Proposal of management policies for contaminated sites - Case Study: Santa Elena Lot in Cartagena, Colombia

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1. ABSTRACT

The process followed in the development of the environmental assessments and remedial procedures of the Santa Elena site in Cartagena, Colombia have been taken as a case study for the proposal of a management procedure for contaminated sites that can be implemented in the country. The study takes into consideration the actions taken at the site, regulatory restrictions and is justified in the lack of specific regulation regarding the management of contaminated sites. The proposed procedure gives a step-by-step, standardized approach to the management of such sites.

2. INTRODUCTION

Since the beginning of agriculture, mankind has ever been looking for ways to increase the yield of their crops; one of those ways has been the development of pesticides. Over time, agrochemicals of greater potency and selective toxicity were developed, resulting in more effective products such as DDT and its derivatives (Unsworth, 2010). After the publication of the book "Silent Spring" by R. Carson in 1962, society begun to recognize the consequences of their actions in the environment (Albert, 1997; United States Fish and Wildlife Services, 2013). As a result of this, national policies across de world have been revised, seeking the use of more environmentally friendly products, as is the case in Colombia. Beginning in 1974, the use, production, import and sale of different pesticides began to be restricted (ICA, 2016).

The National Federation of Cotton Growers (FNA from its name in spanish Federación Nacional de Algodoneros) came into being by a group of farmers with the purpose of representing, supporting and defending the common interests of those producers and companies of the textile industry. The FNA owned several plots of land (among them the Santa Elena plot), in which experimental crops and field tests of agricultural inputs were carried out, including organochlorine and organophosphorus pesticides. The FNA also helped with the storage and distribution of the same supplies. These practices and the management and handling recommendations of the time resulted in the contamination of the site; contamination that was evidenced after the FNA gave the land as payment in kind to one of its creditors (a Bank, currently known as Bancolombia). These findings were the basis of a major intervention on the part of the Ministry of Environment, Housing and Territorial Development - MAVDT (currently Ministry of Environment and Sustainable Development

- MADS) who imposed several obligations on Bancolombia; among them the characterization of the site. There were many pollutants identified, particularly organochloride and orgaophosphorous pesticides, highlighting methyl parathion and toxaphene as the most important (ERM, 2009).

The condition described above made it clear that there is a regulatory gap regarding the issue of management of contaminated sites and it has been through the development of many procedures that the Santa Elena case has served as the basis for proposing management guidelines for the handling of a contaminated site project taking into account administrative, technical, social and environmental issues related to the remediation and recovery of a contaminated site.

a. PROBLEM STATEMENT

Colombia, and some of its latin american neighbors, do not yet have a specific legal framework for the management of contaminated sites and environmental liabilities. However, they have been following some foreign regulations in order to cope up; nonetheless, by using foreign regulatory frameworks, there is the possibility of falling into misinterpretation and misapplication of them.

In Colombia, The 2006-2010 National Development Plan recognized the need for a specific reference framework for the adequate management of environmental liabilities (Ministerio de Medio Ambiente, 2009), but the efforts made failed to cover this gap. In the 2014-2018 National Development Plan the Congress of the Republic continues to recognize this need (Congreso de la República, 2015).

There have been some developments, as a first step, a joint effort between the then called Ministry of Environment (now Ministry of Environment and Sustainable Development) and the then called Administrative Department of the Environment (Now Secretary of Environment, a branch of the Office of the Mayor of Bogotá, D.C.) published, as a reference of good practices, the Environmental Management Guide for Fuel Service Stations developed in 1999 (Ministerio del Medio Ambiente and Departamento Administrativo de Medio Ambiente, 1999); a few years later, the Technical Manual for the Development of Risk Analysis for Distribution Centers of Hydrocarbon Derivatives was developed and published by the then called Ministry of Environment, Housing and Territorial Development (Ministerio de Ambiente Vivienda y Desarrollo Territorial, 2007). However, a definitive regulation has yet to be developed.

This work seeks to establish and propose basic guidelines for the management of contaminated sites, taking as a case study the processes carried out in the Santa Elena site. The study focuses on the administrative and legal actions that took place on the area, without leaving aside the technical context.

b. GENERALITIES AND BRIEF HISTORY

The site subject of the study, Santa Elena Plot, is a parcel of land with an área of 24Ha located in the south end of the city of Cartagena de Índias, Distrito Turístico y Cultural, in the

Department of Bolívar, Republic of Colombia. The sector is known as “Ternera”, (See figure No. 1).

Figure No. 1 Geographical location site of study, Santa Elena Plot

The cotton crop in the northern region of Colombia was carried out since pre-Columbian times by aboriginal communities all the way up to the second half of the twentieth century in which the global economic conditions forced the end of the industry in the country (Sourdis-Nájera, 2008)

The FNA acquired the Santa Elena site in 1969, being its original extension 44 Ha. Its main purpose, as stated before, was centered in carrying out tests and trials on cotton crops with different agrochemicals. By the late 1980’s the cotton growing business was bankrupt and as a consequence, in the year 1987 the FNA was liquidating and foreclosing their assets. Amongst its many creditors there was the Banco de Colombia to whom the Santa Elena site was given as payment in kind for its debt. During those years Banco de Colombia was being sold and eventually became what is known today as Bancolombia.

