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CREEK REVITALIZATION PROJECT: TRANSFORMING SURAT CITY THROUGH SUSTAINABLE AND SOCIAL INFRASTRUCTURE

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Abstract: **: The entire perception of water in Indian philosophy is quite different. The structure of many cities in the world is linked to the water bodies that contribute to their beginning and succeeding development. Waterbodies in urban areas like creeks, ponds and wetlands are vital to the social and ecological health of cities. The revitalization and redevelopment of waterbodies require planners to adeptly respond to other cultural and economic issues at local, state and global scales. Creeks being an important part of natural drainage system in nature should have some special attention towards its preservation, and thus integrated approach of planning becomes vital for development. Adopting such approach of planning the project can be made feasible in all aspects. Creeks don't only provide natural channel for storm water runoff, but at the same time better recreational facility can be provided surrounds it. Surat city has a very nicely distributed creek network in it. This Study carried out in this dissertation is basically centred for the development of creeks in sustainable manner by adopting the integrated approach of planning and this study could be a foot print for the development of water bodies like creek in urban area of Surat city.**

KEY WORDS: Creek Revitalization, Sustainable Planning, Redevelopment, land use pattern, Recreation, Social infrastructure

1. INTRODUCTION

In cities, the undisturbed land use process exacerbates the relationship with the depletion of natural resources. Landscape has always been and worked as an infrastructure. But the role of nature as part of a larger technological system has been through great rejection, mainly during the 20th century, when monofunctional engineering in the task of tame environmental processes became the paradigm of mankind. Particularly in cities, efforts towards efficiency in the control of nature often mean irreversible damage to the performance of ecosystem services. Urbanization processes greatly alter the urban water cycle and the responses of river systems to the built environment. During the initial transition from the industrial phase of urbanization in the second half of the twentieth century. Many cities have found a new base for such development between former industrial complexes and docklands, ideally located along their internal waterways. In recent years, this type of urban project has become a new "normality" to explore the future of contemporary cities on a global scale.

Surat city is one of the fastest growing cities in India. It has a main perennial river Tapi flowing through it. Population of city have crossed sixty lacs according to the 2011 census data. The city of Surat has seen remarkable population growth in recent decades and this process of urbanization causes migration to cities. The growing population has put pressure on the urbanized area and resulted in disastrous urban sprawl. The state government has increased the limits of the municipal area under the administration of the municipal corporation to regulate and make the development sustainable. The Tapi river flows through the city of Surat, though in the southern part of the river, the entire network of natural tributaries i.e. Varachha tributary, Koyali tributary, Mithi tributary, Kankara tributary, Bhedwad tributary, Khajod tributary and Sonari tributary, Mindhola. Relating to river system. About 57 km of the total length of these tributaries passes through the Surat city area. The tributaries are playing an important role in carrying polluted water to the river and are having a significant impact on the water quality, quantity and aquatic life in river as well as well as the Arabian Sea.

Creeks are naturally developed small streams that serve as good surface storm water networks. The development of the area around such water bodies can serve as a recreation area, and prevent unauthorized encroachment near

the it by enclosing the area with some specific purpose, mainly in urban areas along river banks, creeks, small streams and lakes. There are pollution issues in water bodies like Unauthorized encroachment, dumping of waste etc. Pollution in such sources creates ecological imbalance, basically contamination of groundwater and the land near it. So, such land becomes unusable for recreational development or any other use due to unhealthy environment.

Sustainable means "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Over population not only leads to increase in consumption of waste generation and sustainable development if the management of the city is not good to deal with such problem, thus the resources available in the city to meet the demand of serviceability gets reduced. In this sustainable development the water bodies of the urban area are the most prone to problem.

The sustainable development of such valuable urban commodities land and water becomes so essential because of their acquired importance. A definition is self-explanatory, water should be well conserved in a usable form and land should also be developed with certain regulatory measures. Problems like slums can be avoided if the land near the water body is well maintained as reservation land for the local authority. Land parcels near water must have reservations in the form of open land recreation, roads or any other form of temporary structures.

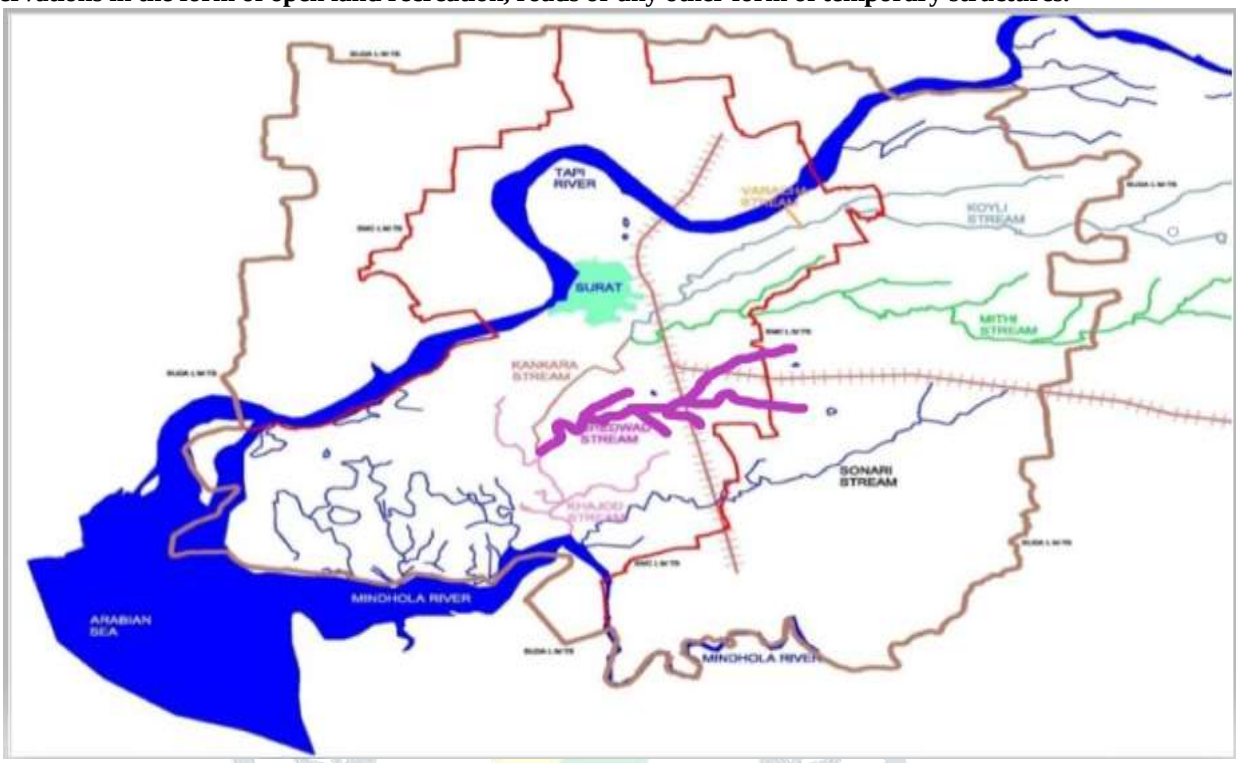


Figure 1- All tributaries of Surat city

2. PROBLEM DEFINITION:

Surat city has observed remarkable population rise in recent decades. This process of urbanisation increases the migration and urban sprawls in city. To regulate such development and make it sustainable, government increased city area under administration of Surat Municipal Corporation. Economy of city is based on diamond, textiles and Zarikam, which has attracted high amounts of migrants to the city. The Surat city has well established network for sewerage collection.

