PROPOSED ADDITIONS AND EXTENSIONS

to the

SEWER SYSTEM

of the

CITY OF TUCSON, ARIZONA

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by

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PROPOSED ADDITIONS AND EXTENSIONS TO THE SEWER SYSTEM OF THE CITY OF TUCSON, ARIZONA.

INTRODUCTION.

The City of Tucson is located in the west central part of the County of Pima in Arizona and is the county seat of that county. It is considered one of the oldest civilized cities of the United States, ranking favorably with the oldest half-dozen cities. It has been assisted in its founding by the proximity of two very old missions build by early missionary priests, Tumacacori, located about 25 miles, and San Xavier about nine miles south of the present city. Its present position near the Mexican frontier and former relative position within Mexico itself, have each had their own peculiar influence in the final makeup of the city's inhabitants and their customs. Thus it becomes evident that Tucson has been one of those communities that have gone through a long period of varying growth, springing up first as a small Indian Pueblo, then a frontier village, transcontinental railroad town, and finally a very modest and unpretentious railroad and mining city. The result has been that parts of the original component elements still exist more or less distinct and, as yet, not fully incorporated with the truly modern features, and that the present policy of extension and growth savors strongly of conservatism. This one element of cautious, perhaps over-cautious, growth has often brought on the name of Tucson the distinction of being called a "slow town," "dead town" and a few others of
similar ring but that have been applied to condemn results from conditions that have long existed, and further have been so essential in the makeup of the community as to be insep-
able. It does not mean that Tucson is not progressive or that it wishes to remain and trail so far behind as to be completely out of sight, but the inertia under which it necessarily must exist permits only a moderately slow and conservative progress.

The above is given in order that a much clearer understand-
ing may be had why certain conditions exist or can exist under present circumstances. Many conditions exist that, although quite undesirable and even a positive hindrance, are so imposed by circumstances upon this community that they must be outgrown gradually because radical changes cannot be brought about---the inertia is too great---or perhaps better stated, the community is too conservative.

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A. D. M.
THEME.

The present sewer system of the city of Tucson is such as would invite generous extension and improvement from a rather generous hand. The needs of this city have greatly outgrown the facilities that the present system offers. The City Council has passed ordinances to the effect that cesspools are no longer permitted to be built within the city limits, consequently toilet and other connections in the future must be made with the existing system. That part of the city that has been sewered has been thoroughly done, but with the multiplicity of connections and the greater per capita consumption of water from the old services, the old trunk lines are fast becoming taxed to full capacity. There has also been a great extension and growth on all sides of the city so that the old trunk lines are becoming farther and farther away, relatively speaking, from the growing section of town; the result has been that connections are becoming more difficult to make on account of the greater distance, and from this it follows that evasion of the law has been brought about and that private cesspools have been constructed within the city limits. Of course, Building Inspection has tended to eliminate such practices but that is not the remedy for conditions resulting from a sewer system that does not serve the city adequately.

The present water system provides water at the rate of 200 gallons per capita, a rather high figure for an average population of 15,000 or about 3,000,000 gallons every 24 hours.
Measurements over 24 hour periods show sewage discharges that average about 1,900,000 gallons per day, showing that about 60 per cent of the water pumped into the mains finds its way into the sewer lines, giving an average rate of about 120 gallons per capita. Figures based on census reports show an average yearly increase in population of about 10 per cent. Sewer lines proposed at this time are based largely on these figures with provision for over 20 years growth.

The large map of the city shows the extent of the present sewer trunk line system in yellow. Tucson has never had a genuine system of sewage treatment but has depended largely on broad irrigation upon so-called city farm lands acquired on the outskirts of the city for such disposal. An intermittent stream, the Santa Cruz River, although generally dry in the summer, carries water almost through the entire winter, but this is largely flood water from characteristic winter rains and melting snows on nearby mountains. Although the winters here are not at all rigorous, they are cold enough to prevent much cultivation, to such an extent as to make irrigation impractical and unprofitable. It then follows from the last two conditions cited that, in the past, sewage waters have been used very advantageously for irrigation during spring, summer and fall months, but that in winter, they must be largely turned into the Santa Cruz River, especially when carrying flood water. A portion of the water is often run on
to the idle land especially during the mild winter weather in order that it may be fortified for spring.

