per cent of the total area of Papua New Guinea is held under customary ownership (i.e. owned by the indigenous communities)¹¹⁷. Moreover, regulations and standards for contaminated land management and remediation need to be developed, and the enforcement of law needs to be strengthened for effective environmental management and contaminated land management.

¹¹⁶ Oxford Business Group, *Papua New Guinea Year in Review 2016*.

¹¹⁷ APEC, *Department of Environment and Conservation in Papua New Guinea* (July 2009).

3.14 PERU

3.14.1 Industrial Development and Contamination Issues

Peru is a developing economy with a growing manufacturing industry, with manufacturing share of GDP having increased from 33 percent in 2003 to 37 percent in 2012. The proportion of services and agriculture to GDP are 56 percent and 7 percent respectively. Although agriculture contributes a small proportion of GDP, it accounts for 25.5 percent of the economically active population in Peru in 2013. Major contributors to the economy are the oil and mining sector which accounted for 12.1 percent of GDP in 2013, crude oil and gas extraction and related services which contributed 2.7 percent, and mining and related services at 9.4 percent.

Due to a shift towards an economy more focused on manufacturing, with reliance still on mining exports, land contamination in Peru tends to be in the form of mercury poisoning and diseases resulting from polluted rivers and water sources. In addition, increasing land clearance and deforestation for mining sites increase the potential of land contamination while poor land management results in erosion and loss of once fertile land.

The contamination problem is focused on water and soil pollution mostly caused by the petroleum and mining industries. Rivers are used as dumping grounds and are affected by chemical waste from oil installations, aside from the frequent oil spills in the Pastaza, Tigre, Corrientes and Marañon river basins where indigenous people live. Peru formed the Environmental National Fund (*Fondo Nacional del Ambiente*) aimed at fostering public and private investment in the development of plans, programmes, projects and activities to improve environmental quality, the sustainable use of natural resources and capacity-building for an adequate environmental performance. Oil exploration has also led to significant contamination of the Amazon River Basin. In 2013, the Peruvian government declared an environmental state of emergency due to contamination in the Peruvian Amazon, which has also been attributed to oil drilling activities in the region in the past decades¹¹⁸.

3.14.2 Drivers for Remediation Services

There are no specific regulations on contamination management and remediation, but this subject is regulated under the General Environmental Law (Law 26811) and the General Law of Water and Sanitation Services (Law 26338). National soil quality legislation, which will form the legal basis for management of contaminated sites in the economy, is currently under development. There are Environmental Quality Standards for Soil (Supreme Decree 002-2013-MINAM and Supreme Decree 002-2014-MINAM).

Although there have been various reports about remediation efforts to clean up the oil-contaminated river waters by either using funds from the Environmental National Fund or funds set up by private companies for cleaning up contaminated soil and/or groundwater, there were no concrete results regarding the success of these efforts^{119, 120}.

¹¹⁸ Global Research, *Environmental Crisis in the Amazon due to Oil Contamination. Peru Declares State of Emergency* (March 2013).

¹¹⁹ ReVista, *Oil and Indigenous Communities, Sowing Discord in the Peruvian Amazon* (2015).

¹²⁰ WHO, *Lead Exposure from Soil in Peruvian Mining Towns: A National Assessment Supported by Two Contrasting Examples* (August 2012).

3.14.3 Technical Expertise

There are several remediation service providers present in Peru, including the presence of European (Spanish) engineering firms which provides environmental services. However, there is a lack of certified laboratories and environmental drillers, and the level of local knowledge in terms of managing contamination and remediation needs to be strengthened.

3.14.4 Major Trends

3.14.4.1 *Soil and Groundwater Pollution Trends*

As Peru primes itself for greater investment in its production industry, there is a shift away from environmental protection. With increasing foreign investment in timber and mineral extraction, there would be a greater future need for remediation services.

3.14.4.2 *Regulatory / Policy Trends*

National soil quality legislation, which is currently under development, as well as increasing public awareness on environmental protection and health issues and focus on contamination of the Amazon region could increase the demand for remediation services.

3.14.5 Challenges and Opportunities

Being a developing economy with a growing manufacturing industry and continuing mining industry, the potential for land contamination and consequently, the demand for remediation services, is projected to grow. Remediation needs are more focused on the Amazon region due to the oil exploration activities. However, there is a lack of regulations on contamination management and remediation as well as a need to address indigenous people's concerns and rights to land. Some of the measures which need to be in place to address the challenges include¹²¹:

- Strengthening environmental institutions and environmental management systems at all levels, and ensuring the effective implementation of environmental protection policies;
- Ensuring that the economy's green growth strategy is a central pillar of development that involves sectoral ministries and makes them responsible for the environmental impact of their policies;
- Promoting greater use of economic instruments for environmental management, particularly environmental taxes, and eliminate damaging subsidies;
- Ensuring better environmental management in the extractive industries, such as improving the handling of chemicals and dangerous substances and combating their negative effects on biodiversity and ecosystems;
- Incentivizing the sustainable use of the economy's rich natural heritage and the opportunities it generates for eco-innovation and the development of new economic sectors; and
- Strengthening information systems, education, participation and justice in environmental matters with a view to raising awareness of sustainable development.

¹²¹ OECD / ECLAC, *Environmental Performance Reviews, Peru 2016*, OECD Publishing (United Nations, Santiago, 2016).

3.15 THE PHILIPPINES

3.15.1 Industrial Development and Contamination Issues

The Philippines is one of the fastest growing economies in ASEAN due to rising infrastructure spending and domestic demand¹²². The major contributors to the Philippines economy consist of industry, service and agriculture, whereby agriculture, although still substantial, is observed to be declining¹²³. Mining industries in chromite, coal, copper, gold, iron and nickel are located on the various islands Luzon, Visayas and Mindanao. This is supported by industrial activities such as fabricated metal products, hydroelectric power plants, thermal power plants, petroleum refining, forest products processing, food and tobacco processing, textile and fiber products processing¹²⁴. The Philippines is currently accelerating infrastructure development brought about by higher spending¹²⁵. Deforestation and overgrazing causes soil degradation which results in unproductive agricultural land.

3.15.2 Drivers for Remediation Services

The Philippines has environmental laws and related statutes that provide for a sound mechanism in the control of land, air and water pollution to protect public health and the environment. However, it does not have a specific statute on management of land contamination. The government did initiate a National Strategy in February 2016 to manage contaminated sites, but it mostly targets pesticide related compounds and is not enforceable at the moment.

