GROUNDWATER DEVELOPMENT FOR PORTABLE WATER SUPPLY

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Abstract— Groundwater hydrology may be defined as the science of the occurrence distribution, and movement of water below the surface of the earth. Geohydrology has an identical connotation, and hydrogeology differs only by its greater emphasis on geology. Utilization of groundwater dates from ancient times, although an understanding of the occurrence and movement of subsurface water as part of the hydrologic cycle has come only relatively recently. SCOPE: Groundwater referred to without specification is commonly understood to mean water occupying all the voids within geologic stratum. No rigid demarcation of water between the two zones is possible, for they possess an interdependent boundary and water can move from owe zone to the other in either direction. The interrelationships are described more in some higher hydrogeology texts.

Keywords: Ground water, Wells, Ground water quality.

I. INTRODUCTION

Groundwater is fresh water (from rain or melting ice and snow) that soaks into the soil and is stored in the tiny spaces (pores) between rocks and particles of soil. Groundwater accounts for nearly 95 percent of the nation's fresh water resources. It can stay underground for hundreds of thousands of years, or it can come to the surface and help Fill Rivers, streams, lakes, ponds, and wetlands. Groundwater can also come to the surface as a spring or be pumped from a well. Both of these are common ways we get groundwater to drink. About 50 percent of our municipal, domestic, and agricultural water supply is groundwater. Groundwater is an important source of drinking water for humankind. It contains over 90% of the fresh water resources and is an important reserve of good quality water and it is also used for agricultural, industrial, household, recreational and environmental activities all over the world. In the last few decades, the ground water potential and its quality level in major cities and urban center's is getting deteriorated due to the population explosion, urbanization, industrialization and also the failure of monsoon and improper management of rain water. The chemical composition of groundwater is a measure of its suitability as a source of water for human and animal consumption, irrigation, and for industrial and other purposes.

II. LITERATURE REVIEW

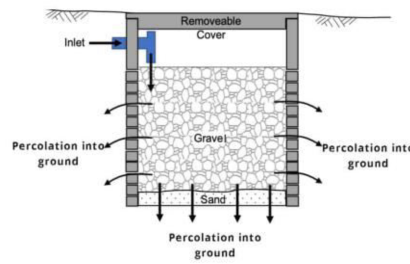
- EARLIER WORKS ON GROUNDWATER DEVELOPMENTS Dr. Rajat Kumar, IAS (2019-2020) The State Level Committee (SLC) held its meeting for Re-Estimation of Ground Water Resources as on March, 2020 on 08/06/202lat 11:30 hrs. on virtual mode to discuss and approve the "Dynamic Ground Water Resources computed for Telangana State for the year 2019-20" under the Chairmanship of Dr. Rajat Kumar, IAS, the Special Chief Secretary, (I & CAD), Govt of Telangana. Shri G. Krishnamurthy (2015) At the outset, Shri G. Krishnamurthy, Head of Office, CGWB; SR & Member Secretary welcomed the Chairman and Members to the meeting and briefed on the Re-Estimation of Ground Water Resource in Telangana, which was carried out based on GEC Methodology, 2015 and thanked all the line Departments for providing the required data well in time and requested the Chair to take up further proceedings of the meeting. The Spl. Chief Secretary, I & CAD & Chairman of the SLC, while giving introductory remarks mentioned that average groundwater level in the State had increased by more than 3 meters in the last five years and rise is observed in 93 % of sandals as compared to last decadal water levels, which is highest in the country. He also informed that the Government of India has appreciated the efforts of the state government in raising water table. The water levels are increased due to multipronged efforts made by the State