The only treatment that sewage has received up to the present time is a partial removal of the coarse solids, while the water has been loaded up with as much of the finer material as it could possibly carry. Upon reaching the City Farm, the 16-inch sewer pipe opens into an open concrete rectangular box provided with an inclined bar filter or sieve made up of iron bars, 1" x 3/16" set in a frame about 1 inch apart; this device holds back about 60 per cent of the coarse solids, but the rest goes through to the end of the line notwithstanding a submerged orifice and a siphon, because faeces has about the same specific gravity that water has and is therefore carried in semi-suspension. From the rectangular box it passes through a submerged orifice into an open ditch for a distance of about a half-mile or less, depending on where the water is to be used, to a siphon under the Santa Cruz river bed or to an open ditch built on embankment, so as to have the necessary drop to reach any part of the fields. The water is taken out by open ditches to the more distant points while seepage supplies all the land adjoining this large ditch for a distance from 50 to 100 feet. Coarse solids are found along the entire length even onto the land itself where the water is delivered. The solid matter that is caught upon the iron grating is raked off every so often and thrown into
an open pile nearby where it is allowed to accumulate (and putrify) until enough is collected to make a wagon load, when it is hauled off and sometimes buried.

A few very serious objections are evident at once to this manner of disposal. The above method has been used for a number of years and has been the only one used except, when in previous years, the sewage was turned directly into the Santa Cruz River without any separation whatever---it has really improved. This system of disposal was introduced when that portion of town in which it now finds itself was very much undeveloped or at best, occupied by such a class of people as did not warrant very elaborate hygienic attention, either because it was considered that they would not appreciate it, or else they were not worth the bother. The moral plane of this people has risen somewhat, but the sewerage system has not moved an inch. Truly it may be said that the people occupying that particular portion of town are not on the very highest plane of morals or champion the highest hygienic standards, still it cannot be denied that we cannot afford to ignore them completely. This is a growing community and of as good a class of people or even better, although entirely Mexicans, as that of some other communities which receive greater proportionate care and attention. That this section of town does not receive the proper hygienic attention is shown by the fact that practically every epidemic of
small-pox, typhoid, dysentery and other intestinal diseases has originated in that section and generally has the longest list of deaths; from this part of town the diseases have spread to other sections. But what else is to be expected when right in the midst of the community a pile of faeces from four to six feet high and other dimensions to suit, is allowed to accumulate and putrify for days to the delight of hordes of flies which find their ways into households only 100 feet away. Then too, the half mile or more of open ditch is an endless source of disease and mortality, especially when one considers that it passes within 25 feet of the back door of some houses and further, so arranged that dogs of nearby houses drink the water. There were several times during the past winter that the sewage water was turned directly into the Santa Cruz River when the resulting dilution was no greater than 10. There is no provision for cover anywhere along the entire ditch line except a siphon 150 feet long.

That some very objectionable features of the present sewer system exist which in some cases, are a positive menace to the health and life of the community, needs no further discussion. They cannot be laid off-handly on intentional carelessness of construction or inadequacy of original design, but rather to the fact that the attempt is made to use a sewerage system adequate to the needs of the city some 15 or
20 years ago, but that cannot cope with the present requirements that make extension and improvement imperative.

The first branch of extension to be discussed is that of main trunk sewer lines, they are shown on the large map in yellow. It becomes evident at once that certain parts of the city may be said to be quite thoroughly sewered in so far as trunk lines are concerned, while other parts have no facilities whatever. The older portion of the city, the nucleus around which the rest may be said to have grown and now characterized by the irregular system of streets, and the trapezoidal blocks, has been comparatively well covered by trunk line net, but the larger portion to the north and south are only partially provided for. Many of these sections have hitherto remained so very undeveloped as to really question the necessity of an extensive trunk line system. At present such a large portion of this section has been built up while the sewer system has remained at a standstill, as to make most urgent an immediate extension of the sewer net to take in these outlying districts. In most cases where the present lines may be considered as being inadequate, the method of increasing capacity that should be used is that of putting such new lines as may be necessary to meet the situation and to provide for the connection of future services and auxiliary lines to the new ones, while the old ones now in good service should be left to take care of their territories as
they stand at present. This policy is recommended on the ground that it is quite possible for the present systems not to be necessarily taxed to their limits and can very well take care of that service provided it is not increased. The new lines to be laid are to be such as to take care of the growth for a period of from 15 to 20 years, together with the possible diversion of a few of the services on the old lines that may conveniently be changed. The proposed trunk line extensions are shown in green.