In 1993 the Bank sold the land and transferred ownership to Cartagena’s Social Interest and Urban Reform Fund, also known as CORVIVIENDA, where there was a plan to develop a large housing project called “Ciudadela 2000”. During the development of the project, in 1994, there were found some interred drums with residual pesticides, causing the suspension of the works in 1995 (Universidad de Cartagena, 2010). As a consequence, the Ministry of Environment ordered CORVIVIENDA to localize and delineate the compromised areas and to come up with a procedure for the extraction and disposal of the contaminated materials (Ministerio del Medio Ambiente, 1995). This situation derived in a litigation between CORVIVIENDA and the Bank that ended in the splitting of the parcel of land into two; the southern part was taken by CORVIVIENDA (a 20 Ha portion already constructed) (Ministerio de Medio Ambiente, 1997) and the northern part (a 24 Ha portion, not developed and subject of this study) was returned to the Bank, with the latter committed to “take care” of the contamination in the form of an in-situ confinement for the contaminated soils and

materials found in the large 44 Ha initial parcel of land (Ministerio de Medio Ambiente, 1999a, 1998). After the construction of the confinement area the Ministry lifted the restrictions for the land use (Ministerio de Medio Ambiente, 2000a, 2000b) freeing the already developed housing project in the southern 20 Ha to be sold and expecting the northern side to be developed similarly.

Through the following years the Santa Elena site (northern portion) was subject to several attempts to development; however, due to some flooding events in the early 2000's there was a great need in the city for housing, particularly low income housing. Given the situation, a coalition of entrepreneurs and government agencies developed a project called "Colombiaton" aimed at providing affordable housing. Bancolombia was part of the partnership and offered the land as donation to the cause. In 2005 during the construction of the Colombiaton project some contamination was found (contaminated soils) halting the construction and forcing the involvement of the Ministry and the abandonment of the project by Colombiaton (Universidad de Cartagena, 2010). The organization "Compartir", managing partner of the Colombiaton project, decides to return the land lot back to the Bank while the Ministry of Environment compelled the latter to "remediate" the site. In 2006, the Ministry issued a stern Resolution forcing the Bank to take several actions at short, medium and long term regarding the site; however, the most important decision was to adopt the Soil Screening Levels of the USEPA as the remediation goals for the site (Ministerio de Ambiente Vivienda y Desarrollo Territorial, 2006a)[1]. This resolution was contested by the Bank and ratified by the Ministry by a second resolution (Ministerio de Ambiente Vivienda y Desarrollo Territorial, 2006b). In 2007 the Bank has sued the Ministry before the Administrative Court asking for the annulment of the effects of the previous resolutions and for restitution and punitive damages.

c. ENVIRONMENTAL ISSUES AND TECHNICAL INTERVENTIONS

After the events with CORVIVIENDA and amongst the activities ordered by the Ministry, there was a sampling program aimed at identifying where and how much contaminated soil there was. This sampling program included sampling of soils up to 4 m deep and determining the concentration of pesticides in the walls and floors of the warehouses. In the figure below, the distribution of sampling points can be observed. The results of this characterization showed as the main contaminants the pesticides Methyl Parathion and Toxaphene (Uribe-Jongbloed, 2007).

[1] This is one of the main issues regarding the management of a contaminated site, i.e. the definition of the endpoint of a remediation procedure; when is a cleanup procedure considered to be finished, under what considerations, what criteria have to be followed, etc.