- Government. These efforts include: de- siltation of more than 26700 tanks under "Mission Kakatiya", lifting of water through "Kaleshwaram Lift Irrigation Project" (KLIP) in to canals and filling of chain of tanks at regular interval, construction of 638 check dams and 138 recharge shafts etc. Further, he directed all officials of the Dept to continue their efforts and ensure that Telangana become a model state in the area of water conservation and management. Dr. Pandith Madhnure (2020) The Director, Ground Water Department, Dr. Pandith Madhnure, briefed about salient features of State and the Government efforts towards improving groundwater scenario in the last 5 years. He further informed that, there is an increase in shallow water table area during 2020 as compared to last decade from 33 % to 48 to and from 66 % to 92 la of states geographical area during pre- and post-monsoon season respectively. He further informed that overall groundwater in the state is suitable for irrigation and for drinking purposes except from few pockets, were either fluoride, a geogenic contaminant or nitrate, an anthropogenic contaminant is beyond maximum permissible limits of BIS. He further directed his Dy. Director and in-charge GEC Cell to present salient features of GEC-2020. Shri P. Jyothi Kumar (2017) Shri P. Jyothi Kumar, Dy. Director, GWD briefed the committee on methodology adopted for GEC computations and made a detailed presentation. The total annual extractable groundwater resources are 15128 MCM, which is 22 to more in comparison to 2017 estimates. The total groundwater extraction for all uses is 7676 MCM which is 69c less than 2017 and the stage of groundwater extraction is 51 %, which is 14 % lesser than the previous assessment (2017). During the present assessment, about 70 % watersheds, 64 9r mandals & 93 to villages fall in safe category

III. METHODOLOGY

WATER BODIES A body of water or waterbody (often spelled water body) is any significant accumulation of water on the surface of Earth or another planet. The term most often refers to oceans, seas, and lakes, but it includes smaller pools of water such as ponds, wetlands, or more rarely, puddles. A body of water does not have to be still or contained; rivers, streams, canals, and other geographical features where water moves from one place to another are also considered bodies of water. Most are naturally occurring geographical features, but some are artificial. There are types that can be either. For example, most reservoirs are created by engineering dams, but some natural lakes are used as reservoirs. Similarly, most harbors are naturally occurring bays, but some harbors have been created through construction. Bodies of water that are navigable are known as waterways. Some bodies of water collect and move water, such as rivers and streams, and others primarily hold water, such as lakes and oceans. Bodies of water are affected by gravity, which is what creates the tidal effects on Earth. Examples of water bodies Laknavaram Cheruvu. Pakhal Lake. Hussain Sagar Lake. Ramappa Lake. Laknavaram Lake. Ali Sagar Reservoir. 3.1.2 RAIN WATER Rainwater is typically devoid of all dissolved solids but contains dissolved gases GROUNDWATER DEVELOPMENT FOR PORTABLE WATER SUPPLY 19 (oxides of carbon, nitrogen and sulphur) which result in pH values of about 5.5 or lower. In coastal areas rainwater may also contain up to 15 mg/l of sodium chloride from seaspray. Rainwater is therefore devoid of alkalinity; it is acidic (low pH), low in mineral content and aggressive towards calcium bearing materials such as concrete and some of the metals typically used in domestic plumbing. The presence of chlorides exacerbates corrosivity. Rainwater is also unpalatable in taste, again due to the low solids content. The roof surfaces over which the rain is collected should be made of materials from which no undesirable compounds may be dissolved or leached if rainwater is intended for human consumption; examples are lead flashings and bituminous roof material. RAIN WATER HARVESTING PITS Concept of rainwater harvesting lies in: 1.Tapping the rainwater from where it falls 2.Techniques of rainwater harvesting involve Catch the rainwater from localized catchment surfaces such as roof of a house, plain and sloping ground surfaces etc. It is easy process to collect Rainwater and diverted into ponds, vessels or underground tanks to store for longer periods and to recharge by construction of RWH Structures in a suitable site RAINWATER HARVESTING IS IN TWO WAYS DIRECT USE: The process of collecting and storing the rainwater by construction of sump through filters for future productive use and ARTIFICIAL RECHARGE TO GROUNDWATER: Recharge the rainwater in a scientifically planned way by construction of rain / roof top water harvesting structures to augment the groundwater.