Most remediation work is performed by international petrochemical companies with more established internal environmental requirements. However, information on land contamination incidences, assessment and remediation work conducted is hard to obtain as most of the reports are confidential to the companies commissioning these works. In other cases, responsible mining companies also set up land reforestation/remediation programs for areas affected by mining activities. However, by and large, private businesses tend to limit their ESAs to Phase 1 ESAs and/or due diligence assessments arising from commercial reasons.

3.15.3 Technical Expertise

There are several international companies with local offices in the Philippines that are able to provide remediation services. The technical knowledge in setting up the remediation systems as well as the physical equipment and chemicals for remediation would typically be imported from overseas. Laboratories and construction / engineering firms are available to support the remediation services. However, highly specialised laboratory analysis would be sent to overseas laboratories.

¹²² Rappler, *Philippines Seen to Remain Fastest – Growing Economy in ASEAN-6 for 2017* (January 2017).

¹²³ Nations Encyclopedia, *Philippines – Economic Sectors*.

¹²⁴ Map Cruzin, *Industry and Mining Map of Philippines* (1973).

¹²⁵ ABS-CBN News, *Philippine Economy to Lead Southeast Asia Growth, IMF Says* (April 2017).

3.15.4 Major Trends

3.15.4.1 Soil and Groundwater Pollution Trends

The Philippine economy is reported to have grown by 6.8 percent in 2016¹²⁶; the Philippines Statistics Authority also reported that the Philippines had a GDP growth of 6.6 percent in in the fourth quarter of 2016, citing manufacturing, trade, real estate, reminting and business activities as the main drivers. Given that manufacturing is one of the key drivers, it is likely that soil and groundwater pollution may also increase.

3.15.4.2 Regulatory / Policy Trends

As the Philippines is undergoing development, stricter environmental regulations and permit requirements have been implemented in tandem. This increase in focus on environmental legislation could lead to an increasing trend for developing a national screening level to assess contamination. The Environmental Management Bureau, under the adoption of a national strategy for the management of POPs (mainly for agriculture-related POPs), recognized that there is currently no centralized source of information on the number of contaminated sites and the magnitude of contamination and that there is no framework for the management of contaminated sites including a system for identifying contaminated sites: rules for site clean-up; defining responsible parties to bear the cost of site investigation and clean-up; financing and incentive mechanisms for remediation and active waste management in identified sites; and clearly defined roles and responsibilities of government agencies. Over time, the strategy aims to address the long-term goal of preventing pollution to remediated and previously unaffected sites as a starting point for classifying and managing contaminated sites.

3.15.5 Challenges and Opportunities

Economic growth is likely to increase land contamination issues in the Philippines. Together with the apparent increase in regulatory focus on environmental protection, there could be an increase in the demand for remediation services. However, the effectiveness of enforcement of the new regulations remains to be seen. The challenge to effectively implement the national strategy proposed by the Environmental Management Bureau stems from the fact that most of the targeted POPs are related to agriculture (e.g. pesticides), which is a major industry in the Philippines, though this does not address industrially produced chemicals. Moreover, the assessment as well as the laboratory testing and corresponding remediation action, if any, will cost a significant amount that businesses, mostly local farmers, might not be willing to address. Having the necessary enabling mechanisms (e.g. enforcement and funding mechanisms) will facilitate successful implementation of the national strategy.

¹²⁶ CNN Philippines, *2016 Economic Growth Fastest in Three Years* (January 2016).

3.16 RUSSIA

3.16.1 Industrial Development and Contamination Issues

Russia is an upper-middle income economy¹²⁷. Mining is an important industry segment as the Russian economy is fuelled by natural resources such as petroleum, natural gas, timber, and precious and non-ferrous metals¹²⁸. In addition, industries such as manufacturing equipment, construction and chemicals as well as agriculture (grain, seeds, meat and dairy products) are also large sectors of the economy. Strategic economic areas / activities are typically conducted by the state or dominated by partially or fully state-owned corporations¹²⁹. In the international arena, stringent international sanctions imposed on Russia have reduced the momentum of the economy.

Land contamination results from the extraction of mineral resources and unauthorised dumping of hazardous industrial chemicals, which has been especially pertinent in southern Russia. An estimated 74 million ha of agricultural land has been contaminated by industrial toxic agents, pesticides and agricultural chemicals¹³⁰. This is exacerbated by poor agricultural land management, which resulted in erosion and encroaching desertification occurring at a rate of 6,400ha per year in Russia's southern regions¹³¹.

3.16.2 Drivers for Remediation Services

Contaminated land management and remediation is regulated under the 'On land remediation and topsoil conservation policy' (Decree No. 140, February 1994), and corresponding regulations for Land Remediation and Topsoil Conservation (Decree No. 525/67, December 1995). Special requirements for land / soil remediation projects and practices are specified by a number of national standards. A set of federal soil quality standards (e.g. GN 2.1.7.2041-06 or GN 2.1.7.2511-09) and regionally recognised background concentrations of contaminants and nutrients are used as maximum permissible levels for soil. However, the large physical size of the economy with different natural conditions as well as land use history and practices across the regions pose challenges to enforcement. There is a lack of effective state environmental monitoring and well-coordinated federal mechanisms for identifying and managing contaminated land.

Remediation could also be required as legacy contaminated sites are discovered as a result of prospective land use changes/redevelopment that puts a plot of land under focus and requiring investigations, assessments and legal procedures.

Another driver for remediation services stems from land use management. Although Russia has the largest land area in the world, only 10 percent of its land is used for agricultural purposes. Moreover, in the past 25 years Russia has lost 0.3 million square kilometres (km²) of arable land, mainly due to poor land management and extraction of minerals¹³². The development of mining and industrial activities on limited arable land could drive the need for remediation services as more land is required for agriculture in future.

¹²⁷ The World Bank, *World Bank Country and Lending Groups*.

¹²⁸ Nations Encyclopedia, *Russia – Economic Sectors*.

¹²⁹ Export.Gov, *Russia – Competition from State-Owned Enterprises* (August, 2016).

¹³⁰ Country Studies, *Russia, Environmental Problems* (1996).

¹³¹ Ibid.

¹³² SIANI, *Land Use Change in Russia – The Choice between Mining and Agriculture* (June 2013).