For recently merged to city limits, the process of equipping with sewage collection network system is taken up. The treated sewage is disposed of in drains (creeks). Quality of treated sewage is being monitored constantly by the established facilities at STPs of SMC. South zone has a key of growth for overall city's development since some of the largest industries like Pandesara GIDC and Sachin GIDC, they are having some manufacturing and processing units which have discharged their polluted wastages in to nearer creek as it flows through the industrial area. Whereas in southern part of city drains its storm water mainly in the creeks namely Koyali, Mithi, Kankara, Bhedwad, Sonari and Khajod.

The reason being the discharges/ inclusion of polluted water from various known and unknown sources such as households, slums, small-scale industries from the areas having no sewerage network and discharges polluted water to the drains having irregular section with weed/bush growth on side slope of drains. Silting and constriction due to uncontrolled solid waste dumping and encroachments by the poor on the banks have interrupted the flow of wastewater and storm waters, thus, causing them to spill into neighbouring areas. Many urban land parcels along the creeks are not yet developed, so there are chances of development of such parcels if creek preserved in sustainable manner. More over the common treatment plant is proposed to functioning the polluted water and waste discharged in to creek, which ultimately helps in flowing of clean water in it.

3. CONCEPT OF CREEK RESTORATION

Natural riverbank characteristics cannot be determined without the communities that lie within the riverbank zone. There are many different ecological communities of living and non-living components that exist along the landforms in and around the riverbed. Natural riverbank communities include hydrology, landforms, soils, aquatic species, and other living habitats such as vegetation and animals. These are located around the river basin and serve various functions that benefit from the riverbank system. For example, the vegetation that grows along river banks

depends on the type of soil and water in a particular area. This indicates that there may be many different ecological communities that exist along the river. The types of landforms and channel slopes contribute to the formation of other riverbank features such as pools, reefs, rapids, cascades and steppes. In fact, as the stream changes, sediment load and soil type play a decisive role in controlling the plant species that grow around the river.

"A narrow stream that is smaller than a river or minor tributary of river or an inlet of the sea"

The growth and development of cities and towns mainly depends on three important factors- its geographical location, physical environment and its socio-economic environment. The presence of water in various forms in the natural environment plays an important role in enhancing the quality of physical environment and socio-economic environment. During the processes of growth and expansion of cities and towns, the location of water bodies is looked after by Planners and policy makers treat it as a liability and a constraint rather than an asset or resource.

Creek restoration in highly urbanized settings offers unique opportunities for the community to prosper in decaying brownfield areas. These projects can enhance a sense of identity through the creation of a cultural system that results in a historical focal point, showing that flood control does not have to be ugly. Successful Urban Creek restoration projects, in which urban design elements have been integrated, have resulted in "river walk" type features that can enhance quality of life and human activity as well as environmental enhancement.

Urban creek restoration (revitalization) involves more than just removing non-native plants and replacing local ones. Redevelopment projects often include existing flood control facilities or flood protection requirements that usually appear as physical barriers rather than as opportunities. The introduction of an urban design element as part of a flood control plan helped develop a vision for the project that integrates adjacent redevelopment areas that would result in vitality and grace to the community.

Creek restoration through urban centres requires a flexible design program in collaboration with river engineering, hydraulics, urban design, environment and ecology, landscape and bioengineering, and commercial development that allows for collective solutions. Add to that: volunteer management skills and a broad knowledge of bird, amphibian, fish and mammal habitats; flood plain control; water quality; Government Ordinances; And the right size for park benches, bike trails and trail chips.

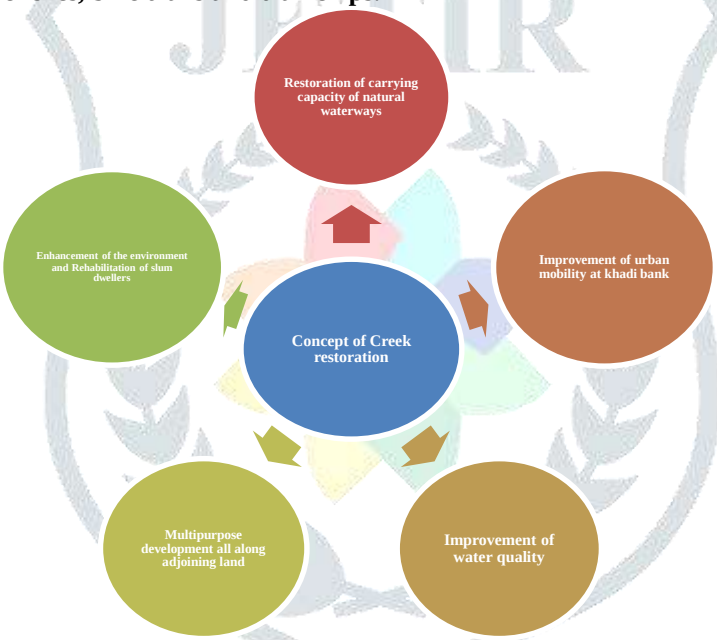


Figure 2 Concept of Creek restoration

4. PARAMETERS FOR SUSTAINBLE CREEK RESTORATION:

Creek restoration typically involves the environmental restoration of riparian corridors with passive public access and providing limited access to the community. However, within densely populated urban centres this primarily single-action restoration program may have limited environmental benefits and funding may be difficult to obtain. A program that focuses on integrating urban design elements can integrate economic benefits for the environment as well as the community which can help fund the program by attracting private investment.

Various parameters are responsible for the creek development and also these parameters are identified to differentiate them in category wise to understand in better way.

The parameters are categorised in physical, social, economic, environmental and Management and further it classified in sub parts.

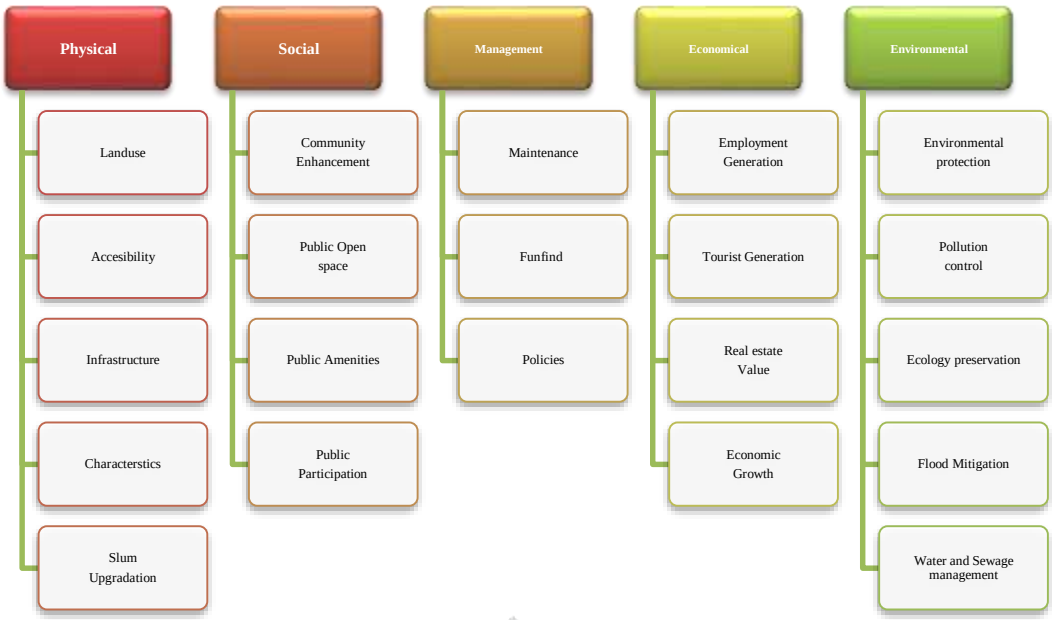


Figure 3 Parameters of development

Sustainable development has gained wide acceptance since its implementation Global Agenda by the World Commission on Environment and Development in 1987. Most cited definition of sustainable development, published in Bruntland Report, refers to

''Development that meets the needs of the present' without compromising on the ability of future generations to meet their own needs''.