SOAK PITS A soak pit is essentially a hole designed with the purpose of allowing this excess waste water to infiltrate into the ground. These are used for the discharge of domestic and industrial waste water. Groundwater is one of the most precious natural resources that needs to be protected from deterioration. Seepage of industrial and extensive pumping has caused serious qualitative and quantitative problems in the aquifer. The final effluents from the industry can't be sent to the recycle or reuse purpose neither they can be discharged to open atmosphere and hence are discharged in a confined and more isolated place from the atmosphere like in soak pits advantage being they even act as filtration mediums. At some places, where there are no waste drains, industrial effluents are discharged directly into the groundwater, through an excavation in the soil serving as a soak pit, causing direct pollution of groundwater. The effluent water percolates into the surrounding soil. An industrial effluent with high Cr6+and CN- has spread vertically2 and laterally and contaminate the groundwater, which is the major source of domestic water supply. 3.4.1. ADVANTAGES ¬ Can be built and repaired with locally available materials ¬ Technique simple to apply for all users ¬ Small land area is required ¬ Low capital costs; low operating costs ¬ Recharging groundwater bodies 3.4.2 DISADVANTAGES ¬ Primary treatment is required to prevent clogging ¬ May negatively affect soil and groundwater properties Applicable only where soil conditions allow infiltration, the groundwater table is at least 1.5 m below the soak pit, there is no risk for flooding and any water well is in a distance of at least 30 m ¬ Difficult to realize in cold climate ¬ Should be avoided for high daily volumes of discharged effluents



ANALYSIS OF WATER LEVELS

The ground water levels observed over a period of time provide valuable information on behavior of the ground water regime, which is constantly subjected to changes due to recharge and discharge phenomena. Balance between recharge and discharge results in decline or rise in the ground water storage. When the recharge exceeds discharge there will be a rise in the ground water storage and vice versa. The decline in water level may be due to increase in draft (for different purposes) or decrease in precipitation (less recharge to ground water). On the other hand, a rise in water level may be due to an increase in rainfall and/or due to changes in irrigation practices. The dug wells are tapping the phreatic aquifer, mostly limited to a depth of 20 m. The depth of piezometers which are tapping both the phreatic and deeper aquifers varies from 20 to 100 m. Hence the water level recorded in the piezometers may not be the same as that of dug wells for a particular period though both the structures are in the same place.

In this report the water level data collected from shallow aquifers (tapping weathered zone and first fracture zone) are presented in detail. Water levels tapping deeper fractures are discussed separately. The data from GWMS for the year 2019-20 was analyzed and for every set of measurements, write up and maps were prepared and are presented here under various paragraphs. The purpose of water level data analysis is

i) Four measurements of depth to water level give an overall idea regarding the ground water level in the state during the year of measurement.

ii) The fluctuation in comparison to the same month in the previous year gives an idea about the change in the ground water level for a particular period with respect to that of the level during the same month in the previous year. This gives an idea about the change in the amount of draft and rainfall between the two years.

iii) The water level fluctuation during the pre-monsoon period in comparison to previous year gives an idea about the seasonal fluctuation, which ultimately reflects the change in dynamic ground water resources.

QUALITY OF GROUND WATER FOR DRINKING PURPOSE

The hydro chemical data is compared with the drinking water quality standards set by Bureau of Indian Standards (BIS) to assess the suitability of ground water from shallow aquifers in Telangana, for drinking purposes. The suitability of the ground water samples collected from shallow aquifers for drinking purposes with reference to chemical parameters is presented in Table 4.

5.2 % of samples in the state are beyond permissible limit of BIS with respect to Total Dissolved Solids (TDS). Highest percent of samples in Nalgonda (9.8%), Khammam (8.3%) and Medak (7.0%) districts are unsuitable for drinking with respect to TDS. Chloride Content in 2.3% of samples in the state exceeds the BIS permissibility. The Nitrate content in 43.7% of samples in the state is exceeding the BIS permissible value indicating the anthropogenic

SEARCHING/EXPLORATION OF GROUNDWATER

Although groundwater cannot be seen on the earth is surface, a variety of techniques can provide information. Concerning it's occurrence and under certain condition even its quality from surface or above surface locations. Surface investigation or exploration of groundwater is seldom more than partially successfully in that results usually leave the hydrogeology picture incomplete. However, such methods are normally less costly than subsurface investigations. Geologic methods, involving interpretation of geologic data and field reconnaissance. Represent an important first step in any groundwater investigation. Remote sensing from aircraft or satellite has become an increasing valuable tool for understanding subsurface water conditions. Finally geophysical techniques, especially electric resistively and seismic retraction method.