3.16.3 Technical Expertise

Russia has low to moderate level of technical expertise in the remediation sector. Most of the remediation related projects are based on locally available resources and provisions, with equipment or chemicals often imported. Most remediation related consultancies are local companies. As for testing services, most are performed within Russia as they have a dense network of state owned and private labs, with the exception of some very far remote areas, where remediation is also rarely conducted.

3.16.4 Major Trends

3.16.4.1 Soil and Groundwater Pollution Trends

The economy returned to growth after a two-year recession that was mainly caused by low oil prices and sanctions imposed on Russian individuals and businesses. The Russian GDP advanced 0.5 percent year-on-year in the first quarter of 2017, following a 0.3 percent growth in the previous period and above market expectations of 0.4 percent, according to preliminary estimates. Exports surged by 35.2 percent to USD 83.8 billion in the first quarter of 2017, marking the first increase since the second quarter of 2014 and the biggest since 2011¹³³. The GDP is expected to expand 1 to 1.5 percent in 2017. With the Russian economy on the road to recovery, and oil exports recovering, it is likely that oil extraction would continue to cause environmental degradation. Other industries such as pharmaceutical and medical technology also grew, reducing some reliance on traditional industries like the chemical and coal mining industries. Despite that, the projected growth in oil extraction and industrial development would probably lead to increased soil and groundwater pollution.

3.16.4.2 Regulatory / Policy Trends

The effectiveness of enforcement of environmental laws in Russia is becoming increasingly stringent. More private companies as well as local authorities seem to be increasing their focus on soil quality and land remediation liabilities.

3.16.5 Challenges and Opportunities

The challenge for Russia is in maintaining economic growth without neglecting the environment. Although there are no official databases on contaminated land, it is likely that legacy contamination is widespread in Russia due to its long history of mining and other activities, and this is expected to increase with further recovery of the economy and increase in oil extraction and mining. Contamination issues are expected to become more pertinent as industrial and associated activities are developed on Russia's already limited amount of arable land or highly populated areas, as well as during redevelopment (i.e. conversion into residential and other land uses) on legacy contamination sites within most of Russia's largest cities. This could increase the demand for remediation services.

¹³³ Trading Economics, *Russia GDP Annual Growth Rate* (June 2017).

3.17 SINGAPORE

3.17.1 Industrial Development and Contamination Issues

Singapore is a developed economy dominated by its service industry. Singapore has undergone major economic development in the last 5 decades, from one focused mainly on industrial activities to one focused more on high tech and service industries. Industrialisation begun in the 1960s with labour-intensive activities, which saw a steady decline through the 1970s and evolved into export-oriented activities. In the 1980s, Singapore became the world's leading producer of hard disk drives. As Singapore edged into the twenty first century, it begun to tap more decisively into regional markets for trade and outward investment, step up the pace of industrial upgrading and promote innovation, enterprise, and entrepreneurship in the economy while liberalising various services sectors such as finance, telecommunications, and utilities¹³⁴. Currently, Singapore's primary industry is limited, while secondary industry includes chemical facilities refinery and processing production, high-end manufacturing such as semi-conductors, consumer electronics and machinery transport equipment and ships.

Due to past industrial and historic landfilling activities, legacy contamination could be possible in parts of Singapore, which could surface as those land parcels are redeveloped for residential and/or commercial uses. Industrial estates in Singapore tend to be located on the outskirts, e.g. Loyang industrial area in the east, Jurong and Tuas industrial areas in the west, and Sungei Kadut, Sembawang / Woodlands industrial areas in the north. Land contamination issues as well as demand for remediation services within Singapore are not widely reported, and site assessments and reports are either kept confidential by companies or submitted to the relevant government agencies. A majority of these assessment reports are submitted to the JTC Corporation (JTC), which is a statutory board under the Ministry of Trade and Industry in charge of managing most industrial sites in Singapore.

3.17.2 Drivers for Remediation Services

The Environmental Protection and Management Act in Singapore regulates the protection of the environment from pollution, and a Code of Practice for Pollution Control provides guidelines for the control of land pollution and remediation of contaminated sites. The Code of Practice adopts the principle that "when a site that is used for polluting activities is to be redeveloped, rezoned or reused for non-polluting activity, a study should be conducted on the site to assess [the] extent of land contamination. It also includes the requirement that contaminated sites be cleaned according to the relevant standards acceptable to the authority.

In terms of contaminated land management, for industrial properties leased from JTC, the requirement to conduct an entry/exit Environmental Baseline Study is mandated under the lease terms for a new lease or a change in a site's lease. The JTC Guideline on Environmental Baseline Study provides guidance for such Environmental Baseline Studies on assessing if a site is polluted, which in turn may lead to site remediation if the pollutants' concentration levels exceed the DTVs¹³⁵ and DIVs (based on the 2000 edition or the latest edition of the Dutch Standards), which are adopted as guidelines for allowable concentrations in soil and groundwater. The Singapore Land Authority has similar guidelines on ESAs for state land and

¹³⁴ MAS, *An Economic History of Singapore: 1965-2065 – Keynote Address by Mr Ravi Menon, Managing Director of MAS, at the Singapore Economic Review Conference 2015* (August 2015).

¹³⁵ The DTVs for soil have been rescinded in the 2009 Soil Remediation Circular, but used as reference within the JTC Guideline.

property in Singapore, when state land under its purview is being re-developed from industrial to less polluting (e.g. commercial or residential) uses.

Other than requirements by government agencies, remediation is driven mostly by commercial decisions for a piece of land, such as in the case of a property transaction, carried out by either the site's buyer or seller depending on the commercial agreement between both parties.

3.17.3 Technical Expertise

Singapore has several companies providing remediation services, with most of the consultancy companies being US-based engineering or environmental companies. The National Environment Agency provides a non-exhaustive list of consultants with track record in conducting site assessments as well as remediation services. Other support services such as accredited laboratories and construction and demolition contractors are also present in the economy, though for highly specialised laboratory analysis the support of overseas laboratories would be required. All technologies related to remediation are imported from overseas – there are currently no known suppliers of specialised remediation equipment or chemicals in Singapore. In terms of knowledge and expertise development, the government invests in R&D work in the sector via provision of grants, with local universities involved in R&D work in this sector, sometimes together with the private sector. Singapore also provides technical assistance and capacity building to other economies in the region via the international branches of its government agencies.