This reflects the dilemma inherent in human evolution between meeting human needs, especially the urgent needs of the world's poor, and limitation on the environment's ability to cope with the consequences. Basin stand at the centre of emerging challenges in terms of water security, food production, socio economic development, as well as climate change. The management of basin therefore needs to recognise and incorporate broad objectives of meeting needs and copying with uncertainties.

As per UNESCO, Sustainable development has four dimensions – society, environment, culture and economy – which are interconnected, not separate. Sustainability is a paradigm of thinking about the future in which environmental, social and economic considerations are balanced in the pursuit of a better quality of life.

The sustainability of a basin is determined by what the river system can do support the long-term ecological and socioeconomic functions of the river basin whole. Five approaches have been identified to describe the stability of systems: Adequate resources, resilience to water hazards, access to water supplies and other services, productive use of water, and fairness among various Users and Generations. Such an approach is used to identify the impacts on addressing stability and impact generators to establish benchmarks, and to identify appropriate targets for improving sustainability.

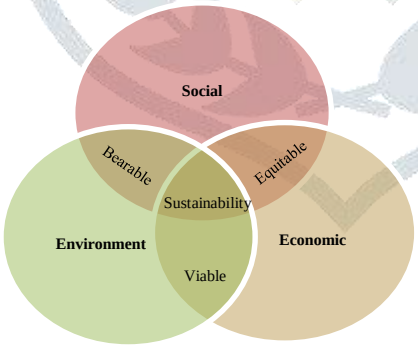


Figure 4 Diagram showing various parameters of sustainable development

1. Social Parameters

The creek can be leveraged for the social benefit of local communities. Enhancing the quality of life of the people through interventions for the upgradation of health, sanitation, public facilities, standard of living and equal opportunity are considered under social. The zone for global transport, open access and common property is socially important and an integrative element in each country's cultures.

2. Economic Parameters

It makes a significant contribution to Human welfare, directly and indirectly, and therefore represents a significant portion of the total economic value of the planet.

i.e. Profit, cost savings, economic growth, research, transportation accessibility.

3. Environmental Parameters

It is important to protect environment at creek side by development process. It has a dynamic zone with frequently changing biological, chemical and geological properties. The zone contains highly productive and biologically diverse ecosystems that provide important nursery habitat for marine species. i.e. natural resources use,

environment management, pollution prevention, prevent and control degradation of land, water and vegetation, improve condition and productivity of degraded areas.

5. STUDY AREA PROFILE

The city of Surat is situated at latitude 21° 12' N and 72° 52' E on the bank of river Tapi having coastline of Arabian Sea is on its west at a distance of about 19.4 km by boat along the Tapi stream about 16 km and by road, along Dumas. It is 13m above the mean sea level. The metropolis is positioned 284 km south of the State capital, Gandhinagar. The city has flat coastal land. It is divided in to nine zones (Central zone, West zone, South zone A, South zone B, South-East zone, South-West zone, North zone, East zone A, East zone B).

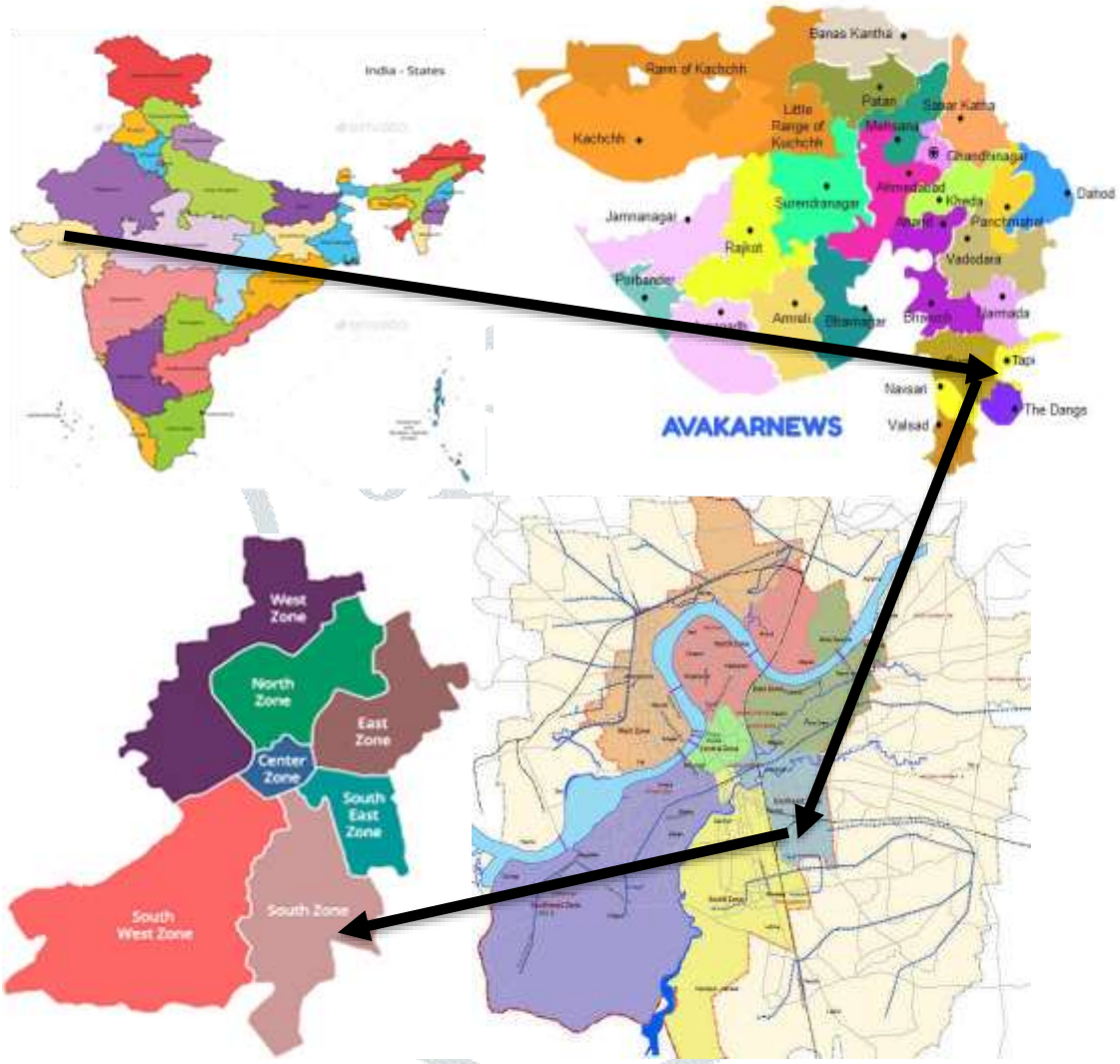


Figure 5 Location of study area

The study area is located in the south zone and it is second largest zone of city with much more amount of industrial development. It is large area which has newly added in to the city limits and still has some developable land parcels if it is does get proper attention towards sustainable planning.

