Comprehensive Project for the Collection and Final Disposal of Municipal Solid Waste, Puerto Peñasco, Sonora.

Contents

Executive Summary

Puerto Peñasco, Sonora, like other communities and cities in Mexico and other parts of the world, is currently facing serious problems in addressing environmental pollution problems caused by inadequate and inefficient final disposal of solid and liquid wastes. In terms of solid waste disposal, the Municipal Government of Puerto Peñasco lacks infrastructure and equipment, and therefore faces critical problems with its public maintenance services, which include: street sweeping, collection, transportation, and final disposal of solid wastes. The situation becomes increasingly critical considering that Puerto Peñasco is an ever growing tourist center.

The City of Puerto Peñasco, Sonora has facilities, equipment, and staff that provide public maintenance services; the department has 8 employees which focus primarily on sweeping streets and public areas, the city's commercial district, and tourist and downtown areas; 1 sweeping truck, 12 collection trucks (4 of which are outdated and inoperable), a CAT D6 tractor, two 7m3 dump trucks, and an open air landfill that covers a surface area of 18.5 acres.

The system provides daily street cleaning service to 11 miles of public streets and areas, collects and disposes of 40 tons of domestic solid waste; and disposes of 12 tons of non hazardous solid waste generated by the fishing, tourism, and service industry, hospitals, businesses, and public areas. The 52 tons of garbage handled on a daily basis total 90 percent of the solid waste generated by the community. This indicates that there are 5 tons being disposed of in illegal dump sites which are not controlled by local authorities.

The collection services provided by the Department of Public Services of Puerto Peñasco, aim basically to provide service to the residential areas and commercial areas in the downtown area of the city. To this effect, the urban area, which covers 2,470 hectares, has been divided into 5 sectors; service is provided to each sector on a weekly basis. Residents must collect and store their garbage for one week before it is collected, causing adverse effects on the health conditions of the residents, giving rise to proliferation of insects and rodents.

The community disposes of its solid waste in an open air landfill; only recently has the City Government of Puerto Peñasco implemented measures to cover the garbage with a layer of dirt and thus avoid negative effects on the environment which are caused by disposing of municipal solid waste in this manner.

With regard to recycling, the existing landfill has approximately 10 peopel who pick through the garbage, collecting metal, aluminum, and cardboard for resale purposes. This activity is practiced under hazardous unsanitary conditions and without any technical controls. Based on figures provided by these people, 661 lb of metal, 132 lb of aluminum (cans), and 1 ton of cardboard are collected weekly. These figures are low in comparison to the amount of garbage being generated by the community.

In Puerto Peñasco, Sonora, the lack of technical, sanitary, and environmental controls in the collection and disposal of solid wastes, is presenting an ever growing pollution problem. These problems have caused the degradation of the landscape as well as pollution to the air, soil, and water. Effects have also been felt by the wild flora and fauna of the region and there has been a proliferation of infectious disease carrying vectors. In addition, there are people sifting through the garbage at the dump site without any technical controls or measures.

This project is being submitted to address these environmental problems, as well as to ensure the well-being of the residents of Puerto Peñasco, by means of the preservation of their environment. In addressing these problems, through the provision of public maintenance services, which are technically, sanitary, and environmentally sound, the project will focus on the following activities:

- *Purchase new trucks to ensure timely and continuous collection services;*
- *Equip and construct a landfill in accordance with existing regulations to avoid negative effects caused by inappropriate disposal of municipal solid wastes;*
- *Close the existing open air dump to mitigate all negative environmental effects caused by this type of facility;*
- *Strengthen the institutional capacity of the Municipal Public Maintenance Department to guarantee efficient system management and operation.*

The project is an environmental infrastructure project and subsequently complies with the objectives of the Border Environment Cooperation Commission (BECC); therefore the Municipal Government of the Puerto Peñasco, Sonora has requested certification, and subsequent financing by the North American Development Bank, through a loan to cover the project's investments.

I. General Project Information

The project's primary objective is to provide the City of Puerto Peñasco the facilities and equipment required to provide its residents efficient public maintenance services, which include: street cleaning as well as collection and final disposal for solid wastes. With these measures, the city will be able to promote and encourage the preservation of the it's environment.

The project applicant is:

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Pursuant to Article 115 of the Constitution of United Mexican States, this authority has the right and responsibility, among others, to provide public maintenance services. In addition, the Ley Orgánica de Administración Municipal del Estado de Sonora, with regard to the faculties and obligations granted to municipal governments, Article 37, Paragraph XI, states that municipal governments are responsible for providing public maintenance services in their areas of jurisdiction.

The project is located within the city limits of Puerto Peñasco, Sonora, located in the northeast area of the State of Sonora, México; it is 270 miles from Hermosillo. Puerto Peñasco is 62 miles from the border cities of Sonoyta, Sonora and Lukeville, Arizona. One of the main activities is tourism due to its location on the Gulf of California, which can be accessed by State Highway No. 86 for travelers coming from the south and southeast areas of the State of Arizona, particularly Tucson and Phoenix. Travelers from the north and northeast areas of Sonora access the city on Federal Highway No. 8 and State Highway No. 2.