3.17.4 Major Trends

3.17.4.1 Soil and Groundwater Pollution Trends

As the economy has shifted towards a more service oriented and high tech manufacturing industry, with an environmental permitting and regulatory framework in place, major increases in new land pollution are not expected. Growth industries identified in 2016 include the IT, healthcare (biotech/med-tech), creative, finance (fintech), retail and education sectors. These are not expected to be highly polluting sectors¹³⁶.

3.17.4.2 Regulatory / Policy Trends

There is no indication of any major changes to contaminated land management and soil remediation related regulations. However, the government is a main driver of the remediation services sector through government-led remediation of state land and investment in R&D. This is unique to land-scarce Singapore, and may result in policies emerging supporting the development of the remediation services sector in the future.

3.17.5 Challenges and Opportunities

Land is a scarce and valuable resource within Singapore. Former industrial sites which lie on prime locations close to the city centre are increasingly being converted into residential, commercial or mixed-use developments in land-constrained Singapore, which could drive the development of contaminated land management and remediation services in the economy.

¹³⁶ Singapore Business Review, *Singapore's 6 key growth industries in 2016* (November 2015).

3.18 CHINESE TAIPEI

3.18.1 Industrial Development and Contamination Issues

Chinese Taipei has undergone rapid industrialisation from the 1950s to the 1980s with an economy which is heavily dependent on its exports, especially to the China market. Chinese Taipei's economy is largely driven by industrial manufacturing, especially exports of electronics, machinery, iron and steel, cement, food processing, vehicles, consumer products, pharmaceuticals and petrochemicals¹³⁷. The major industrial centres are centred around major cities such as Taipei, Keelung, Kaohsiung, Hsinchu, Taichung and Tainan. The current contribution of the mining sector to GDP is small due to depleted natural resources, with small- and-medium sized mining companies focusing on materials for the construction industry such as marble and limestone¹³⁸.

Due to industrial development and the development of industrial parks, as well as legacy contamination issues from past / abandoned mine sites due in part to the lack of a robust environmental law system before the 1980s, industries such as the semiconductor or petrochemical segments have contributed significantly to pollution. This is exacerbated by the lack of a public national system for industrial waste disposal. Soil and groundwater pollution appears to be more severe in the north (near Taipei) and in the central west (near Taichung)¹³⁹, while petrochemical and steel industries around the harbour city of Kaohsiung have been among the worst polluted sites¹⁴⁰.

3.18.2 Drivers for Remediation Services

Chinese Taipei's system for environmental protection was developed at the end of the 1980s, when damages to the environment became so widespread that governmental officials were forced to take action and set up a formal monitoring system, which resulted in the creation of a quasi-ministerial body, the Environmental Protection Administration. While the environmental protection administrative framework is well developed and aligned with relevant international standards today, resolving pollution and related problems often depends on a variety of other issues. In particular, the main hindrance is a lack of / inconsistent enforcement tied to political agendas¹⁴¹.

Chinese Taipei has clear laws regarding land contamination and remediation. There is a national list made available by the Environmental Protection Administration regarding contaminated sites in Chinese Taipei showing the type (e.g. farmland), field register status, soil/groundwater contaminants present that exceeded their screening levels, and status of any remediation. "Control sites" are those that have exceeded the levels of soil/groundwater contaminants while "remediation sites" show clear risks for environmental quality and human health. Remediation sites will need remediation until levels are below the levels for control sites. However, where factors such as the geological conditions, pollutant characteristics or pollution remediation technologies preclude remediation until pollutant concentrations are less than soil and groundwater pollution control standards, the party who is responsible for the clean-up may provide soil and groundwater pollution remediation goals based on

¹³⁷ CIA, *Taiwan* (June 2017).

¹³⁸ USGS, *The Mineral Industry of Taiwan* (May 2015).

¹³⁹ Environment Protection Administration, R.O.C. (Taiwan), *Taiwan Soil and Groundwater Pollution Map* (2010), Soil and Groundwater Pollution Remediation Funds.

¹⁴⁰ Brookings, *Environmental Issues Facing Taiwan* (November 2015).

¹⁴¹ *Ibid.*

environmental impact and health risk assessment results, and submit them for the authority's approval. After obtaining the Environmental Protection Administration's approval, the clean-up will be based on the levels set out in the remediation goals, instead of the applicable control standards. Remediation will either be carried out by the polluter or the competent authority.

3.18.3 Technical Expertise

Being the first Asian economy to implement its Soil and Groundwater Remediation Act, Chinese Taipei has held the leading position in Asia with many investigations and remediation techniques accumulated since the act was promulgated in February 2000. Chinese Taipei has a high level of local technical expertise across the spectrum of remediation and related services.

3.18.4 Major Trends

3.18.4.1 Soil and Groundwater Pollution Trends

Chinese Taipei's economic growth is heavily dependent on external trade. It is currently undergoing economic restructuring to reposition its export-driven economy to improve its competitiveness as industries such as its major electronics industry is facing increasing competition from China. Chinese Taipei is also seeking to develop its knowledge-intensive service sector¹⁴². In recent years, opponents of the petrochemical industry have managed to prevent the development of some projects involving polluting industries. Between 2008 and 2011, environmentalists successfully opposed and stopped the construction of Chinese Taipei's controversial eighth naphtha-cracker or Kuokuang Petrochemical Technology Co., KPT, in central Chinese Taipei¹⁴³. However, with the current focus of the economy remaining in industrial manufacturing, there is a potential increase in future soil and groundwater pollution.

3.18.4.2 Regulatory / Policy Trends

There is no indication of major changes in the regulations for contamination management and remediation in Chinese Taipei; hence significant changes in the demand for remediation services due to regulatory changes are not expected. The identification of legacy contaminated sites is an ongoing process; as such, the number of known contaminated sites will increase. As of December 2014, there were 2,778 pollution control sites with a total area of 11,620,000 m² and 73 pollution remediation sites with a total area of 4,100,000 m². This trend would likely increase as the island is heavily dependent on importing most of its energy needs, dominated by crude oil and petroleum products¹⁴⁴.