METHODS OF GROUNDWATER EXPLORATION

GEOLOGIC METHOD

Geologic studies enable large areas to be rapidly and economically appraised on a preliminary basis as to their potential for groundwater development. A geologic investigation/exploration begins with the collection, analysis and hydrogeology interpretation of existing topographic maps, aerial photographic, geologic maps and logs and other pertinent records. This should be supplemented when possible, by geologic field reconnaissance and by evaluation of available hydrologic data on, stream flow and springs, well yields, groundwater recharge, discharge and levels and water quality. Such an approach should be regarded as a first step in any investigation of subsurface water because no expensive equipment is required, furthermore, information on geologic composition and structure defines the need for field exploration by other methods.

REMOTE SENSING METHOD

Photographs of the earth taken from aircraft or satelite at various electromagnetic wavelength ranges can provide useful information regarding groundwater conditions. The technology of remote sensing has developed rapidly in recent years, while its applications to water resources are still being discovered. Furthermore the ready availability of photographs from commercial firms and government agencies has stimulated their use.

Stereoscopic examination of black and white aerial photograph has gained steadily in importance. Observable patterns colour relief make it possible to distinguish differences in geology, soil moisture, vegetation and land use.

Aerial photographs also reveal fracture patterns in rocks can be related to porosity, permeability, and ultimately well yield springs and marshy areas indicate relatively shallow depth groundwater.

GEOPHYSICAL EXPLORATION

This is the scientific measurement of physical properties of the earth's crust for investigation of mineral deposits of geologic structure. With the discovery of oil by geophysical methods in 1926. Economic pressure for locating petroleum and mineral deposits stimulated the development and improvement of many geophysical methods and equipment. Application of groundwater investigations was slow because the commercial value of oil over shadows that of water.

In recent years, however, refinement of geophysical techniques as well as an increasing recognition of the advantages of the method for groundwater study has changed the situation. Today many organizations concerned with groundwater employ geophysical methods.

The methods are frequently in exact or difficult to interpret, and they are most useful when supplemented by sub surface investigations.

Geophysical method detects differences, or anomalies, of physical properties within the earth's crust. Density, magnetism, electricity and electrical sensitivities are properties most commonly measured.

METHOD FOR DRILLING SHALLOW WELLS

Shallow wells, generally less than 15m in depth, are constructed by digging luring, driving or jetting.

DUG WELLS

Dating from biblical times, dug wells have furnished countless water suppliers through the world. Depth range up to 20m or more, depending on the position of the water table, while diameters are usually 1 to 10m. Dug wells can yield relatively large quantities of water from shallow sources and are most extensively employed for individual water supplies in areas containing unconsolidated glacial alluvial deposits. Their large diameters permit storage of considerable quantities of water if the wells extend some distance below water table.

In the past all dug wells are excavated by hand, and even today the same method is widely employed. A typical dug well in under developed portions of the world is often no more than an irregular hole in the ground that interacts the water tale. Pick and shovel are the basic implements. Lose materials are hauled to the surface a container by means of suitable pulleys caving, lining (or cribbing) of wood or sheet piling should be placed in the hole to brace the walls.

BORE WELLS

Where a water table exists at a shallow depth in an unconsolidated aquifer bored wells can furnish small quantities of water at minimum cost. Bore wells are constructed with hand operated or power driven earth augers. Hand augers are available in several shapes and sizes, all operating with cutting blades at the bottom that bore into the ground with a rotary motion. When the blades are full of loose earth, the auger is removed from the hole and emptied the operation is repeated until the desired hole depth is reached. Power – driven augers will boreholes up to 1m in diameter and under favourable conditions, to depths exceeding 30m. The auger consists of cylindrical steel bucket with a cutting edge projecting from a slot in the bottom. The bucket is filled by rotating it in the hole by a drive shaft of adjustable length. When full the auger is hoisted to the surface and the excavated material is removed through hinged openings on the side or bottom of the bucket. Reamers attached to the top of the bucket can enlarge holes to diameters exceeding the auger size.

DRIVEN WELLS

A driven well consist of a series of connected lengths of pipe driven by repeated impacts into the ground to below the water table. Water enters the well through a drive (or sand) at the lower end of the well. This consist of a scream cylindrical section protected during driving by a steel cone at the bottom are small, most falling in the ratio of 3 to 10cm. Standard weight water pipe having threatened coupling serves for casing. Most depths are less than 15m although a few exceed 20m.