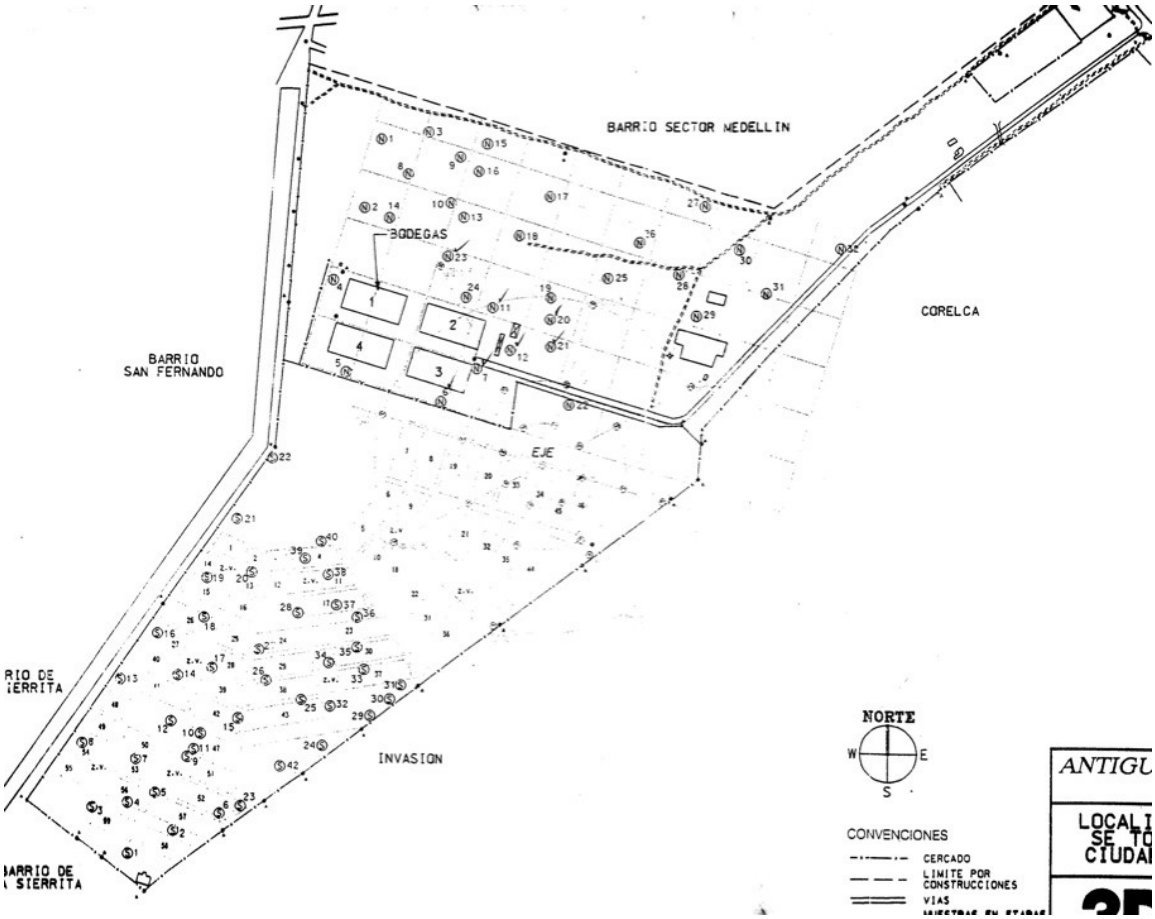

Figure No. 2 General location of sampling points; sampling event 1998 (Taken from(ANLA - Autoridad Nacional de Licencias Ambientales, n.d.)*)*

Additionally, three main areas were defined. The south side (where the development had been already made), the area of the drums, and the north side. In the south side the sampling showed no presence of pesticides or pesticide contaminated soil; the north side showed some small areas with tainted soils and the "drum" area was delineated. The results of this sampling program were the base for the ministry to issue resolution 578/98 where it ordered the construction of the confinement (Ministerio de Medio Ambiente, 1998). In January 1999, the Ministry through resolution 024/99 accepted and approved the designs and technical specifications for the in-situ confinement that was built later that same year (Ministerio de Medio Ambiente, 1999b)[2].

After the events of 2005, a few interventions were made. Of importance were a series of sampling programs and geoelectrical tomographies ordered by the Ministry under resolution 412/06 (Ministerio de Ambiente Vivienda y Desarrollo Territorial, 2006c), which gave as a result the identification of "contaminated areas" within the site (see figure No. 3). These results, in turn, supported the issuance of resolution 1247/06 followed by resolution 2722/06

[2] The confinement area, its contents and the procedures being carried out to maintain it are not part of this case study. They will be addressed in a different text.

where remedial actions (and many other procedures) were ordered by the Ministry (Ministerio de Ambiente Vivienda y Desarrollo Territorial, 2006a, 2006b)[3].