3.18.5 Challenges and Opportunities

Legacy land contamination issues brought about by rapid industrialisation in Chinese Taipei's formative years are yet to be fully addressed. Despite the aim to shift towards a knowledge-intensive service sector, the current focus of the economy remains in industrial manufacturing. As such, potential for land pollution as well as the ongoing identification of legacy contaminated sites is expected to increase the demand for remediation services. The remediation services sector in Chinese Taipei is mature. Stiff local competition has made it difficult for international companies to gain a foothold in the market, especially for consulting and engineering services, which have traditionally been one of the toughest market areas for

¹⁴² USGS, *The Mineral Industry of Taiwan* (May 2015).

¹⁴³ Brookings, *Environmental Issues Facing Taiwan* (November 2015).

¹⁴⁴ Ministry of Economic Affairs, *Energy Supply, Bureau of Energy* (November 24, 2015).

international companies to enter. The best opportunities lie in partnering with local companies. Based on the website of the Industrial Development Bureau under the Ministry of Economic Affairs, there are no tariffs levied on pollution control equipment, essentially making Chinese Taipei very open to the import and use of newer and better environmentally related technologies¹⁴⁵.

¹⁴⁵ Ministry of Economic Affairs, *Taiwan Environmental Industry Profiles*, Industrial Development Bureau (2004).

3.19 THAILAND

3.19.1 Industrial Development and Contamination Issues

Thailand has undergone major industrial development for over half a century, and is now an upper-middle-income economy. It has transitioned from an agriculture-based economy to one more focused on export-orientated manufacturing since the late 1970s / early 1980s, while integrating key high-tech manufacturing production in automobiles (largely assembly) and electronics. Other manufactured goods include textiles and garments, rubber, jewellery, plastics, footwear, and cement. The economy is currently undergoing a transformation into higher value manufacturing and services sectors¹⁴⁶. There is also a relatively small mining and quarrying sector in the economy (i.e. approximately 2 percent of GDP in 2000¹⁴⁷). Development and manufacturing facilities are largely centred around Bangkok, with the North, Northeast and far South being less developed; there are petrochemical activities in the eastern region.

Due to the shift towards a manufacturing economy with the development of dedicated industrial estates, as well as the presence of industrial waste disposal / collection sites and illegal industrial waste dumping sites, Thailand faces significant land contamination issues on brownfield sites. In the State of Pollution Report 2015, pollution incidents were reported in Bangkok and its vicinity and in provinces with high numbers of factories and industrial parks, caused mainly by fires and chemical spills / leaks, as well as incidents and oil spills reported at coastal areas¹⁴⁸.

3.19.2 Drivers for Remediation Services¹⁴⁹

The Enhancement and Conservation of National Environment Quality Act is the main environmental regulation in Thailand. It stipulates soil and groundwater quality standards, and in 2013, a revision was made to include the requirement for environmental insurance for activities with the potential to cause damage to the environment / potential contaminated site, as well as an environmental fund to fund the remediation of contaminated sites.

A new regulation by the Ministry of Industry in 2016, Soil and Groundwater Contamination Control in Factory Area B.E. 2559 (2016), requires certain new and existing factory owners to collect soil and groundwater samples within the factory compound and monitor the quality on a regular interval to ensure that soil and groundwater contamination criteria is not exceeded. Where exceedances are present, factory owners are required to propose contamination control measure and contamination reduction measure and report to the Department of Industrial Works within 180 days after the problem has been detected. The owners are also required to propose a timeframe for resolution of the issue. Another enactment later in November 2016, the Ministerial Notification on Screening Levels and Investigation of the Contamination in Soil and Groundwater within a Factory, provides further details on the methodologies for soil and groundwater contamination assessments and the soil and groundwater quality standards against which the testing results will be compared

¹⁴⁶ ADB, *Thailand: Industrialisation and Economic Catch-up, 2015* (Manila, Philippines, 2015).

¹⁴⁷ Nations Encyclopedia, *Thailand – Mining*.

¹⁴⁸ Ministry of Natural Resources and Environment, *Thailand State of Pollution Report 2015* (Pollution Control Department, 2015).

¹⁴⁹ Chayawee Wangcharoenrung, *Thailand Soil and Groundwater Pollution, Remediation and Management Strategies in last 2 years* (2015), Pollution Control Department, Thailand.

The government has direct authority to enforce a clean-up. Persons suffering from pollution can also request the relevant government authority to look into the contamination and enforce the clean-up. The land owner, tenant and / or polluter are responsible for cleaning up a contaminated area or to compensate for the government to clean-up. However, there seems to be no direct penalties for failing to comply with a requirement to clean up contaminated land, though government authorities can close a factory temporarily or permanently if the operations could cause serious harm to persons or property in the factory or its vicinity.

Another key driver for environmental site assessment and remediation work carried out in Thailand stems from property transactions due diligence process from multinational companies. Besides regulatory and commercial drivers, there is also an increase in public awareness on pollution and the associated health risks, as a result of more exposure to pollution related issues and mass media coverage of contaminated sites. This also serves as a driver for remediation in Thailand.

3.19.3 Technical Expertise

Thailand's remediation sector possesses some relevant technical expertise, such as consultants with technical expertise to assess a site (Phase 1 and 2) and to implement a remediation system arising from the assessment (mostly international firms with offices in Thailand and/or the region) and local contractors for conducting demolition. Industrial hazardous waste management facilities for waste disposal are available, with industrial waste commonly being sent to landfills (post-stabilisation) or incinerated¹⁵⁰. However, highly specialised laboratory analysis would be sent to overseas laboratories. Supplies for treatment products and technology (i.e. physical equipment and chemicals used for remediation, for example, soil vapor extraction or multi-phase extractions systems) would typically be imported from outside Thailand.

3.19.4 Major Trends

3.19.4.1 Soil and Groundwater Pollution Trends

As Thailand is undergoing a transformation into higher value manufacturing sectors with a growing petrochemical industry¹⁵¹, it is expected to result in a larger extent of soil and groundwater pollution in the future, which consequently means a greater need for remediation services. One area where this trend is already present and could become more significant is the eastern seaboard of Thailand, comprising Chonburi Province, Chachoengsao Province, Samut Prakan Province, and Rayong Province, an emerging economic region with many huge industrial estates which has already been facing problems with pollution.

3.19.4.2 Regulator / Policy Trends

The new 2016 regulation on Soil and Groundwater Contamination Control in Factory Area and Ministerial Notification on Screening Levels and Investigation of the Contamination in Soil and Groundwater within a Factory are regulatory developments for contamination management in Thailand. In addition, many contaminated sites have been identified and characterized, with remediation plans proposed for brownfields with known contamination. The government has begun to realise that funding mechanisms for remediation is necessary since the cost of site

¹⁵⁰ C. Visvanathan, *Hazardous and Industrial Solid Waste Management in Thailand – An Overview* (Asian Institute of Technology, Thailand).