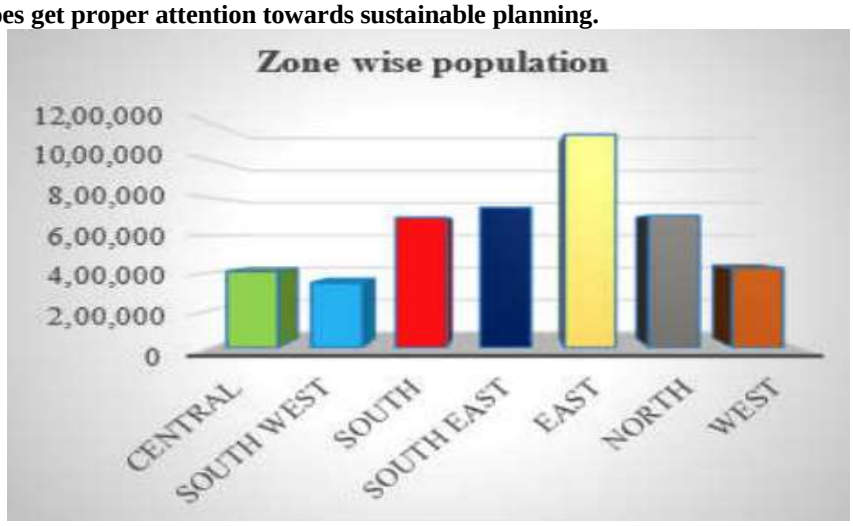


Figure 6 Zone wise Population

Source- Surat Municipal Corporation

Table 1 list of all creek under SMC boundary

Name of Creek	Catchment area (sq.km)	Length from Origin (km)	Length under SMC (km)
Koyali	13.45	8.30	8.30
Mithi	154.05	51.00	11.30
Kankara	226.42	60.00	1.00
Bhedwad	40.50	15.00	11.00
Varachha	85.54	26.51	5.50
Sonari	71.77	21.18	21.18
Khajod	297.92	10.15	-

The river Tapi, a major river of India flows through the northern part of the city and runoff from the catchments in the north parts of the city naturally drains in to the river. The storm water from the Southern part of the Surat, which most of the textile and machinery industries are situated drains in to the three khadis flowing through the city. The koyali and the Mithi khadis- originating in the North-East and flows Westwards and merge near Jivan Jyot cinema in the centre of the city and Thereafter the confluence is called the Kankra khadi. In the South, Bhedwad khadi flows through the heart of the industrial area and meets the Kankra khadi outside the Surat city limits upstream of the Sachin Magadalla Highway near Bamroli village. The Kankra subsequently meets the Mindhola River at its mouth, to the south-west of the Surat city. The Mindhola finally flows in to the gulf of the Khambhat.

6. Data collection and Analysis

As we know creek has very irregular width throughout the its length. In all Four Town Planning Schemes creek has acquired a lot of space, through there is very less flow in the creek except in the monsoon season. The width of creek is studied in four phases according its town planning scheme and taken at every 100 meters chainage. In TPS 62 the top width is vary from 6 meters to 13 meters, so the average comes to be 9.67 meters. Due to encroachments width has been reduced a lot

As we have discussed in previous chapters' creek of Bhedwad has a length of about 11 km from its origin, and the part of the creek passing through the town planning schemes 57, 58, 62 & 72, have experienced partial development on the either side of the banks. Creek is suffering with several problems which are listed below.

(1) Stretch 3 of the creek is having a length of about 3000 mt. and an average width of about 12.38 mt. and has industrial effluents flowing into it. Industrial area of Pandesra is on the eastern side of it means most of the part of creek which starts from its origin have industrial development around it. So the water flowing into it is completely hazardous creating environmental problems.

(2) Stretch 4 with a length of about 2.80 km and average width of 12.03mt. carries the polluted water coming from stretch 1, still there is plenty of vacant land around it. but, due to the odour of the water in the creek less development is there.

(3) On either side of the creek some unauthorized encroachment of slum dwellers is there and they directly throw their solid waste, night soil waste into the creek and thus polluting the water more.

(4) Now due to polluted water the ground water quality has affected and vegetation around the creek is also not possible due to unavailability of proper nutrients to the plants.

(5) Sewage pumping station is located near the creek and it pumps the untreated sewage into the creek.

(6) In the season of monsoon creek also functions as storm water drain for the surrounding area, but due to large amount of water comes into the creek it has a width of about 10.5mt at some sections, and major part of the width is having a shallow depth and thus it does not function for the rest of the year.

(7) The part of the creek at the boundary of both the town planning schemes has such an alignment that it creates some island kind of formation and development of such pockets in proper way is not possible.

Figure 7 Existing scenario of creek

Concept of Planning:

1. Re-sectioning of creek

Creek has a varying width at different sections and so do the section of it though the detail hydrological studies are out of scope but it is clearly seen by inspection the bed width as well as depth and side slope of creek are too much varying at different sections. So, by keeping these issues in mind it is proposed that creeks should be re-sectioned by increasing its cross sectional consequently the area of flow in creek.

2. **Environmental consideration**

At the upstream of creek there is proposal of Effluent treatment plant and its execution have been expected soon. So, the water quality of creek will automatically have upgraded because the waste of industries will be treated before discharging in to the creek, and if the proper monitoring of sewage disposal is done than such waste dumping also can be reduced. So, the water of the creek will be much clean for development of recreational facility around it.

3. **No Construction Belt (NCB)**

The margin of 12mt on the either side of the bank of creek, where no permanent construction will be allowed. Main purpose of this side margin is to have batter control on development around the creek, so encroachments can be avoided In this margin recreational facilities such as gardens have been provided. At some stretches of creek, the duel way cycle track has also proposed so as to have batter transportation links for non-motorised traffic.

4. **Control on Development**

Side margin with No Construction Belt around the creek serve as an open space. The construction in this belt is not permitted, thus the open space can be used for different purpose such as walking or cycling track. Near to gardens. they do provide extra space also.

5. **Recreational Facilities**

In this proposal some facilities such as gardens, walkways, parks and sports facilities are created near to the water body. Large land parcels can be used for such activities and thus providing so revenue generation can also be achieved.

6. **Land Acquisition**

The project area has been delineated so as to maximize utilization of designated government natural water tributary lands. In some places, it seems that land acquisition will be required to maintain the proper geometric shape of the tributary, which will be finalized during a detailed study.

7. **Land Reclamation**

As the proposed delineation of the tributary land has been done for the tributary training project and a separate provision for water carrying of the tributary has also propose, additional land is made available through Reclamation in the tributary area. This recovered land is mostly on the banks of tributaries and needs to be filled with soil for the shape of various tributaries. This reclaimed area provides space for various activities such as buffer zones, cycle tracks / paths etc., if properly developed it can generate good revenue to the authority. The reclaimed land area will be finalized during a detailed study.

Table 2 Average Width and Depth of Creek in TPS 62

No.	Point	Depth(m)	Width(m)	No.	Point	Depth(m)	Width(m)
1	**A**	6.68	6.98	**16**	**P**	4.60	9.98
2	**B**	5.49	7.90	**17**	**Q**	5.63	10.42
3	**C**	5.01	7.46	**18**	**R**	5.93	9.27
4	**D**	5.90	7.58	**19**	**S**	5.79	9.47
5	**E**	4.69	9.69	**20**	**T**	5.74	9.61
6	**F**	4.28	13.66	**21**	**U**	5.68	9.74
7	**G**	3.04	12.19	**22**	**V**	5.40	9.68
8	**H**	4.61	13.33	**23**	**W**	6.48	9.40
9	**I**	5.85	9.85	**24**	**X**	6.64	12.48
10	**J**	4.40	9.40	**25**	**Y**	5.61	9.64
11	**K**	6.20	10.15	**26**	**Z**	5.81	10.01
12	**L**	6.31	10.22	**27**	**a**	5.49	8.99
13	**M**	5.48	9.29	**28**	**b**	4.28	8.69
14	**N**	4.70	9.48	**29**	**c**	4.90	8.49

15	**O**	4.75	9.70	**30**	**d**	5.61	8.28
Average Width							**9.67 m**
Average Depth							**5.40 m**