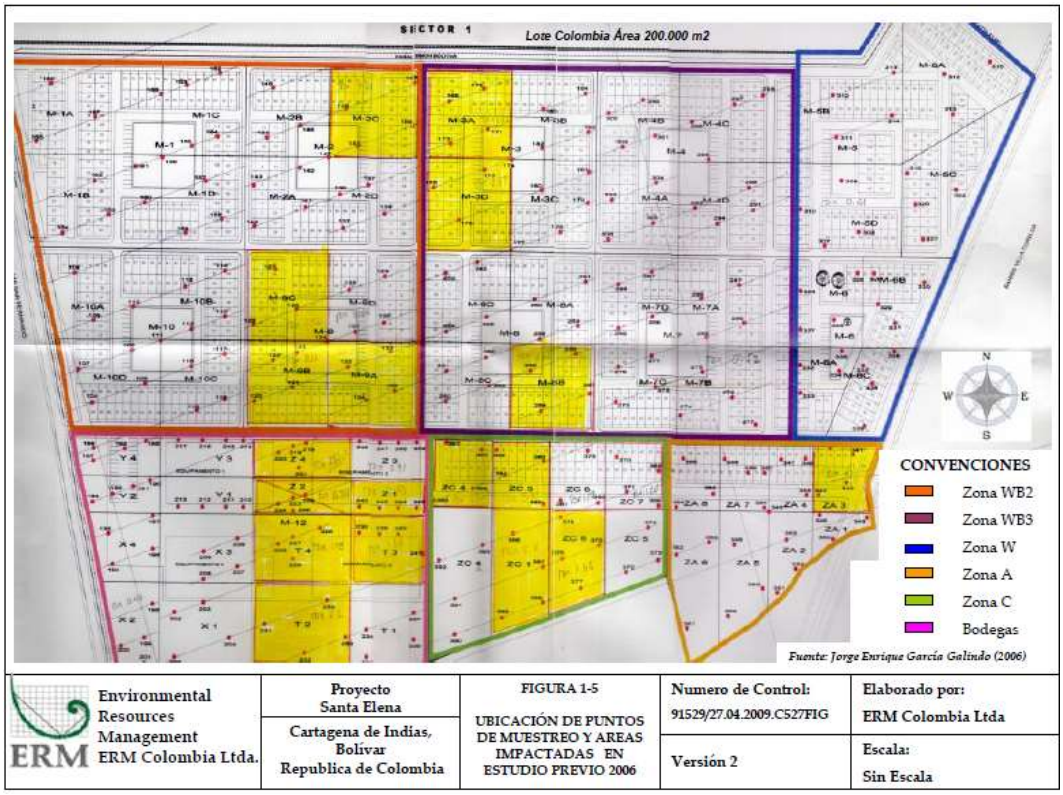

Figure No. 3 Location of sampling points (Compound sampling (red dots)) and affected areas (yellow) from 2006

In order to complement and update the characterization of made in 2006; in 2009 a much more detailed sampling plan was developed in order to localize and delineate the impact previously determined within the yellow areas and the inclusion of the northern access or "strip" within the sampling plan. In figure No. 4 can be seen the sampling zones and delineated in grey the impacted areas.

[3] As a consequence of these latter resolutions, the Bank hires an international consulting firm: Environmental Resources Management, ERM for short. From that moment on, all interventions on the site were made by ERM under contract with the Bank.

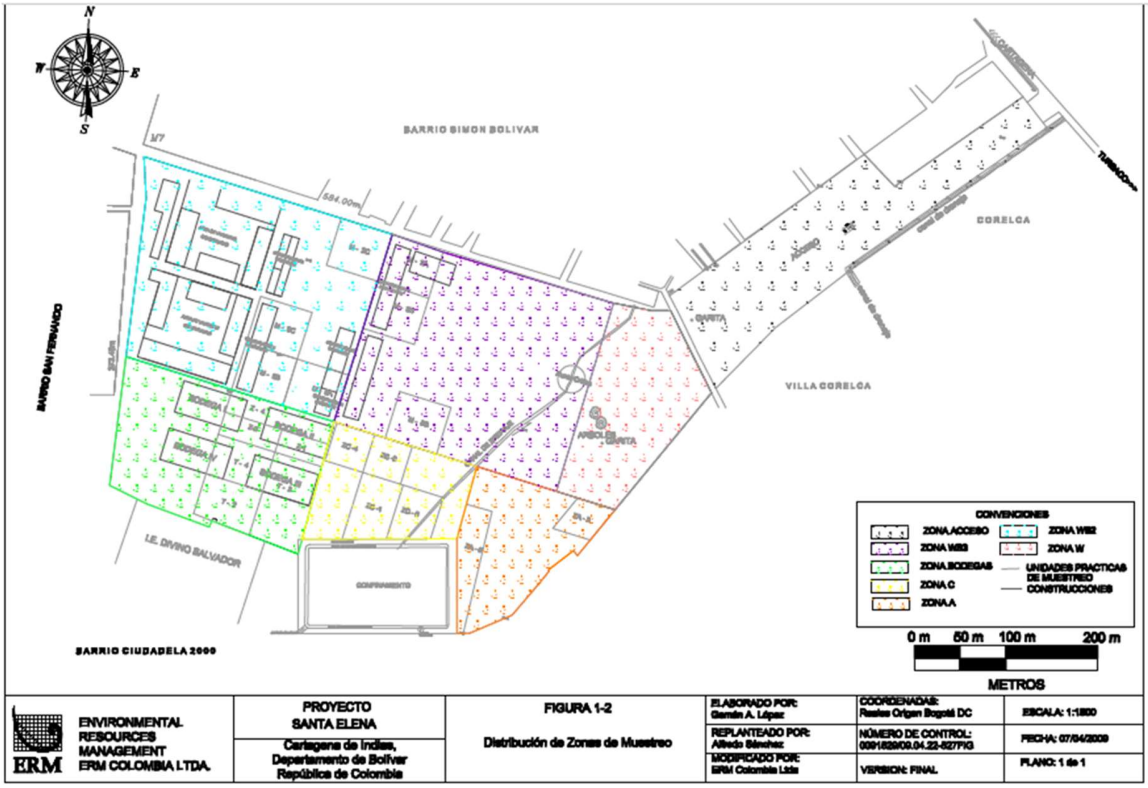

Figure No. 4 Sampling zones for updated characterization 2009

Contamination was confirmed within the previously identified areas. All contamination was due to organochloride pesticides such as 4,4' DDT; 4,4' DDD; Heptachlor Epoxy; Gamma BHC and Toxaphene, the latter being the most abundant in those areas. Within the confinement, a combination of the latter organochloride pesticide along with Methyl Parathion was identified. Table No.1 shows de concentration ranges found at the site.