The City Government of Puerto Peñasco, Sonora submitted a request for assistance to BECC to be able to comply with the eight fundamental certification criteria in order to implement an integral public maintenance service project for the community. The project will address the environmental problems caused by inadequate disposal of solid wastes. Through its Project Development Assistance Program (PDAP), the BECC provided assistance to the project applicant, specifically in areas related to engineering, finance, and institutional capacity building.

Local authorities responsible for street cleaning, collection, transportation, and disposal of solid wastes generated by the residents of Puerto Peñasco, currently face serious problems regarding their ability to offer these services with the required technical, sanitary, and environmental controls. Among some of the problems they face, are:

- *Inefficient utilization of available capabilities for street sweeping.*
  - *Collection equipment is outdated, between 9 and 24 years old, which translates into shortages in collection capabilities.*
  - *Due to collection equipment being outdated, services are provided with low efficiency levels, causing a reduction in the number of collections.*
- *The existing open air dump is operated without management controls or any of the required technical, sanitary or environmental controls, causing an unmanageable dumping of garbage.*
- *Lack of controls has also frequently caused fires, which spurred by winds, take smoke and odors from the dump to the city and tourist areas.*
- *Lack of equipment to arrange, compact, and cover solid waste in accordance with established technical standards.*
- *Scattering of paper, plastics and other light weight materials, caused by lack of required retaining structure and strong winds, has contaminated areas in a 1.3 to 2 mile radius of the dump site.*
- *Institution lacks capacity to maintain an efficient operation and control level of the system it is responsible for.*

These problems are causing continuous pollution to the environment, which if not addressed immediately, will cause irreversible effects. Described below are some of the adverse effects:

- **Degradation of the landscape**. *Caused by the presence of tons of garbage dispersed in a foul smelling area, full of smoke and dust, and in which garbage pickers, insects, rodents and wild animals live. This situation is not limited to the area occupied by the dump site, it reaches a larger surface area, due to paper, plastic and other light weight material being transported by winds.*
- **Air Pollution**. *In addition to the smoke and gases being dispersed by the wind, organic matter contained in the garbage produces foul odors during the decomposition process, which are then dispersed into the outlying areas.*
- **Soil Pollution**. *The adverse effects on the soil caused by the open air dump site are a direct cause of leachates and dispersion of the waste.*
- **Contamination of the subsoil**. *The leachates that are produced during the decomposition of wastes, contain high concentrations of organic toxic substances, which are not controlled and are seeping into the sub soil.*
- **Flora and fauna**. *Uncontrolled dispersion of garbage and leachates are affecting the flora and fauna of the surrounding area; particularly those leachates with high concentrations of contaminants, such as heavy metals, BOD, COD, low levels of pH, among others, and which can be fatal to animal and plant species.*
- **Socio-Economic Effects:** *An open air garbage dump encourages garbage pickers to move in. These people sift through the garbage and collect material for resale under unsanitary conditions; in addition, the surrounding areas are no longer potential sites for production activities or urban development.*
- **Impact on Health:** *Un-managed garbage dump sites propagate a large amount of pathogenic micro-organisms; they also provide favorable conditions for the proliferation of disease carrying organisms.*

The solution to these problems lies in the selection and construction of the most appropriate solid waste management process, that conforms to the environmental, financial, and social conditions of the City Puerto Peñasco. Upon review of the physical, chemical, biological, and thermal processes, it was determined that the most viable process for this landfill project is a compacting process. This option also presents the best technical and financial requirements.

Four possible locations were analyzed during the landfill site location selection process. These options were evaluated utilizing the criteria proposed by SEDESOL; these criteria include: useful life, surface for coverage, topography, access means, dominant winds, location of site in relation to the urban area, geology, geohydrology, surface hydrology, and land rights. Based on these criteria, the site selected is a plot located 2 miles to the northeast of the city limits, on the San Rafael Ejido (public land).

The plot selected covers a 37 acres surface of public land which has not yet been designated for any specific purpose. In order to execute the land title, the Municipal Government of Puerto Peñasco has arranged for the transfer of property rights with the San Rafael Ejido.

The proposed project will resolve the problems relating to public maintenance services for the City of Puerto Peñasco and will require the following components:

- **Street Cleaning**: *Modify street cleaning routes to optimize use of resources available for this activity.*
- **Collection**: *Redesign collection routes. Purchase trucks to replace oldest ones in current operation.*
- **Landfill**: *Build basic infrastructure after purchase of property; prepare cells and fill material for the cover; construct drainage system and evaporation ponds for leachates, biogas control system, and internal roads; construct secondary projects which include: access roads, control booth, surface drainage system, scales, enclosure fence, signs, services, landscaping, and structures to contain light materials; and purchase equipment, i.e. trucks, chain grate tractors and loaders.*
- **Post Closure Program for Existing Landfill**: *Build maintenance systems to monitor and control leachates and biogas; shape filter and surface erosion layers, and landscape area.*
- **Institutional Capacity Building**: *Prepare proposal for modifying and developing maintenance regulations; optimize maintenance management services based on a reorganization program that will ensure institutional capacity building for the long term.*

The total cost estimated to implement this project is $1.37 million; the breakdown for this amount is the following:

$0.36 million - solid waste collection services

$0.63 million - landfill

$0.11 million - postclosure program for the existing landfill

$0.07 million - institutional capacity building

$0.20 million - unexpected expenses, oversee construction, taxes

The required time frame for project implementation is approximately 12 months; however, operations for the new landfill could possibly begin during month nine.