Table 3 Average Width and Depth of Creek in TPS 57

No.	Point	Depth(m)	Width(m)	No.	Point	Depth(m)	Width(m)
1	**A1**	5.04	9.14	**11**	**K1**	5.47	19.02
2	**B1**	5.25	8.27	**12**	**L1**	6.68	13.68
3	**C1**	5.17	9.56	**13**	**M1**	3.90	10.62
4	**D1**	5.19	11.02	**14**	**N1**	4.23	10.04
5	**E1**	4.94	10.73	**15**	**O1**	6.28	16.20
6	**F1**	4.63	8.69	**16**	**P1**	4.70	16.25
7	**G1**	4.98	11.77	**17**	**Q1**	5.61	14.67
8	**H1**	5.81	12.19	**18**	**R1**	4.18	11.62
9	**I1**	5.48	11.08	**19**	**S1**	4.99	19.98
10	**J1**	5.80	9.43	**20**	**T1**	5.78	10.09
Average Width							**12.25 m**
Average Depth							**5.20 m**

Table 4 Average Width and Depth of Creek in TPS 58

No.	Point	Depth(m)	Width(m)	No.	Point	Depth(m)	Width(m)
1	**A2**	5.90	9.60	**17**	**Q2**	5.75	13.23
2	**B2**	5.40	9.03	**18**	**R2**	4.93	12.37
3	**C2**	4.57	9.65	**19**	**S2**	5.71	13.61
4	**D2**	4.90	11.39	**20**	**T2**	4.63	14.86
5	**E2**	4.81	11.60	**21**	**U2**	5.92	15.46
6	**F2**	4.98	11.96	**22**	**V2**	5.90	13.27
7	**G2**	5.47	13.12	**23**	**W2**	6.29	12.09
8	**H2**	5.95	12.93	**24**	**X2**	4.89	11.86
9	**I2**	5.49	10.83	**25**	**Y2**	4.80	13.13
10	**J2**	6.31	13.73	**26**	**Z2**	5.63	14.56
11	**K2**	5.93	10.13	**27**	**a2**	4.38	15.41
12	**L2**	5.69	12.03	**28**	**b2**	4.99	16.31
13	**M2**	5.25	11.78	**29**	**c2**	6.61	14.50
14	**N2**	5.75	10.47	**30**	**d2**	7.05	10.57
15	**O2**	5.47	14.42	**31**	**e2**	6.15	8.20
16	**P2**	5.81	13.56	**32**	**f2**	7.24	10.48
Average Width							**12.38 m**
Average Depth							**5.58 m**

Table 5 Average Width and Depth of Creek in TPS 72

No.	Point	Depth(m)	Width(m)	No.	Point	Depth(m)	Width(m)
1	**A3**	6.14	10.50	**15**	**O3**	6.25	13.33
2	**B3**	5.49	9.49	**16**	**P3**	5.62	11.98
3	**C3**	6.59	16.64	**17**	**Q3**	6.37	15.01
4	**D3**	5.68	14.64	**18**	**R3**	6.28	13.98
5	**E3**	6.18	12.28	**19**	**S3**	8.84	15.57
6	**F3**	5.44	8.83	**20**	**T3**	8.60	13.33
7	**G3**	5.70	13.39	**21**	**U3**	7.49	5.09
8	**H3**	6.28	15.14	**22**	**V3**	9.19	6.47
9	**I3**	5.90	11.03	**23**	**W3**	6.26	7.86
10	**J3**	5.98	14.46	**24**	**X3**	9.00	5.21
11	**K3**	5.34	21.69	**25**	**Y3**	10.61	11.28
12	**L3**	5.68	11.62	**26**	**Z3**	9.19	13.80
13	**M3**	6.18	15.64	**27**	**a3**	6.04	10.47
14	**N3**	6.41	8.22	**28**	**b3**	7.28	10.01
						Average Width	**12.03 m**
						Average Depth	**6.78 m**

In this proposal the creek's present alignment is not changed but its sectional details have been changed. So, the plots on sides of creek have major change in their shapes and area.

Table 6 Area and details of affected private ownerships plots of TPS No.62 by Re-sectioning

No.	FP No.	Area (Sq.mt)	Cut-off %	New Area (Sq.mt)	Difference
1	92/A	1072.00	-18.27	876.15	-195.85
2	93	1776.00	-21.02	1402.68	-373.32
3	94	1381.00	-8.09	1269.28	-111.72
4	90	13711.00	-17.21	11351.34	-2359.66
5	87/A/1	17203.00	-13.46	14887.48	-2315.52
6	89	10083.00	-7.49	9327.78	-755.22
7	87/B	20110.00	-8.27	18446.90	-1663.10
8	15	24319.00	-3.18	23545.66	-773.34
9	87/C/1	26718.00	-11.24	23714.90	-3003.10
10	102/B	14287.00	-15.38	12089.66	-2197.34
11	104	20942.00	-18.43	17082.39	-3859.61
12	84	9530.00	-14.28	8169.12	-1360.88
13	86	6500.00	-10.09	5844.15	-655.85
14	81	1950.00	-28.4	1396.20	-553.80

15	80	3288.00	-20.98	2598.18	-689.82
16	79	13537.00	-11.24	12015.44	-1521.56
17	82	1404.00	-26.16	1036.71	-367.29
18	83	3354.00	-21.04	2648.32	-705.68
19	92/B	7285.00	-43.00	186.96	-141.04
20	78	22763.00	-9.20	20668.80	-2094.20
21	113	7163.00	-13.36	6206.02	-956.98
22	114	7285.00	-13.68	6288.41	-996.59
23	117	11412.00	-21.43	8966.41	-2445.59
24	5	3353.00	-39.28	2035.94	-1317.06
25	77/B	6808.00	-33.61	4519.83	-2288.17
	Total	**250277**	**-17.91**	**216574.71**	**-33702.29**

As observed in above table there is huge cut-off of 43% in private ownership plots after their final plot allotment.

Area and details of affected reservations plots of TPS No.62 by Re-sectioning

No.	FP No.	Area (Sq.mt)	Cut-off %	New Area (Sq.mt)	Difference	Remarks
1	R-33	790.00	-23.21	606.64	-183.36	Utility
2	R-9	28261.00	-7.49	26144.25	-2116.75	STP
3	R-4	3346.00	-10.25	3003.04	-342.97	Garden
	Total	**32397**	**-13.65**	**29753.92**	**-2643.07**	

After re-sectioning total available area is used as an open space around the creek with considerable rise in overall reservation plot area of TPS 62.

Area of each NCB after Re-sectioning of creek in TPS 62

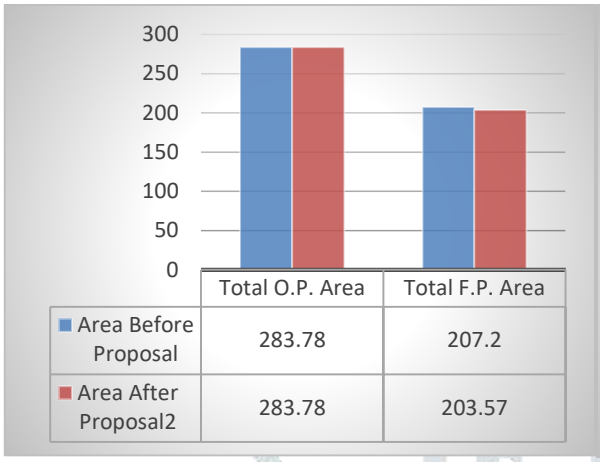
No.	FP No.	Area (Sq.mt)	Remarks
1	EX-1	33702.39	NCB
2	EX-2	2643.07	Open Space
	Total	**36345.29**	

Summary of area for TPS 62 by Re-sectioning of creek

No.	**Particular**	**Area Before Proposal (Hector)**	**Area After Proposal (Hector)**
1.	Total Scheme Area	296.30	296.30
2.	Existing Khadi, Nala	6.97	6.04
3.	Total O.P. Area	283.78	283.78

4.	Total F.P. Area	207.20	203.57
5.	Deduction	76.58	80.21
6.	Total Area of Plots allotted to authority	39.91	43.54
7.	Total Road area	19.21	19.21

This proposal also serves the rise in reservations space, but that is due to NCB and extra reservations plot, but overall TPS is benefitted with vacant land rise.