Table No. 1 Range of Concentrations found at site

Substance	Concentration (mg/kg)			
	Min	Max	SSL*	SCCS***
4,4'-DDT	ND	13.1	1.7	13
4,4'-DDD	1.5	5	2	18
Heptachlor Epoxy	ND	0.35	0.053	0.48
Gamma BHC (Lindane)	0.017	2.4	0.52	4
Toxaphene	0.49	1200 (900)**	0.44	3.9
Methyl Parathion	180**	4300**	15	130

* USEPA Soil Screening Levels
** Concentrations found inside the confinement
*** RBCA – Specific Calculated Concentrations (remediation goals)

In 2013, in situ remediation actions began, obtaining very good results, but some areas are still under treatment.

The first action carried out took place between 2013 and 2014 with the technique of In situ chemical oxidation, ISCO for short. Activated persulfate was used as an oxidizing agent, with additions of sodium hydroxide (NaOH) as regulator of soil acidity. Oxidizer and acidity regulator solutions were injected daily, according to the programming and monitoring carried out. As a result, reductions up to 90% in the concentration of most components and around 88.5% for toxaphene were obtained compared to the concentrations detected in the baseline sample (ERM, 2015). Although the removal efficiencies are high, there were insufficient in the case of toxaphene, making necessary the implementation of a second round of treatment.

During the second action, carried out in 2015, a combined bioremediation technique was applied with cycles of In situ Chemical Reduction or ISCR for short. Anaerobic phases were alternated with aerobic ones to achieve that the byproducts of each were degraded in the other. The anaerobic phase consisted of applying the amendment in solid phase and covering the surface with a geomembrane, favoring the reducing conditions. The aerobic phase consisted of soil tillage, promoting the incorporation of oxygen and water distribution. At the end of this action, a total removal of 85% was achieved, taking as a reference the residual concentration after the first action[4].

d. SOCIAL ISSUES

Prior to the remediation activities, the bank hired BIOPARQUE Corporation, which carried out socialization and education activities in the neighborhoods and communities around the Santa Elena plot. Presidents of and committee delegates from Community Action Boards and other members of the community in general participated during these activities. At all times the Bank maintained an open channel with the community in order to keep it informed on what was to be done, what was being done and results of the activities made.

In 2009, a Health Effects Assessment was carried out in a neighboring area to the site. This study was conducted by professionals from the Universidad del Valle in Cali. The conclusions of this study detailed that there is no causal relationship between the symptoms studied and the contaminants present in the property.

During 2012, a health risk analysis was carried out, using RISC 4.0 and SADA5.0 models and taking as a reference the data of the study mentioned above. The results obtained indicated the absence of risk for neighboring populations, although carcinogenic and non-carcinogenic risks significantly high were identified for within the area of the lot; revalidating the need for a remedial intervention on site (Echeverry-Prieto, 2012)

3. DISCUSSION AND PROPOSED MANAGEMENT GUIDELINES FOR CONTAMINATED SITES

In this section we present some regional context regarding the management of contaminated sites in Latin America followed by the proposed guidelines for Colombia.

[4] The high removal efficiency was enough to remediate most of the site. A little area remains with a concentration slightly above the remediation goal. All remediation goals were calculated following RBCA methodology with residential soil use as the main parameter.

a. ARGENTINA AND LATIN AMERICA

Since 2006, Argentina has had the Program for the Environmental Management of Contaminated Sites PROSICO, created by the Secretariat of Environment and Sustainable Development of the Nation. The methodology presented in the program is very similar to the one proposed by the US EPA. At present, there is also an inventory of sites that, once characterized, would form part of the national list of priorities. The steps of PROSICO are summarized in the figure below (Pflüger, 2007).