The northern section of town is conspicuously inadequately sewered, there is only one trunk line from Speedway, the present northern city boundary, to Seventh street, that is, on Third street. This is a typical overcrowded sewer that is fast becoming overloaded. This section is being very rapidly built up, but the only outlet for sewer service is through Third street. For this reason a 12-inch trunk line is recommended for First street paralleling Third street to take all of the new services and branches that normally would feed Third street, as well as all possible auxiliary lines that can be diverted from Third street. This line should be kept to itself and run as a combined sewer (to be discussed later) to the Santa Cruz River and through the intercepting trunk lines. For like reasons a 12-inch trunk line sewer is recommended for Fifth street down to Tenth avenue where it should be turned off into the proposed arroyo combined sewer,
(to be discussed later) when running as a storm sewer but emptying into main intercepting line under normal sewerage flow conditions. Such laterals from the trunk line as may be necessary at present with a judicious allowance for growth should be installed with provision for further laterals as occasion may require.

The southern part of the city is divided into two sections, the western half is well covered but the eastern half is not sewered at all. For this reason a trunk line sewer is recommended down Eighteenth, Twentieth and Twenty-second streets extending west through the main intercepting sewer along Twelfth avenue. These are all to be sewers of the combined type, running into an arroyo combined sewer that will empty into the Santa Cruz River. Here too, such laterals are to be installed as the situation would require at the time of construction with due allowance for future growth, but not building such lines as are obviously not needed or will not be for a reasonable length of time, say two or three years. That portion of the present line from the intersection of Main and Sixth streets should be replaced by a 36-inch line, with the necessary provisions for cutting in for present lines that connect with it. This same section should be carried out to the proposed filtration site outside the present city limits.

The past success of the broad irrigation method of
sewage disposal has been such as to warrant the continuation of the same system as far as it may be possible to use it. The results in the past have shown an added productiveness of from 30 to 75 per cent in weight and size of crops as has been applied to barley, alfalfa and some oats although the latter does not thrive as advantageously throughout this section as the two other crops. In carrying out this method of disposal the city has acquired large tracts of land along both sides of the river; it thus becomes apparent that the method of disposal that can be used most advantageously considering all the preparations that have been made, is that of broad irrigation. The barley and alfalfa from these lands has been used for all the stock of the city comprising about 50 head of horses and mules, while the surplus has found a ready local market at a good price. It is doubtful whether any other crops are to be recommended for cultivation according to this system, especially such products as may be put up for direct human use, particularly on account of the natural prejudice to which such products would be subject, notwithstanding the fact that they may be perfectly safe. There is no particular danger of over-production of the crops now under cultivation because of the wide local market which cannot be entirely supplied by local products yet and must depend upon outside shipments to some extent.

The object in sewage water treatment now is to load the
water with as much of the organic matter as possible either in suspension or solution, but the suspended matter must be of a fine and silt like character in order that it may combine readily with the soil and that the plants may have access to it readily. During the transit of the sewage from its source to the end of the sewer outfall, the larger part of the coarse solid sewage is broken up into fine particles, but there still remains as much as from 30 to 40 per cent of the solid content in hard lumps. Only some special method of treatment would render all this matter material fine enough to pass through the screen used, while it becomes highly objectionable to allow it to go through with the liquid. This solid matter hardens readily and refuses to combine with the soil and is consequently of very little use to plants. Some sort of screen becomes necessary and to this end Figure 5 has been submitted; the design is based somewhat on a screen now in use but with a number of features added that should facilitate the handling of the material. The screen is to be made of 1 1/2" x 3/16" bars fastened together like a grate, with bars 1 inch from center to center thus allowing a space of about 3/4" between bars. This screen will hold back all solid lumps of sewage. At definite intervals the screen is drawn up by pulling up the lower end by means of a crank and the material raked into a trough. The bottom of this through is covered with quarter inch or three-eights inch holes so that the excess
water may run out. This material should be hauled out immediately in sheet steel or iron-lined carts and distributed in furrows from 12 to 18 inches deep made with a heavy plow and covered up. These furrows should be made about three feet apart in such plots of land as may be set aside temporarily for that express purpose.