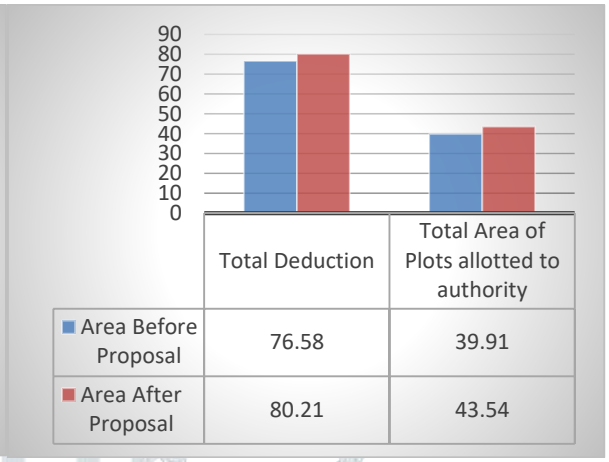


Figure 8 Total OP Area and Total FP Area of TPS 62 (Before/After Proposal Figure 9 Total deduction and Total area of reservations of TPS 62 (Before/After Proposal)

Area and details of affected private ownerships plots of TPS No.58 by Re-sectioning					
No.	**FP No.**	**Area (Sq.mt)**	**Cut-off %**	**New Area (Sq.mt)**	**Difference**
1	100/A	10146.00	-18.68	8250.72	-1895.28
2	99	14681.00	-19.35	11840.64	-2840.36
3	101/B	3960.00	-26.75	2900.79	-1059.21
4	100/B	5656.00	-12.53	4947.35	-708.65
5	119/A	20793.00	-13.13	18062.66	-2730.34
6	116	33497.00	-19.17	27075.79	-6421.21
7	101/C	1236.00	-45.47	674.03	-561.97
8	102/A	2939.00	-22.11	2289.24	-649.76
9	101/A	4260.00	-10.10	3829.89	-430.11
10	103/A	11749.00	-14.51	10044.24	-1704.76
11	98/A	9645.00	-17.01	8004.77	-1640.23
12	78/A	6522.00	-14.53	5574.6	-947.40
13	78/B	3194.00	-9.64	2886.05	-307.95
14	103/C	7370.00	-8.74	6726.06	-643.94
15	104/A	33078.00	-13.68	28552.89	-4525.11
16	76	14508.00	-15.15	12309.75	-2198.25
17	63	16754.00	-5.10	15900.24	-853.76
18	62	7588.00	-4.28	7263.39	-324.61
19	110	5585.00	-3.34	5398.52	-186.48
20	61	18090.00	-5.16	17156.42	-933.58
21	145/A	3449.00	-1.17	3408.49	-40.51

22	111/A	26109.00	-6.05	24528.51	-1580.49
	Total	**260809**	**-13.89**	**227625.04**	**-33183.96**

As observed in above table there is huge cut-off of 45% in private ownership plots after their final plot allotment.

Area and details of affected Reservations Plots of TPS No.58 by Re-sectioning

No.	FP No.	Area (Sq.mt)	Cut-off %	New Area (Sq.mt)	Difference	Remarks
1	166	2802.00	-43.55	1581.6	-1220.4	Garden
2	167	2468.00	-6.09	2317.72	-150.28	Social Infrastructure
3	168	1633.00	-16.80	1358.61	-274.39	Garden
4	176	4842.00	-26.44	3561.54	-1280.46	Garden
5	178	2794.00	-9.88	2517.88	-276.12	Social Infrastructure
6	180	5904.00	-4.50	5638.26	-265.74	Social Infrastructure
7	183	20149.00	-31.13	13875.96	-6273.04	Open Space
	Total	**40592**	**-19.77**	**30851.57**	**-9740.43**	

Area of each NCB after Re-sectioning of creek in TPS 58

No.	FP No.	Area (Sq.mt)	Remarks
1	EX-1	33183.96	NCB
2	EX-2	1345.00	Open Space
3.	EX-3	9740.43	Open Space
	Total	**44268.49**	

Summary of area for TPS 58 by Re-sectioning of creek

No.	**Particular**	**Area Before Proposal (Hector)**	**Area After Proposal (Hector)**
1.	Total Scheme Area	297.35	297.35
2.	Existing Khadi, Nala	20.50	19.23
3.	Total O.P. Area	278.34	278.34
4.	Total F.P. Area	260.80	247.63
5.	Total Deduction	17.54	30.17
6.	Total Area of Plots allotted to authority	30.43	34.43
7.	Total Road area	19.68	19.68

This proposal also serves the rise in reservations space, but that is due to Extra and extra reservations plot, but overall TPS is benefitted with vacant land rise.

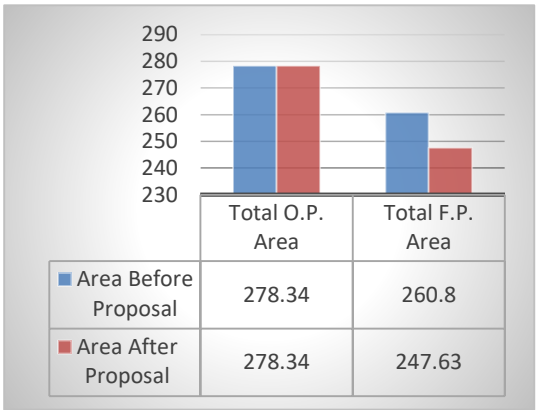


Figure 10 Total OP Area and Total FP Area of TPS 58 (Before/After Proposal)

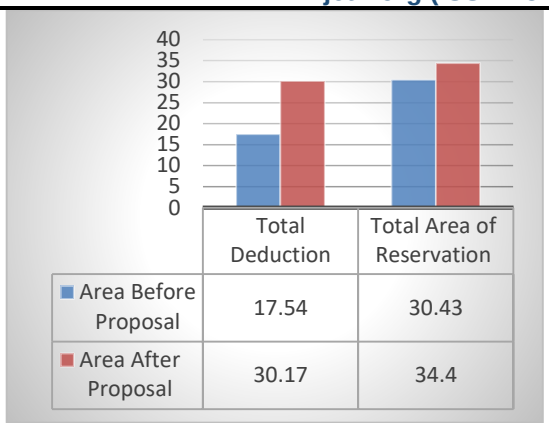


Figure 11 Total Deduction Area and Total Area of reservation of TPS 58 (Before/After Proposal)

Area and details of affected private ownerships plots of TPS No.72 by Re-sectioning					
No.	**FP No.**	**Area (Sq.mt)**	**Cut-off %**	**New Area (Sq.mt)**	**Difference**
1	6	4189.00	13.26	4809.31	620.31
2	7	4006.00	15.69	4634.39	628.39
3	9	1396.00	33.28	1860.58	464.58
4	66/A	84200.00	-40.72	49912.39	-34287.61
5	66/B	24333.00	-34.65	15901.85	-8431.15
6	66/C	44495.00	-38.78	27240.88	-17254.12
7	66/D	16619.00	-12.59	14526.02	-2092.98
8	95	4735.00	25.42	5938.47	1203.47
9	96	4067.00	6.15	4316.98	249.98
10	30/A	1654.00	21.21	2004.81	350.81
11	89	1275.00	7.16	1366.25	91.25
12	90	1274.00	8.45	1381.62	107.62
13	63	18697.00	-24.46	14123.73	-4573.27
14	78/A	7334.00	11.38	8168.6	834.60
15	78/B	4999.00	-17.95	4101.55	-897.45
	Total	**223273**	**-1.81**	**160287.43**	**-62985.57**

As observed in above table there is huge cut-off of 38% in private ownership plots after their final plot allotment.