CONSTRUCTION PROGRAM

I T E M	1	2	3	4	5	6	7	8	9	10	11	12
1. Collection												
2. Landfill												

2.1 Basic Infrastructure												
2.2 Supplemental Projects												
2.3 Equipment												
3. Closure Existing Dump												
4. Institutional Cap. Bldg.												

2. Environment and Public Health

The environmental problems currently being experienced by the community, caused by inadequate final disposal of their solid wastes, are critical due to the negative effects being generated. An immediate solution to these problems requires the construction of a landfill that complies with existing regulations; closure of the current dump, and purchase of new equipment.

This project aims to avoid the continuous environmental degradation which is currently being experienced; in addition, closure of the existing open air dump, signifies that measures will be taken to mitigate environmental impacts and restore those caused by this source of pollution.

Compliance with various standards and laws, relating to pollution prevention and control is required. The Norma Oficial Mexicana NOM-083-ECOL-1994, defines required conditions for sites that will be used as landfills for the final disposal of municipal solid wastes. The site selected for construction of the landfill complies with the specifications outlined in this Standard, relating to soil, groundwater tables, useful life, location in relation to bodies of water, and urban areas, drainage and topography.

Compliance with NOM-084-ECOL-1994 is also required; this standard establishes landfill design and project construction requirements. The design of the proposed landfill is subject to the guidelines and procedures established under this standard.

With regard to the Ley General del Equilibrio Ecológico y la Protección al Ambiente, the article pertaining to public cleanup is: Article 6, Section XII, which addresses environmental preservation and protection in urban areas; and Articles 110, 117, and 134 pertain to prevention and control of air, water, and soil pollution.

In addition, the project falls under Chapter III of the Ley 217 del Equilibrio Ecológico y Protección del Ambiente for the State of Sonora, which pertains to the prevention and control of soil pollution by non hazardous solid waste; and under Article 22, Section IV, Paragraph VII, which pertains to environmental impact assessment requirements.

Currently, the Environmental Impact Assessment is being developed; it will be submitted for authorization to the state authorities on environmental and urban development. The National Anthropology Institute (Instituto Nacional de Antropología), has certified that the project has no effects on historical or cultural resources. In addition the National Water Commission (Comisión Nacional del Agua) will be requested to certify that the project has no effects on any surface or underground water resources.

The project area is located in the Sonoran Desert, which is a part of the Sepultadas Mountain Range; the region is characterized mainly by the presence of a long range of mountains broken up into parallel blocks that go from northwest to southeast; they are separated by wide plains which extend even more as they get closer to the coast. The landscape differs from the northwest area because it is interrupted by the Pinacate Sierra which is the highest point of elevation in the area; the area has no structural faults that could pose a potential risk to the construction of the landfill. Geotechnical and geophysical analysis indicate the soil types are made up of a layer of sandy clay containing caliche; permability is low, making them appropriate for construction of the proposed project. The site is located 19 miles away from the closest surface water resource, the Sonoyta River; in addition, drilling 394 feet deep did not locate any underground water.

The project has no impact on the physical environment; it does, however, have a positive impact on the social and economic conditions of the project's sphere of influence. Based on the studies carried out by SEDESOL, the environmental, sanitary, and social benefits resulting from a landfill, when compared to the existing open air dump in Puerto Peñasco, are outlined below:

ENVIRONMENTAL, SANITARY, AND SOCIAL BENEFITS PROVIDED BY A LANDFILL

FACTORS	OPEN AIR DUMP	LANDFILL
Ground	*Serious Contamination, loss of value.*	*Avoids contamination, recovery of unused lands.*
Water	*Contamination to surface and underground water resources.*	*No pollution exists.*
Air	*Fires produce dust, smoke, toxic gas.*	*No emissions caused by fires.*
Wild Flora & Fauna	*Poisoned and die.*	*No effect*
Dangerous Animals	*Proliferation of flies, rats, etc.*	*Controlled*
Sanitary	*Proliferation of disease carrying, and other types of rodents.*	*Total control of rodents.*
Socio-Economic	*Effect on agriculture, fishing, commercial, recreational activities, and on populated areas. Encourages economic conditions under deplorable conditions.*	*Minimal effects.*
Landscape	*Negative impact.*	*Minimal effects.*

Source: Technical-Management Manual for Public Maintenance Services. SEDESOL. November, 1995.

3 Technical Feasibility

For the final disposal of municipal solid wastes generated by the community of Puerto Peñasco, the process being proposed is physical and is carried out through the compacting of waste at the site of the landfill.