Driven wells are best suited for domestic supplies, for temporary water supplies, and for exploration and observation. Batteries of driven wells connected by a suction header to a single pump and effective for localize lowering of the water table. Such installations are known as well – point systems. Driven wells are limited to unconsolidated formations containing no large gravel or rock that might damage the drive point. The drive a well, the pipe casing and threads should be protected at the top with a drive cap. Driving can be made by or wt a manledge, drop hammer, or air hammer. It is usually good practice to place (by boring or driving) an outer protective casing to at least 3m below ground surface.

Important advantages of driven wells are that they can be

a. Constructed in a short time
b. At minimum cost and
c. Even by one person

JETTED WELLS

Jetted wells are constructed by the cutting action of a downward directed stream of water. The high velocity stream washes the earth away while the casing, which is lowered into the deep entire hole, conducts the water and outings up and out of the well small hole of 3 to 10cm are formed in this manner (although the method is capable of producing diameters up to 30cm or more) to depths greater than 15m. Jetted wells have only small yields and are best adapted to unconsolidated formations. Because of the speed of jetting a well and the portability of the equipment, jetted wells are useful for exploratory test holes, observation well and well point systems.

METHODS FOR DRILLING DEEP WELLS

Most large, deep, high capacity wells are constructed by drilling construction can be accomplished by the cable tool method or by one of several rotary methods. Each methods has particular advantages, so experienced chillers endeavour to have equipment available for a diversity of drilling approaches. Construction methods differ regionally within the United States and also from one driller to another. General construction methods are described in the following sections.

AIR ROTARY METHOD

Rotary drilling can also be accomplished with compressed air in place of drilling mud. The techniques is rapid and convenient for small diameter holes in consolidated formation where a clay hiring ie unnecessary to support the walls against caving. Drilling condition depth can exceed 150m under favourable circumstances. An important advantage of the air rotary method is its ability to dully through fissured rock formations with little or no water required.

ROTARY PERCUSSION METHOD

A recently developed rotary percussion procedure using air as the drilling fluid provides the fastest method for drilling in hard rock formations. A rotating bit, with the action of pneumatic hammer, delivers 10 to 15 impacts per second to the bottom of the hole: penetration rate of much 0.3m/min have been archived. Where coving formations or large quantities of water are encountered, a change to conventional rotary drilling with mud usually becomes necessary.

COMPLETION OF WELLS

After a well has been drilled, it must be completed. This can involve placement of casing, cementing of casing, placement of well screens, and gravel packing, however, wells in hard rock formations can be left as open holes so that these components may not be required.

WELL CASINGS

Well casing serves as a lining to maintain an open hole from ground surface to the aquifer. It seals out surface water and any undesirable groundwater and also provides structural support against caving materials outside the well. Materials commonly employed for well casing are wrought iron, alloyed or unalloyed steel, and ingot iron. Joints normally consist of threaded couplings or are welted, the object being t o secure water tightness.

CEMENTING

Wells are cemented in the annualar space surrounding the casing to prevent entrance of water of unsatisfactory quality to protect the casing against exterior corrosion and/or to stabilize caving rock formations. Cement grout, consisting of a mixture of cement and water and sometimes various additives, can be placed by a pump bailer, by a tremie pipe, or by pumping. It is important that the grout be introduced at the bottom of the space to be grouted to ensure that the zone is properly sealed.

SCREENS

In consolidated formations, where the material surrounding the well is stable, groundwater can enter directly into an uncased well. In unconsolidated formations, however, wells are equipped with screens.

These stabilize the sides of the hole, prevent sand movement into the well and allow a maximum amount of water to enter the well with a minimum of hydraulic resistance.

Screens are made of a variety of metals and metal alloys, plastics concrete, asbestos cement, fibre glass reinforced epoxy, coated base metals and wood. Because a well screen is particularly susceptible to corrosions and incrustation, nonferrous metals alloys and plastics are often selected to prolong well life and efficient operation.

WELL DEVELOPMENT

Following completion: a new well is developed to increase its specific capacity, prevent sanding and obtain maximum economic w ell life. These results are accomplished by removing the finer material from the natural formations surrounding the perforated sections of the casing. Where a well has been gravel packed, much of the same purpose has been accomplished, although development is still beneficial. The importance of developing wells cannot be under estimated all too often development is not carried out adequately to produce full potential yields.

Development procedures are varied and include pumping, surging, use of compressed air, hydraulic getting, and addition of chemicals, hydraulic fracturing and use of explosives. These are briefly described in subsequent paragraphs.