Area and details of affected Reservations Plots of TPS No.72 by Re-sectioning						
No.	FP No.	Area (Sq.mt)	Cut-off %	New Area (Sq.mt)	Difference	Remarks
1	101	8537.00	8.49	9261.79	724.79	Social Infrastructure
2	104	8408.00	55.00	13302.40	4624.40	Open Space
3	108	2514.00	23.12	3095.23	581.23	Open Space
4	110	30845.00	16.23	35851.14	5006.14	Open Space
5	112	1419.00	-21.38	1115.50	-303.50	Open Space
6	114	2105.00	23.41	2597.78	492.78	Social Infrastructure
7	126	42075	-1.73	41343.50	-731.50	SEWS
8	127	22755.00	10.13	25060.08	2305.08	Open Space

9	134	8480.00	-10.28	7607.76	-872.24	Open Space
	Total	**127138.00**	**11.44**	**139235.16**	**12097.16**	

After re-sectioning, total available area used as an open space around the creek with considerable rise in overall reservation plot area of TPS 72.

Area of each NCB after Re-sectioning of creek in TPS 72			
No.	FP No.	Area (Sq.mt)	Remarks
1	EX-1	4551.01	Open Space
2	EX-2	12097.16	Open Space
3	EX-3	67985.57	NCB

Summary of area for TPS 72 by Re-sectioning of creek			
No.	**Particular**	**Area Before Proposal (Hector)**	**Area After Proposal (Hector)**
1.	Total Scheme Area	172.52	172.52
2.	Existing Khadi, Nala	4.08	3.97
3.	Total O.P. Area	172.52	172.52
4.	Total F.P. Area	105.93	99.13
5.	Total Deduction	66.59	73.39
6.	Total Area of Plots allotted to authority	43.79	45.45
7.	Total Road area	19.21	19.21

This proposal also serves the rise in reservations space, but that is due to NCB and extra reservations plot, but overall TPS is benefitted with vacant land rise.

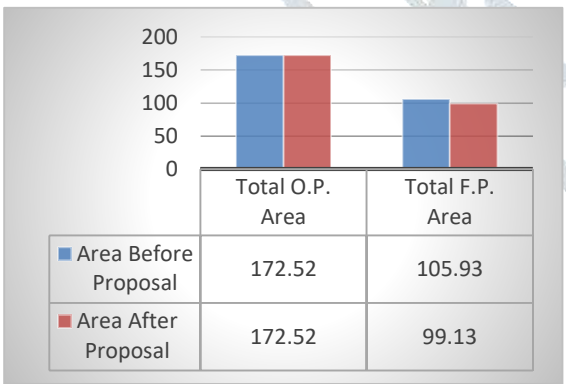


Figure 12 Total OP Area and Total FP Area of TPS 72 (Before/After Proposal)

Figure 13 Total Deduction and Total Area of Reservation of TPS 72 (Before/After Proposal)

Area and details of affected private ownerships plots of TPS No.57 by Re-sectioning					
No.	**FP No.**	**Area (Sq.mt)**	**Cut-off %**	**New Area (Sq.mt)**	**Difference**
1	16/C	35150.00	-7.32	32575.88	-2574.12
2	16/D	29790.00	-3.54	28735.35	-1054.65
3	16/E	21640.00	-6.20	20298.13	-1341.87
4	21/B	15505.00	-25.43	11560.76	-3944.24

5	27	2509.00	-42.30	1447.58	-1061.42
	Total	**104594**	**-16.96**	**94617.70**	**-9976.30**

Area and details of affected reservations plots of TPS No.57 by Re-sectioning

No.	FP No.	Area (Sq.mt)	Cut-off %	New Area (Sq.mt)	Difference	Remarks
1	R-1	3310.00	-30.85	2288.75	-1021.25	Garden
2	R-5	4285.00	-11.96	3772.37	-512.63	Garden
3	R-6	4735.00	-8.93	4312.09	-422.91	Open Space
4	R-9	6820.00	-29.19	4828.85	-1991.15	SEWS
	Total	**19150.00**	**-20.23**	**15202.06**	**-3947.94**	

After re-sectioning total available area is used as a open space around the creek with considerable rise in overall reservation plot area of TPS 57.

Area of each NCB after Re-sectioning of creek in TPS 57

No.	FP No.	Area (Sq.mt)	Remarks
1	EX-1	9976.30	NCB
2	EX-2	3947.94	Open Space
3	EX-3	650.00	Open Space

Summary of area for TPS 57 by Re-sectioning of creek

No.	**Particular**	**Area Before Proposal (Hector)**	**Area After Proposal (Hector)**
1.	Total Scheme Area	82.90	82.90
2.	Existing Khadi, Nala	3.59	3.01
3.	Total O.P. Area	76.98	76.98
4.	Total F.P. Area	63.84	62.38
5.	Total Deduction	13.14	14.60
6.	Total Area of Plots allotted to authority	2.73	2.33
7.	Total Road area	12.34	12.34

This proposal also serves the rise in reservations space, but that is due to NCB and extra reservations plot, but overall TPS is benefitted with vacant land rise.

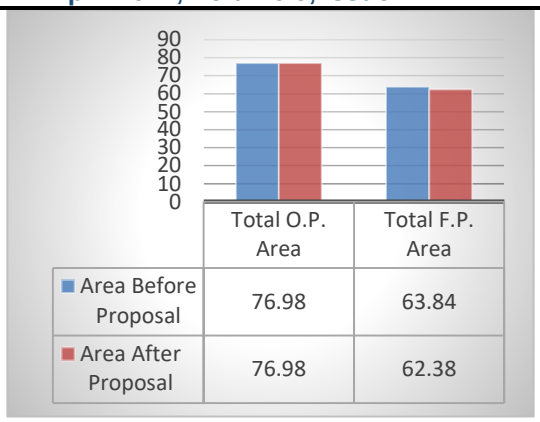


Figure 14 Total OP Area and Total FP Area of TPS 57 (Before/After Proposal)

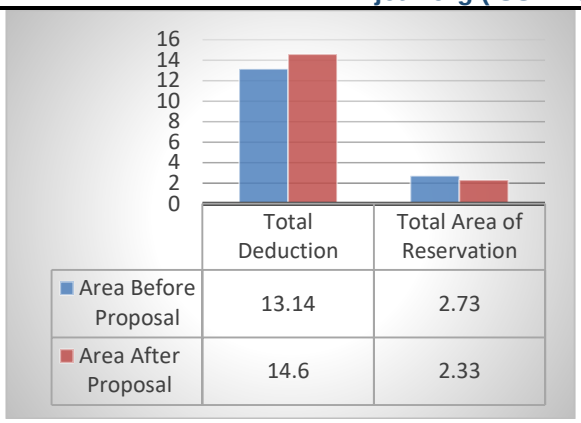


Figure 15 Total Deduction and Total Area of Reservation of TPS 57 (Before/After Proposal)

	After Re-sectioning			Natural	
Chainage	Water Level (m)	Velocity (m/s)	Discharge (cumec)	Water Level (m)	Velocity (m/s)
0	13.368	3.656	83	13.767	3.164
1000	12.216	3.260		12.896	1.127
2000	11.031	2.324		11.116	3.322
2500	10.129	2.279		10.799	1.400
3000	10.436	3.755	225	10.686	0.792
3500	9.981	3.856		10.320	2.368
4000	9.702	3.679		9.802	1.817
4500	9.489	3.450		9.636	1.378
5000	9.059	3.524		9.464	1.158
5500	8.873	3.109	317	9.213	2.913
6000	8.559	3.270		9.115	0.785
6500	8.310	2.990		9.049	1.127
7000	8.219	2.947		9.036	0.738
7500	7.778	2.379		8.727	1.492
8000	7.614	2.294		8.631	0.841
8500	7.501	2.430	342	8.452	1.204
9000	7.346	2.106		8.204	1.497
9500	7.237	2.530		7.837	0.981
10000	7.150	1.912		7.696	1.721
10500	7.061	1.800		7.385	1.919
11000	7.000	1.711		7.000	2.265

7. PROPOSAL

Development proposal without realignment also have tremendous scope for recreational as well as transportation linkages development for non-motorised traffic between various major roads of both TPS.