The landfill process is a technique used for the disposal of garbage into the ground, without affecting the environment, and without causing problems or a danger to public health and safety. This method also incorporates engineering principles to confine solid waste into the smallest surface area possible; it reduces the volume of solid wastes by compacting them into the smallest volume possible, and covers the wastes, deposited in this manner, with a layer of dirt as often as required, or at the end of every day. The objective of having a landfill is to establish a barrier between the environment and the waste, reduce and control gas emissions, and avoid filtering and leaking of leachates produced during the decomposition of the wastes.

Based on analysis of the physical, social, and environmental surroundings of the projects, and also on the Programa de Ordenamiento Territorial y del Centro de Población de Puerto Peñasco, Sonora, , the most feasible location to implement the landfill project was selected among 4 choice sites. The selected site is located to the northeast of the community and 2 miles from the city limits.

Basic evaluations were carried out to determine whether the selected site complies with conditions outlined in the Norma Oficial Mexicana NOM-083-ECOL-1994. The evaluations include: topography, to determine whether the natural slope was less than 30 percent; geotechnical, determined whether the subsoil material in the area has a permeability coefficient of 10^{-5} cm/seg; geophysical, determined that through 7 vertical electrical drillings (VED) distributed in two research profiles 394 feet deep each, identified three units, or strata with matter showing low levels of permeability, no structural anomalies; and geohydrology, determined that no groundwater tables were found during the drillings.

In the 1995 census, INEGI determined that the population of Puerto Peñasco, Sonora, totaled 27,610, differing greatly from the 35,000 that local authorities are handling. Bearing this difference in mind, it was determined that the real 1996 population count could actually reach 31,214; this figure has been estimated and applied for the urban development programs proposed in the Programa de Ordenamiento Territorial y del Centro de Población de Puerto Peñasco, Sonora, prepared and published in the Diario Oficial by the State Government in 1995.

Due to development prevalent in the area, specifically in the tourism and fishing industries, projections indicate that these conditions will remain constant. The average population growth rate will remain at an annual constant rate of 3% percent. Based on this annual growth rate in population, applied in the population projections that appear in the Programa de Ordenamiento Territorial y del Centro de Población de Puerto Peñasco, and developed by the State Government, they indicate that by the year 2011, the population is expected to reach 48,630; this is also the last year of the project useful life-time.

The project area is located in the Desierto del Altar (Altar Desert). It is characterized as being one of the most arid regions in North America with climate conditions being dry heat and with an average annual temperature of 88°F. Annual average rainfall is 3 inches and is lower than the recorded annual average evaporation rate of 7.5 feet.

With regard to soil types, analysis indicate that soil in the project area is composed of a layer of clayish sand with caliche; underlying this layer is a sand packed in clay, with a permeability level less than 10^{-5}; these characteristics are suitable for the construction of the proposed landfill.

STREET CLEANING

Street cleaning services for public streets are provided primarily in the tourism and business sectors of the city. Streets are cleaned both mannually and with mechanical equipment; there is an 8 person public cleaning staff as well as a sweeping machine. According to data provided by the Public Services Department, service routes for the area of 11 miles of paved avenues and streets are not defined.

Based on data developed by SEDESOL, the efficiency levels for this service is 0.3 mi/sweeper/day; considering the city has 11 mi of paved avenues and streets and a public maintenance staff of 8, along with one sweeping machine, it has been determined that both the manpower and mechanical equipment are sufficient to provide 100 percent service to public paved roadways.

Based on this information, the public maintenance department would keep the current staff of street sweepers to provide service to parks and public areas; the street sweeping machines will provide service to the paved areas in accordance with the routes that have been developed.

GARBAGE COLLECTION

Collection services are the most important element of an comprehensive public maintenance system requiring between 60 and 80 percent of the total costs.

Currently, collection services for the City of Puerto Peñasco, Sonora, utilize a direct sidewalk pick up service. This service consists of the vehicles going through the city streets with operators picking up the garbage that residents have placed in either trash cans or plastic bags along the sidewalk. Each truck has its assigned sector or zone. Once the truck is full, it transports the garbage to the final disposal site.

The City Government of Puerto Peñasco has 12 collection trucks, though only eight are in working condition; these trucks provide service to the six sectors of the city that have been zoned for collection service. Of these sectors or routes, 5 consist of residential areas the trucks provide service to on Monday through Friday, and 1 truck provides service to the tourist and business sector on Saturdays. Because routes are long and efficiency levels low in all the sectors, only one pickup per week is feasible; users must store their garbage for at least 7 days before their next pickup. Only the northeast of the city which is the most densely populated, has pickup services twice per week.

Collection services are provided to 100 percent of all residential areas as well as to some businesses and offices located in the downtown area of the city. Forty tons of garbage are collected on a daily basis; considering there are eight trucks in operation, efficiency levels are 5 tons/truck/day. Of the volume collected, 37.5 tons are domestic waste and 2.67 tons are non hazardous solid waste generated by manufacturing activities.