¹⁵¹ Thailand Board of Investment, *Thailand of Investment*.

investigation and remediation which is under the government's responsibility is very high and rising. The budget for pollution management in 2015 was only 0.36 percent¹⁵² of the total national budget, which results in untimely and unsustainable resolution of pollution problems.

There is desire to recognise and prevent contamination at an early stage – the Pollution Control Department under the Ministry of Natural Resource and Environment has held a capacity building seminar for government officials on pollution control from mining and other contaminated sites in June 2015. In May 2016, the government ordered the shutdown of the gold mining industry in the economy on environmental and health grounds, and announced that no new licenses will be issued and rehabilitation of gold mine sites would be conducted. This included the largest gold mine in the economy prior to its closure, the Chatree mine, where it was deemed that the environmental concerns outweighed the economic benefits.

3.19.5 Challenges and Opportunities

The government has enacted new regulations and notifications in the area of contamination management, which would be a key driver for the development of the remediation services sector in Thailand. The government also seems to be taking the lead and initiative to drive clean-up and prevention of contamination, as can be seen from its identification of brownfield sites in the economy with legacy contamination issues and the capacity building activities by the Pollution Control Department. Moreover, the increasing expansion of the manufacturing and petrochemical industries, with a consequence of increasing pollution in the economy, presents opportunities to develop and drive the development of the remediation services sector in Thailand.

However, challenges to developing the remediation sector include ineffective enforcement of regulations and the lack of penalties for failure to comply with remediation requirements, as well as lack of / low funding allocation from the government for effective and efficient remediation. More effective enforcement of regulations or better means to deter polluters from the onset would help to reduce the amount of post-contamination remediation that the government has to undertake.

¹⁵² Ministry of Natural Resources and Environment, *Thailand State of Pollution Report 2015* (Pollution Control Department, 2015).

3.20 UNITED STATES

3.20.1 Industrial Development and Contamination Issues

The United States is a developed economy. Primary industries in the United States include extractive industries including oil & gas and mining, along with pharmaceutical, high tech, and manufacturing for electronics, metals, and machinery.

Due to historical indiscriminate disposal of industrial wastes, much industrial waste by-products found their way into soil as well as surface waters and groundwater, either through direct dumping, or through leaching from dumping or recycling sites¹⁵³. Pesticides and fertilizers from agriculture, untreated waste from septic tanks and toxic chemicals from underground storage tanks and leaky landfills could have also leached into groundwater supplies over time.

3.20.2 Drivers for Remediation Services

The Industrial Revolution which started in the mid-1800s introduced new sources of pollution, and led to the emerging environmental movement in the United States in the 1960s, which sought to manage and prevent these pollutants from damaging the environment as the adverse pollution effects were beginning to be felt in the United States and economies around the world. The United States is one of the earliest economies in the world to embark on the management of contaminated land issues following events such as Love Canal, Valley of the Drums, and the Cuyahoga River Fires. The demand for remediation services increased exponentially in the 1980s following judicial decisions related to a liability scheme to effect site clean-up. Under the federal regulation Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), a buyer, lessor, or lender may be held responsible for remediation of hazardous substance residues, even if the contamination was not caused by them (i.e. by a prior owner). This comes after the Resource Conservation and Recovery Act (RCRA) passed in 1976, which regulates operating business for controls over hazardous waste from generation to disposal.

The Superfund Clean-up Acceleration Act was passed in congress in 1998, amending the CERCLA. Among other things, it provides funding for grants to eligible entities (e.g. States, local governments, redevelopment agencies and tribes) to assess, characterize and/or clean-up contaminated brownfield sites.

The number of federal and general (non-federal) sites under the Superfund programme is provided on the US Environmental Protection Agency's website¹⁵⁴. The RCRA, CERCLA and the Superfund Act have been very strong drivers for the development of the remediation services sector in the US.

3.20.3 Technical Expertise

The United States is at the forefront of developing and testing remediation technologies and techniques. This is due to a few key factors: (a) its longer history of experience in managing as well as physically cleaning up contaminated sites; (b) its understanding and recognition of the impacts of toxic chemicals in relation to their human health effects; (c) presence of clear and

¹⁵³ Pollution Issues – *History*.

¹⁵⁴ USEPA, *Superfund: National Priorities List (NPL)*.

enforceable regulations; and (d) financial support for research and development. Based on the United States International Trade Commission report in March 2013¹⁵⁵, there were more than 4,500 remediation service providers in the United States. Some of these firms cater to a specialized area, while others provide the full range of services related to the cleanup of contaminated mine sites and buildings, soil and groundwater remediation, wastewater treatment, oil spills cleanup, and the removal of hazardous materials such as lead and asbestos.

3.20.4 Major Trends

3.20.4.1 Soil and Groundwater Pollution Trends

There is no literature indicating a potential shift in the main types of polluting industries in the United States (i.e. mining and manufacturing); hence there are no major changes expected in the potential for future soil and groundwater pollution compared to current status.

3.20.4.2 Regulatory / Policy Trends

RCRA, CERCLA and the Superfund Act will remain the main regulations and drivers for contamination management in the United States. Regulations are changing due to refinements to facilitate action or due to new information regarding new and emerging contaminants such as PFOAs. The ongoing discovery of legacy contaminated sites will increase the number of known contaminated sites, some of which may be classified as Superfund sites.

3.20.5 Challenges and Opportunities

The United States has a mature remediation services sector. There is scope for the export of technical expertise and remediation technologies to the APEC economies seeking to develop their remediation sector.

The United States enjoyed a trade surplus in remediation services between 2003 and 2010, and remediation accounts for about 15 percent of the annual revenue from the waste industry¹⁵⁶. The challenge in the US with regards to exploring new remediation technologies is in making the technologies commercially viable and sustainable, meaning that market incentives rather than regulations should be the driver. By developing a market with reasonably well-defined risks and opportunities to create financial returns, both the service providers and clients could perceive financial benefits from improved remediation of contaminated properties. This would help safeguard the interest of the general public by ensuring that contaminated sites are cleaned up, while possibly leading to further development and innovation within the remediation technology market as it becomes evident that new technologies can create real value for customers.¹⁵⁷

¹⁵⁵ USITC, *Environmental and Related Services*, Investigation No. 332-533 (USITC Publication 4389, March 2013).