PUMPING

This procedure involves pumping a well in a series of steps from a low discharge to one exceeding the design capacity. To be more effective the intake area of the pump should extend to near the centre of the screened section. At each step the well is pumped until it clears after which the power is shut off and water in the pump column surges back in to the well. The step is repeated until only clear water appears. The discharge rate is than increased and the procedure repeated until the final rate is the maximum capacity of the pump or well. The coarser fraction entering the well is removed by a boiler or sand pump from the bottom. This development method of by pumping is recommended as a finishing procedure after any of the development techniques described subsequently.

SURGING

Another method for developing a well is by the up and down motion of a surge block attached to the bottom of a drill stem. Such blocks are particularly applicable with a cable tool rig. Solid, vented and spring loaded surge blocks, often constructed by well drilling contractors, are employed. The cylindrical block is 2 to 5cm smaller than the well screen and fitted with belting rubber leather that will not damage the screen; as the block is moved up and down in the screen a surging action is imparted to them. The down stroke causes back wash to break up any bridging that may occur, while the upstroke pulls dislodged sand gram in the well.

EXPLOSIVES

Donation of explosives in rock wells often increases yields by enlarging the hole, increasing rock fractures, and removing fine grained deposits on the face of the well bore.

PROTECTION OF WELLS

Sanitary Protection: Wherever groundwater pumped from a well is in tended for human consumption proper sanitary precaution must be taken to protect the water quality, pollution sources may exist either above or below ground surface.

Surface pollution can either enter the well through the annular space outside of the casing or through the top of the well its self to prevent foreign bodies from entering the well or undesirable water outside the casing, the annular space should be filled with cement grout for deep well water light should be provided to avoid the entrance of undesirable material from entering the well.

FOST PROTECTION: In regions where winfer frost occurs, it is important to protect pumps and water lines from freezing. The pitless Adapter, attached to the well casing, provides access to the well, while the discharge pipe runs about 2m underground to the basement of the house.

Abandonment of Wells: Whenever a well is abandoned, for whatever reason, it should be sealed by filling it with clay, concrete or earth. Not only is surface contamination them unable to enter the well, but sealing serves other useful purposes, prevents accidents, avoids possible movement of inferior water from one aquifer to another and conserves water in flowing wells.

5.3 WELL REHABILITATION

A well, properly drilled, cased, and developed, will little attention. Many wells fail, however, that is the yield decreasing quantities of water with time, well rehabilitation refers to the treatment of a production well by mechanical, chemical or other means to recover as much as possible of the cost production capacity.

One cause of failure is depletion of ground supply, not a fault of the well, this trouble can sometimes be remedied by decreasing pumping drafts, resetting the pump, or deepening the well.

A second cause of well trouble results from faulty well construction, such items as poor casing connections, improper perforations or screens, incomplete placement of gravel packs, and poorly seated wells are typical of difficulties encountered.

Depending on the particular situation as determined from a television or photographic survey of the well it may be possible to repair the well, but sudden failures involving entrance of sand or collapse of a casing often requires replacement of the entire well.

The third and the most prevalent cause of well failure results from corrosion or incrustation of well screen. Corrosion may result from direct chemical action of the groundwater or from electrolytic action caused by the presence of two different metals in the well. The effects of corrosion can be minimized by selecting nonmetallic well screens or one of corrosion resistant metal (such as nickel, copper, or stainless steel) and by providing cathodic protection.

RESULTS

YEAR	POPULATION (IN MILLIONS)	INCREASE IN POPULATION (x)
2018	35.5	-
2019	36.6	1.2
2020	37.8	1.2
2021	38.47	0.67
2022	40.01	1.54

POPULATION STATISTICS (2018-22)

CONCLUSION

Ground water development can be taken by various means like Rainwater Harvesting, Soak Pits, Longitudinal, Afforestation, Deep wells etc., ¬ It will improve Water Table and yielding of Ground water at various places, detailed study has been carried out in Various places of Telangana State and which are illustrated in above paragraphs. ¬ However, to meet Potable water requirements, water samples have been tested at various places collected from Ground water in Telangana which are meeting the required standards ¬ To meet potable water requirements in future based on population growth and demand , we need to still work on extensively to identify various methods for better implementation

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