In addition to the solid waste managed by the collection system, there are other sources generating garbage, which is taken directly to the municipal dump site. These other sources have been identified and include the fishing industry, businesses, service providers, hospitals, and markets. The total amount generated by these other sources totals 12.26 tons per day.

Taking into account these volumes of garbage and considering that local authorities have identified illegal dumping that totals 10 percent of the total amount of garbage being disposed of in the city dump, it has been determined that the total amount of garbage being generated by the city of Puerto Peñasco, Sonora, is 57.67 tons of garbage per day. With a population of 31,214, the average amount being generated is 4 lb per person/day.

The project proposes to provide collection services to 100 percent of all generators of solid waste, but assumes that 21.3 percent of all wastes will continue to be deposited directly by users into the landfill. The collection system design includes:

- *Increase collection routes to eight (8)*
- *Purchase five (5) collection trucks, with a capacity of 20 cubic yards*

The project proposes the immediate purchase of five collection trucks to replace the most outdated trucks currently being used; subsequent purchase of the remaining trucks would be carried out until all requirements for the project have been met.

INFORMATION ON COLLECTION SYSTEM

Item	Unit	Current Status 1996	Project Status 1997	Project Status 2011
Population (1995)	*Person*	*31,214*	*32,150*	*48.630*
Rate of Garbage Generation	*lb/person/day*	*4*	*4*	*4*
Amount of Garbage Generated	*Ton/day*	*57.7*	*59.4*	*89.8*
Collection Requirements	*Ton/day*	*40.2*	*46.8*	*70.8*
Avg. Garbage Density	*lb/ft^3*	*25*	*25*	*25*
Total Volume Collection Requirements	*ft^3/day*	*3546*	*4129*	*6246*
Capacity of Trucks	*yd^3*	*20*	*20*	*20*

Trucks Required	*no.*	*7*	*8*	*12*
Available Trucks	*no.*	*8*	*5*	*9*
Double Shifts	*no.*	*0*	*3*	*3*

FINAL DISPOSAL

In spite of efforts being carried out by local authorities, 52.4 tons of solid waste generated by the community, are being dumped in an open air location without any technical, sanitary, or environmental controls.

The collection trucks compact garbage to an average density of 25 lb/ft^3; during the disposal process; it increases in density to an average between 31 lb/ft^3 to 38 lb/ft^3, and later when garbage is covered with the cover material, it increases to an additional 6 to 9 lb/ft^3. Pursuant to Official Mexican Norm #NOM-083-ECOL-1994, which establishes landfill volume requirements, it is advisable to consider a density of 38 lb/ft^3 in an open, daily cell design. To determine the landfill's useful life, the density considered should be 47 lb/ft^3.

Considering disposal in rectangular cells, the spatial and volumetric characteristics have been established for the daily cell for each year of useful life-time of the project, considering thicknesses of 5.6 ft of garbage, 1 ft of cover material between layers, and 52 ft wide daily cells of variable length.

DESIGN FOR DAILY CELL PROCESS

Year	Popu-lation	Garbage Generated Ton/day	Volume of Garbage yd^3/day	Volume of Cover Material yd^3/day	Total Volume yd^3/day	Surface of Daily Cell ft^2
1997	*32,150*	*59.40*	*128.70*	*38.61*	*167.31*	*692*
2000	*35,131*	*64.89*	*140.60*	*42.19*	*182.78*	*756*
2005	*40,727*	*75.22*	*162.98*	*48.90*	*211.87*	*877*
2010	*47,214*	*87.20*	*188.94*	*56.68*	*245.62*	*1017*
2011	*48,630*	*89.82*	*194.61*	*58.38*	*253.00*	*1047*

Based on topographic surveys of the selected site, 37 acres of surface area are available for the landfill project; surveys also indicate the feasibility of disposing of solid wastes in three layers. Each of the three layers will be 5.6 ft deep; the middle/interval layers will be 1 ft deep; and top cover seal will be 2 ft deep. In order to obtain the highest efficiency levels of the surface area and given the natural slope of the selected site, the project proposes to develop the landfill with 3 layers that will be 20 ft deep with a 3:1 slope ratio. The first two layers will bury the cells under the natural slope and the third layer will be placed on top of the natural slope. Under these conditions, the useful life-time of the landfill was determined to be:

USEFUL LIFE-TIME OF THE LANDFILL

Year	Accumulated Generated Garbage Mass (Tons)	Accumulated Generated Garbage Volume (yd^3)	Accumulated Volume of Cover (yd^3)	Required Surface Area (acres)
1997	*19,186*	*32,257*	*9,976*	*2.0*
2000	*80,268*	*139,131*	*41,739*	*8.2*
2005	*194,915*	*337,853*	*101,356*	*19.86*
2010	*327,822*	*568,225*	*170,468*	*33.40*
2011	*356,843*	*618,527*	*185,558*	*36.36*

In order to guarantee proper operation of the landfill, the following measures have been considered necessary:

- *Purchase of 37 acres from Ejido San Rafael.*
- *Clean up of 155,000 ft^2 and excavation of 17,265 yd^3 of material to open up the first stage and have a stock of cover material.*
- *Construction of a drainage system for leachates; pipes will be made of PVC and 2789 ft long with varying diameters.*
- *Construction of treatment ponds for leachates; ponds will be 1471 yd^3 and levees will be 863 yd^3.*
- *Construction of 30 structures to control biogas.*
- *Construction of 26,911 ft^2 in internal roads.*
- *Control booth with 111 ft^2 of building area.*
- *Supply and installation of weigh station with a 40 ton capacity.*
- *6600 gallon tank and pump; 1321 gallon fuel storage tank; and a radio communications system.*
- *Construction of 3 miles of access roads.*
- *Landscaping with 160 trees.*
- *Construction of 5250 ft of enclosure fence.*
- *Construction and placement of 69 signs.*
- *Equipment consisting of one pick-up truck, a 2100 gallon tank truck, a 130 HP bulldozer equiped to work with chains and a 120 HP chain carrier, both should have landfill operation capabilities.*

RECYCLING

The official Mexican Standard, NMX-AA-22/85 was applied for the selection and quantification of municipal solid waste by-products. Studies have determined that the composition of garbage generated by the community of Puerto is composed of:

organic material: 35 percent

paper and cardboard: 20 percent,

glass: 20 percent

plastic: 6 percent

tin: 5 percent,

aluminum: 2 percent

textiles: 7 percent

other: 7 percent

By-products that could potentially be recycled are: paper, cardboard, glass, tin, and aluminum and represent 51 percent of all waste being generated.

These numbers suggest the possibility that recycling could lead to a more sustainable project, however, preliminary financial estimates, as well as visits to several collection and recycling centers, indicate recycling systems are not cost effective due to the low commercial value of by-products, and therefore, recycling is not a feasible component for this project. The commercial value of cardboard is $38/ton, paper is $23/ton, glass is $34/ton, aluminum is $52/ton, and plastic is $88/ton; the distance to collection centers, such as Hermosillo and Navojoa, Sonora; Mexicali, B.C.; Monterrey, N.L., and/or Phoenix, Arizona, ranges between 250 to 940 miles. The distance factor relates directly to the high transportation costs, which are currently running approximately $0.60/ton for the 1st mile and $0.17/ton for each subsequent mile.

CLOSURE OF THE EXISTING OPEN AIR DUMP SITE

With the construction of a new landfill, the existing open air dump site will have to be closed in order to mitigate any negative environmental effects. Construction of the new landfill will also avoid illegal dumping of solid waste as well.

In this regard, the required studies have been carried out to determine among other things, the current conditions of the humidity levels, cation exchange, and height of garbage layers. The clean up system has been designed with four biogas monitoring stations, four leachate monitoring stations, final cover seal, landscaping components, and facilities for shelter and site control.

4 Financial Feasibility

The project preliminary budget, which includes the proposed infrastructure and equipment components for the maintenance system sums $1.37 million. Most of the investment costs are for the landfill equipment, $0.37 million; supplemental infrastructure for the landfill, $0.14 million; and collection equipment, $0.36 million.

INVESTMENT SUMMARY

ITEM	AMOUNT ($)
1. Collection	*363,333*
2. Landfill	*625,166*
2.1 Basic Infrastructure	*114,499*
2.2 Supplemental Projects	*139,339*
2.3 Equipment	*371,327*
3. Closure of Existing Dump	*106,052*
4. Institutional Capacity Bldg.	*69,920*
Sub Total	*1,164,471*
Unforseen Expenses 5%	*58,224*
Construction Oversight 5%	*21,593*
V.A.T. 10% (Value Added Tax)	*124,429*
Total Investment	*1,368,716*

With regard to the financing sources, the project proposes to have the Municipal Government of Puerto Peñasco contribute 15 percent of the total investment costs, SEDESOL (federal grants) to contribute 35 percent, and NADBank to grant a loan for the remaining 50 percent.

FINANCIAL STRUCTURE

SOURCE	AMOUNT	CONTRIBUTION (%)
Municipality	*$205,308*	*15*
SEDESOL (Grants)	*$479,050*	*35*
NADBANK Loan	*$684,358*	*50*
Total	*$1,368,716*	*100*

Since the City of Puerto Peñasco has not held public meetings on rates for the municipal clean-up services and thus be able to satisfy the NADBank loan payback requirements, this breakdown is still preliminary. The meeting has been scheduled for September 27, 1996.

The project total operation and maintenance costs for the first year have been preliminary estimated at $0.77 million per year; these costs will increase gradually to $0.99 million during the last year of the project's implementation. It must also be noted, that these costs include capital equipment replacement and facilities investments. During 1995, the Municipal Government of Puerto Peñasco spent $0.36 million on capital equipment replacement; however this amount does not include the depreciation of equipment and facilities.