1. **Working Platform of 0.5 mt wide:**

   In the case of the failure of functioning of creek such as some obstruction to the flow of water some repair work of side slopes etc. This place of 0.5 mt wide strip around the creek is very helpful for such works.

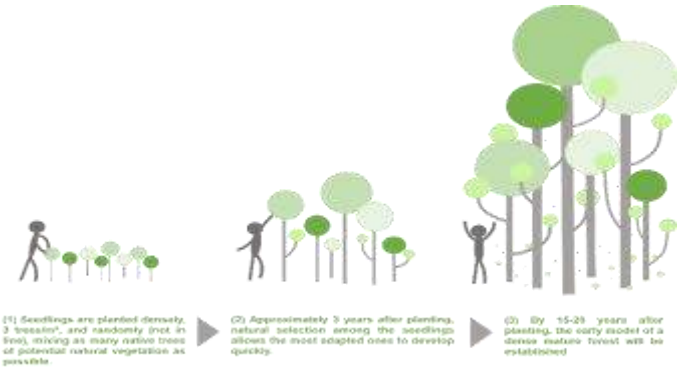
2. **Jogging Track 7.5 mt wide**

   Nicely developed the jogging track on one side of the creek could be a very important place for healthy living and some recreation. 7.5 mt wide strip includes the 3.0 mt cycle track also.

3. **Dense Tree Plantation 2.0 mt wide**

   This space is for thickly vegetation with trees in it providing a green belt type space. Environmentally it is really an important part of proposal. It is provided with thick tree cover can serve benefits of urban forestry to the area.

Mainly the Function of this belt includes biochemical cycles, gas exchange, primary productivity, competition, succession, and regeneration.

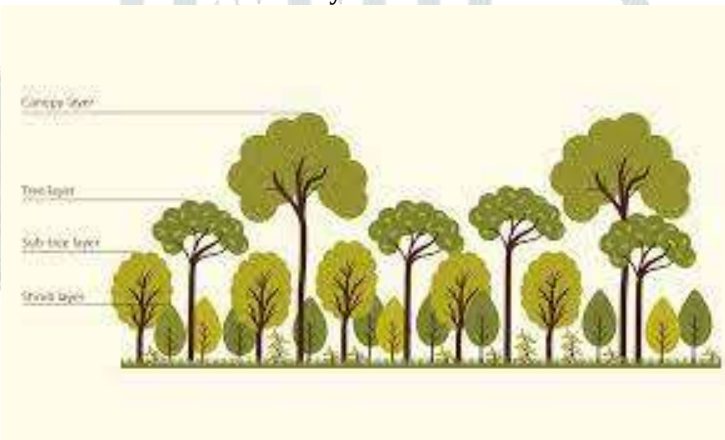


4. **Footpath 2.0 mt wide**

Various junctions of roads of both the TPS are connected by creek, and side margin with 2.0 mt of width could provide a good transportation link between such important roads. The main objective of this is to encourage no motorised traffic use by people. Workers from industrial area, children of schools can have batter environment for their trip, and safety is also achieved because this space will only accommodate slow moving traffic.

5. **Dense Urban Theme Forest**

Reservation spaces of EX-2 of TPS 62 and TPS 57 can be developed as urban forest. This place is very nearer to the main creek. Urban forests play an important role in the ecology of human habitats in many ways. Aside from the beautification of the urban environment, they offer many benefits like impacting climate and the economy while providing shelter to wildlife and recreational area for city dwellers



6. **Differently Abled Park**

Extra Reservation space EX-2 & Ex-3 of TPS 72 merged as a one Plot and can be developed as a park for differently abled people. There are special facilities for children with disabilities, including speech therapists, physiotherapists and vocational training instructors.

7. **Vertical Green Infrastructure**

Rainwater runoff in urban areas is a major cause of water pollution. It carries waste, bacteria, heavy metals and other pollutants through storm sewers into local waterways. Heavy rainstorms can cause flooding that damages property and infrastructure. Green infrastructure could include an open park space outside the city centre, planting a rain garden or building a wetland near a residential housing complex.

8. **Other Structural Proposal**

The innovative filtration system has gone viral for being so simple yet brilliant. The net is placed at the outlet of two drainage pipes, located between residential areas and natural areas. These pollutants allow the net to capture the total pollutants carried by rainwater from the local road network before they are released and pollute the natural environment at the downstream end of the outlet area. Once nets fill up, use a machine to lift them up and empty

them into the truck and headed for a landfill. A large water mill is turned by the flowing river which powers a system of pulleys that turn a large conveyor belt and an array of rakes which help scoop floating debris onto the conveyor belt as trash floats downstream. The trash wheel has 2 long floating buoys which trap garbage that's floating on the surface and funnels it into the mouth of Mr. Trash Wheel. From there it gets carried up the conveyor belt and emptied into a large dumpster. A small crew easily removes and empties the floating dumpsters as they get full.

8. BENEFITS AND CHALLENGES OF CONCEPT

Community has increased understanding about and exercises stewardship towards creek.

Goals of this concept are:

(1) Provide clean water for safe physical contact with creek

(2) Aesthetically pleasing natural green space provide for spiritual experiences.

(3) High property resale value maintained.

(4) Maintain pleasant pedestrian and bicycle recreation and travel.

(5) Maintain and increase diversity and abundance of terrestrial wildlife in watershed.

(6) Bird watching opportunities are maintained or improved.

Negative environmental impacts from development include: increased runoff of rainwater, erosion along the bay, siltation of streams, flooding and habitat destruction through clear cuts. Some rules contradict best practices in environmental management. For example, in order for Americans to comply with the Disability Act, greenways must be paved for wheelchair access, increasing the impermeable surface area. The Residential storm water containing fertilizers, pesticides and motor oil is likely to contribute to the deterioration of water quality and they did not know what they could do to improve the situation. Development in watersheds has led to an increase in population in the area. Thus, an increase in residents means an increase in traffic. More traffic can force the roads to widen, thus increasing impermeable surfaces.

9. CONCLUSION:

The analysis indicates that the project resulted in a comprehensive watershed assessment that identifies potential causes and sources of damage, a concrete watershed management plan with goals, objectives and strategies to address those causes and sources, and a working watershed group to move the plan forward. Too gain sustainable development, demonstrate that it is technically, financially and politically possible under the conditions described in part of land reform, upgradation of water, electricity and transport supply, formation of development corporation etc. Relevant conditions are relatively easy to fulfill due to land improvement and financial viability of the project due to the good condition of the real estate market; The next 20 years should also see substantial improvement in Surat city's infrastructure to make this project possible.

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