¹⁵⁶ Grid Waste, *The Unknown \$ 75 Billion Industry* (August 2014).

¹⁵⁷ NRC, Sciences, Engineering and Medicine, *Market – Based Approaches for Stimulating Remediation Technology Development, Innovations in Ground Water and Soil Cleanup: From Concept to Commercialisation*, National Academies Press (New York, 1997).

3.21 VIET NAM

3.21.1 Industrial Development and Contamination Issues

Viet Nam has undergone rapid economic transformation, from a largely agricultural and forestry based one to one specialising in manufacturing. Viet Nam achieved approximately 8 percent annual GDP growth between 1990 and 1997, and 7 percent GDP growth between 2000 and 2005, becoming the world's second fastest progressing economy. Viet Nam has built industry zones in several places including the Que Vo district and the Bac Ninh province. They specialise in developing supporting industries, such as garment, textile, leather, electronics, IT, automobile and engineering. Favourable government policies and business climate is supporting foreign direct investments and is helping Viet Nam become one of the major manufacturing hubs in the world¹⁵⁸.

Due to the shift in economy towards high tech industry and manufacturing (Doi Moi policy in 1986), different types of contaminants have been produced, in addition to the pollution caused by the Viet Nam war¹⁵⁹. These would require targeted land remediation services. In 2016, a marine spill disaster caused by illegal toxic industrial waste release from Formosa Ha Tinh Steel, a steel company, caused massive fish deaths in Ha Tinh, Quang Binh, Quang Tri and Thua Thien Hue provinces in Central Viet Nam. This has affected more than 260,000 people who make their living from fishing related activities¹⁶⁰. In addition, there have been reports involving industrial factories dumping waste and chemicals into soil which is located in close proximity to agricultural land has resulted in numerous health issues experienced by the agricultural communities¹⁶¹.

3.21.2 Drivers for Remediation Services

Viet Nam's main statutory environmental framework is given by Law on Environment Protection No. 55/2014/QH13. However, there are no specific regulations for the remediation of contaminated property. Remediation drivers would likely be created once the government puts more focus on the quality of the economy's major export commodities such as rice and other agricultural products, livestock and aquaculture products, which are impacted by contamination issues.

3.21.3 Technical Expertise

Most of the technical expertise and equipment related to remediation come from foreign companies. An example is the clean-up of the Danang Airport by USAID of high dioxin concentrations in soil and sediment from 2010 to 2016 via thermal treatment. The dioxin presence was a remnant of the United States-Viet Nam war¹⁶². Another example is the clean-up work of POPs such as dichlorodiphenyltrichloroethane (DDT) and hexachlorocyclohexane (HCH) by a Dutch firm under UN Development Program (UNDP) from 2010 to 2014.

¹⁵⁸ Forbes, *The 5 Engines that Guarantee Viet Nam More Fast Economic Growth This Year* (January 2017).

¹⁵⁹ Nakagami K., *Environmental Management and Sustainable Development in Viet Nam* (October 1999).

¹⁶⁰ The Voice of Viet Nam Online, *Post-marine Environment Incident Fixing Efforts Continue* (May 2017).

¹⁶¹ Tuoitrenews, *Contaminated Soil A Major, but Ignored, Problem in Viet Nam* (October 2014).

¹⁶¹ USAID, *Environmental Remediation*.

¹⁶² Ibid.

3.21.4 Major Trends

3.21.4.1 Soil and Groundwater Pollution Trends

Agriculture remains one of Viet Nam's backbone sector. However, due to poor farming practices as well as the focus on manufacturing, projected increase in soil and groundwater pollution would ensue, which would consequently bring about problems in food quality and resource management in the future.

3.21.4.2 Regulatory / Policy Trends

Viet Nam is undergoing an economic reform by reallocating and streamlining resources in a modernised way which is in line with its commitments. These commitments include rapid and sustainable economic development, administrative reform, the fight against corruption and wastefulness, and the building of a modern administrative system. In addition, land use right, labour and information technology markets, which are crucial to production, will be restructured as well¹⁶³. Given these economic imperatives, land contamination will continue to be a major problem and demand for remediation services will likely also increase in the future, along with an increase in demand for waste management services¹⁶⁴.

3.21.5 Challenges and Opportunities

The main challenge in Viet Nam is to balance its economic drive while also giving importance to the environment. There is a lack of contamination management regulations, hence regulations and standards for contaminated land management and remediation need to be developed, and the enforcement of law needs to be strengthened for effective environmental management. Other factors which need to be addressed for effective contaminated land management include:

- Educating the labour force of the population involved in agriculture with regards to the negative health effects of chemical fertilizers and pesticides, as well as in providing basic knowledge on rotation farming/best farming practices to keep the land useful;
- Have in place a requirement and / or system to assess agricultural areas for contaminant concentration as well as the irrigation water (whether metals or POPs), coupled with providing incentive programs by the government to the private industries in exchange for assistance in improving soil quality in agricultural areas;
- International cooperation with other economies as well as private institutions and international organizations such as UNDP could serve to facilitate site assessments, as the cost for carrying them out usually poses a challenge; and
- Enforcement of stricter regulations and corresponding penalties to primary and secondary industries with regards to pollution and waste disposal.

¹⁶³ The Saigon Times, *Viet Nam Needs US\$480 Billion for Economic Restructuring* (October 2016).

¹⁶⁴ Tuoitrenews, *Contaminated Soil A Major, but Ignored, Problem in Viet Nam* (October 2014).