PROJECTED OPERATION & MAINTENANCE COSTS

($/YEAR)

ITEM	1ST YEAR	2ND YEAR
1. Public Sweeping Service	*$95,809*	*$95,809*
2. Collection	*$322,211*	*$530,097*
3. Final Disposal	*$355,882*	*$365,896*
Total	*$773,903*	*$991,802*

User Rates

Currently, the Municipal Government of Puerto Peñasco does not directly bill users for public maintenance services. Property taxes include payment for these services, however, this contribution does not include it in a specific line item. Normally, costs for each one of the public maintenance components have been subsidized by the different city administrations. This has turned into an economic burden on the city and has had a substantial effect on the public finances and on the efficiency levels of all the services provided by the city. Based on this, it has been considered necessary to establish a rate system that will allow the Municipal Government of Puerto Peñasco to bill for public maintenance (street sweeping), and solid waste collection and final disposal in order for the system to operate efficiently and profitably.

In applying the methodology proposed by SEDESOL, for establishing a rate structure for the comprehensive public maintenance and solid waste handling and disposal system, it has been determined that the total cost for services will be $38.11 for each ton of garbage that is handled.

COSTS FOR COMPREHENSIVE PUBLIC MAINTENANCE SYSTEM

ITEM	COST ($/month)	COST ($/ton)
1. Street Sweeping	*$7,987*	*$4.16*
2. Collection	*$35,224*	*$18.34*
3. Disposal	*$30,048*	*$15.61*
TOTAL	*$73,259*	*$38.11*

The rate structure required by the project is currently being developed and will be presented to the community at the aforementioned public meeting. It must be noted that in addition to the estimated income from user rates, the City Government has agreed to allocate part of tolls charged at the San Luis Rio Colorado international bridge for loan amortization. Municipal subsidies will facilitate gradual increases in resource generation during the first years of operation and will also consolidate a payment culture in the community.

5 SOCIAL ASPECTS

Despite the current economic crisis being experienced in Mexico, during recent years economic development in Puerto Peñasco has experienced a constant increase, spurred in large part by the tourist industry.

With regard to the production sector, in the primary activities, fishing is the most important activity due to its production and also to the 2,730 jobs generated by the industry. In the secondary sector, industries connected to the fishing industry are the most prominent; there are eight packing and freezing plants, and ten shipyards. As stated earlier, the tourism industry is one of the main economic activities. The area has nine tourist developments, 13 hotels with 698 rooms, and facilities with 786 spaces for mobile/camper homes.

Based on information provided by the Population & Housing Census, during 1960 and 1995 Puerto Peñasco's population increased from 3,370 to 27,160; this increase represents an annual growth rate of 6.14 percent. However, during 1980 and 1995, the growth rate in absolute terms has experienced a decrease and is at 4.0 percent during 1980 and 1990 and 0.77 percent during the 1990 - 1995 period. Based on the most recent annual growth rate and applying it to population projections starting in 1990, it is estimated that the current population of Puerto Peñasco is 31,214.

Residents of the city are able to rely on all basic urban services; 95 percent of the community has water supply; 70 percent has sewage and wastewater collection services, and solid waste collection and disposal services. All of these services are offered on a restricted basis due to problems in operation that local authorities face in the provision of these services. These issues must be addressed to avoid negative impacts on the environment.

The project proposes to address problems related to public maintenance: street sweeping and solid waste collection and final disposal, which translates into an overall benefit to the entire population of Puerto Peñasco, Sonora.

The most significant socio-economic benefits are:

- *Improving quality of life for residents of the community; residents will not have to endure foul smells and smoke currently being dispersed by the existing open air dump into the city.*
- *Collection services will be more constant; garbage will not have to be stored. Diseases and harmful fauna will be eliminated.*
- *The land surrounding the dump site will gain any value lost; it may be utilized for urban commercial purposes.*
- *Closure of the existing open air dump site will eliminate a source of groundwater pollution and no significant economic investment will be required to treat contaminated soil or water resources.*
- *There is no effect on restricted environmental areas, archaeological sites, or cultural or historical resources.*
- *The site of the landfill will be better utilized.*
- *Risks to health will be reduced once the source of disease carrying rodents is eliminated.*

6 COMMUNITY PARTICIPATION

The Comprehensive Community Participation Program is in the process of being designed to present the Comprehensive Public Maintenance Project to all the residents of Puerto Peñasco, Sonora, as well as to provide access at all times to the technical, financial, social, and environmental information, supporting the project. It has also been designed to encourage the community to play an active role in all stages related to planning, programming, the BECC certification process, as well as the NADBank loan process required for the construction of said project.

To reach these objectives, an extensive outreach program has been implemented and a Municipal Committee has been established with members from non governmental organizations and the community in general.

The following measures have been established by the committee in order to fully comply with the those objectives established by the Comprehensive Community Participation Program:

- *Develop an opinion survey that indicates community support for the project; provide written report to BECC.*
- *Prepare press releases.*
- *Hold informational meetings regarding the project in the various sectors of Puerto Peñasco, Sonora.*
- *Hold meetings with interested environmental organizations, whether governmental or non-governmental, from both the U.S. and Mexico.*
- *Hold weekly meetings with members of the Municipal Committee present, in order to evaluate progress and results of the community participation program.*
- *Develop a radio outreach program with regional scope.*
- *Schedule General Public Meeting on September 27, 1996, public notice given under terms established by BECC.*
- *Submit to BECC written report on results obtained from the Program.*
- *Develop a post-certification community participation program to keep public aware and informed.*

7 Operation and Maintenance

The Administrative Section of the Municipal Government of Puerto Peñasco has under it the Department of Public Services which is directly subject to the Mayor's Office. This division is in charge of managing and operating the comprehensive public maintenance system: street cleaning and solid waste collection and disposal.