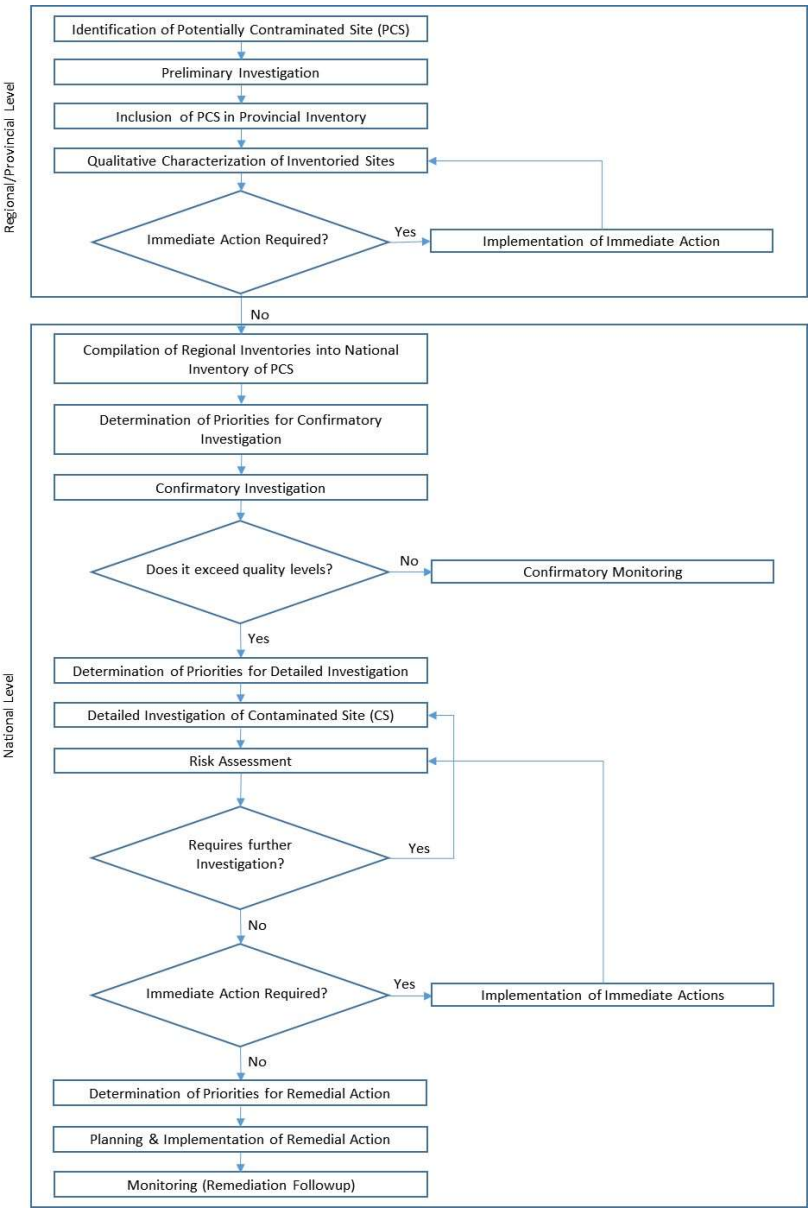

Figure No. 5 PROSICO's detailed methodological flow chart

Although there is a program at the national level and other regulatory tools at the provincial level (Law 14,343 of environmental liabilities in Buenos Aires and the definition of environmental liabilities in chapter XVII of Law 10,208 of the Environmental Policy of

Córdoba) they are not fully regulated for its implementation. For this reason, the national law 24,051 of Hazardous Wastes is applied to the management of environmental sites and liabilities.

In the mining and hydrocarbons sector, the Environmental Site Assessments Phase I, Phase II and risk analyses are normally applied (the most used methodology is RBCA), although to establish the remediation goals, the values established in the Hazardous Wastes law continue to be used.

At the regional level, the Latin American Network for the Prevention and Management of Polluted Sites (ReLASC by its acronym in spanish) has existed since 2006 -, made by an agreement of the governments of Colombia, Argentina, Brazil, Mexico, Peru, Chile, Ecuador and Uruguay and other organizations of public and private nature. The main objective of this network is to promote the production, dissemination and exchange of knowledge in the field of prevention, management and revitalization of contaminated sites (ReLASC, 2008). Several of these countries have already adopted guidelines similar to those set out by the USEPA within their normative body, as decrees, resolutions or action guidelines. Brazil and Peru are the countries with the greatest advances in regulations, since they have developed their own reference standards and reference values for soil quality.

b. COLOMBIA

As stated before, Colombia still does not count with a regulatory framework regarding the management of contaminated sites specifically; therefore, all actuations by the Environmental Authorities have not followed the same standards and have not had the same reach. Most interventions have been made following the Hazardous Waste Management regulation, which is not intended to this particular situation and constricts enormously the room for action.

With that in mind, all the procedures and actions taken in the Santa Elena Plot, used as a case study were, from the regulatory stand point, an isolated effort.

In general, the actions and management approach in this case were based on the procedures established in the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (United States Congress, 1980).

The main procedures applied included Environmental Site Assessments Phase I (ASTM International, 2005) and Phase II (ASTM International, 2002), risk analysis (according to RBCA methodology) (ASTM International, 2000), treatability studies and remediation processes. Although the implemented actions and procedures were punctual (centered in the needs of the site), it is also important to point out that the decisions were made according to the situation at the moment and the expertise of the official in charge at that time. This is the consequence of Colombia not having a specific regulatory framework for this type of cases.

In this particular case, the officials at the Ministry of Environment made a rather large misinterpretation of the Superfund procedure mandating the Bank to reach the Soils Screening Levels - SSL (previously known as Primary Remediation Goals – PRGs) as the

actual remediation goals obviating the risk assessment. The USEPA clearly states in the introduction to the User's Guide for the procedures that *"…It should be emphasized that SLs are not cleanup standards…"* (USEPA, 2016), establishing these values as a reference guide during the diagnostics stage and specifically instructing that they should not be taken as remediation goals. When the concentrations obtained in the field exceed the RSL, it is understood that the potential risk must be evaluated and not necessarily that there is a need to take immediate remedial actions (Uribe-Jongbloed, 2016).

4. PROPOSED GENERAL GUIDELINES FOR MANAGING CONTAMINATED SITES

Based on the work done in Santa Elena a set of general guidelines for the management of contaminated sites in Colombia were defined, whose principal objectives are the protection of the environment as well as the wellbeing of the people.