As shown in Figure 2 under the title of "Partial Filtering Arrangement" the sewage is delivered from a 36 inch trunk line into a chamber provided with gates into three other chambers, so that the sewage will divide itself into two or three parts according to the total amount flowing or if one of the sections is being cleaned out or held in reserve. The sewage flow will have slowed up somewhat and will pass through the screen in a steady flow of moderate velocity, from here it passes through a submerged orifice into another chamber provided with wooden scum baffles to hold any of the coarse sewage that may go through the iron bar screen. At the end of this section is another flat bar grate with spaces one-half inch between bars. The space is large enough to allow the finer settling material to go through but narrow enough to hold back all the coarse solids that may have gone through up to this point. The individual flows are then combined into one and led away in a 36 inch pipe to within a reasonable distance of the final point of distribution from where it may run in open ditches onto the
soil where it finally used. Screens should be cleaned periodically according to accumulations, by diverting the flow into two sets of chambers while the third is being cleaned out.

At this time I would recommend the putting through of a project that has been under consideration for a long time: the burying of the present arroyo that flows through the north central part of town from the east side through to the west side. It should be made into a large storm sewer according to Figure 3 but with a tapering section, increasing toward the west. The double compartment barrel is based upon the present section of a double barrelled culvert at the intersection of Stone avenue and Sixth street, which so far has proven fully adequate to meet the needs of the arroyo within the past eight or ten years. Some of the present bridges over this arroyo, for example across Ninth street, Fourth and Stone avenue, and Main street could very well be replaced by reinforced concrete culverts of a section similar to that of Stone avenue, while the intervening sections could be made of brick as shown in Figure 3. The Bridge across on Sixth avenue has very nearly reached the age limit while all the other bridges are wooden structures that will have to be replaced within the course of a very few years, so that no very great actual loss will result from having them replaced by reinforced concrete culverts. An earth cover of from four to six feet over the sewer section would readily distribute any heavy loads
that might come upon it, while the most of the traffic could be required to go over the accustomed street crossings. It is proposed that this section be a combined sewer with an interceptor at right-angles on New street, this interceptor being one of large section and coming from the western side of the south section of town. No heavy construction should be allowed on the course of this new proposed combined sewer.

The recent introduction of paved streets has added a new complication to the problem. The pavement must be washed every so often and the washings must be carried off and disposed of. At the present time streets are washed nightly or every other night by means of a wagon provided with a rotary squeegee cleaner while the small culverts carrying the washings away are flushed with a four-inch fire hose every few nights. In both cases the washings must flow along muddy gutters upon leaving the paved district and sooner or later find their way into the natural drainage gourses that are followed by storm waters. Thus it is that certain street gutters are always muddy and vile smelling. At the present time all the washings of Stone avenue south of Congress street find their way to a storm-water wooden culvert on Meyers street between McCormick and Ochoa streets which flows west to Main street through an open arroyo, then down Main street for a short distance and finally west to the Santa Cruz River. This arroya carries large storm-water flows, draining the
south-central portion of town between Congress and Sixteenth streets, west. The proposed change is to install storm-water inlets on the west sides of street intersections which would open into 12-inch storm water drains flowing from two to four feet below the ground surface just outside gutter line as shown in Figure 4. These storm water lines are to be combined into auxiliary lines which in turn are combined and flow into the main lines shown in red on the large map and having sections according to Figures 9, 10 and 12.