The division has 75 employees; 41 of the employees work in public maintenance. Eight of the 41 are assigned to street cleaning, 28 to collection,, 1 operates the final disposal equipment, and 4 employees are in charge of maintenance of facilities and equipment.

The project proposes keeping these employees, however hiring an additional eight more employees will be necessary. There will be a need to hire 2 operators, 3 drivers, 2 assistants, and 1 supervisor for the final disposal section.

All staff members will receive required training regarding detailed landfill operations, safety, fire prevention and control, and environmental protection.

Operation of the landfill shall be carried out in an organized and disciplined manner. The manager or supervisor shall be required to have the technical knowledge to facilitate, among other things:

1. *Control of all solid waste imported to landfill*
2. *Control of all vehicles and persons passing through the gates*
3. *Direction of traffic and discharges.*

The project operation start up program will start once the first level of the landfill has been leveled and the leachate collection pipes have been installed. The portion of waste discharged and taken by tractor/loader to the landfill location, will be arranged and distributed homogeneously in 8 inch. layers; the tractor/loader will then pass over the parallel strips 4 or 6 times in order to compact the surface of the extended garbage.

To conclude one day's worth of filling, the tractor will extend a 1 ft layer of soil, and will compact it so that it entirely and uniformly covers the garbage. Once this first stage is concluded, this section will be covered again with a 2 ft layer that will level and support the vegetation that will be planted; this vegetation should be native to the surrounding area. Pedestrian and vehicle access means shall also be designed, depending on the size of each section; an iron mesh will be installed to protect the gas discharge pipes.

The control system for the landfill shall include operational, administrative, and environmental aspects. The operational controls will facilitate continuous and permanent operations of the equipment; the administrative controls will facilitate the efficiency through the use of statistics that indicate yields, as well as all output and input. Environmental controls will consist of verification of adequate permeability of the sub-soil and efficient operations of the leachate and biogas control systems; biogas and water quality monitoring will be mandatory at different distances as well as depths of the landfill.

The site of the landfill shall be linked, at least by portable radio; it is also advisable to implement required fire control measures to control any fires starting in the garbage itself, the equipment or facilities. Fire extinguishing equipment should be readily available at the landfill, including volume required to cover given surface, and a water line. Close communication should be maintained with the Fire Department in order to respond immediately to any emergency. The landfill will also have a guard booth at the entry which will have three extinguishers ready for any type of emergency. The system also includes the installation of a permanent tank truck that will be used to compact the daily coverage soil. Therefore, water will always be readily available for any emergency.

Furthermore, garbage picking will not be allowed in the daily operations of the landfill.

8 SUSTAINABLE DEVELOPMENT

The National Development Program for 1995-2000, defined the Environmental Policy for Sustainable Growth, in order to make better use of the natural resources. The Policy also warns against the drastic degradation of the ecosystems caused by inadequate and illegal disposal of 30 percent of all municipal solid waste that is not collected. Based on this, it has been considered that the project complies with this policy and contributes directly to the strengthening of sustainable growth of the area.

In addition, the project will make several contributions to the sustainable development of the area, such as:

- *Elimination of air, water, and soil pollution caused by solid waste disposal in the existing open air dump site.*
- *The public maintenance system will be efficient and will decrease the number of illegal dumpings; it will also improve the image of the community by having cleaner streets; the community will not have to store garbage for several days. The system will also provide final disposal services that are controlled and will mitigate any risk of pollution.*
- *The solid waste disposal process that will be utilized is the most viable and economically feasible because of the level of training required.*
- *Control of all leachates will mitigate any risk to the wild fauna y flora.*
- *The project fully complies with existing standards and design for confinement and final disposal facilities as well as with prevention of solid, water, and air pollution caused by the disposal of solid wastes.*
- *The project will create eight permanent jobs.*
- *The project will control infectious disease carrying rodents that pose a risk to the health of the community.*
- *Closure of the existing open air dump will eliminate a source of air, water, and soil pollution.*
- *During the project useful life-time, recycling will be encouraged if sale of by-products is economically feasible.*
- *The 3R Culture, **Reduce, Reutilize, and Recycle**, will be promoted and encouraged within the community in order to address problems relating to solid wastes and also to reduce negative environmental effects.*

INSTITUTIONAL CAPACITY BUILDING

One of the project highlights consists of the efforts aimed at institutional capacity building. Through the Department of Public Services, the project will increase efficiency levels of its assigned operations. Some of the identified actions include: development of a project proposal for modifications and additions to the regulations pertaining to public maintenance, collection, transportation and disposal of solid wastes. Actions would be implemented through a reorganization program designed to optimize management of services that will strive for institutional capacity building that will guarantee its permanency.