As a necessary first step, it is imperative to have formal and legal definitions of some terms such as environmental liability, contaminated site and potentially contaminated site[5]. As an administrative tool It is also necessary to count with a legal and administrative procedure that allows to trace back the ownership history of the land plot or site in order to help identify potential responsible parties. This last procedure does exist in Colombia though the Notarial and Registry Superintendence.

A figure similar to Superfund must be available with the ability to identify, prioritize and remediate contaminated sites. It must also have the capability and resources necessary to recover the costs of remediation through legal actions when possible or solve them with funds from fines, sanctions, or other mechanism that may be decided to implement in order to obtain financial resources.

Figure No. 6 shows, schematically, the proposed methodological approach to the management of a contaminated sites in Colombia.

As shown, the approach implies a series of steps and involves legal declarations; these declarations are necessary for the Environmental Authority to be able to legally act upon the responsible parties.

The process begins with the occurrence of any of four different conditions, either because there is a complaint from a citizen, collective, community or any institution placed to the Environmental authority regarding the potential contamination of a site; or the environmental authority, in exercise of its duties, has gathered enough information that indicates potential contamination; or there are previous inventories of potentially contaminated sites; or, lastly, there is a self-declaration of potential contamination. Any one of these will trigger the immediate declaration of Presumptive Contaminated Site by the Environmental Authority and will begin an internal search of further information, specifically environmental samples, that will indicate presence of substances of interest. If there are no records of environmental

[5] Currently, the legal definitions of these terms in the colombian legalframework are still to be agreed upon and publicly promulgated.

samples in the archives of the environmental authority, it will order the performance of an Environmental Due Diligence Assessment (a standardized assessment specifically intended to determine the potential of contamination of a particular site). Should the environmental authority have proof of contamination it, nonetheless, will order the Environmental Due Diligence Assessment in order to determine if there are no other substances present that may contribute to the contamination.