The sections for the proposed lines in the southern portion of town are recommended to Figure 13. are to be combined sewers in order to care of the heavy storm water flows to which this section is subject. Connections with the surface are to be made by means of intakes shown in Figure 4, while the regular sewer service lines connect direct.

A large reinforced concrete storm-water sewer is recommended for Congress street expending from the E. P. & S. W. right-of-way line west to the Santa Cruz River. The section proposed is according to Figure 14. It is to carry only storm water.
CONCLUSION.

The details of the Improvement Act are such as to require the approval of at least a majority of the property owners along some proposed improvement before it can be undertaken by the city. Such a provision is, undoubtedly, a splendid safeguard against extravagant expenditures of money in improvement or the installation of improvements on an extravagant scale, but it has often happened that the individual property owner is prejudiced and blinded by his own petty troubles and loses sight of the greater needs of the outside community. It is true that the property owner must pay the bills for such improvements but he, too, is the one to derive the greatest benefit from such improvements due to the added facilities and greater comfort of his tenants who in turn are willing to pay their share of the expenses arising from such improvements.

It has been conservatively estimated that the proposed set of extensions, improvements and additions would cost from a quarter to a half million dollars, and it would certainly be a long, hard fight with tax-payers before the necessary bonds would be issued to carry out the construction. Complaint would be made on the basis that the proposed changes are not needed, or that human existence is still possible without them. But the pressure would eventually come from within when hygenic conditions are general sewer service
may become such as to cause endless complaint from tenants
dependant upon such services that the property owner and
tax payer will be forced to consent to have the improvements
made as the necessities for them increases. These are the
absolute necessities.

There is another type of changes that often must be
taken up and effected on the basis of civic pride. Circum-
stances for which local inhabitants are not responsible,
may prevent Tucson from ever becoming a really large city;
it does not have the particular natural advantages necessary
for a large scale growth, but there is every reason to
believe that it will become a first class city of moderate
size so that its greatness shall lie in quality rather than
quantity. For this very reason it will be up to Tucson to
undertake improvements of a purely civic nature. Under this
category may come the converting of the present arroyo into
a storm sewer, but which for greater usefulness is recommend-
ed as a combined sewer. It is true that such an improvement
is not an absolute necessity, but the time is coming when
Tucson will not be able to afford to have such an unsightly
forked gash extending through the center of the city and
can better afford to have it covered over. The same may be
said of the old arroyo extending from Meyer street to Main,
through block number 222 and on out to the Santa Cruz River.

The exact value of storm-water sewers is very difficult
to ascertain because, after all, it is a question based on civic values. Just how long Tucson will afford to have streets one-quarter of the width or more, full of storm water on each side every time it rains is a moot question. Good storm-water underground drainage is a feature characteristic of modern communities that have care for the conveniences of their citizens. On the other hand storm-water flows help to flush out the entire sewerage system by sending full capacity discharges through the entire system that do not have to be treated and may be turned directly into the Santa Cruz River. Such storm waters would not carry as much heavy sediment and debris as is found in the surface flows because the heavy loads are due to high velocities but these high velocities are due to long flows on high grades. With a system of storm water intakes that would not allow the storm waters to flow more than a block on the surface, the velocity would be kept low until the sewer drain is reached, after that it could obtain any suitable velocity according to grade but there would be no opportunity to gather up additional heavy loads of sediment, on the contrary, the high velocities in the sewer would keep it scoured out and prevent choking of the lines.

So that just when it will pay Tucson to have a system of storm-water sewers is yet to be seen, but eventually it will pay.
HOURLY SEWAGE DISCHARGE CURVE

CITY OF TUCSON, ARIZ.

MAY 12, 1938, A.M.

MAY 13, A.M.
Fig. No. 4

STORM-WATER INLET.

METCALF & EDDY.
Fig. No. 5.

GRATING FOR FILTRATION APPARATUS.
Fig. No. 6.

TURNOUT FROM COMBINED SEWER.
FIG. NO. 9.

STORM SEWER FOR FRANKLIN ST.
Fig. No. 10.
STORM SEWER FOR ALAMEDA ST.
Fig. No. 11.

TURNOUT FROM COMBINED SEWER.