4 CONCLUSION AND NEXT STEPS

This report presents an overview of the characteristics of the overall environmental damage remediation sector within the APEC member economies. Despite considerable differences in terms of state of regulations, demand for services, level of awareness and capacity to absorb new service providers across the member economies, some trends are apparent:

- Soil and groundwater contamination issues in the APEC economies are strongly related to the industrialisation history of the economies and waste management practices. Legacy contamination from past extractive industries, waste disposal and industrial activities is one of the main causes of contamination-related issues (e.g. environmental and human health issues) in many of the economies.
- The key driver for the development of the remediation services sector is a robust regulatory framework. Less than half of the APEC member economies have specific regulations on management of contaminated land management and/ or remediation either at a national level and/or sub-national level, while most of the rest either have regulations under development or have only related non-legally binding guidelines. Some have adopted guidelines or standards from other APEC economies or non-APEC economies.
- The level of technical expertise and maturity of the remediation services sector are typically higher in more industrialised and developed economies where transparent regulations and effective enforcement exist. There is potential for these economies to share and export their expertise to economies which are developing their remediation services sector. Trade in the remediation sector is currently generally limited to the initial site assessment and planning phases of a remediation project, where multinational environmental firms, usually with a local presence, provide technical and scientific consulting services.
- The discovery of legacy contaminated sites in developed and developing economies and the continuing industrialisation and pollution in developing economies present opportunities and challenges for the development of the remediation services sector in the APEC economies: opportunities include the potential for increased active soil and groundwater contamination management and corresponding development of the remediation services sector, while challenges hindering the realisation of the opportunities include the lack of transparent regulations and effective enforcement.

There is increasing recognition of the negative environmental and socio-economic impacts caused by pollution. Without a viable remediation services sector and corresponding local technical expertise, some APEC economies may find themselves faced with costly clean ups (i.e. higher costs arising from spread of contamination due to lack of management, and lack of local expertise and cheaper technologies), as well as increased socio-economic costs (i.e. impaired or unproductive lands and higher health care costs).

With the environmental remediation services market expected to grow in the coming years, there is strong business impetus for developing the sector, at the same time bringing about the development of other associated goods and services. Work on liberalisation of trade in the sector would require regulatory authorities in the individual economies to recognise the need to not just liberalise and reduce trade barriers in the remediation services sector but also the associated goods and services.

To facilitate the process of developing and putting in place relevant regulations and a systematic approach for contamination management, APEC economies may benefit from

working together and facilitating dialogue among themselves, such as sharing from economies with mature remediation services sectors such as the United States; Australia; Chinese Taipei; Japan; Korea; and Canada. Economies which are recipients of development funds from international financial institutions with requirements for managing environmental and social risks for high-value projects (which could include contamination management and/or remediation requirement), such as the IFC Performance Standards, could also make use of these international standards either as benchmark or to develop their own national standards.

In many economies, the level of technical expertise in the remediation services sector were not fully investigated as part of this Study Report, mainly due to lack of publically available information and time constraints. Further work to examine the current degree of technical expertise and gaps across the spectrum of remediation and related services would aid in the identification of key services within the remediation sector requiring support. This would then set the stage for trade liberalization and facilitation as well as cooperation in environmental services across the APEC economies.

ANNEXES

1. GLOSSARY

The following words and expressions shall have the meanings hereby assigned to them except where the context otherwise requires:

Term	Definition
Asia-Pacific Economic Cooperation (APEC)	A forum for 21 Pacific-rim member economies that seeks to promote open trade and practical economic cooperation throughout the Asia-Pacific region.
APEC Environmental Goods and Services (EGS) Work Programme	A key thrust in APEC's sustainable growth agenda, under which a set of concrete actions will be developed and implemented to support sustainable growth in the region, advance work to increase utilisation and dissemination of EGS, reduce existing barriers and refrain from introducing new barriers to trade and investment in EGS, and enhance capabilities of economies to develop their EGS sectors.
APEC Environmental Services Action Plan	An action plan endorsed by APEC Senior Officials in September 2015 in Cebu to provide APEC economies with greater insights about efficient regulatory and trade promotion policies in environmental services under the CPC94, and to consider and study broader environmental industries/businesses with a view to building and enhancing a common understanding of the roles of services in these industries/businesses. Key actions to be implemented over 3 phases from 2016 to 2020 have been identified.
APEC Member Economies / APEC Economies	A term used for an official member of APEC. Members taking part in APEC activities do so as economic entities rather than as sovereign states. Currently, APEC comprises 21 member economies: Australia; Brunei Darussalam; Canada; Chile; China; Hong Kong, China; Indonesia; Japan; Korea; Malaysia; Mexico; New Zealand; Papua New Guinea; Peru; the Philippines; Russia; Singapore; Chinese Taipei; Thailand; the United States; and Viet Nam.
APEC Policy Support Unit	A research and analysis arm for APEC attached to the APEC Secretariat, assisting APEC members and fora.
Central Product Classification 94 (CPC94)	A complete classification of all goods and services that are the result of production in any economy provided by the Department of Economic and Social Affairs of the United Nations Secretariat. CPC94 covers classification of goods and services for sewage and refuse disposal, sanitation and other environmental protection services.
Senior Officials' Meeting	Submits proposals to Ministers and implements policies made at Ministerial Meetings. SOM supervises and coordinates budget and working programs of APEC fora to implement declarations and directives given by APEC Leaders and Ministers. SOM is held in advance of and to prepare for Ministerial Meetings.

2. ABBREVIATION LIST

APEC	Asia-Pacific Economic Cooperation
ASEAN	Association of Southeast Asian Nations
CAGR	Compound Annual Growth Rate
CEMS	Continuous Emission Monitoring Systems
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CPC	Central Product Classification
CPC94	Central Product Classification 94
DDT	Dichlorodiphenyltrichloroethane
DIV	Dutch Intervention Values
DoE	Department of Environment (Malaysia)
DTV	Dutch Target Values
EGS	Environmental Goods and Services
EIA	Environmental Impact Assessment
EPMO	Environmental Protection and Management Order
ESA	Environmental Site Assessment
ESAP	Environmental Services Action Plan
GDP	Gross Domestic Product
GSR	Guided Self- Regulation (Malaysia)
ha	Hectare
HCH	Hexachlorocyclohexane
IFC	International Finance Corporation
IT	Information Technology
JTC	JTC Corporation
km ²	square kilometre
m ²	square metres
NAFTA	North American Free Trade Agreement
NAICS	North American Industrial Classification System
n.e.c	Not Elsewhere Classified
PCP	Pentachlorophenol
PFAS	Poly-fluoroalkyl Substance
PFOA	Perfluorooctanoic acid
POP	Persistent Organic Pollutants
PSU	Policy Support Unit
RBRG	Risk-based Remediation Goal
SCCL	Soil Contamination Countermeasures Law
SME	Small and Medium Enterprises
SOM	Senior Officials' Meeting
TCLP	Toxicity Characteristic Leaching Procedure
UN	United Nations
UNDP	UN Development Program
US	United States
WTO	World Trade Organisation

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