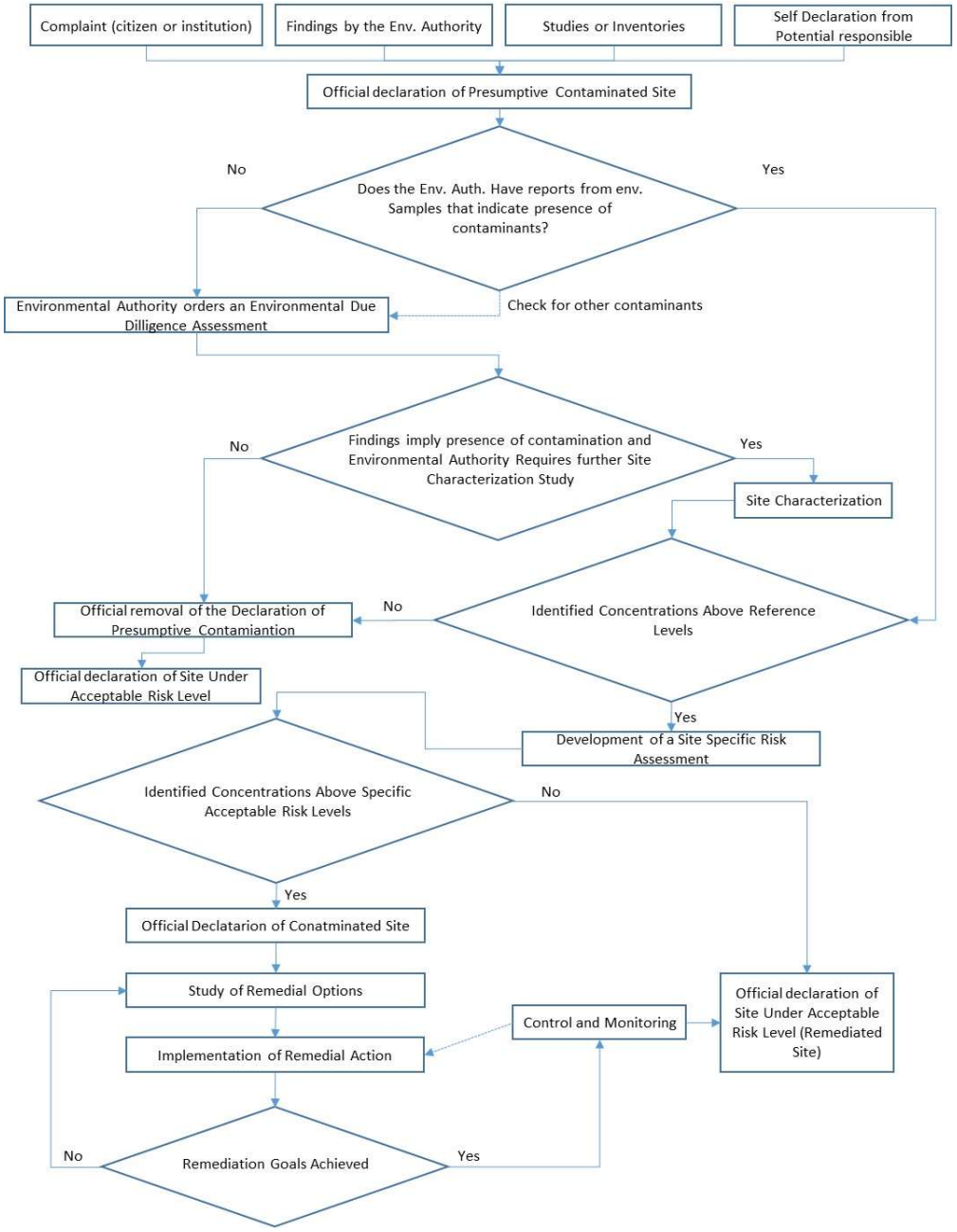

Figure No. 6 Proposed Management Sequence Flow Chart

The results of the Environmental Due Diligence Assessment will define one of two possible outcomes. If there is enough evidence to imply contamination the environmental authority will order the development and implementation of a site characterization procedure in order to identify, quantify and locate the contamination within the site being studied. If the assessment returns no indication of potential contamination the Environmental Authority will officially remove the declaration of presumptive contamination and declare the site within acceptable risk.

After the characterization of the site is made the results (concentrations of substances within the soil matrix) will be compared with a series of reference levels (concentrations of substances below which the risk associated with it is acceptable). Should the determined concentrations at the site be above those in the reference levels the responsible partner associated to the site is compelled to develop a Site Specific Risk Assessment in order to quantify the specific risk associated to the site given the concentrations found and the current land used defined for the site[6]. This risk assessment should be developed following a standardized procedure and should be submitted for approval to the authority.

The results of the Risk Assessment will be concentration values below which the risk is acceptable given the specific conditions at the site; if the determined concentrations are below this calculated value, the environmental authority will officially remove the declaration of presumptive contamination and declare the site under acceptable risk. If, in the other hand, the concentrations measured at the site are above those calculated by the risk assessment, the environmental authority will immediately declare officially that the site is contaminated (declaration of contaminated site) and will order the development of a study for Remedial Options to be prepared by the responsible parties and sent for approval to the environmental authority.

Once the Remedial Options are approved by the authority, the remedial procedures should be implemented. At the same time a periodical monitoring will determine the achievement of the remediation goals. Should those goals not be achieved by the implemented procedure, an alternative complementary procedure should be developed and implemented until the remediation goals are, indeed, achieved. Once the concentration goals are met, a monitoring program should be put in place and the environmental authority will officially remove the declaration of contamination and declare the site under acceptable risk level

It should be noted that in order to achieve a correct application and interpretation of a policy with this level of specificity, it is necessary that the officials and the professionals involved participate periodically in training and updating programs.

In the meantime, it is imperative to know or obtain background concentrations or background levels in order not to make the unnecessary effort of remedying at levels that are below natural concentrations.

[6] It is being currently discussed that the responsible party can skip its obligation of performing the Risk Assessment if it declares the reference levels as its remediation goals within a Remediation Plan to be submitted to the authority.

Another important point being discussed extensively deals with the sources of funding for the development of the environmental studies proposed within the framework. According to Colombian law, in particular Law 1333/09, the burden of proof lies in the citizen in environmental cases (Congreso de la República, 2009); which would imply that whoever the Environmental Authority declares as presumptive responsible should bear the costs. However, it would not be surprising that most potential responsible parties involved in a contaminated soil case might not have enough financial resources to fulfill the costs associated with the needed studies. Should the State cover those in the justified by the public interest?; should there be a national fund dedicated to such an end?. The answers of these questions cannot be addressed by an executive action, as the one proposed, but by the passing of a national law by congress. The specifics of such a bill are well beyond the reach of this work.

5. CONCLUSIONS

It is obvious the need for a legal framework for the management of contaminated sites on which the environmental authorities will base their actuation. Although there has been some progress, particularly in the hydrocarbon/energy sector, most of the administrative pronouncements have been based on the Hazardous Waste Management regulation which is not meant for the case of contaminated soils. This problem has been identified not only in Colombia but also in Argentina, even though the latter has developed some regulatory framework already. This highlights the need for training and communication of new regulatory developments towards environmental officials so they can apply the proper regulation to the problem at hand.

The creation of the ReLASC network has been an interesting development for the member countries and has served as stepping stone for the development of local regulation, mostly based upon USEPA procedures, as is the current case.

The development of the Santa Elena project gave the opportunity to identify the regulatory voids in the case of contaminated soils; the possibility of developing the procedures undertaken under the supervision of the Ministry of Environment allowed us to construct a sound proposal for the management of contaminated sites within Colombia.

The implementation of the proposed procedures implies the determination of background concentrations of some substances of interest within the national territory. This is a massive undertaking for the country. It is also necessary to define reference levels, either by adoption and adaptation of international ones of by development of a proprietary procedure for its definition.

The outcomes obtained in the Santa Elena case have been validation of the proposed procedure, given that most of what was done there came from the application and evaluation of a series of steps taken during the development of the project itself.

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